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Economics of the Iceland Deep Drilling Project, IDDP

Conventional geothermal boreholes are 2500 m deep, with resource temperature of 230°C.

The IDDP boreholes are almost 5000 m deep, with resource temperature of 450°C.

The intention of IDDP is to determine if high temperature geothermal fluid from deep boreholes as compared to conventional boreholes would improve the economics of power production.

By increasing reservoir temperature from 230 to 450°C, increase of power output from 5 to 40 MW could be expected. An eight-fold increase.

First attempt for deep drilling IDDP-1 in Krafla Iceland 2009 failed as the borehole was unintentionally drilled into a magma reservoir. The well had to be abandoned due to undesirable substances in the geothermal fluid.

Second attempt for deep drilling in Iceland IDDP-2 is currently in execution phase at the Reykjanes peninsula adjacent to the Reykjanes Geothermal Power Plant. The setup is to start from the existing and unutilized 2500 m deep borewell RN-15 and drill downwards to the depth of 4626 m. The drilling project has now been completed. The current plan consists of ongoing research work and installation of a pilot power plant.

Recent article in the ThinkGeoEnergy Newsletter - 01/24/2017 on IDDP by Alexander Richter states the facts in table 1 on costs of drilling and borehole power.

Table 1. IDDP Costs of Drilling and Borehole Power

Case	Drilling	Depth from->to (m)	Costs (MISK)	Costs (MUSD)	Power (MW)	Unit Cost (MUSD/MW)
A	Conventional	0->2500	600	5.2	5	1.0
B	IDDP	2500->4626	2000	17.4	40	0.4
C	Deep Drilling	0->4626	2600	22.6	40	0.6

The following assumptions are made:

- Power Plant Costs 1.9 MUSD/MW
- Utilization 8000 hours/year
- Lifetime of boreholes 15 years, lifetime of power plant 25 years
- Interest rate 6% yearly
- Yearly cost of Operation and Maintenance 2.5% of capital costs
- Currency rate 115 ISK/USD

Table 2 shows the corresponding production costs.

Table 2. Power Plant Production Costs and Drilling Costs for single flash geothermal power

Case	Drilling	Depth from->to (m)	Energy Production (GWh/year)	Production costs		
				Power Plant (USD/MWh)	Drilling (USD/MWh)	Total (USD/MWh)
A	Conventional	0->2500	40	25 (59%)	17 (41%)	42
B	IDDP	2500->4626	320	25 (78%)	7 (22%)	32
C	Deep Drilling	0->4626	320	25 (73%)	9 (27%)	34

Deeper boreholes (case C) and therefore higher resource temperature could possibly lead to additional benefits due to lower power plant costs, not taken into account in table 2.

The significant lowering of drilling costs per produced MWh from 17 USD/MWh for Case A to 9 USD/MWh for Case C is an impressive improvement.

Table 2 reveals how the rule of thumb for cost of geothermal power has changed for single flash geothermal power (P:Cost of Power Production, D:Cost of Drilling):

- (P=50%, D=50%) the old rule of thumb of capital costs
- (P=53%, D=44%) a revised model of capital costs (P=1.0/1.9, D=0.9/1.9)
- (P=59%, D=41%) the conventional case A of production costs
- (P=78%, D=22%) the IDDP case B of production costs
- (P=73%, D=27%) the deep drilling case C of production costs

Table 3 shows an example of sensitivity analysis for risk aversion.

If the assumptions for deep boreholes in Case B and C are revised as shown in table 3, then the resulting production costs are as follows:

Table 3. Production Costs with revised assumptions for boreholes in cases B and C
10 years lifetime, 8% interest rate and 5% cost of operation and maintenance

Case	Drilling	Depth from->to (m)	Energy Production (GWh/year)	Production costs		
				Power Plant (USD/MWh)	Drilling (USD/MWh)	Total (USD/MWh)
A	Conventional	0->2500	40	25 (59%)	17 (41%)	42
B	IDDP	2500->4626	320	25 (69%)	11 (31%)	36
C	Deep Drilling	0->4626	320	25 (64%)	14 (36%)	39

Production of geothermal power in high temperature geothermal areas of the world is still one of the most feasible alternative of energy production from natural and renewable energy resources.