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Saurdal hydropower plant

Background information

- Name: Saurdal
- Owner: Statkraft
- Year of construction: 1985
- Installed capacity: 640 MW
- Annual electricity production (on average): 952 GWh
- Turbines: 4 Francis turbines (two of which can be reversed for pump-storage)

Saurdal hydropower plant is located in Suldal municipality, Rogaland county, Norway. It was built in 1985 and uses water and the height of fall from Blåsjø reservoir, Norway's largest reservoir. The inflow for energy production is through a series of tunnels from Blåsjø reservoir, and outflow is in Suldalsvatn lake - a regulated lake/reservoir upstream from Suldalslågen river - through the Kvilldal power plant (see Figure 1 in Annex for a map of the hydropower network). Suldalslågen is one of Norway's best known Atlantic salmon rivers.

Two of the four turbines can be reversed to pump water back into the intake reservoir, thus allowing the plant to also operate as pumped storage. Guarantees of Origin are only issued for the non-pumped capacity, so only these volumes are suitable for EKOenergy certification.

Due to the design of the Saurdal hydropower plant where it is a part of a network of highly regulated reservoirs, man made tunnels and other power plants, the environmental criteria is applied for the river reach downstream from the outflow of the powerplant, in this case the Suldalslågen River. See the EKOenergy criteria document linked in the bibliography below for more information on the criteria definitions and classification.

Criteria 1: Fish Migration

Level achieved: Basic

There are two fish ladders on the Suldalslågen river, both located near the mouth of the river at Sandsfossen waterfall in the village of Sand, Suldal region, Norway. They were built around the same time as the first hydropower plants further upstream.

Fish populations in Suldalslågen have been studied and monitored by the Norwegian Environmental Agency since the late 1970s. Many different fish species can be found in the river, however, due to their ecological and economical importance, most of the research carried out has focused on salmonids, namely Atlantic salmon (*Salmo salar*) and sea trout (*Salmo trutta*). Fish biodiversity surveys are also regularly conducted by the local fisheries association, in addition to the monitoring reports that are commissioned by Statkraft. The findings from these and other reports have been used to adjust the annual flow conditions in the river, as described in the section below in Criteria 2: water flow.

Most recent reports from 2016, 2017 and 2018 show that adult salmon and trout have been recorded by the automatic counters in the fish ladders. In addition, juveniles and smolts (juvenile fish on their first migration down to the sea) have been recorded along the river, suggesting a reproducing fish population. The presence of smolts is particularly encouraging as it suggests the flow in the river at critical periods for fish migration are sufficient for downstream migration through the Sandsfossen waterfall (bypassing the fish ladders). However, a 2017 report by UniResearch found that the number of spawning salmon in the Suldalslågen is relatively low when compared to the numbers found in other rivers in the area, suggesting the natural salmon stocks could be improved.

Criteria 2: Water Flow

Level achieved: Basic

Since June 2012, the flow conditions in Suldalslågen have been included in the Saurdal hydropower plant operational permits. As recommended by the findings from fish monitoring reports mentioned in the section above (and the river habitat report described in the section below), minimum flow volume (controlled by releasing water from the Suldalsvatn reservoir upstream of Suldalslågen, downstream from the Saurdal power plant) is set at 12 m³/s in winter months to prevent dry riverbeds and improve fish egg survival. Summer water flow conditions fluctuate between 40 and 80 m³/s following a fixed pattern. During the flood seasons in spring and autumn, the flow is gradually increased to 200 m³/s (see Figure 2 in Annex for detailed flow conditions). The regulated flooding in spring time particularly is designed to facilitate the downstream migration of smolt juveniles.

Criteria 3: River Habitats

Level achieved: Advanced

In addition to the fish monitoring, several studies have been conducted in Suldalslågen investigating the presence of suitable habitats for fish reproduction. A 2004 river habitat report investigated the effects of different flow regimes during 1998-2003 on characteristics such as sedimentation, water vegetation, substrate fauna and habitat availability for fish reproduction at seven different locations along the Suldalslågen river. Amongst many of its findings, the report demonstrated that higher flow conditions created preferable river habitats for salmonid fish, and played a vital part in introducing the seasonal flow regulations described above.

In addition, in 2016 and 2017 habitat studies were carried out in Suldalslågen by the Norwegian Institute for Natural Research (Norsk institutt for naturforskning, NINA), on behalf of Statkraft. Habitat quality and production potential (meaning the potential for fish to spawn successfully and produce viable offspring) for juvenile salmon was assessed by mapping riverbed substrates, meso habitats (including the flow morphology of the river) and shelter availability on the riverbed (measured as the availability of cracks, caves and crevices for the young fish to hide in to escape predators). The assessments were supplemented with data from juvenile fish surveys conducted in 2016. Of the areas surveyed, 66% were classified as moderately productive, 28% were classified as highly productive and 5% were classified as low productive. Analysis of bottlenecks for salmon production showed that the most important limiting factor is access to shelter. The report suggests several measures that

could be implemented to restore the habitat, including measures that increase access to shelters in the riverbed, especially in the upper part of Suldalslågen river.

Based on these findings, Statkraft have asked for and received a plan from the Norwegian Research Institute NORCE to implement habitat-improving measures in the Suldalslågen. The plan suggests a pilot study to be carried out at 9 locations along the river. The river bed in these locations will be cleared of excessive vegetation (moss and algae) that inhibits fish spawning. Any changes in the presence of salmonids (among other indicators of habitat use) before and after the clearing work will be recorded and used to decide whether to implement these measures on a larger scale across the river system. This plan will be discussed with the authorities and the measures are planned to be implemented either in 2019 or 2020 dependent on the application process.

Conclusion

Based on the information provided by Statkraft, gathered through the reports described here and the environmental requirements presented by EKOenergy, Saurdal hydropower plant achieves the basic level in fish migration and water flow criteria, and advanced level in the river habitat criteria. Therefore, we conclude that it is suitable for EKOenergy approval.

Bibliography

<https://www.statkraft.com/energy-sources/Power-plants/Norway/Saurdal/>

(Saurdal hydropower plant on the Statkraft website. Last accessed online on 28.3.2019)

<http://webfileservice.nve.no/API/PublishedFiles/Download/200701199/1267579>

(Saurdal concession documents in Norwegian. Last accessed online on 28.3.2019).

https://www.ekoenergy.org/wp-content/uploads/2018/03/EKOenergyHydropowerCriteria_2019_2_14_ENG.pdf (EKOenergy hydropower criteria in English. Last accessed online on 28.3.2019)

<http://www.radgivende-biologer.no/uploads/Rapporter/2691.pdf> (2017 Fish biodiversity report in Norwegian. Last accessed online on 28.3.2019)

https://www.statkraft.no/globalassets/old-contains-the-old-folder-structure/documents/no/46---fis-kehabitat-i-suldalslagen.-et-studium-av-sedimentasjonsdynamikk-begroing-habitattilbud-og-habitatbruk-hos-fisk._tcm10-4173.pdf (2004 river habitat report in Norwegian. Last accessed online on 28.3.2019)

<https://brage.bibsys.no/xmlui/handle/11250/2445880> (NINA Suldalslågen river habitat report, in Norwegian. Last accessed online on 28.3.2019)

Annex

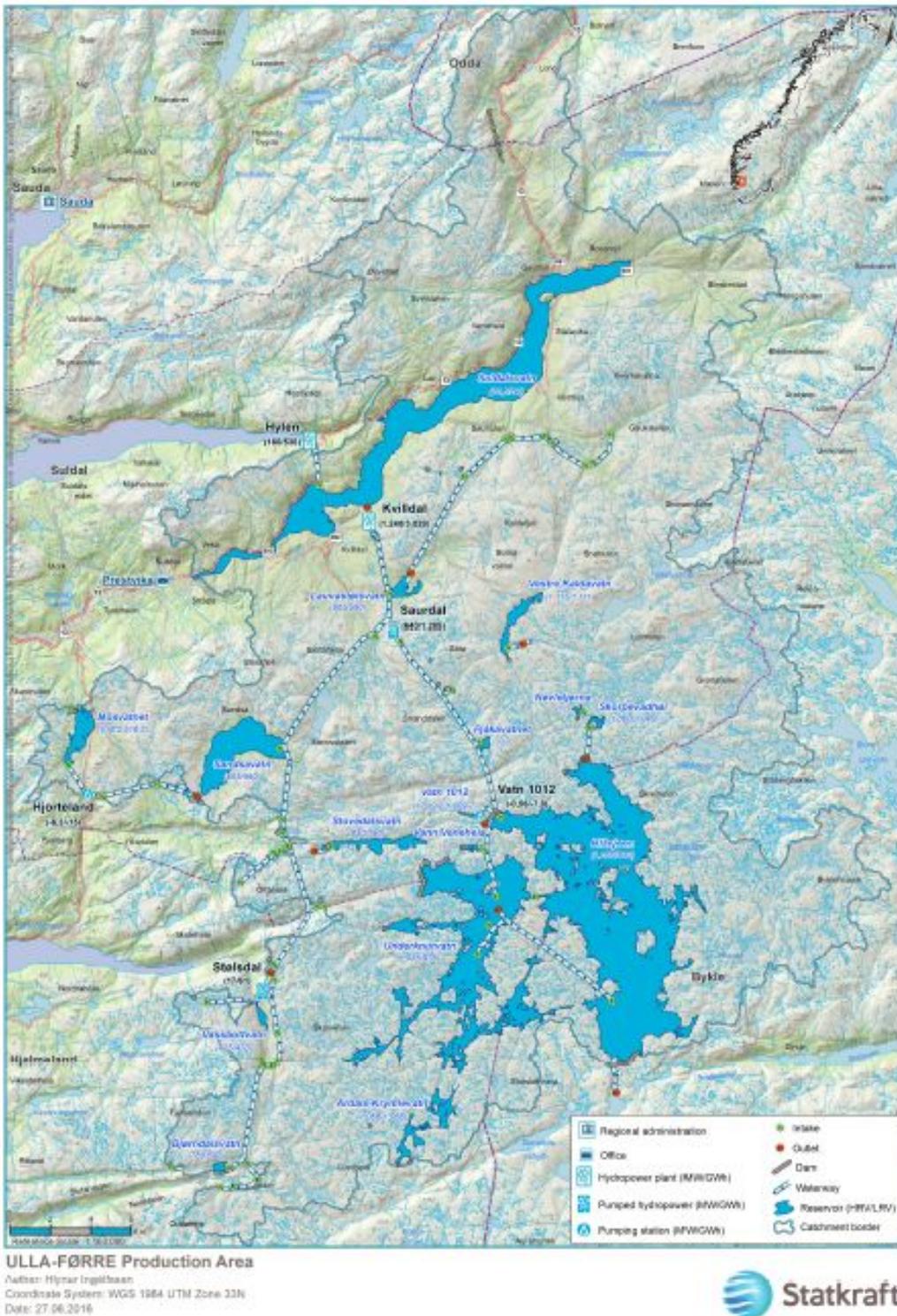


Figure 1. Map of the Saurdal hydropower plant and the larger production area. Map provided by Statkraft and included with permission (a higher resolution image available upon request).

| Periode | Vannslipp ved Suldalsosen | Utfyllende kommentarer |
|-------------------------|---------------------------|---|
| <i>Vinterperiode</i> | | |
| 1/12-10/4 | 12 m ³ /s | |
| <i>Vår og forsommer</i> | | |
| 11/4-24/4 | 20 m ³ /s | |
| 25/4-30/4 | 20-200 m ³ /s | Vannføring økes til 200 m ³ /s i løpet av to døgn (25-26/4). Holdes 4 døgn (27-30/4) for så å bli redusert. |
| 1/5-5/5 | 20 m ³ /s | Vannføringen reduseres fra 200 til 20 m ³ /s. |
| 5/5-14/5 | 20-100 m ³ /s | Vannføring økes til 100 m ³ /s i løpet av to døgn (5-6/5). Holdes 7 døgn for så å bli redusert. |
| 15/5-30/6 | 42 m ³ /s | |
| <i>Sommer</i> | | |
| 1/7-30/9 | 60 m ³ /s | Pendle mellom 40 og 80 m ³ /s. Det totale slippvolum skal tilsvare et gjennomsnitt på 60 m ³ /s i perioden. |
| <i>Høst</i> | | |
| 1/10-15/10 | 50 m ³ /s | |
| 16/10-30/10 | 35-200 m ³ /s | Innenfor perioden 16. oktober til 30. oktober skal det slippes to flommer på 200 m ³ /s, begge med varighet på 24 timer. Mellom og etter flommene skal det slippes 35 m ³ /s. |
| 1/11-14/11 | 35 m ³ /s | |
| 15/11-30/11 | 19 m ³ /s | |

Figure 2. Flow regulation in Suldalslågen river in winter, spring, summer and autumn. Taken from the official concession documents and shared here with owner's permission.