# Geothermal Project Risk & Financing


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**Mannvit Kft, Arctic Green Energy**


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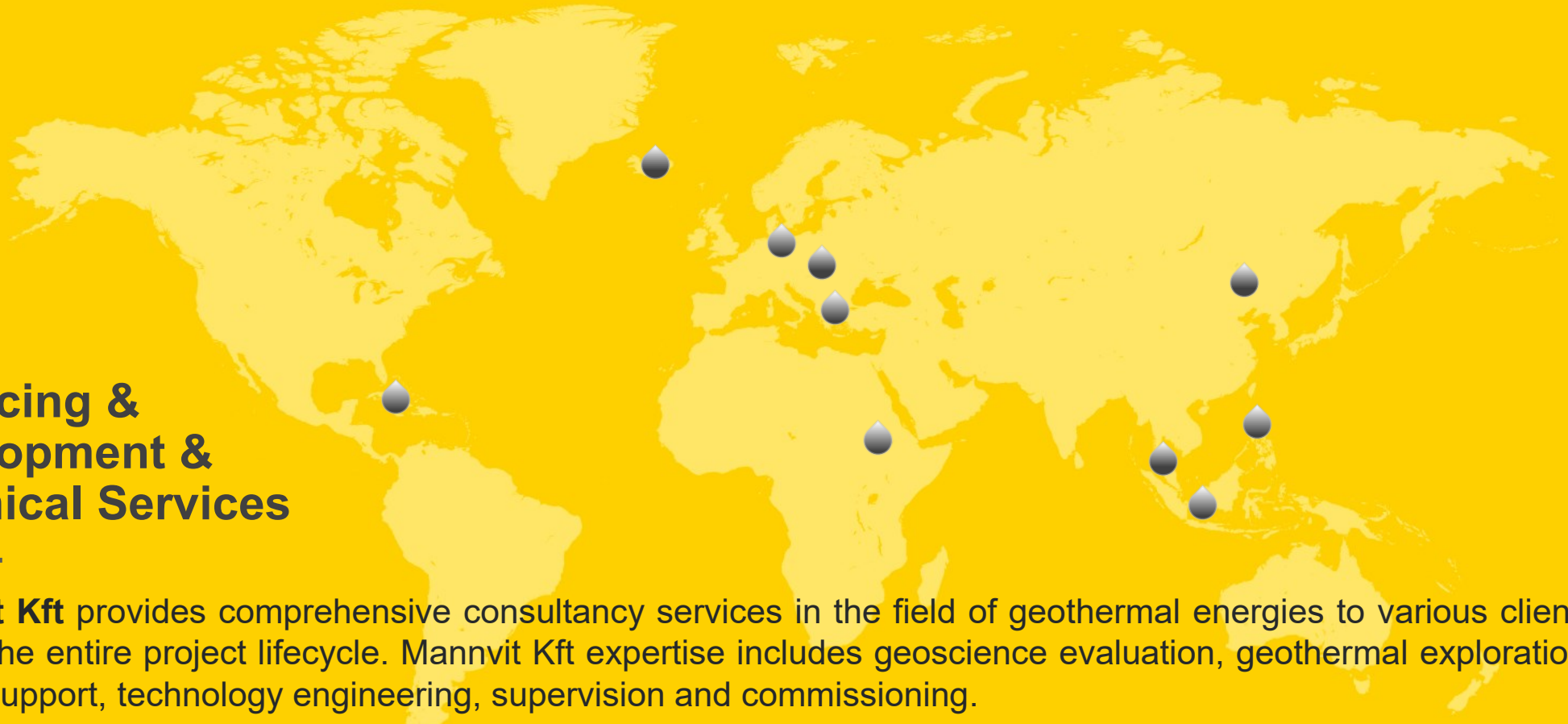
# Arctic Green Energy | Mannvit

Iceland | Hungary | Singapore | China



## Financing & Development & Technical Services

**Mannvit Kft** provides comprehensive consultancy services in the field of geothermal energies to various clients across the entire project lifecycle. Mannvit Kft expertise includes geoscience evaluation, geothermal exploration, drilling support, technology engineering, supervision and commissioning.

**Arctic Green** is the leading geothermal and renewable energies project developer around the globe. Its projects range from clean heating and cooling to green electric power generation across Asia, Europe, and the Middle East. Creates customized solutions to meet each community's needs through collaborations with local partners.

# Geothermal References

## Velika Ciglena, Croatia
*Geothermal Power Plant*

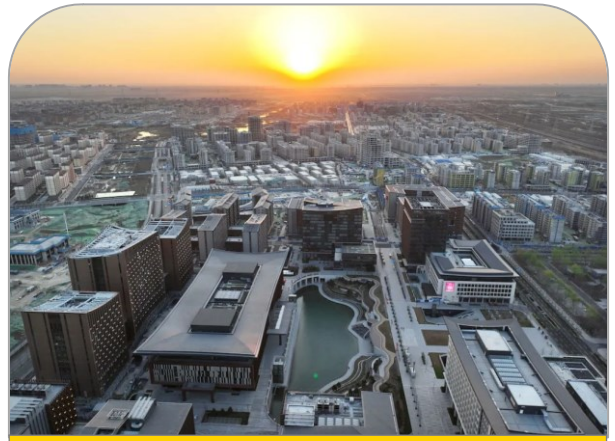
| | |
|---|---|
| Capacity: | 16 $MW_e$ |
| Year of Implementation: | 2016 – 2019 |

Geothermal Power Plant built in East-Croatia, utilizing the energy harvested from two deep production wells ot generate clean electricity.

## Budapest, Hungary
*Geothermal Heating System*

| | |
|---|---|
| Capacity: | 20 – 100 $MW_{th}$ |
| Year of Implementation: | 2021 – … |

Geothermal Heating project in the capital city of Hungary in cooperation with Főtáv, the District Heating company of Budapest, aiming to provide clean geothermal heat to the existing distribution system.



## Xiong'an, China
*Geothermal Heating and Cooling*

| | |
|---|---|
| Capacity: | 350 / 400 MW |
| Year of Implementation: | 2009 – 2014 |

Geothermal heating and cooling system utilizing 128 wells with 54 heat centrals. It has a mixture of district heating and cooling, energy storage, photovoltaic power plant, supplying 7.2 million $m^2$ area.

Ministry of Foreign Affairs and Trade of Hungary

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# Geothermal Project Phases

Project screening
Pre-studies

- Project leads
- Preliminary negotiations
- Concept studies
- Preliminary cost estimate

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# Geothermal Project Phases

Project screening
Pre-studies

Feasibility
Studies

- Conceptual planning
- Market research
- Cost estimate
- Business planning
- Risk analysis

Heat market

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# Geothermal Project Phases

**Geothermal Exploration**

Project screening Pre-studies → Feasibility Studies → Geology & Site surveys

- Exploration permitting
- Geological evaluation
- Geophysical surveys
- Reservoir modelling
- Well siting

Geothermal reservoir

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# Geothermal Project Phases

**Geothermal Exploration**

Project screening Pre-studies | Feasibility Studies | Geology & Site surveys | Licensing & Agreements

- Basic design
- Land acquisition
- Establishment permitting
- JV agreements
- Project execution planning

Heat market

Geothermal reservoir

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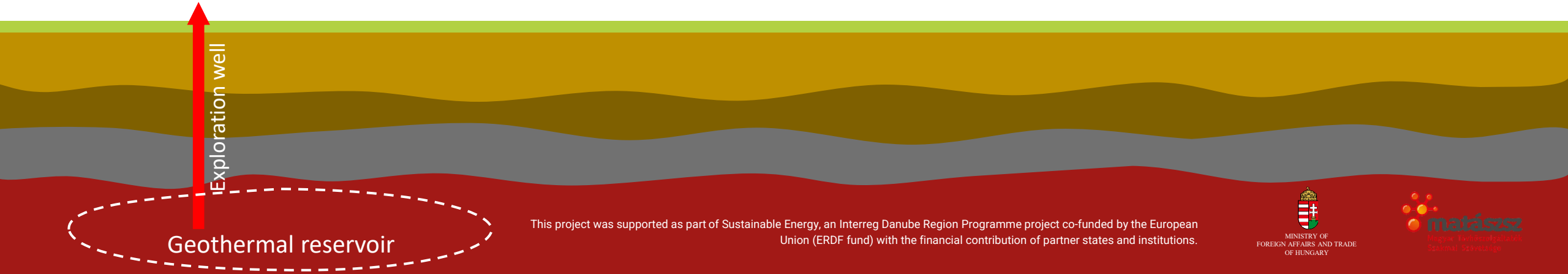
# Geothermal Project Phases

**Geothermal Exploration**

| Project screening Pre-studies | Feasibility Studies | Geology & Site surveys | Licensing & Agreements | **1st Drilling** |
|---|---|---|---|---|

- Drilling procurement
- Exploration drilling
- Well tests
- Update of project concept
- Update of business plans

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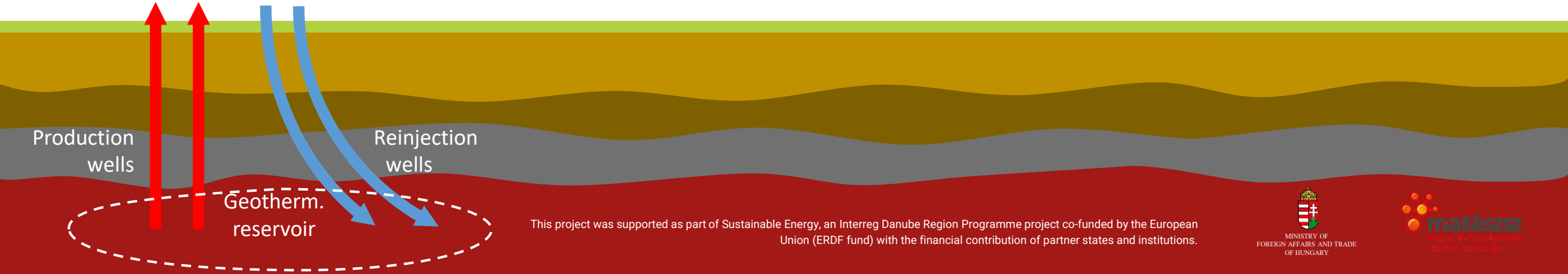
# Geothermal Project Phases

**Geothermal Exploration** | **Exploitation**

Project screening Pre-studies → Feasibility Studies → Geology & Site surveys → Licensing & Agreements → **1st Drilling** → Drilling & Construction

- Field development planning
- Procurements
- Drilling further well(s)

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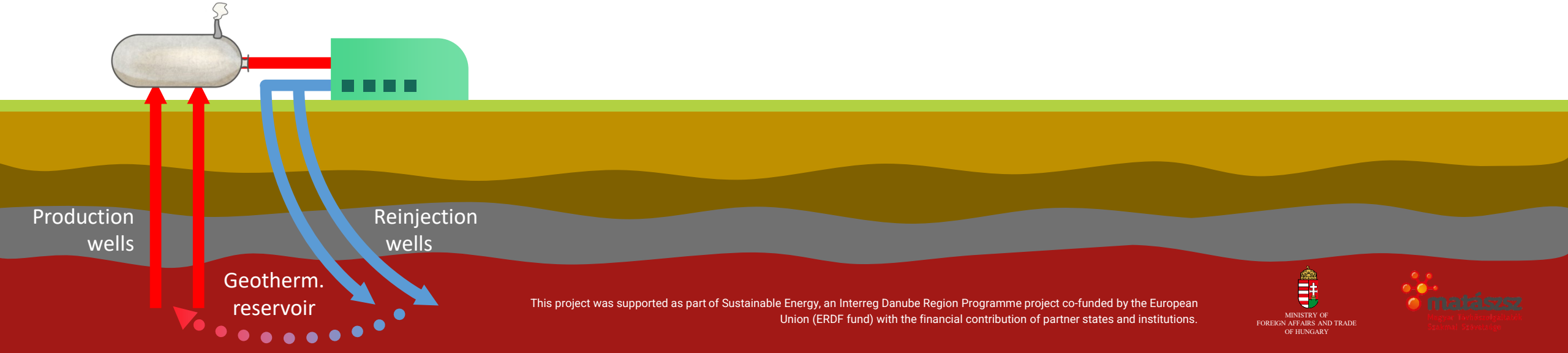
# Geothermal Project Phases

**Geothermal Exploration** | **Exploitation**

Project screening Pre-studies → Feasibility Studies → Geology & Site surveys → Licensing & Agreements → **1st Drilling** → Drilling & Construction

- Field development planning
- Procurements
- Drilling further well(s)
- Surface system construction
- Operation permitting

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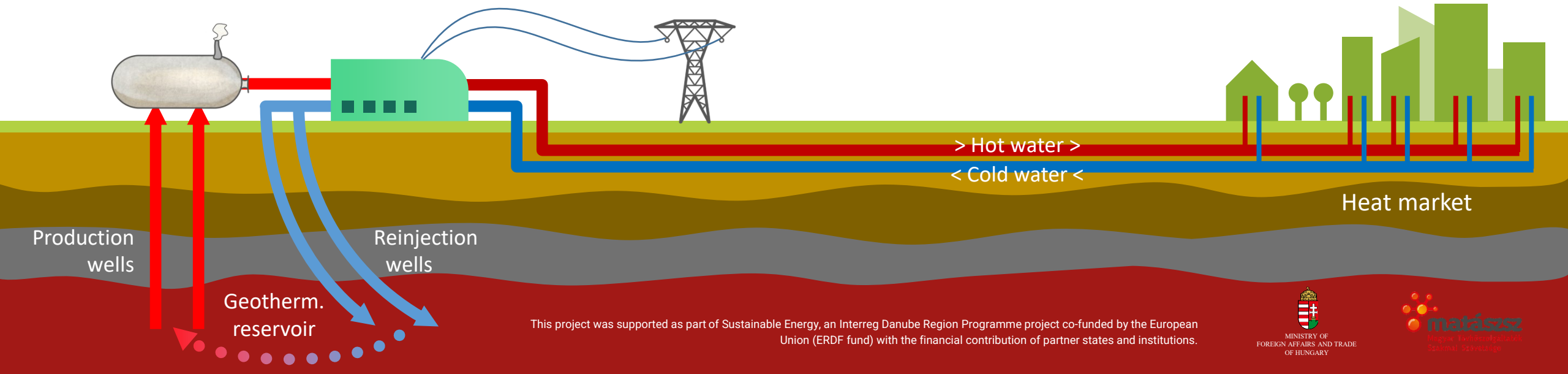
# Geothermal Project Phases

**Geothermal Exploration** | **Exploitation**

Project screening Pre-studies → Feasibility Studies → Geology & Site surveys → Licensing & Agreements → **1st Drilling** → Drilling & Construction → Operation

- System optimization
- Operation
- Maintenance
- Monitoring

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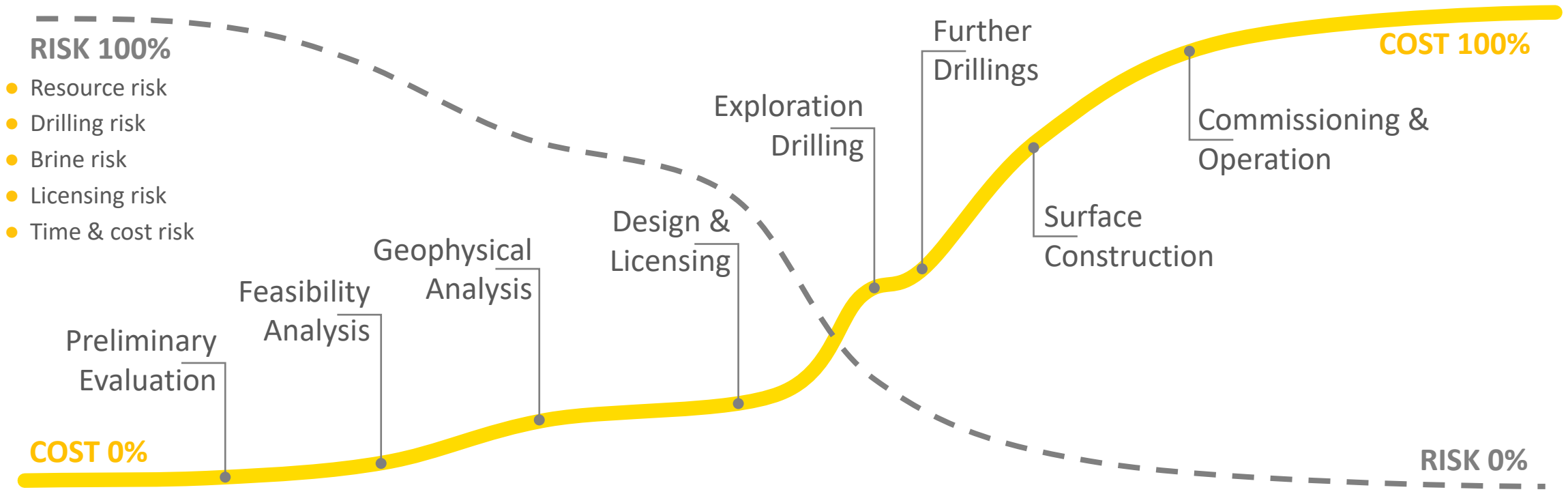
# Geothermal Project Development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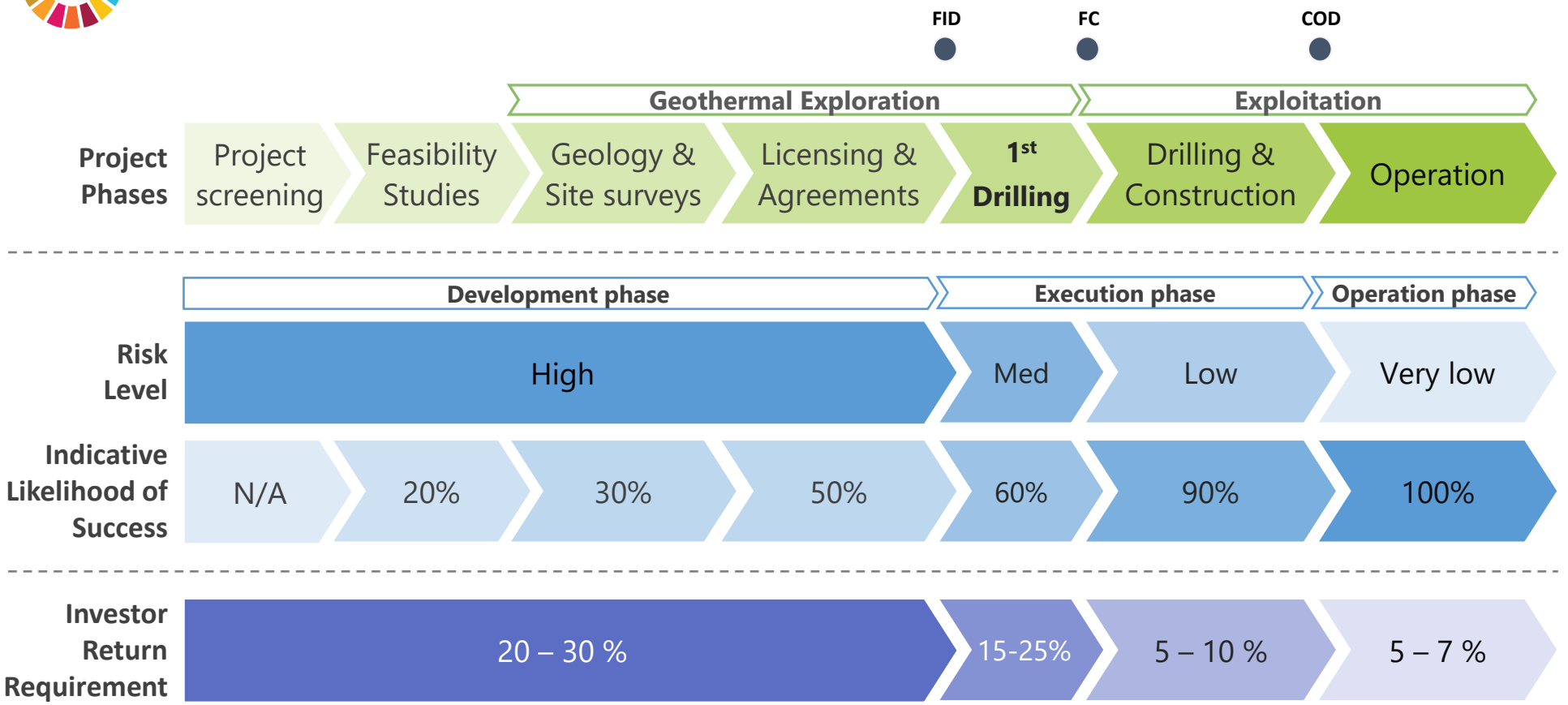
# Risk & Return




**Development phase**

- High risk phase from unproven resource, licensing and permitting, as well as offtake / route-to-market
- Likelihood of success is low until permits and route-to-market is secured
- High return requirements due to project having exploration risk

**Execution phase**

- Geothermal exploration risk from start of drilling, which impact project economics as offtake contracts has been agreed upfront FID
- Equity funding of project up until successful 1st drilling, which dramatically decreases risk and return requirements
- Low residual construction risk for drilling additional wells, civil works, heating plant and grid connection

**Operation phase**

- Low operational risk and return requirements
- High debt service capacity
- Likely interesting investment object for long-duration, low-risk cash flows

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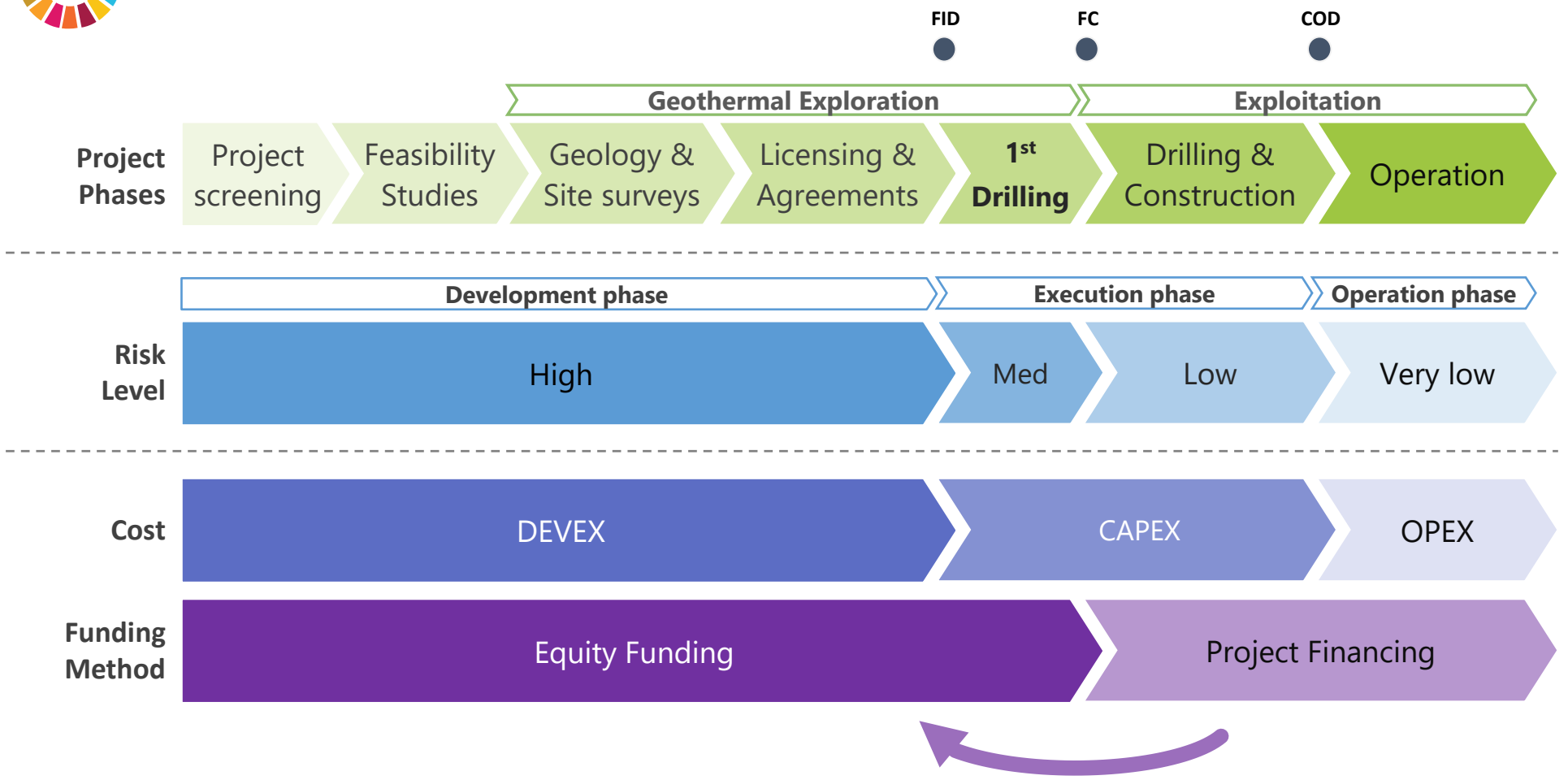


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# Geothermal Heating Project Cost Example

**Geothermal heating system (example)**

**Main parameters**

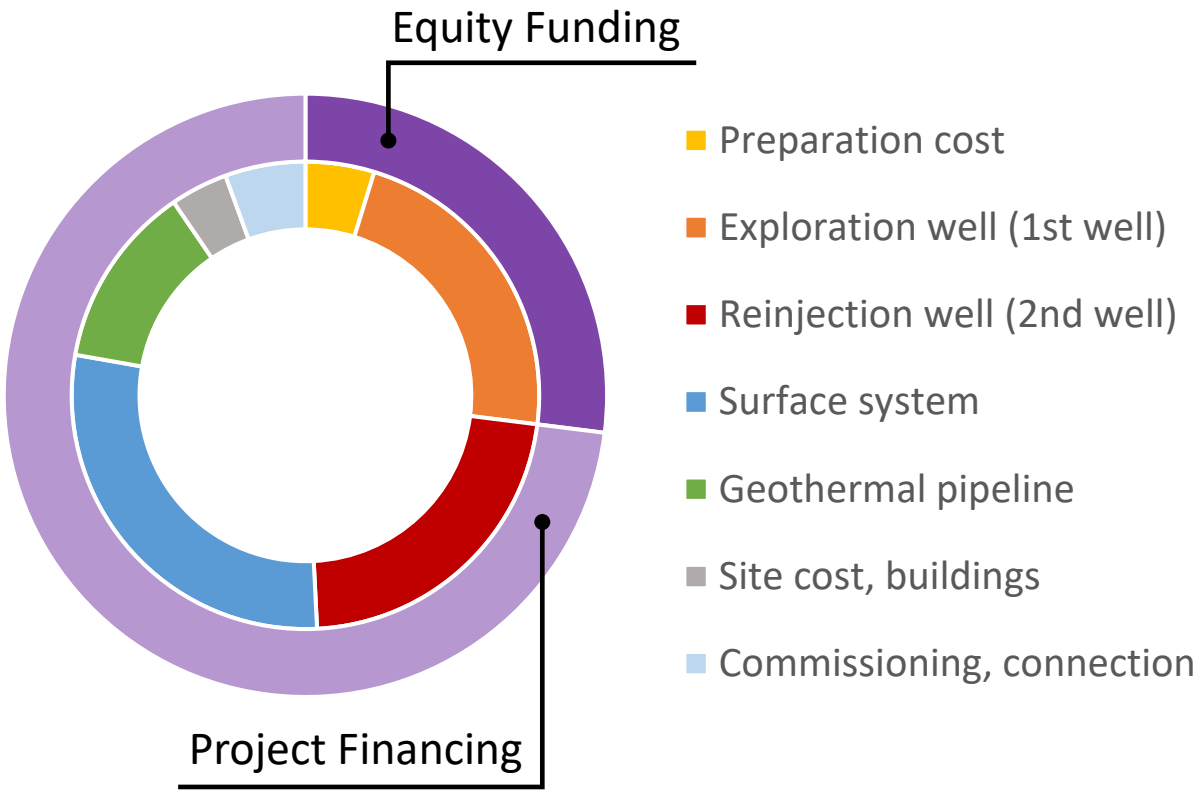
- Number of wells: 1+1
- Heating capacity: 15 $MW_{th}$
- Annual heat amount: 300 000 GJ

**Investment cost**

| | | |
|---|---|---|
| Preparation cost | 600 thEUR | 5% |
| Exploration well (1st well) | 2 800 thEUR | 20% |
| Reinjection well (2nd well) | 2 700 thEUR | 20% |
| Surface system | 3 600 thEUR | 25% |
| Geothermal pipeline | 1 600 thEUR | 10% |
| Site cost, buildings | 500 thEUR | 5% |
| Commissioning, connection | 700 thEUR | 5% |

**Operational cost**

| | |
|---|---|
| Electricity consumption | 600 thEUR |
| Maintenance cost | 180 thEUR |
| Personnel cost | 120 thEUR |
| Administrative costs | 40 thEUR |

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# Geothermal Power Plant Project Cost Example

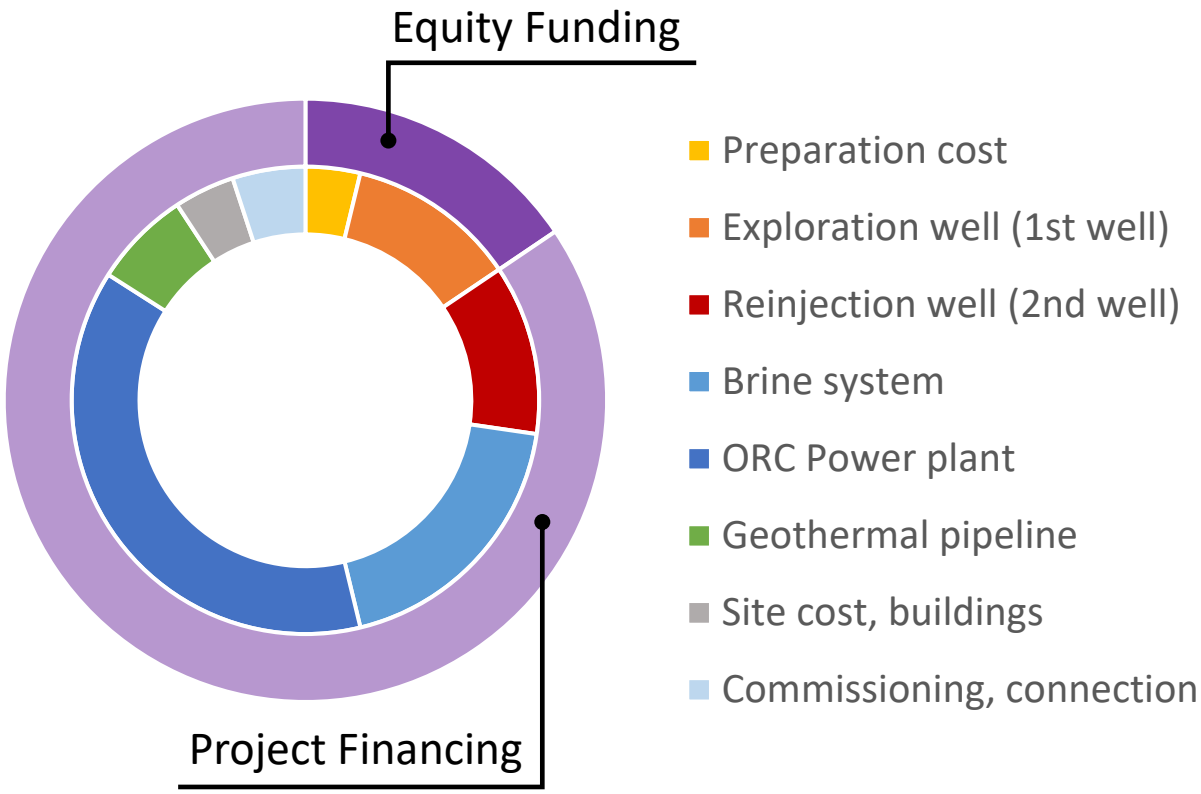
**Geothermal power plant system (example)**

**Main parameters**

- Number of wells: 1+1
- Electrical capacity: 4 $MW_e$
- Heating capacity: 12 $MW_{th}$
- Annual power production: 26 000 MWh
- Annual heat amount: 250 000 GJ

**Investment cost**

| | | |
|---|---|---|
| Preparation cost | 900 thEUR | 5% |
| Exploration well (1st well) | 2 800 thEUR | 12% |
| Reinjection well (2nd well) | 2 700 thEUR | 12% |
| Brine system | 4 500 thEUR | 20% |
| ORC power plant | 9 000 thEUR | 35% |
| Geothermal pipeline | 1 600 thEUR | 7% |
| Site cost, buildings | 1 000 thEUR | 5% |
| Commissioning, connection | 1 200 thEUR | 5% |

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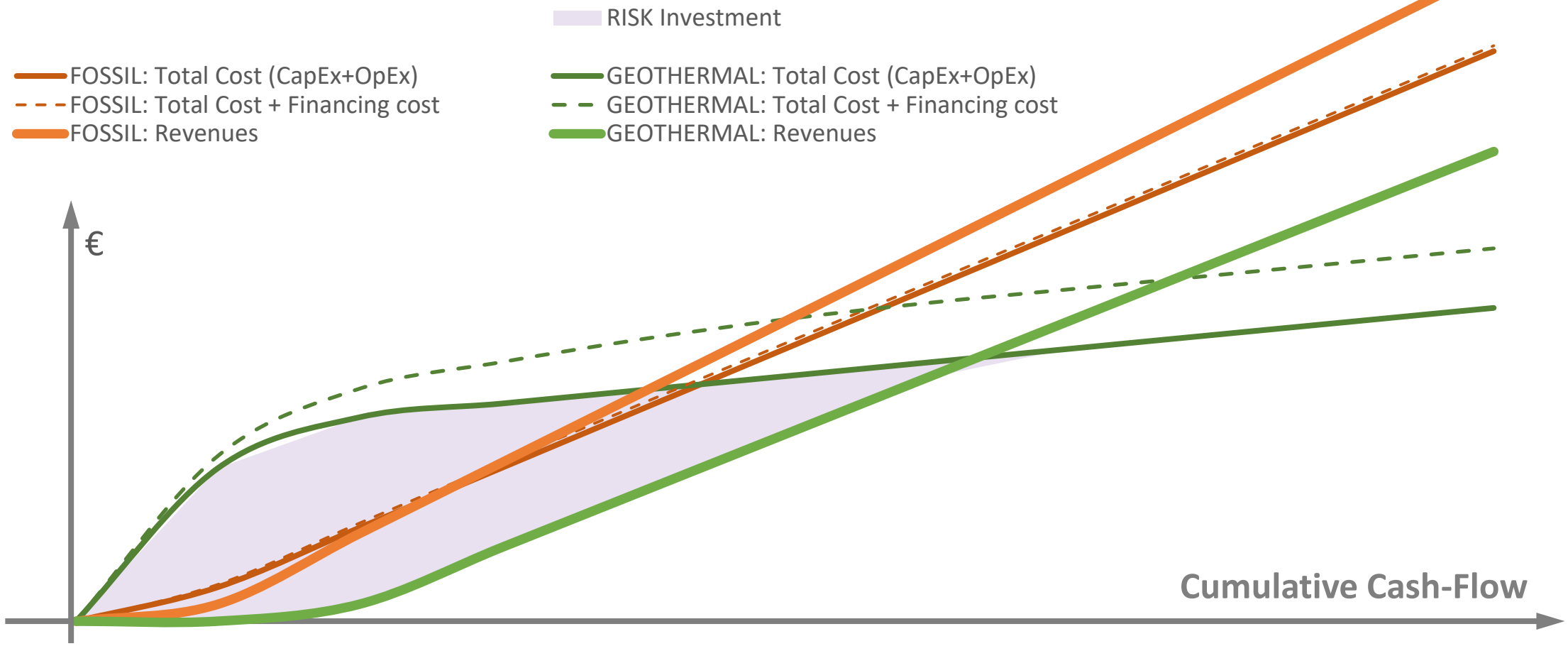
# Lifecycle Cost Comparison

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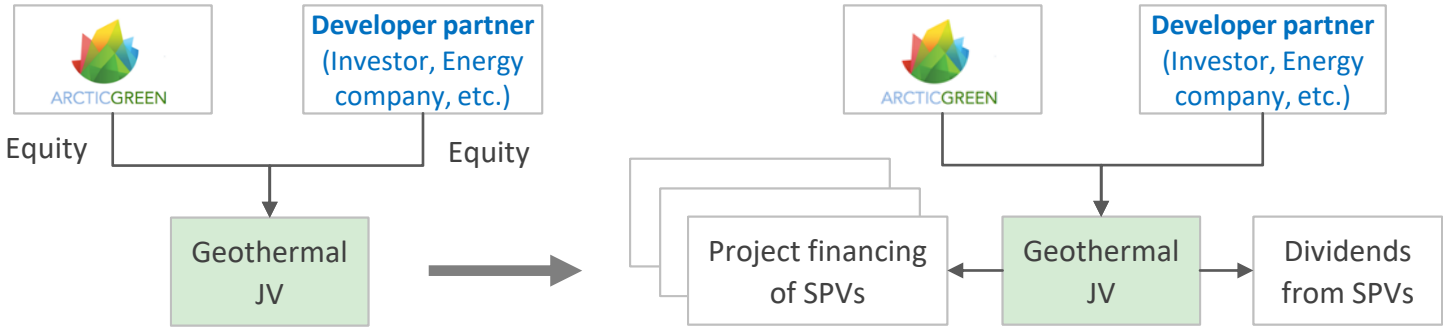
# Arctic Green Project Development Structures

## EXAMPLE 1




## EXAMPLE 2


**Initial phase**

- Funding of equity with JV partner in initial phase to cover BD initiatives, studies, project screening
- Activities to support further creating project opportunities and maturation of pipeline projects towards FID

**2nd phase**

- Increased funding requirements from the JV partners as projects are maturing towards FID and execution phase
- Geothermal JV's capital spend will be funded by:
  - Equity from JV partners
  - Project financing of SPVs and refinancing post COD
  - Dividends from SPVs

**3rd phase**

- No funding requirements from JV partners to Geothermal JV as the JV has capacity for upstreaming cash to owners
- Geothermal JV's future growth is self-funded through:
  - Dividends from SPVs
  - Project financing of SPVs and refinancing post COD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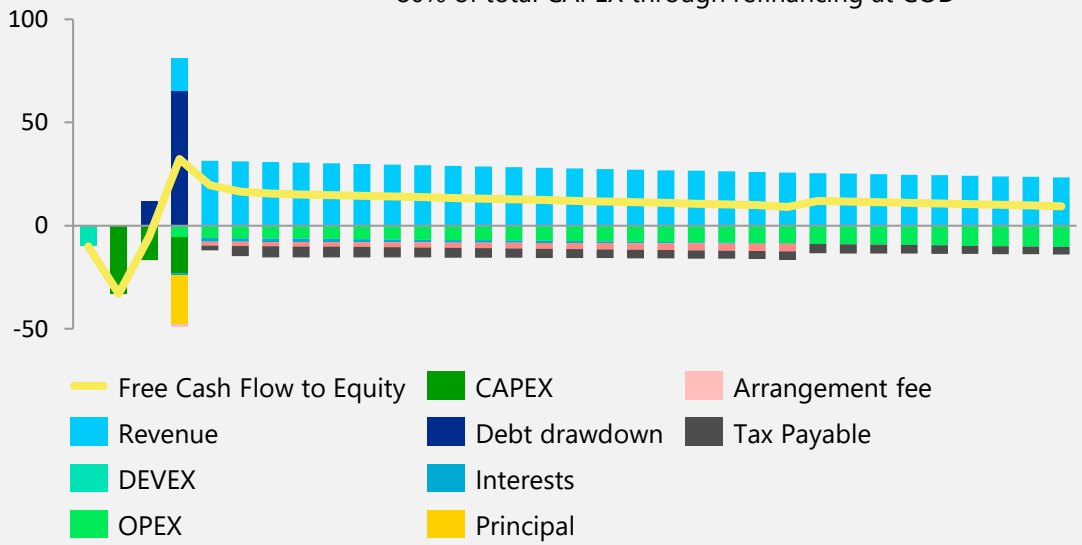
# Arctic Green Project Financing

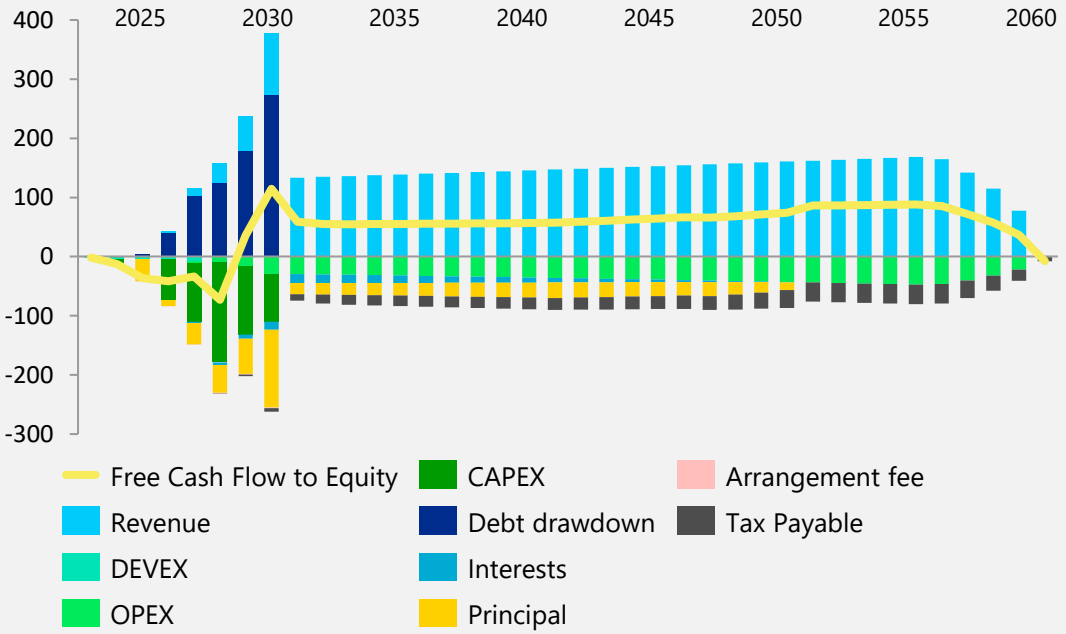
## Project SPVs (#1-10)

- Geothermal JV ownership share: 51%
- CAPEX range: EUR 40-220m
- SPV Project IRR range: 10-15%
- SPV Equity IRR range: 15-27%
- JV level Equity IRR range: 13-21%
- Financing: 75% of CAPEX post successful drilling
  80% of total CAPEX through refinancing at COD




## Aggregated 10 projects (2022 – 2060), EURm

- Total DEVEX: EUR 40m (100% level)
- Total CAPEX: EUR 1bn (100% level)
- Total funding to projects SPVs post project financing: EUR 605m (100% level)
- Total funding to project SPVs from Geothermal JV: EUR 309m (51% level)

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# Thank you for your attention

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