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Swedish hydropower and the EU Water Framework Directive

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CEDREN
Centre for Environmental Design of Renewable Energy

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ABBREVIATIONS

CIS	Common Implementation Strategy
GEP	Good ecological potential
GES	Good ecological status
HMWB	Heavily modified water bodies
MEP	Maximum ecological potential
MLQ	Mean low flow
PoM	Programme of measures
SEA	Swedish Energy Agency
SwAM	Swedish Agency for Marine and Water Management
WFD	EU Water Framework Directive
WAR	Water Activity Review

ABOUT CEDREN

CEDREN – Centre for Environmental Design of Renewable Energy: Research for technical development and environmental impact of hydropower, wind power, power lines and implementation of environment and energy policy.

SINTEF Energy Research, the Norwegian Institute for Nature Research (NINA) and the Norwegian University of Science and Technology (NTNU) are the main research partners. A number of energy companies, Norwegian and international R&D institutes and universities are partners in the project.

The centre, which is funded by the Research Council of Norway and energy companies, is one of 11 Centre for Environment-friendly Energy Research (FME). The FME scheme consists of time-limited research centres which conduct concentrated, focused and long-term research of high international quality in order to solve specific challenges in the field of renewable energy and the environment.

INTRODUCTION

The regulatory framework for hydropower development is currently under review in Sweden. The introduction of, and the obligation to implement, the European Water Framework Directive (WFD) has meant that several European Union member states need to re-evaluate the status of different water-related activities. Consequently, revisiting the regulatory framework for producing hydropower and changes to water flows is a key issue in countries such as Sweden where it is a major influence on the characteristics of rivers.

No final agreement has yet been reached between the stakeholders on how to balance multiple objectives in the management of hydropower. A key issue at the national level is how to maintain energy security while preserving and enhancing ecosystem goods and services. The regulatory frameworks related to these two concerns appears to conflict, with overlapping directives, policies and laws.

Sweden depends on hydropower for electric power generation. About half of all electricity produced in the country originates from hydropower resources (Swedish Energy Agency 2016). However, the legal framework in which the hydropower plants operate in Sweden is outdated. An ongoing national review on sustainable operation of hydropower constitutes the largest effort to review the policy framework for hydropower generation since the early 20th century (Lindqvist 2013). A wide spectrum of actors in the Swedish energy and environment landscape are involved in the review.

1.1 This paper

This working paper provides an overview of ongoing processes in Sweden intended to aid implementation of the 2000 European Water Framework Directive (WFD; Directive 2000/60/EC) in relation to hydropower generation, meeting both WFD and national targets.

The paper explores how Sweden currently addresses trade-offs between different objectives of preserving good water and environmental status while at the same time striving to meet requirements for renewable energy and targets set to mitigate climate change, as defined in the WFD and also in other relevant EU directives.

It describes and assesses the development of relevant contemporary national regulatory systems, strategies and policies. It further aims to provide insight into how Sweden interprets relevant key concepts introduced by the WFD and what can be said to be desired outcomes of different measures suggested therein. In addition, the paper seeks to identify research gaps or relevant issues where the overall process can be strengthened.

The paper is based mainly on an extensive literature review of sources relevant to the recent development of sustainable hydropower generation in Sweden. Much of this literature consists of strategic and guiding documents issued by national responsible authorities. This literature review has been complemented with online searches of relevant news outlets and other web-based information, in order to take into account recent developments and perspectives from specific stakeholders.

Section 2 describes the current regulatory arrangements for hydropower in Sweden, and the implications of the WFD. Section 3 surveys recent and current processes designed to update these arrangements in line with the Swedish Environmental Code, the WFD and other EU Directives. It includes summaries of some key proposals and guidance documents that are so far available only in Swedish. Section 4 picks up and discusses some key issues emerging from these processes, along with a short survey of how and how far recent judicial rulings related to hydropower in Sweden reflect the evolving EU and national legislation and have interpreted key issues. Section 5 offers some conclusions. Annex 1 provides a map of the current governance arrangements for hydropower in relation to the WFD in Sweden.

2 THE SWEDISH REGULATORY CONTEXT AND IMPLICATIONS OF THE WFD

Sweden adopted new environmental legislation in 1999, the Environmental Code (Miljöbalken; Statute 1998:811), and a new type of legal instrument was introduced: environmental quality standards. These quality standards were originally designed to address problems related to diffuse pollution and to be applied at various scales. Rather than imposing specific restrictions on human activities, the standards set targets for the desired status of different aspects of the environment: air quality, water quality and so on. These standards were based on scientifically determined criteria and were consequently linked to the evolving European Union standards. Also in 1999, the Swedish Parliament decided on 15 (later 16) national Environmental Quality Objectives. It also adopted the so-called Generational Goal, which in its current iteration states that "The overall goal of Swedish environmental policy is to hand over to the next generation a society in which the major environmental problems in Sweden have been solved, without increasing environmental and health problems outside Sweden's borders".[1]

The Environmental Quality Objectives are divided into subcategories, each with different sets of indicators. The most immediately relevant to hydropower impacts is Objective 8, "Flourishing lakes and streams", which has 11 indicators.[2] These existing indicators have, however, been deemed too vague and unsuitable to provide an overall view of the current state of Swedish lakes and water bodies, and thus for assessing progress towards water targets (Degerman et al. 2015).

The WFD was transposed into Swedish law, and specifically the Environmental Code, in 2004 through the Ordinance on Water Quality Management (Ordinance 2004:660). This can be seen as a key step in strengthening and making more specific the legal framework for environmental issues, while also addressing the newer EU requirements introduced through the WFD.

A subsequent regulation, 2007:825, assigned Swedish county administrative boards (*länsstyrelser*) to establish five national water districts (*vattendistrikt*) in accordance with WFD requirements.[3] When the first official planning cycle of WFD implementation (2009–2015) was launched, the five districts had decided on River Basin Management Plans (RBMPs) for all districts, including environmental quality standards to reach water quality objectives for all surface and groundwater resources in Sweden. The water quality classification system of the WFD was adopted for these environmental quality standards.[4]

2.1 Implications of the WFD for Swedish hydropower

Given the new environmental legislation in Sweden and the WFD, questions about how to assess the value and impacts of hydropower have become increasingly pertinent. Several of the Environmental Quality Objectives are highly relevant for hydropower generation, beyond "Flourishing lakes and streams".

Sweden has just over 2000 hydropower plants, most with a capacity below 10 MW, which have an annual output of approximately 64 TWh – about half of the country's electricity consumption. This corresponds to about 1000–1200 defined water bodies with hydropower installations on them (SwAM 2012a). Taking a river system perspective, about 80% of Sweden's river systems have hydropower installations on them.[5] An additional 5000 dams for other purposes also exist in Swedish water courses (SwAM 2012a).

1 See http://www.miljomal.se/Environmental-Objectives-Portal.

2 These are (freely translated): Good ecological and chemical status; unexploited water courses; quality of surface waters; ecosystem services; structures and water flow; preservation and genetic variation; threatened species and restored habitats; invasive species and genome types; genetically modified organisms; preservation of natural and cultural values; and outdoor life. The Swedish Agency for Water and Marine Management (SwAM) is responsible agency overseeing the "Flourishing lakes and streams" objective. See http://www.miljomal.se/Environmental-Objectives-Portal.

3 These 5 are: Norra Östersjöns vattendistrikt, Västerhavets vattendistrikt, Södra Östersjöns vattendistrikt, Bottenhavets vattendistrikt, Bottenvikens vattendistrikt. Each has its own dedicated authority (*vattenmyndighet*).

4 On the implementation status of River Basin Management Plans in Sweden see http://ec.europa.eu/environment/water/participation/map_mc/countries/sweden_en.htm.

5 http://www.wwf.se/wwfs-arbete/wwfs-arbete/1582825-projektkarta-strommande-vatten-och-vattenkraft.

About 90% of hydropower concessions active today in Sweden were granted long before modern environmental legislation with implications for hydropower generation was enacted (Rudberg 2013). This means that the Water Law of 1918, which was designed largely to enable rapid development of hydropower generation to meet burgeoning demand, regulates most of the current hydropower capacity in the country (including on key issues such as water diversion from rivers and reservoir impoundment). Permits granted prior to the introduction of the Environmental Code are essentially open-ended and have legal force for all parties (Rudberg 2013). As a consequence, many measures incorporated in modern hydropower practice designed to promote ecological sustainability – such as fauna passages and minimum flow rates – are not common among the active concessions.

EU directives can sometimes conflict with each other. This is particularly true for several EU targets relating to quality of aquatic environments and biodiversity, on the one side, and targets on limiting climate impacts, on the other. Perhaps the foremost example of this is the perceived conflict between the WFD and the EU Renewable Energy Directive (2009/28/EC), which is very evident in relation to hydropower in Sweden. Hydropower is the dominant source of renewable electricity in Sweden; but its implementation needs to be harmonized with broad water ecological standards. Particularly relevant to this is the interpretation of "good ecological potential" (GEP; see below), which was introduced in the WFD and the Swedish Ordinance on Water Quality Management but currently lacks any coherent definition in the Swedish context.

2.2 EU criticism of Swedish WFD implementation in relation to hydropower

The European Commission has several times criticized Sweden about a number of aspects of its implementation of the WFD since 2007. One recurring criticism has revolved around the allegedly inadequate or incorrect transposition of EU law into Swedish law regarding water use issues. Among issues cited relevant for hydropower is faulty application of Article 4.7 of the WFD; the EU argues that Sweden has granted permits for activities that do not meet the critieria for exemption from reaching Good Ecological Status (see below). Sweden has countered that these cases were all in line with the Ordinance on Water Quality Management. However, the EU has maintained that the legal grounds for granting new permits are still unclear. Another criticism relates to a perceived lack of clarity with regard to financial responsibilities and cost recovery in water-use activities (European Commission 2016; Bergh 2011).

The efforts to improve hydropower-related assessments described in this report can be seen as partly coming in response to this criticism.

3 OVERVIEW OF RECENT PROCESSES AFFECTING GOVERNANCE

This section provides a quick guide to some of the most significant recent and current processes that have significant implications for hydropower governance and environmental impact limitation in Sweden. It starts with a large-scale public consultation on hydropower governance, and then looks at a government inquiry into water-related activities, which made specific recommendations for hydropower. The appendix provides an organizational map illustrating the functions of and relationships between institutions involved in implementing the WFD in Sweden.

The next part of the section is devoted to detailed summaries of some significant recent documents that are currently available only in Swedish that explicitly respond to the WFD and other EU directives. In 2014, the Swedish Energy Agency (SEA) and the Swedish Agency for Marine and Water Management (SwAM) published a proposed national strategy for hydropower that aims for a balanced approach between the WFD (and Environmental Quality Objective 8) and the EU energy directives. In 2016, SwAM published recommendations related to one of the most critical issues in balancing implementation of the WFD: how to identify a water body with a hydropower installation as "heavily modified". The final guidance publication reviewed is SwAM-SEA recommendations on changes to the review process for hydropower concessions, published in 2015.

3.1 Consultative processes on hydropower governance

A key process to produce a broadly based national dialogue on hydropower was delegated to SwAM by the Swedish government in 2011. A consultative process involving diverse stakeholders, which ran from 2012 to 2016, sought to share perspectives on the current state of hydropower governance and what is needed to make it more sustainable. In parallel, different Swedish authorities have produced guidance documents in recent years (see later sections). The project group involved with organizing meetings as part of the dialogue consists of members from SwAM, the SEA, the Swedish Legal, Financial and Administrative Services Agency, energy industry organizations and relevant county authorities (SwAM 2012b).

Issues discussed at dialogue meetings are tied to the overarching aim of coordinating national targets on water, energy and culture where specific issues identified in previous years are carried on and explored further (SwAM 2015). The dialogue process crucially provides an opportunity that did not previously exist in Sweden for hydropower to identify points of agreement and conflict between stakeholders.

Earlier recommendations coming out of the 2014 cycle were the approval of a SwAM-SEA 2014 national strategy as a useful base to continue joint work. Another key outcome was an identified need to harmonize understanding of what detailed demands are actually put on operators and authorities by the WFD. It was also agreed that there is a gap between the existing law and interpretations made by the environmental court system. A more proactive stance, where courts put stronger focus on the balance between environmentally adjusted hydropower and the need for renewable energy, was requested (SwAM 2014).

The 2015 cycle centred on deepening understanding of recommendations in the 2014 SwAM-SEA national strategy. This included building on the proposed system of priority for river basins, enabling a drilling down to regional level (i.e. analyses at the scale of river basins and parts of river basins). An important component of that work was identifying appropriate environmental measures for specific basins (SwAM 2015). The 2015 dialogue concluded that recommendations produced by national agencies guiding hydropower governance were on the right track. Other conclusions were that pilot projects will be crucial to test recommended methods and that national authorities should be tasked with disseminating results of pilot projects as well as assuring the quality of the final programme of measures (SwAM 2016a)

Publications issued parallel to the dialogue process from concerned authorities – SwAM and SEA – address many of the issues raised through the dialogue meetings. These outputs include for example joint recommendations on the process of environmental permits and the suggestions on a financing mechanism.

3.2 The Water Activity Review

The Water Activity Review (WAR) was a governmental inquiry regarding new and changed legal frameworks for water activities that ran from 2012 to 2014. The WAR came in response to EU criticism of a perceived lack of Swedish commitment regarding aspects of implementing the WFD.

Key objectives included to review and propose updates to regulations on water-related activities and to explore how to harmonize differences in legal regulations between these and activities classified as "environmentally hazardous" (Water Activity Review 2014). The inquiry was carried out by a broad expert group representing a spectrum of actors engaged in hydropower development in Sweden, including representatives of the hydropower industry.

Its report (Water Activity Review 2014) included some recommendations for the hydropower industry that have proved controversial:

1. It recommended that all hydropower plants be required to acquire new permits in accordance with the Environmental Code, including those operating on licences granted under the Water Act of 1918. This recommendation has often been interpreted as a demand for minimum flows of water in river systems and an attempt to reduce drastic variations of high and low water levels in water storage reservoirs. The suggestions also imply compulsory use of fish ways, which currently only exist in about 10% of Swedish hydropower plants (Jensen 2012).

2. Another key recommendation was that hydropower concessions should be time-limited rather than practically open-ended, as is currently the case.

3. It was further suggested that hydropower be deemed an "environmentally hazardous" industry, and thus required to submit environmental management reports to relevant authorities regularly (Water Activity Review 2014).

The WAR recommendations are under review by the Ministry for the Environment and Energy and a proposition for new legislation is expected during 2017 (Älvräddarna 2017). The current government appears to be hesitant to act on them, however. It has been suggested that one reason for this is generally limited knowledge about energy- and climate-related consequences to the power system (Alskog 2014). This has motivated other concerned actors such as SwAM and SEA and a number of NGOs to produce information and knowledge to fill the information gaps, resulting in some key guiding documents on assessing how water quality and energy targets can be achieved in the Swedish context.

3.3 A proposed strategy for measures to balance environmental and energy goals around hydropower installations

The SEA and SwAM published a joint report in 2014: *Strategi för åtgärder inom vattenkraften: avvägning mellan energimål och miljökvalitetsmålet Levande sjöar och vattendrag* (Strategy for Measures in the Area of Hydropower: Balancing Energy Targets and the Environmental Quality Objective "Flourishing Lakes and Streams"; SEA and SwAM 2014). The study leading to the report assumed that EU directives on energy as well as environmental directives such as the WFD are of equal importance from a national perspective, but that meeting objectives for environmental quality and renewable energy in a future energy mix, with a possible increase of balance power, will demand some far-reaching societal decisions. The proposed national strategy thus aims to provide a framework for prioritization in regulating Swedish river basins, based on a system designed to determine the respective energy and environmental values of major Swedish river basins.

A central question for resolving conflict between the EU Directives in the context of hydropower is when a water body containing a hydropower installation can be considered a *heavily modified water body* (HMWB). The WFD states that, as a general rule, countries should aim to bring all domestic water bodies up to at least *Good Ecological Status* (GES; see Box 1) by 2015. However in cases where it is assessed that GES cannot be achieved by 2015 for one reason or another, extension of the deadline for reaching the target can be allowed to 2021 or 2027. HMWBs (and artificial water bodies) are exempt because they could not be brought to GES without *significant adverse effect* on valuable services to society: for example energy generation, irrigation, navigation or flood prevention. Instead, countries should seek to bring HMWBs up to *Good Ecological Potential* (GEP; see Box 1).

The SwAM-SEA strategy assumes that in defining significant adverse effect in the case of hydropower generation, the impacts on the national energy system as a whole needs to be taken into account, including baseload, balance power (real-time coverage of deviations between planned supply and actual demand) and regulation capacity (portion of river flow stored, allowing regulation of energy supply during seasonal flow variations; Försund and Hjalmarsson 2010).

The proposed strategy assesses the value of each major river basin in Sweden with hydropower installations, based on national environmental and energy targets

and assigned water quality indicators (mentioned in the section below) applicable in all relevant river basins. This exercise provides a foundation for evaluating what environmental measures can be implemented locally in the river basins to balance energy and environmental targets.

The assessment of river basins

The first step in assessing the value and appropriate environmental measures in a river basin used in the report involves selecting indicators with regard to both energy production and environmental priorities. For energy production, the chosen indicators are capacity, production, and regulation capacity. Water quality indicators utilize eight of the eleven indicators provided by the national Environmental Quality Objective Flourishing Lakes and Streams.[6] The data/parameters used for the energy indicators were gathered into an electronic database on existing hydropower plants with their main characteristics. The environmental data/parameters consisted mainly of GIS analyses from several sources, including Sweden's five water authorities. Much of the data was based on extrapolation from single water bodies to basin scale, due to resource constraints and the lack of data. Indicators were normalized on a scale from 0 (lowest) to 1 (highest), in order to overcome imbalances between used parameters and indicators due to different scales and units. Indicators have subsequently been aggregated by weighting in accordance to their relative importance in each assessed river basin.

Perhaps the most important outcome of the work is the definition of *significant adverse effect* on power production. The report proposes a threshold of 2.3% or 1.5 TWh loss of annual national hydropower power production due to measures taken to improve water quality. Measures also need to ensure no major disturbance to delivery of regulation and balance power. The calculations underlying the suggested 1.5 TWh limit simulated power production losses from different typical environmental measures (such as minimum flows and fish ways) given specific conditions, to come up with different scenarios of power loss. The cap also implies that strategic thinking is needed when implementing environmental intervention measures, that river basins of less importance to the energy system should be prioritized for environmental measures, and that measures employed should have as little impact on hydropower generation as possible.

One criticism of the strategy has been that impact on electricity generation is the deciding factor for environmental measures rather than water directives, national laws or environmental requirements (Jonsson 2015).

3.4 Guidance for identifying HMWBs in relation to hydropower

In 2016, SwAM published *Vägledning för kraftigt modifierade vatten med tillämpning på vattenkraft* (Guidance for Heavily Modified Water Bodies with Application to Hydropower; SwAM 2016a). It builds on work under the Common Implementation Strategy (CIS) for the Water Framework Directive[7] and European Commission Guidance Document 4 on the Designation of HMWBs (European Commission 2003a). This document is significant, since there is no common definition or method among EU member states on how to identify HMWBs.[8]

The guidance document suggests five steps as part of a unified approach to identify HMWBs and consequently how to assess Good Ecological Potential.

The first step is preliminary identification as an HMWB. If the physical characteristics of the water body are assessed as having been severely altered due to human activity, and if it seems unlikely that it could achieve Good Ecological Status, then it is preliminarily identified as an HMWB. Otherwise, it is classified as a "natural water body".

The second step, which includes several subcomponents, is an in-depth analysis to confirm this identification. First, there is an assessment of the potential for different environmental measures to bring the water body to Good Ecological Status. Initially, it is advised that measures that would be able to achieve

6 The 3 excluded indicators relate to quality of surface waters, invasive species and genome types, and genetically modified organisms, which the report deems unaffected by hydropower generation.

7 The Common Implementation Strategy for the WFD was agreed on by the member states, Norway and the European Commission shortly after the WFD came into effect. The need for a CIS reflects the transboundary nature of river basins and water resource issues, and the many common technical challenges countries face in implementing the WFD. Read more at http://ec.europa.eu/environment/water/water-framework/objectives/implementation_en.htm.

8 On recent EU work related to assigning HMWBs in relation to hydropower see Halleraker et al. (2016).

Box 1: Ecological Status and Ecological Potential

Ecological status and chemical status are the two dimensions for defining "surface water status" of a natural water body under the WFD (the overall status of the water body is set according to the poorer of the two). Annex V of the WFD sets out parameters for measuring ecological status in different types of surface water body, which are divided into three categories: biological, physicochemical and hydro-morphological. The ecological status levels are: high, good, moderate, poor and bad. Ecological status is in essence a measurement of the presence and quality of aquatic flora and fauna. According to the WFD: "Member States shall protect, enhance and restore all bodies of surface water … with the aim of achieving good surface water status at the latest 15 years after the date of entry into force of this Directive" (Article 4); which is to say, by 2015 if there are no reasons to apply time extensions or exceptions to reaching the status.

The reference condition for ecological status of surface water bodies, high ecological status, is also the highest ecological status or environmental quality standard in the Swedish system, and is loosely defined as the conditions of a comparable water source of pristine conditions. If there is lack of data on the parameters for defining ecological status, expert opinion will prevail.

An exception is made for HMWBs and artificial water bodies. For these, the equivalent classification scale is "ecological potential". The reference condition is Maximum Ecological Potential, described in CIS guidance as "the best approximation to a natural aquatic ecosystem that could be achieved given the hydromorphological characteristics that cannot be changed without significant adverse effects on the specified use or the wider environment" (European Commission 2003b). Member states should aim for Good Ecological Potential, in which estimated values for biological quality elements are only slightly below Maximum Ecological Potential (MEP), and physico-chemical conditions are such that they ensure ecosystem functions and meet environmental quality standards for specific pollutants. Criteria for ecological potential are also set out in Annex V of the WFD.

GES are identified. Then there is an assessment of whether these measures would have a negative impact on the water-using activity in the water body, and whether these impacts qualify as "significant adverse effect", (as well as whether the measures might have a negative effect on the environment at large). It should also be determined whether the societal value gained from the activity could be obtained in other ways, or in different locations, with less environmental impact. If it is assessed that measures to reach GES can be implemented without adverse effect on the activity in the specific context, the water body should be classified as natural; if not, the water body can be confirmed as a HMWB. The reasoning behind this classification is to be recorded in the river basin management plan.

When the water body has been confirmed as an HMWB, the ecological potential can be assessed. GEP is the lowest acceptable status of a HMWB. The first step in this assessment is defining MEP for the HMWB. MEP can be described in general terms as the conditions most closely resembling the ecological conditions of the closest comparable natural surface water body, but with consideration given to the fact that the water body needs to be heavily modified in order to continue a specific water-related activity. The next needed steps are therefore to assess the exact current ecological potential of the relevant water body; to determine measures to achieve GEP (or, put another way, to identify which of the measures needed to reach MEP can be considered unnecessary, as they would not bring substantial ecological good. GEP cannot be achieved by implementing no measures at all, as it is assumed that there will always be some measures that can bring significant ecological good to water bodies with hydropower, or ensure no further deterioration. Recommendations for environmental measures to be considered to reach GEP are presented in another SwAM report: Kling (2015) .

The 2016 SwAM guidance document offers additional recommendations based on CIS Guidance Document No. 4 on what can be considered the lower limit for conditions that should be delivered by measures to achieve GEP (European Commission 2003a):

- That upstream and downstream connectivity is maintained so that certain fish species can maintain a viable population in the long term.

- That sufficient connectivity is maintained with tributary water courses for fish species to reach crucial habitats during their lifecycle.

- That minimum discharge should be equal to at least mean low flow (MLQ) or at least 80 % of the "wet contact surface" is never drained.

- That the morphological state ensures that important habitats in the water body can maintain basic ecological functions.

As mentioned earlier, there are however cases where time extensions can be made in relation to the obligation to reach GEP by 2015 made or when less stringent environmental requirements can be called for. Then it must first be assessed if there is legitimate reason for this. If it is assessed that there are reasons to extend the deadline for when GEP should be reached, a new specific deadline must be set. If it is decided that less stringent demands are appropriate, the justifications need to be recorded.

3.5 Proposed changes to the environmental review process for hydropower concessions and scheme for financing environmental measures

In December 2015 SEA and SwAM built further on the 2014 proposed strategy for hydropower, addressing some outstanding issues in a new document that suggests how review processes for hydropower operating licences can be harmonized with modern environmental requirements (SEA and SwAM 2015). The document also provides suggestions for how this revised process can be financed. The suggested timeframe for when all Swedish hydropower should be brought up to modern environmental standards, in line with EU standards and with regular check-ups at the end of each six-year cycle of WFD implementation, is 20 years. In many regards, the proposal addresses many of the elements deliberated in the WAR, but makes some different recommendations.

Suggested review process

The document proposes that individual reviews should be carried out that reflect the specific water-using activity (e.g. hydropower plant) and local conditions. It also recommends that although existing permits can be subject to complete reassessment, it would be most efficient only to review their conditions, not the permit as a whole.[9] However, specific conditions must be added – if they do not already exist –that would allow for the hydropower plant to be decommissioned if found necessary. It also recommends that the scope of the review should not be determined solely by the applicant (i.e. power plant operator), but that the supervisory authority, or at least some other relevant stakeholder, should be able to influence it.

In contrast to the WAR, however – which recommended that reviews should generally lead to termination of existing permits and the award (or denial) of a new permit – the SwAM-SEA proposal recommends that it should be possible for new environmental requirements to be added to existing permits, except in areas covered by a new review, where they would be superseded or complemented by new permits.

Financing of costs related to environmental measures

The 2015 proposal recommends a financing approach that shares the costs related to environmental measures needed to achieve required ecological status between the state, the affected producer and a special fund established by hydropower producers. These costs reflect both costs of actual implementation, any needed structural changes to the power plant, and loss of revenue due to any reduction in power generation that is accepted within the suggested cap of 1.5 TWh. The total assessed cost or loss to the hydropower industry was subsequently assessed to 13 billion SEK, of which one-quarter each would be financed by the state and the special fund, while the remaining half would be funded by the hydropower industry.

The industry is under existing legislation currently protected from shouldering costs corresponding to a production loss above 5%, and the state should cover any costs exceeding this limit, along with 85% of "tear-down" costs (e.g. removing physical structures that hinder environmental flows and fauna passage) in existing installations. The proposal recommends keeping this rule until alternatives are further explored. Although establishment of the special fund might be seen as removing the need for this protection, the hydropower industry argues that it should remain in place in case the fund should collapse for any reason (Swedish Hydropower Association 2015b).

The special fund would tentatively be organized in a voluntary manner, with funds available only to producers who contribute consistently for the entire duration of the existence of the fund (i.e. the 20 years estimated to be needed to bring Swedish hydropower in line with modern environmental standards). The fund would be financed by a fee based on every produced kWh, estimated as approximately €0.00025

9 Each permit issued normally has several conditions specified for the activity that can be changed or revoked.

per kWh. It is, however, suggested that the numbers need further analysis.

Given that the costs of specific environmental improvement measures are deemed reasonable the producer might be allowed up to 85% coverage of implementation costs from the fund.

Again, reactions have been divided and they differ between producers and environmental groups. Environmental groups have argued that so called "five percent rule" should be abolished and the polluter-pays principle apply fully (Sportfiskarna 2017). Operators, in contrast, have been positive about the idea of a fund based on a solidarity principle. However, in addition to keeping the 5% limit (see above), they have argued that both legal costs and associated procedures should be covered by the fund (Swedish Hydropower Association 2015a)

In a key agreement struck between major political parties about Sweden's long-term energy development in 2016, it was determined that hydropower producers should carry costs related to legal and relicensing procedures. The same agreement concluded that the property tax imposed on hydropower producers should be lowered stepwise, starting in 2017. This action in essence frees up capital for hydropower producers enabling them to better manage the costs of implementing modern environmental standards (Swedish political parties 2016).

3.6 Suggested guiding principles and legal interpretation of some key concepts

Besides the consultative processes and the development of other more technical systems to decide on how to find suitable trade-offs between different goods related to hydropower, the judicial system could also help to shape the updated rules for hydropower generation in Sweden. How the courts interpret and internalize new knowledge is fundamental to what changes will eventually be implemented at the national level. However, as illustrated below, there is a risk that the courts' rulings in cases requiring interpretations of the Environmental Code and the WFD for licensing purposes will diverge from those emerging from the consultations and technical studies.

There have been a number of relicensing cases processed through the Swedish courts, most prominently through the Land and Environmental Courts system. These rulings offer some indication of what has been evaluated and prioritized when interpreting EU directives and national legislation. Below we summarize an analysis of important rulings in relation to different relevant topics (Korsfeldt and Linton 2011).

Renewable energy

One observation is that rulings seem to stress that renewable energy is a "strong societal good", even when this issue was not part of the official dispute. However, more rulings would be needed to conclude that this is a constantly overriding interest stressed by the courts. Observations can also be made when it comes to court interpretations related to climate change and CO_2 reduction as part of the renewable energy contribution through hydropower. Relevant rulings not only indicate that this issue should be observed in licensing but also that there is no "geographical boundary" to how this good can be referenced or limited. In other words, court rulings appear to treat it as a good coming from hydropower generation that cannot be assessed in the traditional river basin/water body perspective as indicated in the WFD.

Implementing the WFD

Within the WFD there is a requirement of "no further deterioration" of water resources, something that is pointed to as an argument against developing new hydropower. In an indicative verdict related to construction of a new hydropower installation (plant and reservoir) on the river Ljungån, the county administrative board blocked the project, citing the no-deterioration criterion. The claim was overturned by the court thus indicating that there are no general contradiction between new hydropower construction and the concept of "no further deterioration".

Minimum discharge

How much water should be allocated to maintaining ecosystem functions – and thus not be used for hydropower – is obviously an important question, from both environmental and energy security perspectives. There are different views of what minimum requirements should be and there have been several cases where Land and Environmental Courts have been asked to rule. In general, the courts have seemingly argued for the maintenance of at least mean low flow (MLQ), though urging that minimum flow be kept as high as possible.

Relevant rulings highlight that measures necessary for the movement of fish should be established without any reimbursement to the operator of related costs – except when the cost is disproportionately large compared to the expected environmental gain,

in which case the operator can be freed from the specific responsibility. However, there are also cases where MLQ has not been assessed as a requirement due to limited impacts on the environment.

Fauna passage on relicensing

Changes to existing installations may require that the licence, or certain of its conditions, be reassessed. An indicative case is the hydropower installation Laxöringen, which sought a permit to install a new turbine. The notion of the need to install fauna passage or other fish migration measures was revoked by the court ruling, on the grounds that the impact of the change to the riverbed was not significant enough to require such measures. However, the verdict can also be interpreted to mean that operators making changes deemed to cause significant alteration to the riverbed should be required to implement such measures.

From the rulings above it seems clear that the Land and Environmental Court system recognizes ambitions and targets from both energy and environmental EU Directives as being incorporated into the Environmental Code to at least some extent. It seems that there is no pattern suggesting minimum flow or fauna passage as a definite requirement; such measures are preferred but contextual factors ultimately decide. There is evidently some latitude regarding possible environmental impacts, with reference to less stringent quality targets (i.e. similar to the conditions of HMWBs, thought the process of establishing this concept vis-à-vis hydropower is still incomplete). The value of renewable energy to the national system seems to be a priority factor, as defined by the EU Renewable Energy Directive (2009/28/EC),[10] but the rulings reviewed do not offer any explanation as to how this value has been quantified and weighed against environmental benefits. Overall, it is difficult to identify any clear system for how EU Directives and policies have been interpreted and incorporated into decision-making on hydropower in Sweden. Judging by the reviewed rulings, it would seem that the WFD has so far had only a peripheral impact on the functioning of the Land and Environmental Courts system, as the rulings investigated make few specific references to the Directive or its key concepts.

10 On the Renewable Energy Directive see https://ec.europa.eu/energy/en/topics/renewable-energy/renewable-energy-directive

4 DISCUSSION

The hydropower sector is currently under intense scrutiny in Sweden. In many regards the sector has lagged behind when it comes to adherence to modern environmental legislation (Rudberg 2013). The state, diverse interest groups and the hydropower industry are, however, engaged in a reform process that is likely to change the current modus operandi – though to what extent can only be speculated. This discussion zeroes in on particular aspects of the key processes described in the previous section, with the proposed cap on production capacity loss a core reference point.

Also significant is that the demand profile for large-scale hydropower in Sweden is changing. A policy of phasing out nuclear power (which now accounts for around 41% of Swedish electricity generation, the same share as hydropower) means that hydropower might need to make up much of the potential capacity shortfall in electricity generation.

Large-scale hydropower is the only feasible option to meet the need for regulation capacity in the transition to an all-renewable Swedish power sector, planned for 2040 (SEA, Svenska kraftnät and SwAM 2016).

4.1 The proposed cap on production capacity loss

As noted above, the SwAM-SEA proposed national strategy for balancing environmental and energy concerns in hydropower (SEA and SwAM 2014) and the guidance note on identifying HMWBs (Kling 2014) suggest that a national annual loss of more than 1.5 TWh or 2.3% of power generation (and/or a total a minimum requirement corresponding to 140 MW balance power) due to environmental improvement measures around hydropower installations should be considered a "significant adverse effect" on societal goods, and thus justification for reducing environmental ambitions in the affected water bodies. In other words, it is the point at which energy security concerns are deemed to "overtake" environmental quality priorities.

Understandably, this proposed cap has been controversial. Some interest groups argue that the figure has no scientific justification and is merely a politically assigned number (Älvräddarna 2015). In contrast, the WAR, for instance, can be interpreted as allowing larger production losses from implementing environmental measures.[11]

Though opinions on its validity diverge, there is an explicit rationale and a mathematical process behind the suggested value. The calculations start from environmental measures likely to have an impact on energy production given conditions for MLQ based on EU standard values for this and related to fauna passage for all hydropower plants.[12] The calculations assume that fauna passage needs on average 1 m^3/s for medium- and small-scale plants and 3 m^3/s for large plants. These were also adjusted for the 10 m^3/s assessed to be required for "luring" fish to fauna passages and with an assumed mean regulation capacity of 49% (Swedish Hydropower Association 2015b).

The exercise found that installing these measures in all hydropower plants nationally would incur a production loss of 15–16 TWh, which was deemed unacceptable, and also well above any indicated values presented in the corresponding CIS guidance. Potential measures in large facilities, which typically have no minimum flow requirements today, would take the major part of the energy production loss. If the production loss were to be capped at 1.5–1.7 TWh, SwAM-SEA further assumed that 120 of the biggest installations would not be subject to demands of fauna passage and minimum flow requirements. The plants in question also constitute the absolute bulk of regulation and balance power in Sweden (Swedish Hydropower Association 2015a). The findings of the national strategy have been accepted and absorbed into the ongoing national dialogue process managed by SwAM.

Understanding the maximum acceptable loss to the energy system from hydropower is a major step towards possible implementation of associated aspects of the WFD. When the boundaries are known, it is possible to design subsequent adjustments and measures at the basin level. At this stage, no final decision has been made on what the cap would be on production losses, but different arguments have been made by concerned stakeholders.

In view of the important future role large-scale hydropower is likely to play in providing regulation power, SwAM, the Swedish Energy Authority and Svenska Kraftnät (the authority responsible for the national transmission system) carried out studies during 2016 to define limits for "adverse effects" in relation to regulation from hydropower. They

11 http://www.alvraddarna.se/aktuellt/infor-valet/.

12 http://svenskvattenkraft.se/hav-talar-om-atgarder-inte-om-utrivning/.

concluded that it was currently not possible to quantify the impact on regulation power at national level from environmental measures; thus, any impact on the regulation contribution from hydropower should be considered "adverse" (SEA, Svenska kraftnät and SwAM 2016).

Critics of the national strategy argue, however, that the methodology behind the limit value of 1.5 TWh is not clear (Älvräddarna et al. 2015). They also often cite the likelihood of advances in other energy production technologies as well as increases in future precipitation, making it easier to maintain or add to current hydropower generation capacity (Borg 2016). However, these predictions are arguably not a good basis for current policy-making, due to the inherent uncertainties (e.g. of climate impacts, of precisely what technologies will become economically viable and when) and the fact that favoured technical options such as hydrogen storage are only expected to be viable at scale well outside the timelines for existing climate agreements such as the EU 2030 target (Kuznetsov 2013).

4.2 The analytical unit related to HMWBs

There are also differing opinions over the use of the water body as the analytical unit when designating HMWBs in connection to hydropower. For example, it has been argued that current efforts to designate HMWBs, based on interpretations of the WFD, seemingly only take into account water bodies directly connected with the hydropower installation, thus potentially discounting knock-on effects downstream (Fortum Generation AB 2015).

Sweden is the country with the largest number of identified surface water bodies in the EU, numbering 23 418 (Drakare 2014). Approximately 1200 water bodies have hydropower installations (SwAM 2012a). While this represents only 5% of Swedish water bodies, in fact around 80% of river systems in the country have hydropower installations [13] At slightly over 4%, Sweden has the lowest number of designated HMWBs among total water bodies in the EU (Fortum Generation AB 2015; Kampa et al. 2011), and all current HMWBs are of moderate ecological potential (OECD 2014). It is therefore likely that the option of designating water bodies as HMWBs due to hydropower is for one reason or other underutilized in Sweden.

The current system established through the WFD allows river systems to be divided into several separate water bodies, which risks missing possible cumulative impacts of water-using activities upstream, which can have far-reaching effects also at considerable distance downstream of a hydropower installation. Arguably the possibility of designating a greater portion of a connected river system as HMWBs due to hydropower operations in that system should be recognized as part of ongoing efforts to reform the HMWB designation process. This might allow Sweden to better utilize the option provided by the WFD, reflecting actual conditions better and striking a balance between environmental targets and the protection of societal goods.

13 http://www.wwf.se/wwfs-arbete/wwfs-arbete/1582825-projektkarta-strommande-vatten-och-vattenkraft.

5 CONCLUSIONS AND OBSERVATIONS

Sweden is currently in a critical period for determining how to address the sometimes conflicting environmental and energy security ambitions of both regional (EU) and national policies and legislation. Some key observations and recommendations seem pertinent.

5.1 Developments in Sweden

A central issue regarding hydropower and the WFD is defining acceptable trade-offs between environmental ambitions and societal goods. The identification of a threshold of 1.5 TWh total generation capacity loss is a major accomplishment, given the complexity of such a process. Though there are still question marks over the methodology, and the figure remains somewhat controversial, it appears to have been broadly accepted (and thus, arguably, legitimized) in the multi-stakeholder dialogue process managed by SwAM. Clarification of the methodology and rational behind the figure would be a welcome and necessary step.

The 2012–2016 stakeholder dialogue process managed by SwAM was a novel and valuable feature in hydropower development. It offered a platform for diverging perspectives on hydropower to come together and generate practical solutions and where new concepts and measures could be discussed and tried while they were being developed. In parallel, subsequent outcomes and results from these dialogues can be fed into decision and policy-making related to hydropower.

When it comes to scale, there are two separate but connected issues that pose specific challenges. One relates to how best to assess the societal good coming from renewable electricity produced by hydropower vis-à-vis the environmental impacts. The other is the relevance of scale in determining environmental impacts from hydropower as a whole. These are expanded on below.

The WFD takes the river basin as the basic unit for assessing environmental impacts and societal goods from a water-using activity. The CIS claims that focusing analysis on this scale "provides an opportunity to integrate strategic planning for hydropower development and water environment objectives". The reason for this is most likely related to the dominance of the concepts of integrated water resources management (IWRM) and the linked concept of integrated river basin management (IRBM) in water resources management thinking (Timmerman et al. 2008), both of which were integral to the development of the WFD. A central theme of IWRM and IRBM is assessments based on the natural flow of water, making the river basin the most obvious management unit. While this makes sense from a strictly hydrological perspective, it has obvious limitations in the case of activities such as hydropower, as goods, benefits and also risks transcend the river basin in various ways.

The weaknesses of IWRM-based analysis have long been recognized, and IWRM has been increasingly marginalized by other possibly more flexible approaches not necessarily confined to predefined scales and fixed institutions. Nevertheless, WFD implementation is one of several current processes still based on the logic of IWRM (Timmerman et al. 2008), and thus risks missing suitable trade-offs between environmental and energy considerations beyond the basin scale. Any emerging systems for assessing environmental–societal good trade-offs in relation to hydropower should be able to take into account the wider development context.

The WFD further divides river basins into sub-basins and those into constituent water bodies, in accordance with specific definitions. The water body is the primary unit for classification in the ecological status/potential system introduced by the WFD. A river system with hydropower can therefore be composed of a number of water bodies, some that are artificial and some that are natural. A major reservoir, for example, may have significant impacts on other water bodies up and downstream that might make it impossible to achieve GES without changes in or around the hydropower installation itself. It should therefore be a possible option to designate water bodies further downstream in a river basin possibly affected by a hydropower installation as HMWBs. This would enable a fuller understanding not only of the potential environmental impacts from hydropower, but also of the effects of measures taken to mitigate them.

In this context, it should also be noted that there are approximately 5000 dams in Swedish water courses that are not linked to hydropower. An equally vigorous debate, seemingly absent today, on these other dam structures and their cumulative environmental impact is needed. This would not only be useful in order to understand potential impacts coming from hydropower but also if there are other types of dam of less societal value that could more easily be removed or altered to reach desired environmental outcomes.

5.2 The wider regional perspective

The role of hydropower, including Swedish hydropower, in the existing European energy mix needs to be further addressed. In order to reach agreed renewable energy targets, the issue of balance power is a key concept that needs further research. As Europe seeks to increase the renewable share of energy, the demand for regulating abilities and balance power will increase, and hydropower can play a fundamental role in this.

The major Scandinavian hydropower producers can claim to offer a new service in Europe. Developing a system that takes these wider considerations into account, indicating how much potential balance power needs to be reserved to facilitate a European transition to meet common targets would strengthen the understanding of the value of this service, as the EU moves to meet 2030 targets and beyond.[14] This type of knowledge also has scale-up potential to the global level, in terms of understanding how the EU as a region can help to fulfil the 2015 Paris Agreement. From this perspective a potential increase of hydropower generation capacity in Europe might become desirable, arguably changing the dynamics of energy security in the EU as well as related interdependencies between member states.[15]

Finally, the conflict between energy and environmental targets needs to be linked to a broader understanding of global commitments to reduce climate change and the use of renewable energy. Local trade-offs relating to hydropower generation should be put in a larger context, and the value of hydropower in societal development better assessed and compared to other power-production sources on criteria beyond impacts on water bodies. The WFD is not designed to take such larger system benefits into account. Thus, tools that can weigh the broader services from hydropower against the negative impacts at local scale need to be developed at the macro-regional scale. Sweden, Norway and other hydropower-dependent countries in Europe should lead the way in the development of these systems through continued, and strengthened, collaboration.

14 The CEDREN project HydroBalance is addressing these concerns: http://www.cedren.no/english/Projects/HydroBalance.

15 On the role of hydropower in renewable energy transitions see http://www.sciencedirect.com/science/article/pii/S1876610215030519.

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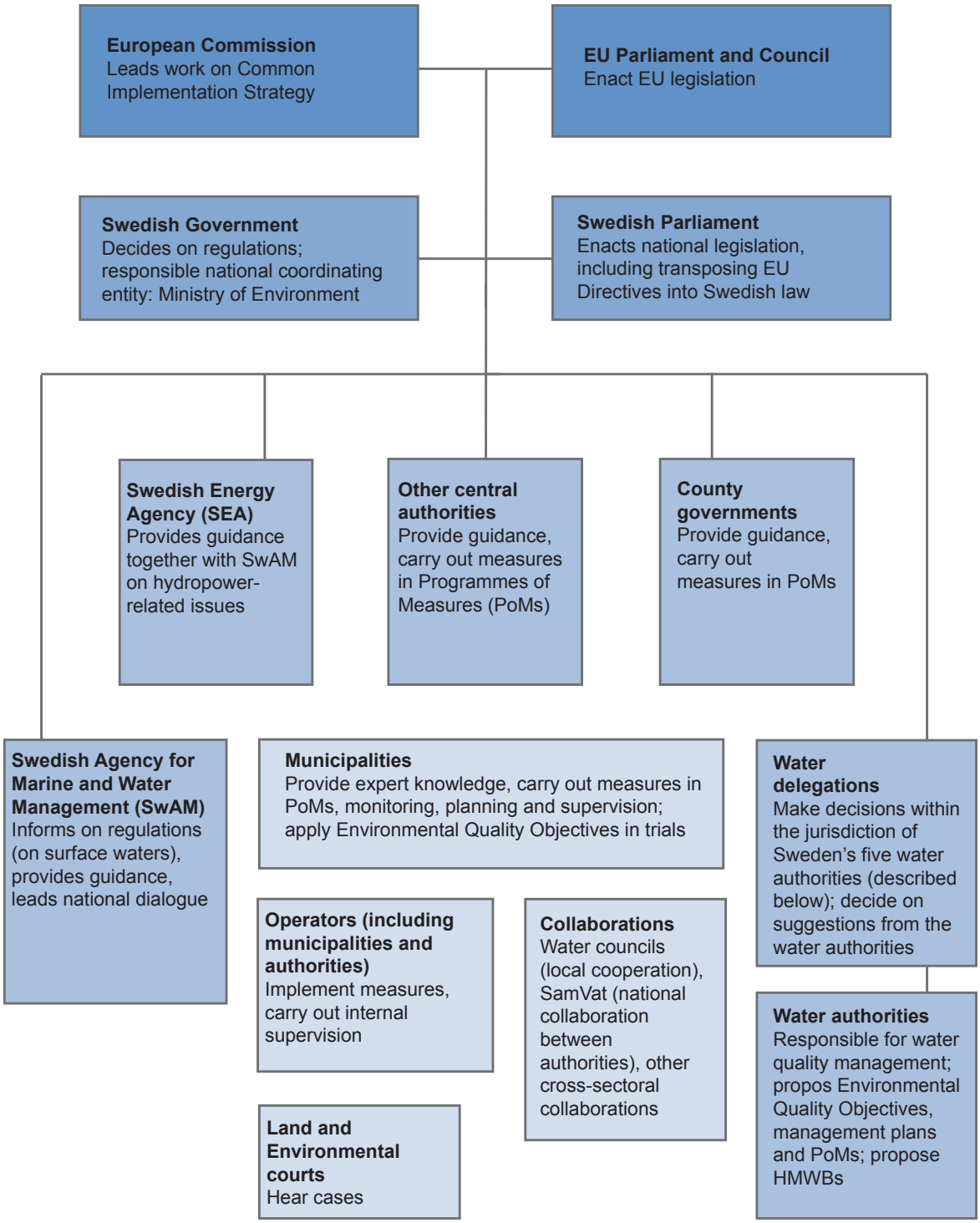
APPENDIX: THE SWEDISH WATER GOVERNANCE STRUCTURE



Source: Vattenförvaltingen och tillsyn enligt miljöbalken. Miljösamverkan Västra Götaland, 2013.

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