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OPP350L Geothermal Pump Development - From Preliminary Concepts to Field Installation

*Benjamin Eilan, Brian Canning, Zachary Duran, Omri Meshulam, Tom Regev, Nadav Darf
Ormat Technologies Inc
beilan@ormat.com

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INTRODUCTION

The OPP350L is a newly developed lineshaft pump model developed by Ormat, designed specifically to meet the demanding requirements of geothermal applications. This innovative pump offers a unique combination of low axial thrust and large axial end play, enabling significantly increased flow rates from existing geothermal production wells.

Ormat has traditionally relied on third party vendors to supply lineshaft production pumps for geothermal fluid production. This is a niche market, since geothermal is a relatively small industry, only a few companies have ever supplied geothermal lineshaft production pumps. Relying on third party vendors had drawbacks for Ormat including product availability, price markups, quality issues, and lack of design control.

Since Ormat already had turbomachinery design and manufacturing expertise, and prides itself on vertical integration, it was only natural to bring production pump design and manufacturing in house.

The first Ormat Production Pump (OPP) was installed at the Brady geothermal facility around April of 2009. This was an OPP300 that is still running to this day. The "300" refers to the pump's designed Best Efficiency Point (BEP) in m^3/h (the same naming scheme applies for the rest of the pump models discussed in this paper). Between 2012 and 2019 three additional models were introduced (OPP400, OPP500 & OPP800) and implemented successfully, with the OPP800 being a game changer - 14" LSP model with unmatched flow in the geothermal pump lineup.

1 IDENTIFYING THE NEED FROM THE FIELD + DEFINING FLOW TARGET

While implementation of the 4 models was successful, the BEP flows of OPP300 and OPP400 (1320 and 1900gpm respectively) left Ormat with a large gap between the OPP300 and OPP400. This amounted to the OPP300 needing to cover flows from 1300gpm to 1900gpm, resulting in less-than-ideal operating point, or continuing the undesired reliance on third party vendors. In addition, the OPP400 had a relatively high thrust coefficient (K_T), a parameter whose value helps determine the axial load a vertical pump is exerting on its rotor at a given operating point) making it difficult to use in deep, high head applications.

The need for a new pump was therefore two-fold. A pump was needed to bridge the gap between the OPP300 and OPP400, as well as be suitable for the increasing demand for a pump that could reach deep targets. The OPP350 design BEP was 1540gpm, nicely bridging the gap between OPP300 and OPP400, with the added requirement for deep installation.

2 CREATING A TECHNICAL SPECIFICATION FOR COMPUTATIONAL FLUID DYNAMICS (CFD) DESIGN

With target flow and an aim to have the new pump a deep-set pump, the next step was developing a comprehensive and clear technical specification to guide the hydraulic design process. This specification helped minimize iterative work between different disciplines within Ormat by clearly defining hydraulic requirements such as pump curve characteristics, geometrical requirements such as compatibility with existing parts and well diameter constraints etc. This specification also incorporated lessons learnt from previous designs.

During this phase the strategy of deep-set pumps was defined – an emphasis on low thrust coefficient (K_T) alongside increasing the length of the axial travel of the pump. Both design decisions later proved significant, since combined, they significantly increased the allowable setting depth of the pump, which has a direct contribution to increasing flow from a given well. This design principle is supported by Kunaruk (1991), who

demonstrated that reduced axial thrust allows for deeper pump installations by limiting shaft elongation and maintaining rotor-stator stability.

As elaborated in the next section, we successfully defined and achieved exceptionally low K_T values, key contributors to the enhanced performance range of the OPP350L model, particularly when compared to existing pump designs.

3 HYDRAULIC DESIGN AND VALIDATION WITH COMPUTATIONAL FLUID DYNAMICS (CFD)

Initial 1D (meanline) design was done using Ormat's internally developed design tools, considering the technical specification and hydraulic considerations arising from the desired performance. During this preliminary design stage, the impeller's diameters and the blading shape at the inlet and outlet are set, as well as the diffuser's inlet dimensions and blade angle.

Next, a 3D CAD model was built based on aforementioned dimensions and then used as the basis for the creation of a CFD model.

CFD validation of the design was done using Cadence (formerly Numeca) tools. Initial CFD simulations were done on the flowpass alone in an iterative manual optimization process. Later simulations of the leading candidates included the front and aft cavities around the impeller in order to estimate the axial forces and the cavities' effect on performance.

Comparison between CFD results and 1D design showed an underprediction of performance by the 1D design compared to CFD results. This discrepancy would later be compared to results obtained in the testing facility and the models would be calibrated accordingly.

As mentioned, one of the key specifications for this pump was thrust reduction, for deep installations. However, due to the large axial gap between impeller and diffuser, traditional methods for thrust reduction such as expeller vanes and seals could not be utilized. Therefore, the main thrust reduction tool in the designer's control was careful optimization of the geometry, which needed to balance all the design requirements set out in the technical specification (see section 2 above), without sacrificing the pump's desired performance.

4 MECHANICAL DESIGN AND FACTORY TESTING

The mechanical design of the new pump model was built upon a well-established platform, drawing from prior successful developments. Known and proven material specifications were retained, along with the same trusted vendors and subcontractors, ensuring reliability and consistency.

Wherever possible, existing parts were reused to streamline manufacturing and assembly, simplify inventory management, and maintain mechanical interface compatibility across models. The design process incorporated lessons learned from earlier models – adopting solutions that proved effective and eliminating those that did not.

As previously mentioned, this model was targeted at deep-set pumps, and it was therefore designed with an additional 1.25" of axial travel (see Figure 1) thus enhancing flexibility and meeting the deep-set target requirements.

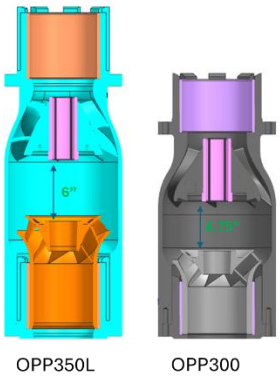


Figure 1 - OPP350L's larger axial travel

Overall efficiency was further improved by optimizing geometry, such as reduction of sharp corners to minimize flow resistance.

The validation of the mechanical design included structural Finite Element Analysis (FEA), to confirm structural integrity under anticipated operational loads and CFD, to ensure that the final product meets the hydrodynamic results obtained at the hydraulic design process (see Figure 2).

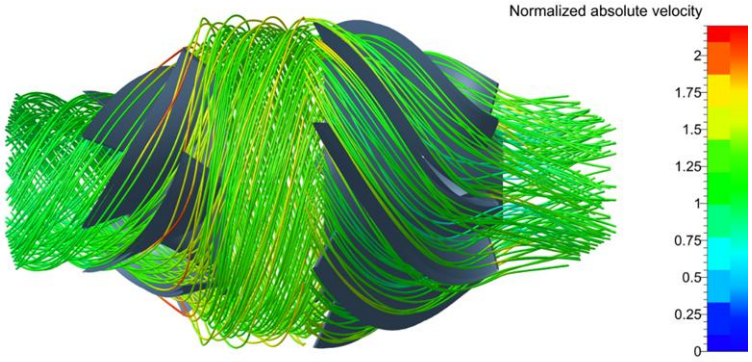


Figure 2 - CFD validation prior to manufacturing

Factory testing was conducted using the dedicated facility developed for previous models, covering all plausible operating speeds and flow conditions to validate performance across the expected range. When actual performance was compared to CFD results some expected discrepancies were found. These discrepancies helped us to further calibrate our hydraulic design tools and methodology to reach better agreement in future designs between tested results and predicted results. Despite the discrepancies, the efficiency values measured were considerably higher than previous designs, as much as 5% more efficient in BEP when compared to older designs.

During performance testing an exceptionally good thrust coefficient (K_T) was measured, as low as 30% below values for other models. Given the promising results it was decided to proceed with a first field installation. Combined with the extended axial travel of this pump, it was realized that we have a potential game changer in our hands, which can deliver on its promise to reach targets at depths none of the previous pumps could, reducing our reliance on the existing models.

5 IDENTIFYING SUITABLE CANDIDATES FOR FIRST INSTALLATION

The next step was identifying the most suitable well for the first installation. The ideal well would have target flows within the OPP350L's BEP region and would greatly benefit from this new model's deep-set capabilities.

Ormat acquired Cove Fort in January 2024. Cove Fort has 5 active production wells, that were all utilizing ESPs at the time of acquisition. To improve MTBF as shown by Canning et al (2025), Ormat elected to perform ESP to LSP conversion starting in mid-2024 (conversions to take place at the time of failure). The Cove Fort wells have a deep water level, with high productivity. This makes this a high-head application that is well suited for the OPP350L. Ormat currently has two OPP350Ls installed, with plans for two more installations in Q1 2026.

6 RISK ANALYSIS PROCESS

The geothermal industry tends to be conservative, due to the high costs associated with failures, especially in production wells. As a company that is always striving for excellence, Ormat must foster and promote innovation while maintaining a responsible approach towards changes in high-risk operations such as geothermal pumps. Therefore, Ormat cultivates a culture of risk analysis and mitigation in all projects from "standard" projects to cutting edge R&D activities. The conservatism is well-documented in industry literature, including Matek (2014) and Liu & Lin (2025).

Consequently, prior to the first field installation of the new pump model, a thorough and methodical risk analysis and mitigation process was conducted. Risks were evaluated using a standard HAZID (Hazard Identification) risk matrix in which each hazard was assigned a probability score (1–5) and severity score (1–5). The resulting risk ranking determined whether mitigation actions were required before field deployment.

Two potential pump models were compared: OPP350L and OPP300. While the former is a new model with higher potential risk and gains, the latter was a well-tested model, with a smaller production potential for this well.

The HAZID process that was used is a standard procedure for the drilling division in Ormat. The result of this process is unambiguous and is presented on a 2D plot (see Figure 3, where option 2 is the preferred solution), where the higher the values of risk and likelihood, the less an alternative is recommended.

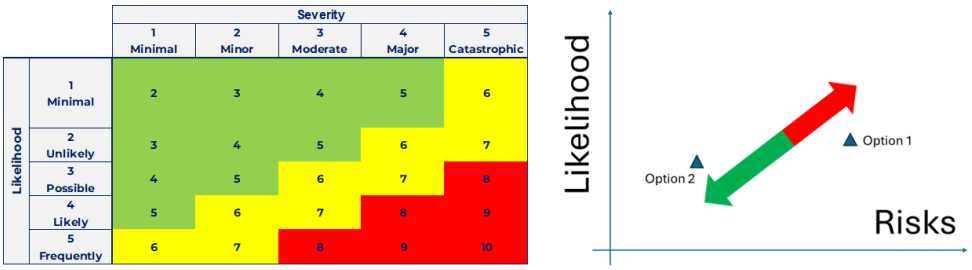


Figure 3 - HAZID risk matrix and typical result

At the end of the HAZID process, there was a clear "winner," and OPP350L was chosen as the preferred pump. All risks that were identified as yellow per the risk analysis matrix were assigned preventive actions, and only after the completion of these actions did Ormat's management give the green light to proceed with the first OPP350L installation.

7 INSTALLATION, PERFORMANCE MONITORING

Installation of the first OPP350L took place in June 2024 and was done using Ormat's standard installation procedures, by Ormat's highly trained and experienced personnel. Since the design relied on existing parts and utilized the existing design platform, for the team on-site this installation did not pose any significant challenge.

Following commissioning and initial testing, the pump was handed over to the operations team, while production and reservoir engineers closely monitored its performance. Ormat tracks multiple parameters (such as pressure, flow etc.) to evaluate actual pump performance. These parameters enable the calculation of the actual TDH (Total Dynamic Head) the pump is generating, which enables us to compare it with the expected TDH based on the curves from design testing.

A value we use for performance monitoring is Wear Factor: WF = Actual TDH / Curve TDH. The WF is a good indicator of pump performance and health – a pump with WF consistently close to 1 is anticipated to have a long lifetime. The WF at the two Cove Fort conversions is closely monitored and is overall satisfactory. The graph below shows the wear factor between Nov-24 and Dec-25. Data between June and November 2024 is not presented as this period was used for commissioning, control tuning, and stabilization of operating conditions.

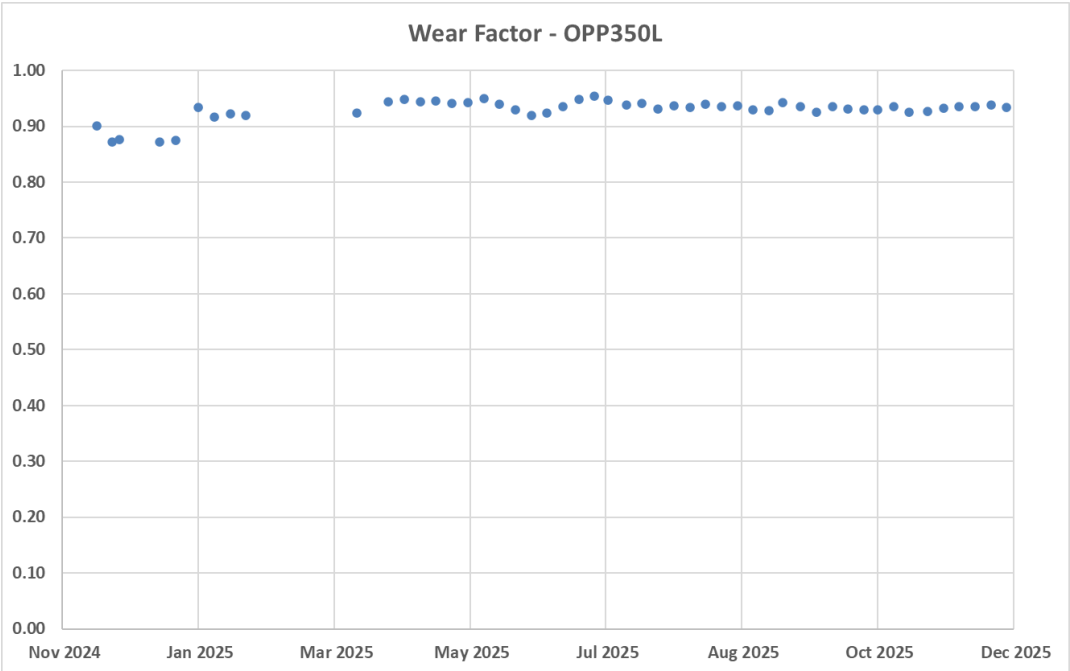


Figure 4 - OPP350L Performance monitoring

As can be seen, the wear factor is satisfactory, with a mean value of approximately 0.95. While not being a perfect 1, the performance from this pump significantly exceeds the potential performance of the OPP300 in this well. Ormat will continue to monitor performance, as more data becomes available, and there is a larger sample of installed OPP350Ls to monitor. If performance does not meet expectations, the OPP350L may need to be retested, and the curves adjusted.

8 SUMMARY

The OPP350L pump development highlights Ormat's vertical integration and its ability to turn field-driven needs into high-performance solutions. The entire process – from concept through design, testing, and deployment – was carried out internally by Ormat, reflecting the company's unique position in the geothermal industry. Designed to bridge flow gaps and enable deep-set installations, the pump was engineered using proprietary tools, validated through CFD and mechanical testing, and successfully deployed in high-head geothermal wells. With improved efficiency and thrust characteristics, the OPP350L not only fills a critical operational gap-it sets a new benchmark in geothermal pumping technology.

REFERENCES

Kunaruk, U. Design and Selection of Deep Well Pumps for Geothermal Wells. UNU Geothermal Training Programme, Iceland (1991).

Canning, B., and Duran, Z.: Ormat Production Pump Philosophy and Runtime Data, Proceedings, 49th Workshop on Geothermal, Geothermal Resources Council, Reno, NV, USA (2025).

Matek, B. Manageable Risks of Conventional Hydrothermal Geothermal Power Systems. Geothermal Energy Association (2014)

Liu, PH., Lin, JC. Integrated risk assessment and mitigation strategies for geothermal energy development: technical, socio-political, and financial dimensions. Sustainable Energy Research **12**, 64 (2025)