

Environmental improvement through revision of terms of hydropower licences

To improve environmental conditions of old hydropower licences and to implement the objectives of the European Water Framework Directive in Norway, revision of the terms of licenses is considered the most important instrument. We examined the completed revisions to give an overview of processes, content and outcomes. The first completed revisions were long-lasting processes. They incorporated the claims of the interest groups to a varying degree while often seeking “middle ground” solutions that had low impact on hydropower production. Future revisions could be improved by conducting more structured, empirically based analyses of costs and benefits. More holistic assessments of all licenses in the river basin could enhance the outcome. Including the potential for upgrading and extending the hydropower production in a systematic way, will further improve the results.

Hydropower (HP) delivers currently 96% of the Norwegian electricity consumption. It is a renewable source of energy, but can entail an impairment of the ecological conditions, recreational use and aesthetics in and along rivers and lakes. Currently, around 70% of the large Norwegian river and half of the country's total water-covered area are impacted by HP (Norwegian Environment Agency 2017).

Before 2022, approximately 430 HP licences are due for revision in Norway, potentially enabling change in environmental flow requirements, reservoir regulations and other mitigating actions (NVE 2013). These revisions provide the possibility to weigh the costs and benefits of HP production for the environment and society after 50



Dam in the Tesse reservoir.
Photo: GLB

years of operation¹. License revisions are also the most important instrument to implement the European Water Framework Directive (WFD), statutory by the Norwegian "Vannforskrift" (2006).

We analysed the completed revisions of license terms by assessing the documents issued by the HP companies, all public hearing documents, the recommendations given by the Norwegian Water Resources and Energy Directorate (NVE) and the final decision/royal decree by the Norwegian Ministry for Petroleum & Energy (OED). These comprised exclusively documents that were either publicly accessible or accessible from NVE's archive. Our analysis aims to inform and support the future work on HP license revisions. Despite the large poten-

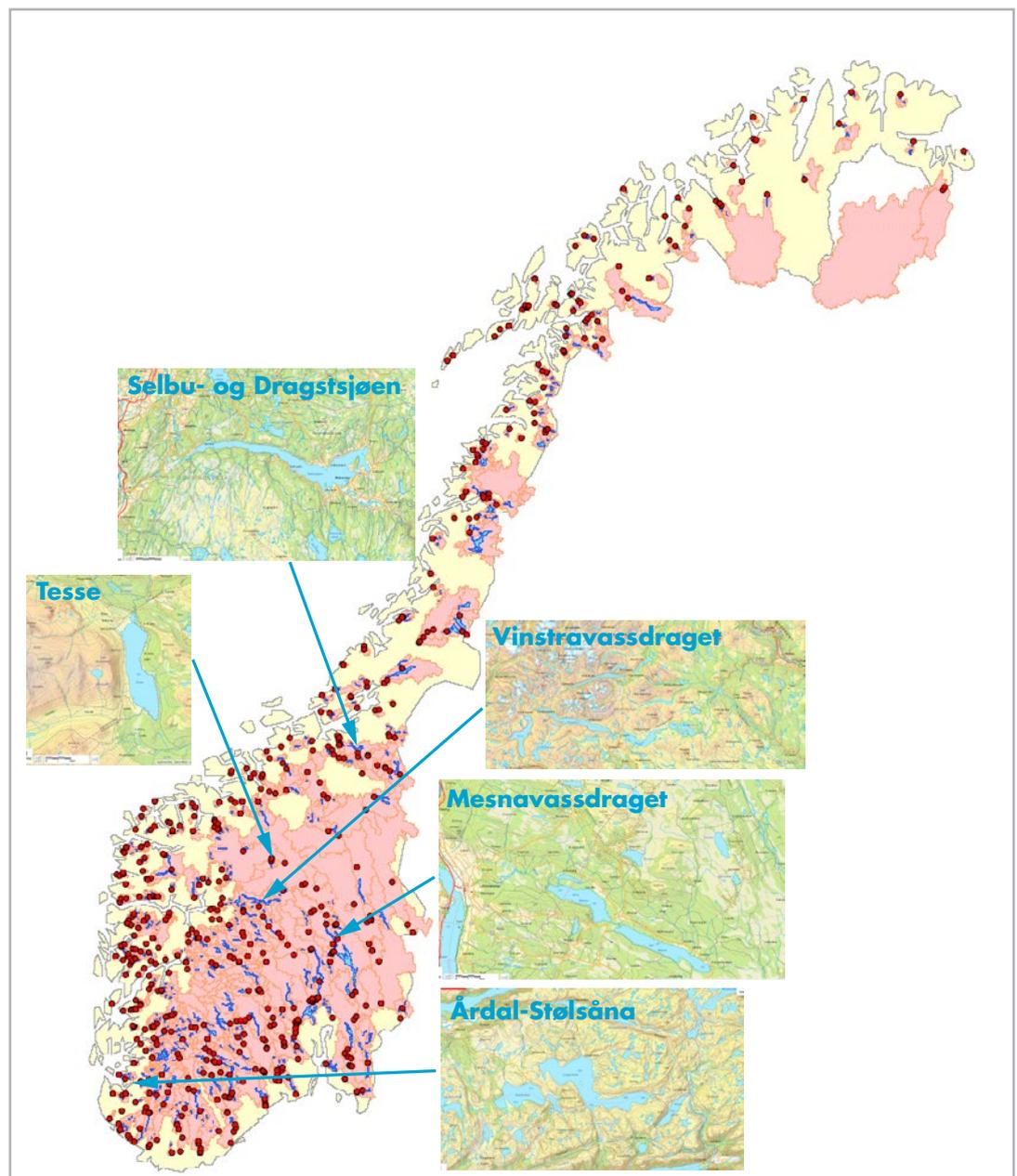


Figure 1. Geographical overview of the completed revisions.

¹ The revision interval was reduced to 30 years for licenses granted after a change in law in 1992..

tial, revision processes have been opened for only 43 watercourses, and only 6 revisions have been completed. **Figure 1** gives an overview over these revisions.²

The affected municipalities placed the request for licence revision, except in the Tesse and Mesna cases (**Table 1**). The power company (GLB/Mesna Kraftsselskap) itself called for revisions probably because these cases included not only revision of terms for licenses of unlimited duration but also renewal of time-limited licences. All revision cases have taken a long time with a duration from 12 years (Vinstra) to 25 years (Mesna). **Table 1** indicates that it is often difficult to state the exact production capacity (in GWh/year) for a single revision, and different documents give partially deviating numbers.

Table 1. Overview over general aspects that describe the completed revisions. (Abbreviations: power plant/s=PP; Tesse regulation=TR)

REVISION CASE	VINSTRÅ	TESSE	SELBU-/DRAGSTJØEN	ÅRDAL-STØLSÅNA	MESNA
Company holding the license	GLB	GLB	TEV/Statkraft	Lyse AS	Mesna kraftselskap/ GLB
Licenses included in the revision	Regulation Bygdin, Vinsteren, Olstappen, Kaldfjord; regul. & transfer Nedre Heimdalsvatn/Øyangen	«large» TR in connection with licence renewal for the «small» TR	Regulation of Selbusjøen and Dragstjøen	Regulation of the Årdal and Lyse river basin; transfer of parts of Årdal river basin to Stølsåna	Reinsvatnet, Mell- and Kroksjøen; Nord- and Sør-Mesna; Sjusjøen; transfer of Brumunda
Year(s) of licenses	1928-1956	1941	1919	1948	1920/1954/1957
Potential of power production in GWh/year	1306 for all reservoirs (GLB 1996)	167,3 («large» TR) +25 («small» TR) = 182,3 (NVE 2003a) 204 for all PP (NVE 2013) 98-182 towards regulated 280 (OED 2011)	1010 (TEV/NVE 2003b) 621 Bratsberg PP + 110 Svean PP (NVE 2013) + 30 Løk-aunet PP (Statkraft 2017) =761	1242 i Lysebotn PP (resp. 1422 i Lysbotn PPII) (Lyse; OED 2015) 1209 i Lysebotn PP (NVE 2003c) 1300 Lysebotn PP & 54 Breiava PP (NVE 2013)	175,5 (NVE 2003d) 167 (Mesna KS 1991) 161 (NVE 2013)
Estimated production loss (NVE 2013)	-	-	5-20 GWh/year, < 5 % of total production	75-100 GWh/year, < 5 % of total production	< 5 GWh/year, < 5 % of total production
Claim for revision from	Vang municipality/ Concession committee for Vinstra watercourse/Nord-Fron	GLB	Tydal municipality (also on behalf of Selbu & Klæbu municipalities)	Hjelmeland municipality; Alf A. Lyse (private person)	Mesna Kraftsselskap (claim for renewal)
Year revision claimed/opened	1996/2000	1993/1994	1999/2001	1998/2000	1991/1991
Recommend. NVE	24.01.2003	15.07.2003	17.11.2003	26.03.2003	2003 and 12.11.2015
Final decision (OED/royal decree)	10.12.2008	25.10.2011	11.03.2014	17.04.2015	24.3.2017

² The 6th revision (Veo-transfer) is closely linked to the regulation of the Tesse reservoir and comprised solely the introduction of standard terms for nature management. We excluded it since we analysed here only the most comprehensive revisions. At present date, NVE has given a recommendation for a 7th revision (Skoddebergvatn). We have not included it in this policy brief since it is still awaiting OEDs final decision/royal decree.

A number of user interests were represented in the revisions, but they differed in importance (**Table 2**). Fish and fishing were of most importance in all cases, but also recreation and landscape perception/aesthetics were relatively important. Other, more delimited interests had high importance in single cases, e.g. agriculture (Tesse) and the red listed freshwater pearl mussel (Selbu-/Dragstsjøen). Except for the freshwater pearl mussel in the Selbu case, there was little focus on biodiversity beyond fish. "Flood security" was not of large public interest since it was mainly brought forward by the power companies in the revision processes. The interests "reliability of power supply" and "power balance" were brought forward by the power companies, NVE and OED as arguments to reduce/omit minimum flow release or to have less stringent reservoir restrictions, but without specifying loss or gains of different alternatives. Most of the cases were characterised by the same interest groups and bodies entitled to comment in the public consultation. It was mainly the municipalities, land owners/rights holders and local or county sections of the central environmental NGOs (DNT, NNV og NJFF), county administrations, county authorities and the Norwegian Environment Agency that were engaged in promoting environmental interests. National and regional cultural heritage authorities became involved only in cases that handled issues with a clear cultural heritage agenda (all cases except Årdal-Stølsåna).

Table 2. List of user interests that were involved in licence revisions and level of importance in the revision according to our evaluation of the analyzed documents (all hearing documents as archived by NVE, NVE`s recommendation, and OED`s final decision).

(red = high importance; orange = medium importance; green = low importance; white = no importance) (MFR = minimal flow release)

Interest	Revision	VINSTRA	TESSE	SELBU-/DRAGSTSJØEN	ÅRDAL-STØLSÅNA	MESNA
Fish and fishing		Trout			Atlantic salmon	
		European whitefish & minnow			Sea trout	
Other biodiversity		General	General, birds	Freshw. pearl mussel; birds; general		General; game, birds
Recreation, tourism and traffic		General; boat use; ice & security issue	Fishing; boat use; erosion; cultural heritage	Fishing; canoeing; hiking/paths; bathing	General; boat use; path accessibility to reservoir	General; fishing, bathing
Landscape perception/aesthetics		Low water level; large regulation zones/erosion	Low water level and large regulation zones/erosion	Visible regulation zones/erosion	Too low MFR; new technical structures (power plants)	Too low MFR; large regulation zone/erosion
Agriculture				³		
Cultural heritage		Erosion, mapping and protection	Erosion and protection	Low MFR; mapping/public info		Low MFR/cultural history
Flood security						
Power balance/reliability of supply/renewable energy		General	Regulating reservoir	Regulating reservoir	General	
Water quality			Siltation			Sewerage recipient
Other aspects		Clearing; marking of water level; local climate change	Holistic evaluation (incl. revision of Veo-transfer)		Erosion of Strandvatn reservoir	

³ Agriculture is indirectly concerned by flood security considerations that had medium importance in this case. Since this concern was not explicitly expressed in the analyzed documents (i.e. by the interest groups, NVE or OED), it is nevertheless classified here as of "no importance".



Figur 2. Illustration of examples of typical conditions in reservoirs and river reaches that revision of terms aim to amend. 1) Bygdin reservoir (Vinstra river basin); 2) River with restricted minimal flow release (River Måna); 3) Low water level at Selbu lake; 4) Erosion zone in Strandvatn (Årdal-Stølsåna river basin). Photo: 1 and 3 LVK, 2 Asbjørn S. Torgersen, 4 Karianne Lundgaard

The analysis also showed that in all cases it was difficult to distinguish between the different interests. Claims for various measures – especially related to fish, fishing, biodiversity (general environmental interests), recreation and landscape – were often argued for with regard to several of these interests (with the exception of the freshwater pearl mussel in the Selbu-/Dragstsjøen case). These were mostly impacted by lack of or very restricted minimum flow release (MFR) and the operation of the reservoirs (OR). The terms of the revised licenses to improve these challenges were therefore also the most central ones in all revision cases

Table 3 gives an overview over the claims for terms that can affect future power production by the interest groups in the consultation rounds for new terms (green fields). These are related to 1) minimum flow release in the impacted river reaches and 2) the operation of the reservoirs. **Table 3** shows further the recommendations by NVE (blue fields), the final decision by OED/royal decree (red fields) and the resulting expected

Table 3. Claims and decisions related to revised terms with effect on hydropower production. (Abbreviations: minimum flow release in the impacted river stretches = MFR; operation of the reservoirs = OR; general low water discharge = GLWD; North = N; South = S).

CASE	VINSTRÅ	TESSE	SELBU-/DRAGSTJØ	ÅRDAL/STØLSÅNA	MESNA
Claims of the interest groups	<p>MFR: claimed for all river reaches; more studies</p> <p>OR: filling of Olstappen to quota 666,5 from 1. May</p>	<p>MFR in Tessa river: volume not specified</p> <p>OR Tesse: summer < quota 853,87 until 15.9.; filling < quota 853,4 before 1.9.; higher spring and summer water levels</p>	<p>MFR from Ss to Hyttfossen: 3-10m³/s summer</p> <p>MFR from Ds: 0, 1 m³/s</p> <p>OR Ss: >quota 158 from 1.5.quota; 160 from culmination of spring flood/10.6. until 31.8.; > quota 159,3/159,5 1.9.-31.10.;</p> <p>OR Ds: summer > quota 262 - 262,5</p>	<p>MFR Årdal: 4m³/s summer; 1,5-2m³/s winter (both at Nes); studies on utilisation of MFR in new mini power plants</p> <p>MFR Stølsåna: 0,5-1 m³/s summer; 0,2m³/s winter</p> <p>OR Strandvatn & Nilsebvatn: more stable</p>	<p>MFR Reinsvatnet/Mellsjøen/Kroksjøen: 0, 1m³/s/0, 12m³/s/0, 15m³/s June-Sept.; 0,05m³/s/0,06m³/s/0,07m³/s rest of year (up to 0,2m³/s for all 3 lakes for whole year</p> <p>MFR Sjusjøen: 0, 1 m³/s June-Sept.; 0,05 m³/s rest of year</p> <p>MFR S-Mesna: GLWD</p> <p>MFR N-Mesna: 1 m³/s summer; 0,6m³/s winter</p> <p>OR N-Mesna: lower summer water level</p> <p>MFR all reaches: max 10cm/t variation in discharge; trial period</p>
Recommendations of NVE	<p>MFR Kaldfjorden-Vinstra river: 1-3 m³/s July-Sept. (trial regulation)</p> <p>MFR all other reaches: no</p> <p>OR Olstappen: no</p>	<p>MFR Tessa river: no</p> <p>OR Tesse: < quota 853,67 from end of tapping season until 1.9.</p>	<p>MFR Ss to Hyttfossen: 1,4m³/s 1.6.-31.8.</p> <p>MFR from Ds: no</p> <p>OR Ss: > quota 160 from culmination of spring flood until 31.8.; > quota 159,3⁴ 1.9.-31.10</p> <p>OR Ds: all water to storage 1.1.-31.10.; tapping possible 1.11.-31.12.</p>	<p>MFR Årdal: 2 m³/s 1.6.-15.9.; 1 m³/s 16.9.-31.5. (NVE 2003); NVE revised in 2014 to 3 m³/s and 1,5 m³/s, respectively) (all at Kallveit)</p> <p>MFR Stølsåna: none</p> <p>OR Strandvatn & Nilsebvatn : no changes</p>	<p>MFR Reinsvatnet/Mellsjøen/Kroksjøen: 0, 1m³/s/0, 12m³/s/0, 15m³/s June-Sept.; 0,05m³/s/0,06m³/s/0,07m³/s rest of year</p> <p>MFR Sjusjøen/S-Mesna: no/no</p> <p>MFR N-Mesna: 1 m³/s June-Sept.; 0,6m³/s rest of year</p> <p>MFR Brumunda: 0, 1 m³/s entire year</p> <p>OR N-Mesna: <quota 519, 19 June-Sept.</p> <p>MFR general: softer variation in discharge; no trial period</p>
Final decision by OED / royal decree	<p>MFR fra Kaldfjorden til Vinstra river: 1-3m³/s July-Sept. (trial regulation); 0,5m³/s 1.10.-30.6.</p> <p>MFR all other reaches: same as NVE</p> <p>OR Olstappen: same as NVE</p>	<p>MFR Tessa: none</p> <p>OR Tesse: water level > quota 850,67 until 1.7.; thereafter constant filling; from end of tapping season < quota 853,67 until 1.9.</p>	<p>MFR Ss to Hyttfossen: same as NVE;</p> <p>MFR from Ds: 0, 1 m³/s (10-year trial period)</p> <p>OR Ss: same as NVE</p> <p>OR Ds: same as NVE; tapping permitted 15.6.-31.10. if water level > quota 261,87</p>	<p>MFR Årdal: 2 m³/s 15.5.-14.10.; 1,5 m³/s 15.10. -14.5.</p> <p>MFR Stølsåna: same as NVE</p> <p>OR Strandvatn & Nilsebvatn: same as NVE</p>	<p>MFR Reinsvatnet/Mell-/Kroksjøen/Sjusjøen/S-Mesna/N-Mesna/Brumunda/ general: same as NVE</p> <p>OR N-Mesna: same as NVE</p>
Estim. average production loss (GWh/year) / % total prod.	<p>12 (MFR summer/2m³/s) + 9,6 (MFR winter) = 21,6</p> <p>1,7 % (assumed prod. 1306 GWh/year)</p>	<p>< 11 (tapping restrictions) <3,5 (water level summer) = <11⁵;</p> <p>< 3,9-6 % (assumed prod. 182,3-280 GWh/year)</p>	<p>10-20 (OR Ss) 1,2 (MFR to Hyttfossen) = 11,2 - 22,2;</p> <p>1,1 - 2,9 % (assumed prod. 761-1010 GWh/year)</p>	<p>20-30 (MFR) Årdal</p> <p>1,4-2,4 % (assumed prod. 1242-1422 GWh/year)</p>	<p>~0 (MFR; Reinsvatnet/Mell-/Kroksjøen/Sjusjøen/S-Mesna/N-Mesna) 1 (Brumunda)</p> <p>0,6 % (assumed prod. 161-175,5 GWh/year)</p>

⁴Adjusted to the official height system (NN 1954) are quotas 160/159,3. They were the former quotas 156, 87/156,17. These quotas can deviate in order to uphold MFR of 30 m³/s at Svean power plant.

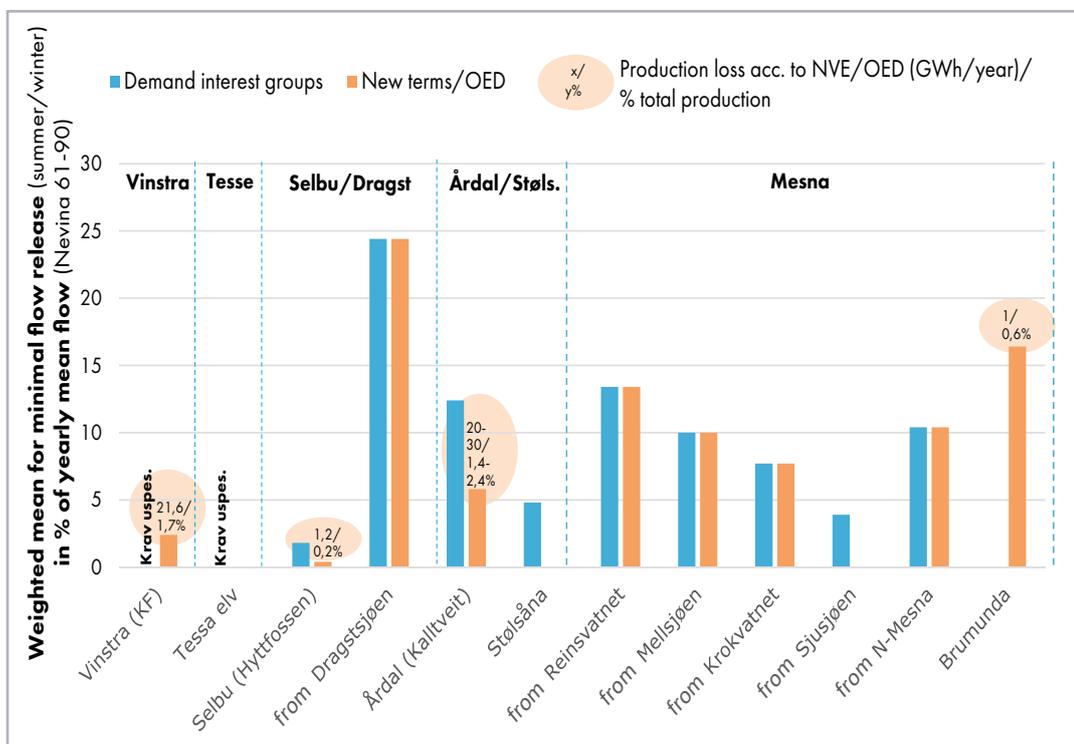
⁵Due to the combination of the renewal of licenses (for the "small" TR and the private owners in the "large" TR) and the revision of terms (only for the public partners in the "large" TR) it is not possible to define the actual estimated loss of production. Our estimate is therefore the maximum production loss related to the revision of the "large" TR if one does not relate it to the respective parts of the licences. (i.e. max. 11 GWh/year = 3,9-6% of total production)

power loss (orange fields). As **table 3** indicates, the claims of the interest groups for new terms were to a varying degree taken into account in the resulting new terms of license. In the Vinstra and Selbu-/Dragstjøen cases a period of trial regulations was introduced to improve the knowledge base of the effects of new MFR and the subsequent environmental conditions in and along the river.

The estimates for the average loss of production in GWh/year and the percent of the loss in total production resulting from the new licence terms are uncertain due to the difficulties to pinpoint precise production potential or unclear/changed inflow of water into the reservoirs (as for example in the case of the Årdal-Stølsåna revision). Notwithstanding do these estimates indicate that the loss of power production based on the new terms is significantly less than the gross estimates provided by NVE, listed in **table 1**. The calculation of the total resulting production loss⁶ in relation to the production potential shows that it was substantially lower than 5% (the average estimated in NVE 2013) and as low as ~0,6% in the Mesna case. This order of magnitude is also visible in the relationship of the yearly mean flow and the requested/granted minimal flow release together with the respective estimated production loss (**figur 3**).

There were also claims placed and new terms given that have no effect on power production, but that nevertheless imply costs for the licence holders. These claims/terms comprised three types:

- 1) economic compensation for effects of power production on fish/fishing, recreation and landscape perception (e.g. business/compensation/agricultural funds, facilitation funds for fish/game and recreation, or adjustment of licence taxes);
- 2) standard terms for a range of subjects (e.g. nature management; weirs/ramps; pollution; accessibility/transport; cultural heritage; clearing and marking of ice);
- 3) other terms related to mitigation measures (e.g. development of a hiking path network around the reservoir).



Figur 3. Order of magnitude for demanded and granted minimal flow releases in relation to the yearly mean flow in the respective river and estimated production loss.

⁶Numbers for production loss as stated in the analysed revision documents

Economic compensation was granted only in the form of funds for promoting fish, game and recreation in the first cases (Vinstra and Tesse), and in the Mesna case. Standard terms for nature management and several other subjects were introduced in all revisions.

We also analysed important organisational aspects of revisions. Here, the relevant questions were:

- 1) whether the revision assessments were done comprehensively for the entire watercourse (across several licences)
- 2) whether the possibility to combine the single revisions with potential plans for upgrading and expansion of existing power plants in the same area was taken into account.

Both aspects are explicit objectives for licence revisions according to the OED revision guidelines (OED 2012).

We found that even though interest groups placed the claim to assess the river basin more inclusively in the Tesse, Selbu-/Dragstjøen, Årdal-Stølsåna and Mesna cases, they were not treated com-

prehensively. A complete assessment of all licences in the respective river basin was only done in the Vinstra case even if some of the revised licences were less than 50 years old⁷. The revision assessments were not combined with existing upgrading/extension possibilities, or plans for new power plants, despite this was possible in the Tesse, Selbu-/Dragstjøen and Årdal-Stølsåna cases.

In sum, we find that these first completed licence revisions were long-lasting processes. The claims of the interest groups that were raised in the public hearing were taken up to a varying degree, reflecting that decisions did seek compromise and "middle ground" solutions, with low impact on hydropower production. An alternative to the described practice would be to conduct more structured, empirically based analyses of costs and benefits, looking across all licences and including the whole watershed, including potential for upgrading and extension. Such practices would also to a larger degree be in accordance with overall objectives put forward by the Ministry for Petroleum and Energy (OED 2012).

⁷It is possible to deviate from the 50-year limit of licenses that can be taken up for revision according to OEDs revision guidelines (OED 2012).

Facts about the SusWater project:

SusWater - Sustainable governance of river basins with hydropower production. The project aims to look at different ways towards a water resources management in regulated watercourses that can be accepted both locally and nationally.

SusWater follows a knowledge- and dialogue-based approach in order to strengthen a management practice that includes economic, social and environmental dimensions. An important objective is to develop a decision support tool that can help to build acceptance for good and more holistic solutions. Work package 4 works on the question of how decision-support methods and procedures can be optimised at the water-body and river basin scales.

Project duration: 2016-2018

SusWater has a budget of 17 Mill. NOK and is financed by the ENERGIX-programme in The Research Council of Norway, industry and administration.

Read more:

Köhler, B., Aas, Ø., Ruud, A. (subm.) **Hva kan vi lære fra gjennomførte vilkårsrevisjoner av vannkraftkonsesjoner i Norge? En dokumentanalyse av resultater, prosess og kunnskapsgrunnlag.**
Kart og Plan

CEDREN website: <http://www.cedren.no/Projects/SusWater>

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