The LIHI Experiment: Certifying "Green" Hydropower since 1999

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Abstract

The Low Impact Hydropower Institute (LIHI) was established in 1999 for the purposes of setting criteria to evaluate the environmental attributes of hydropower facilities and making information about the environmental effects of power generation more available to the public. To fulfill these purposes, LIHI operates a hydropower certification program, the core of which focuses on eight objective environmental criteria. Since the program began, LIHI certification has become the most widely accepted, independent standard for electricity consumers to use in evaluating "green" and sustainable hydropower in the U.S. Participation in the LIHI certification program is voluntary, but LIHI certificates are recognized across the US by several state renewable portfolio standards, state regulatory agencies and energy purchasers making voluntary choices to opt for green power. LIHI certifications provide positive recognition and good public relations, plus meaningful economic value to hydropower owners who take steps to improve their facilities and invest in the local environment.

1. Background and Approach

1.1 Formation

In 1998, a forward-thinking group of hydropower stakeholders, led by American Rivers and the Green Mountain Energy Company, with assistance from the Center for Resource Solutions, formed a new task force to explore the feasibility of establishing a voluntary certification program that would inform consumer choice of environmentally acceptable hydropower (Grimm, 2002). This group was motivated by the possibility that energy deregulation would be coming in the near future and that electricity consumers would soon have a choice of green power sources such as wind, solar, and hydropower. Grimm (2002) describes the early stages of development of what became the Low Impact Hydropower Institute (LIHI or Institute, www.lowimpacthydro.org).

LIHI was established to help reduce the impacts of hydropower generation by providing consumers with a credible and accepted way of evaluating this important source of renewable energy. It has been well established that some hydropower development, both large and small, can have significant adverse environmental effects (e.g., Mattice, 1991; WCD, 2000). The adverse impacts from hydropower dams include altered downstream flow regimes, degraded water quality in rivers and reservoirs, disruption of the natural migratory movements of aquatic organisms, mortality of fish passing through and around power plants, increased erosion of shorelines and river channels, and much more. Despite these potential issues, hydropower can

also provide a clean, low-emission source of renewable electricity that has increasing value in the carbon-challenged world of today. Much progress has been made in mitigation practices in recent years, to the point that most of the adverse impacts from hydropower can be minimized or eliminated with good siting, design, and operation (e.g., March and Fisher, 1999; IEA, 2006). The Institute was incorporated as a 501(c)(3) nonprofit organization in June 1999 and opened for business in January 2000. The stated purposes of LIHI operation in its Articles of Incorporation are:

- Setting criteria for characterizing hydropower as "low impact,"
- Conducting a program to certify dams that meet these criteria with a goal of (1) reducing the environmental impacts of hydropower and (2) creating a credible standard for consumers to use in evaluation hydropower, and
- Making information about the environmental effects of power generation available to the public.

Selecting an appropriate name for the new organization was difficult for the LIHI founders. While "no-impact" would have been preferred by some interests, that was deemed impractical because few, if any, energy sources have zero impacts. The term "low-impact hydropower" was decided on as the best identifier for environmentally preferable hydropower. The LIHI certification system was designed to be credible with consumers, transparent and understandable, based on objective criteria, and relatively easy to use.

The bylaws set up for LIHI defined other important aspects of the organization. The Governing Board of LIHI is to be comprised of 50% or more of representatives from environmental organizations. The remainder of the Board can consist of representatives from industry, recreational boating, resource agencies, native American tribes, recreational or commercial fisheries, advocacy groups, academia, or others deemed appropriate by the Board. Governing Board members are the primary decision-makers for issuance of certifications. Non-voting advisory panels are part of the Institute's governance to enable input from the hydropower industry and from other, non-hydropower renewable energy interests. The Board reviews the LIHI certification program annually to evaluate whether it is accomplishing the organizational goals and to make adjustments as needed.

The mixture of environmental and industry perspectives on the LIHI Board is a unique characteristic that exists in very few other parts of the hydropower industry in the U.S. Current Board and advisory members are listed in Table 1. This diverse participation in the governance of LIHI has been steady over the history of the Institute, but membership has been refreshed on a regular basis.

1.2 Original LIHI Certification Approach

The basic structure of LIHI's certification process has not changed much since its inception; it consists of eligibility requirements, evaluation criteria and associated goals, and standards for satisfying each criterion. The first edition of the LIHI Certification Handbook (i.e., versions dated up through April 2014) defines the original certification process (LIHI, 2014). The first Handbook was developed by the Implementation Task Force in draft form and then was

Table 1. Governance structure for the Low Impact Hydropower Association as of May 2016 (for the most recent listing, see http://lowimpacthydro.org/governance/).

Governing Board Members:

John Seebach, Acting Chair, American Rivers, DC
Steven Malloch, Vice Chair, Western Water Futures LLC, WA
Jacob Palmer, Treasurer, Kleinschmidt Associates (retired), DE
Nicholas Niiro, Secretary, Rogers Joseph O'Donnell, CA
Kenneth Kimball, Member-At-Large, Appalachian Mountain Club, NH
Pierre Bull, Member-At-Large, Natural Resources Defense Council, CA
Victoria Taylor, Member-At-Large, Catawba-Wateree Relicensing Coalition, NC
Laura M. Wisland, Member-At-Large, Union of Concerned Scientists, CA
Tara Moberg, Member-At-Large, The Nature Conservancy, PA
Glenn Cada, Member-At-Large, Oak Ridge National Laboratory (retired), TN
Patrick O'Connor, Member-At-Large, Oak Ridge National Lab, TN
Shawn Seaman, Member-At-Large, Power Plant Research Program, MD
Kate Miller, Member-At-Large, Trout Unlimited, DC
Rebecca O'Neil, Member-At-Large, Pacific Northwest National Laboratory, OR

Hydropower Industry Advisory Panel:

Brendan McCarthy (co-chair), Portland General Electric, OR
Sean Faulds (co-chair), Brookfield Renewable Energy Group, NY
Sarah Hill-Nelson, Bowersock Mills and Power Co., KS
John Ragonese, TransCanada, NH
Elizabeth Ablow, Seattle City Light, WA
Deb Malin, Bonneville Power Administration, OR
Dave Youlen, Eagle Creek Renewables, NJ

Renewable Markets Advisory Panel:

Philip Raphals (chair), Helios Centre, Quebec, Canada
Ian McGowan, 3Degrees, CA
Jennifer Martin, Center for Resource Solutions, CA
Omay Elphick, Gravity Renewables, NY

Natural Resource Technical Advisor:

Robert Deibel, U.S. Forest Service (retired), CO

Executive Advisory Panel:

Richard Roos-Collins, former Governing Board chair, Water and Power Law Group, CA

Staff:

Michael J. Sale, Ph.D., Executive Director, TN
Dana Hall, Deputy Director, NJ

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circulated for public comment in September 1998. It underwent several minor revisions and improvements up through April 2014, but the general approach remained the same.

Eligibility requirements. The types of hydropower facilities that were designated as eligible for LIHI certification are

- Those located inside the U.S.,
- Those located at dams or diversions that were constructed before August 1998, and
- Those that involve incremental power development at existing dams (e.g., construction of new power plants at previously non-powered dams).

Hydropower facilities located outside the U.S. were not originally considered for LIHI certification, because they were subject to different regulatory systems (e.g., other than that of the Federal Regulatory Commission, FERC) and therefore were likely to have a different existing information base and a different level of resource agency oversight. The cutoff date of August 1998 for dam/diversion construction was established to ensure that LIHI certification, including any economic benefit derived from that, was not the cause of construction of new structures in rivers. Pumped storage hydropower facilities were not allowed for LIHI certification because of a perceived difference in environmental effects beyond those covered by the original criteria. Facilities located at a dam that had been recommended for removal by a resource agency were also not eligible for certification, as long as that recommendation was made as part of a legal or administrative proceeding or other legally enforceable agreement – this aspect was originally addressed as a criterion but was moved to an eligibility requirement in the 2nd Edition Handbook (below).

Criteria, goals, and standards. LIHI certification requires that eight environmental criteria be satisfied on a pass/fail basis. The original eight criteria were (for a detailed explanation of these criteria and the goals and standards applicable to each, see: Grimm, 2002, and LIHI, 2014)

- Flows,
- Water quality,
- Fish passage and protection,
- Watershed protection,
- Threatened and endangered species,
- Cultural resource protection,
- Recreation, and
- Facilities recommended for removal.

All criteria must be satisfied for a facility to become certified as low impact. This evaluation approach distinguishes LIHI from other regulatory approaches, such as FERC's, where tradeoffs are allowed among power and nonpower resources – the LIHI approach requires that all environmental resources must be protected.

Another distinguishing aspect of the original LIHI criteria was that they relied heavily on agency recommendations as standards that could be used to satisfy criterion goals. It was recognized that this was an imperfect but necessary solution to designing a certification system that is based on readily available information, therefore both objective and cost effective. Applicable agency

recommendations were defined as those made by state, federal, or tribal resource agencies pursuant to a legally binding, regulatory proceeding (e.g., a FERC licensing proceeding).

Application steps. The application process for certification involves several steps, starting with informal and confidential consultation with LIHI staff. A preliminary intake review of draft applications is strongly encouraged, so that LIHI staff can comment on the information provided in an application and help the applicant fill any information gaps. LIHI employs independent contractors who serve as application reviewers of both the intake application and a subsequent revised application. The reviewers' job is to evaluate all application materials, investigate public information sources and public comments received, and contact relevant regulatory agencies to confirm their positions on a given facility. Applications are posted on the LIHI website for a 60-day public comment period. The end product from the LIHI reviewers is a report to the Executive Director that documents the facts and proposes recommended certification actions. The most important part of an application under the original handbook was a questionnaire that described how a facility satisfied each of the criterion goals. The questionnaire was structured as a decision tree with alternative paths to satisfying each criterion.

Decision-making on certification applications. LIHI certification decisions were originally made by a two-thirds majority vote of the Board members. Input to these decisions typically includes a reviewer's report on the application, a recommendation from the Executive Director to the Board, and a teleconference to hear presentation and discussion of the facts of the application. Delegation of decision-making authority has been employed in recent years, either to the LIHI Technical Committee (a subset of the Board) or to the Executive Director, to expedite decision making. Certification decisions are considered preliminary until a 30-day waiting period has passed, during which appeals of the decision can be made. Appeals are accepted from the applicant or from public entities that had provided input during the public comment period.

Certificate Term and Recertification. The concept that LIHI certificates would be issued for a fixed term and subsequent recertification would be required has been another constant for the Institute. This approach is based on the fact that conditions may change over time at hydropower facilities, either in the design or operation of the facility or in the local environment. Such changes require that a certification be re-examined. Initially, the Implementation Task Force thought that a 2-year term would be required, but that idea was quickly changed to a five-year term. More recently, options have been added that allow terms up to 10 years in some situations. These changes have been in response largely to industry comments.

The intensity of analysis in recertification depends on whether material changes have occurred at a facility. If there have been no changes at a facility during the previous certificate term, then the recertification process is relatively simple and quick. If changes have occurred either at the facility or the local environment, or if LIHI's criteria have changed in any way, then recertification is more rigorous.

Funding of the Institute. The principal funding for the Institute comes from application review fees paid by applicants and from annual fees paid during the term of certification. From time to time, LIHI also receives donations, as well as grants from government and charitable

foundations, but those are a minor part of the Institute's budget. The LIHI fee structure is periodically reviewed by the Governing Board. LIHI's current fee schedule can be found in the Certification Handbook and at www.lowimpacthydro.org/fees. For the first fifteen years of the LIHI certification program, fees were calculated primarily as a function of average annual generation. In 2015, with the help of the LIHI advisory panels, this fee structure underwent a major upgrade that ensured the Institute fully recovered its operating costs (e.g., reviewer fees) and also set its fees to be more commensurate with the benefits that certified facilities received from participating in renewable energy markets (see below).

1.3 Major LIHI Revisions in 2015-2016

During the period from 2006 and 2015, LIHI Governing Board members, staff and other contributors put extensive efforts into finding ways to improve the LIHI certification approach. Several proposals for revised criteria where circulated for internal and public comments, but none of these were found to be fully acceptable or practical. In 2014, under the leadership of Julie Keil, an industry advisor from Portland General Electric, and John Seebach of American Rivers, a new approach was finalized – the revised criteria for this version was approved by the Governing Board at the LIHI Annual Meeting in Seattle, WA, in October 2014. A new certification handbook that implemented these revised criteria was developed in 2015.

LIHI announced the release of its 2nd Edition Certification Handbook in March 2016. The 2nd Edition Handbook replaced the April 2014 Edition as the primary document explaining the LIHI Certification Program policies and rules. It implemented the revised certification criteria defined a new application process for all intake and certification applications submitted in 2016 or later. The old LIHI questionnaire (the application form under the April 2014 Handbook) has now been replaced in its entirety by a new set of forms covering the information needed to evaluate a facility, including project description, selection of alternative standards for satisfying criteria and their goals, and supporting information to justify the standards that are selected.

Key improvements in the 2nd Edition Handbook are

- The availability of a "Not Applicable/De Minimis Effect" standard (NA/DME) for each criterion,
- The opportunity for longer-term certificates up to 10 years in length, when "PLUS" standards are attained,
- A menu of alternative standards for applicants to use to satisfy each criterion, including best practices and best-available technologies, and
- The opportunity for conduit facilities and other very-low impact project types with simplified application forms and lower cost.

Other enhancements to the 2nd Edition Handbook are

- A new emphasis on science-based recommendations to strengthen how criterion goals are satisfied,
- A new approach to contracting the use of the LIHI Certification Mark, and
- A new 'Zone of Effect' concept that provides a more complete evaluation of the full environmental footprint of hydroelectric facilities.

The 2nd Edition Certification Handbook is available at http://lowimpacthydro.org/how-to-apply/.

1.4 Evolving Renewable Energy Markets

The first significant era for growth in renewable energy supply in the U.S. occurred in the period from the 1940s to the early 1970s, during what is often remembered as the golden age of hydropower development. The next era of renewables dates to the passage of the Public Utilities Regulatory Policy Act (PURPA) of 1978 which required utilities to purchase energy from qualifying third party generators to force more acceptance of non-hydropower renewable electricity supply. In the 1990s, the era of deregulation and the restructuring of integrated utilities saw little new development of renewable capacity, yet around 1997 states began to enact policies which drove new development of renewable capacity. These new policies included Renewable Portfolio Standards (RPS)[1], the use of public benefit fund programs and changes in interconnection rules and new net metering programs. This era also saw the creation of new voluntary green power pricing programs offered by utilities to customers, and new federal, state and local tax incentive programs. The LIHI program emerged toward the end of this third era, and was founded on the premise that consumers do not assume that all hydropower is environmentally preferable, and seek assurance that the source of the generation has reduced the site-specific impacts associated with hydropower (Grimm, 2002).

Despite the uncertainty after the chaos in energy markets post-Enron collapse, between 2004 and 2014, renewable sources of electricity increased from 8.8% of supply to 13.5 % (NREL, 2014). Over this period of growth, LIHI Certification has become the most commonly used tool in green markets to determine hydropower's eligibility as a renewable generation source, affirming the premise that differentiation and standards to evaluate the environmental impact of hydropower is a useful guide for renewable markets.

Renewable markets fall into two main categories; compliance markets and voluntary markets. Compliance markets are a function of state law or regulation, while the voluntary market has no jurisdictional boundaries. When green markets first emerged, hydropower was included as an element in over half the retail green power products in use in 2002 and in early green pricing programs, though participation was limited because of the focus on "new" power generation sources. (Grimm, 2002) In all cases, there were limits on the type of hydropower to be eligible, specifically the size or capacity of the generation facility. These eligibility limitations stemmed from the perception that the public wants "small" hydropower, even though size is not an effective standard for evaluating environmental impacts. Grimm (2002) identified the "small hydro" standard as dominant because it is "...easy, quick, requires no changes to the project, is easy to explain and apply, and has the patina of acceptability," The small hydro standard was more accepted than low impact certification, which was perceived as "rigorous, requires site-specific analysis, may require changes in the project, is not as easy to explain or apply, and is relatively unknown." (Grimm, 2002).

[1] Renewable Portfolio Standards (also called Renewable Energy Standards, Clean Energy Standards and Alternative Energy Portfolio Standards) are government regulation or laws that impose an obligation, usually on load serving entities (LSE), to provide a certain percentage of their electricity supply portfolio from eligible renewable sources over a period of time. Renewable energy certificates (RECs) are used to track the ownership of environmental attributes, and are sometimes sold in bundled transactions with electricity sales, other times sold separately from the underlying electricity. In the case of unbundled REC sales, the electricity which is sold separate from the RECs is viewed as "null" energy with no environmental attributes, as if it were generated by non-renewable resources such as fossil generation.

2. Results

2.1 Certification trends

The first LIHI certificate was issued to the Stagecoach facility in Colorado in 2001. As of the end of 2015, LIHI had issued 127 certificates for low-impact hydropower. The general trend of approximately 10 new certificates issued per year has been relatively constant since 2008 (Figure 1). Of the active certificates at this time, approximately 70% are FERC-licensed facilities, 30% are FERC-exempted facilities, and two are facilities located at Bureau of Reclamation dams that do not require a FERC license. Because of the new certification procedures contained in the 2016 edition of LIHI's certification handbook, there are more options for hydropower facilities that are not regulated by FERC, so we expect to see more applications from those types of facilities.

There is no indication of market saturation in the growth pattern of active LIHI certificates so far (Figure 1). That is in contrast to some renewable energy markets that seem to have plateaued. As a baseline reference for the numbers of LIHI-certified facilities, there are ~1,824 existing hydropower projects in U.S., some of which are multi-dam systems. These break out as 1,031 FERC licenses, 630 FERC exemptions, and 163 federal projects owned by the Corps, Reclamation, or TVA). Approximately 38% of FERC-regulated hydropower facilities are FERC exemptions. In contrast, LIHI's active certificates include only 30% exemptions. The reasons for this under-representation is likely related to the small sizes of exemption and the corresponding low capacity for owners to bear certification cost and effort. It also may be due to the states where most exemptions are located; i.e., states without strong renewable energy policies and markets.

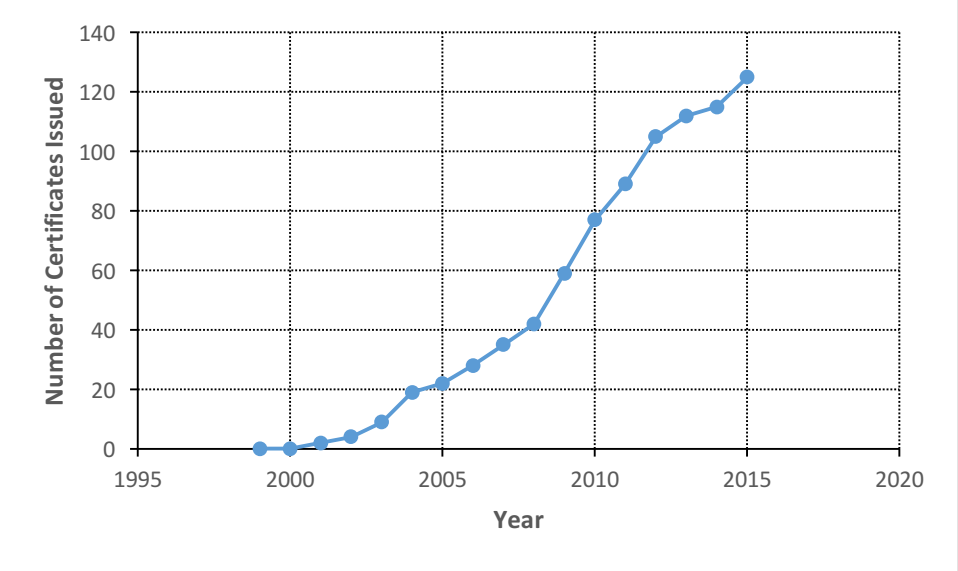

Figure 1. Cumulative number of LIHI certificates issued by year.

As explained above, LIHI does not consider size, or capacity, in defining eligibility for certification. All sizes of facilities may apply, and this is reflected in the distribution of certified facilities (Figure 2). Eight percent of active certificates are greater than 100 MW in capacity, 11 percent are between 100 and 30 MW, 25 percent are between 30 and 5 MW, 35 percent are between five and one MW, and 20% are less than one MW. These distribution characteristics are in strong contrast with many state RPS programs that use size cutoffs to define eligible hydropower.

To date, LIHI has certified hydropower facilities in 23 states (Figure 3).[2] More than half of the active certificates are clustered in the northeastern states, within the New England (NEPOOL) and Mid Atlantic (PJM) regions.

2.2 Revenues to the Institute

In the early years of the Institute, certification fees were calculated at a fixed rate per MWh of generation, ranging between 3 and 4 cents per MWh. This approach proved to be problematic, because not all of the fixed costs of the Institute were being recovered. Revenues from the certification of smaller facilities did not fully cover the Institute's expenses for processing these applications, and the opposite was true for some larger facilities. In many cases, the cost of certification to applicants was very small compared to the economic benefits derived from certification (Section 2.4 below).

In November 2014, the Governing Board adopted a significant revision to the fee structure to be applied to all existing and future certifications (http://lowimpacthydro.org/fees/). The new fee structure changed the way application reviews were priced to ensure all organizational costs were covered, increased the annual maintenance rates paid per MWh of generation to align the fees better with the market benefits to certificate holders, and set floors and caps on fees. These changes injected much needed additional revenue into the Institute's operations, so that in fiscal year 2015, gross LIHI revenue had grown to almost $500,000 per year, putting the organization in a much healthier financial position. In 2016, additional changes were made to the LIHI fee structure to reduce rates for "very low impact" (VLI) facilities that could qualify for all of the first, not-applicable/*de minimis* effect standards – conduit facilities are the best example of these VLI type of applications.

2.3 Acceptance by Stakeholders

Acceptance of Low Impact certification as an appropriate tool to differentiate hydropower suitable for green markets by hydropower generators, power marketers, environmental organizations and the general public have all improved over the past fifteen years, to varying degrees. In the 2010s, hydropower continues to be an element in green markets, though restrictions related to size/capacity, technology and vintage persist. Large hydropower, typically distinguished by 30 MW or larger are often limited, while smaller projects are eligible in as many as 25 states (Stori, 2013).

[2] LIHI has certified facilities in the following 23 states: AK, CT, GA, ID, KS, KY, MA, ME, MT, NC, NE, NH, NY, OR, PA, RI, TN, UT, VA, VT, WA, WV, WY.

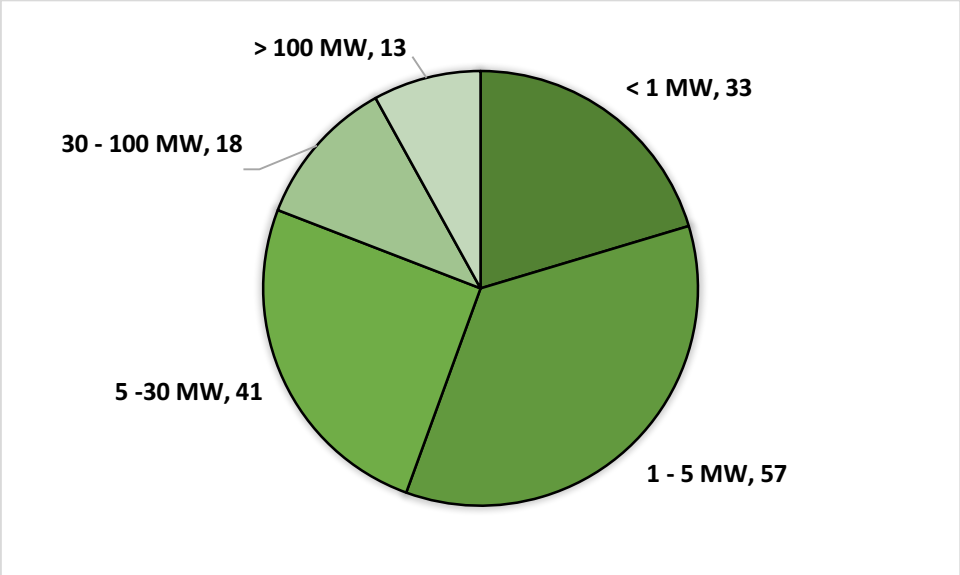

Figure 2. Size distribution of LIHI-certified power plants, by installed capacity (MW).

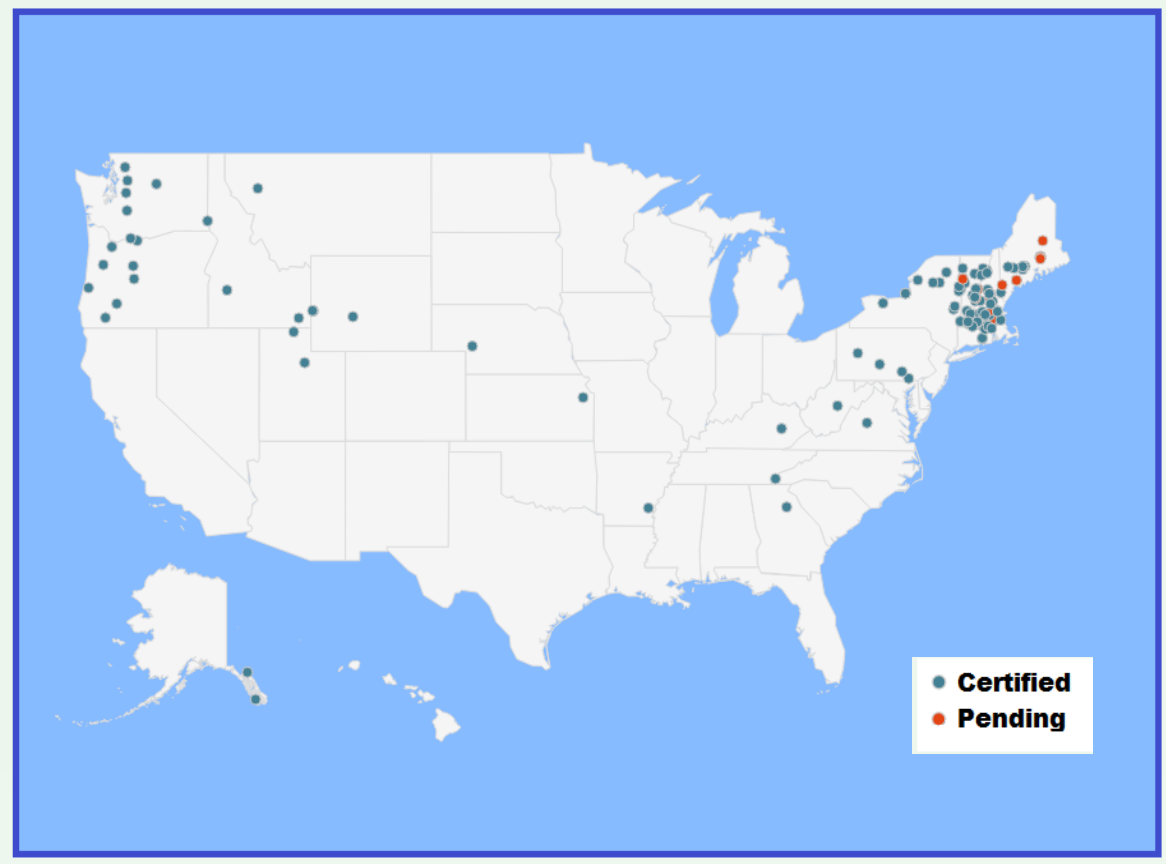

Figure 3. Geographic location of LIHI-certified facilities.

At the initiation of the LIHI certification program, there was a lack of acceptance or eagerness by hydropower generators to participate. Dam owners were suspicious of the reliance on resource agency recommendations to satisfy the certification standards, fearful that certification would incentivize agencies to set arbitrary, difficult and expensive conditions on operation. They were also reticent to take on the expense of applying for certification given the uncertainty of the ability to monetize the certification benefits. Lastly, there was objection to any effort to differentiate between hydropower projects, preferring instead to posit that all hydropower deserves the same treatment as other renewables such as wind and solar power. (Grimm, 2002). In 2016, the numbers tell a different story. There are now over 65 entities, including utilities, independent power producers (both large and small) and municipal owners that own hydroelectric facilities who find value in the LIHI certification program sufficient to apply and maintain certification. (see section 2.4)

In 2002, power marketers were generally unaware of the LIHI certification program, and assumed that only small hydropower was environmentally preferable. They were discouraged by the complexity and detail involved in the LIHI program, and even when the credibility of a standards based approach was explained, they still expressed an interest in small projects only, underscoring the perception that "small" hydro is the only "green" hydro. (Grimm, p. 57). The use of LIHI certification as an eligibility requirement for green markets has expanded significantly since 2002, however the perception that "small" hydro is the only "green" hydro continues, evidenced by the continuing placement of capacity limits on many green power programs. Today, power marketers generally claim to be technology neutral, though they do have a better understanding of the complexity involved in determining hydropower's suitability for green markets. Still, demand for low impact hydro RECs on the voluntary side is paltry in the 2010s. Voluntary transactions are driven directly by the demand of purchasers, many of who are specifically looking only for solar and wind, or strongly prefer generation verified by Green-e Energy and resist low impact hydropower that is not also Green-e verified.

2.4 Values returned to certified facilities

LIHI certificate holders are realizing value from their participation in a range of ways, from improved public relations and acceptance by stakeholders, to the ability to use green attributes associated with LIHI certified generation towards a compliance obligation under an RPS law, to lucrative REC sales from their certified generation at values as high as $60/MWh in REC contracts, including sales of bundled power and RECs to utilities with a compliance obligation, to unbundled REC sales in direct transactions with corporate buyers who are seeking to satisfy corporate sustainable energy goals.

Table 2 presents examples of the different ways that certificate holders are currently recognizing value from their investment in maintaining LIHI certification. In Oregon, Portland General Electric (PGE) uses the generation from the Pelton Round Butte facility towards their RPS compliance obligation. Under the Oregon RPS, hydroelectric facilities older than 1999 are eligible if they are LIHI certified (newer facilities are eligible without a LIHI certificate). The value to PGE to be able to use generation from Pelton Round Butte towards their RPS obligation is immense. Should PGE construct a wind facility towards the satisfaction of their RPS obligation, the cost of construction would likely fall in a range between $200 and $320 million.

In Maine, Brookfield Renewable's Orono facility located in Maine qualifies for Class I of the Massachusetts RPS. 100% of their generation output is listed by the MA DOER as Class I eligible. The AAG of the Orono facility is $32,726, and Class I REC prices have averaged between $50 and $65 for the past four years. Assuming Brookfield is successful in selling all the Class I eligible RECs from the Orono facility at a mid-range prices of $55/REC, the value of the LIHI certificate exceeds $1million annually.

In Kansas, the Bowersock Mills & Power Company (BMPC)'s Bowersock Mills hydroelectric facility initially earned LIHI certification with the goal of developing an additional revenue stream through the sale of RECs. BMPC initially sold RECs on the market, and later developed a branded REC product with the Bonneville Environmental Foundation. When BMPC negotiated a new long-term contract in 2011, the project's LIHI certification was critical to the completion of the contract, as the power purchaser had a strong desire for Green-e certified energy. The result is a multiyear bundled REC contract, which would not have been possible without LIHI certification.

In Pennsylvania, Brookfield recently acquired the Holtwood 248 MW facility on the Susquehanna River. Pennsylvania qualifies up LIHI certified facility for Tier 1 of the Alternative Energy Portfolio Standard and all other non-LIHI certified hydropower as Tier 2. According to InClime, the administrator of the PA AEPS program, the portion of the Holtwood generation output that qualifies for Tier 1 is 129 MW (52%). Tier 1 RECs have been averaging between $15 - $20, which means the annual REC value of the portion of Holtwood's generation output that qualifies for Tier 1 is significant.

These examples are just a sampling of the values that certificate holders enjoy in the markets which utilize LIHI certification as a qualifier for hydropower eligibility. As many as six states use LIHI certification in some form, and more detailed explanation about how those states use the LIHI certificate is available at www.lowimpacthdyro.org/green-markets. RPS markets continue to evolve, with many states revising their standards to reflect newer more aggressive targets. These include new standards of 50% renewable energy by 2030 in both California and

Table 2. Examples of how LIHI certificate holders obtain value recognition.

State	Oregon	Maine	Kansas	Pennsylvannia
Project name	Pelton Round Butte	Orono	Bowersock Mills	Holtwood
Project size	366 MW	2.7 MW	7 MW	248 MW
Average Annual Generation	1,444,076 MWh	19,000 MWh	32,726 MWh	1,030,053 MWh
Use of certificate	RPS compliance	REC sales	REC sales	REC sales
Market	OR RPS	MA Class I (avg. $55/REC)	Green-e (private contract)	PA AEPS - Tier 1 (avg. $15/REC)
LIHI cost	$30,000/yr	$1,900/yr	$1,500/yr	$30,000/yr

New York, 100% renewable energy by 2045 in Hawaii, 75% renewable energy by 2032 in Vermont (Leon, 2016).

2.5 Benefits to the environment

In addition to the monetary values that LIHI certification provides to facility owners, there are a wide range of non-monetary, environmental benefits that are the result of certification. Examples of environmental benefits of certification include new studies of ecological flows in bypassed reaches, new water quality monitoring, new fish passage mitigation (e.g., upstream fishways and operational changes to minimize downstream mortality for American eel), more active management of endangered species, and better operational coordination among multiple dams in the same river basin. The requirements for these benefits are incorporated as conditions to a LIHI certificate in cases where they are necessary to satisfy one of the LIHI criterion goals. These types of benefits can be referred to as "additionality," because they occur above and beyond the results of FERC licensing or other pre-existing environmental requirements. Facility owners have been willing to implement such additional environmental measures because they are also receiving a monetary benefit from certification. In many older FERC exemptions, the LIHI certification process triggers an examination of the current situation at a hydropower facility that would not otherwise happen.

3. Future Directions

3.1 Discord and opportunity in the voluntary markets

The voluntary green market is informed primarily by Green-e Energy, the widely accepted certification trusted by purchasers on the voluntary market to verify the environmental claims of generators. A primary function of the Green-e program is to target new sources of renewable supply, and for generation to be "new" it must have begun operation or have been repowered within 15 years of the REC sale year. Green-e requires LIHI certification for conventional hydropower eligibility, while allowing turbines installed in pipelines or irrigation canals without a LIHI certificate. While Green-e Energy had previously included a 5 MW cap on hydropower, there is currently no capacity cap on new conventional hydropower in the Green-e standard. Green-e Energy does allow repowered hydropower to qualify, however they impose a 10 MW cap on repowered hydropower facilities and the repowering. This 10 MW cap, adopted in 2013, has resulted in the withdrawal of some certified facilities from the LIHI program.[3] As LIHI does not allow new hydropower installed on dams constructed after August 1998 to be eligible for certification there is a conflict with Green-e's new requirement, with a limited pool of sources that can qualify for both standards (Figure 4). Renewable Energy Marketers have said to LIHI that they transact almost no hydropower as a result of the structural dissonance between LIHI and Green-e, as well as a persisting belief that hydroelectric generation is not environmentally preferable.

The persistent approach towards vintage or legacy hydropower assets as having little value is problematic for the development of a sustainable clean energy future. It is economically

[3] Upon losing Green-e Energy eligibility, the Clark Fork facilities in Idaho withdrew from the LIHI program because the voluntary market was the only option for monetization, and the facilities exceeded the 10 MW cap.

irrational to continue to demand new resources and place higher value only on new resources, when existing and vintage resources are providing valuable emission free generation. In environmental markets, both compliance and voluntary, aging assets are routinely counted out and discriminated against, without any account taken for the cost avoidance resulting from their continued operation. Such costs include the replacement of aging assets that are allowed to go offline, and the question becomes, what will replace it, especially if it is baseload generation? Hydropower would benefit from a resolution of the discord between LIHI and Green-e Energy. Green-e is an important driver in the voluntary market, because it is the premier certification program to verify environmental claims of generators and the most widely accepted standard for power purchasers. Green-e is also an element of both the U.S Green Building Council's LEED Certification program and the GHG Protocol Scope 2 Guidance, which heavily influence the energy decisions of power purchasers.

Recently, a significant increase in the commercial and industrial sector's interest in renewable energy has seen the emergence of larger scale purchases of renewable energy by the corporate sector.[4] Today, nearly two-thirds of Fortune 100 and nearly half of Fortune 500 companies have made renewable energy commitments. (Penndorf, 2015). A real opportunity now exists for low impact hydropower to engage with this important new market, through direct transactions. These purchasers strongly prefer wind and solar, however they are sophisticated and willing to learn about low impact hydropower.

3.2 Changes to eligibility requirements

By design, the current LIHI eligibility requirements limit the types and numbers of hydropower facilities that can apply for certification. However, the current version of the LIHI certification

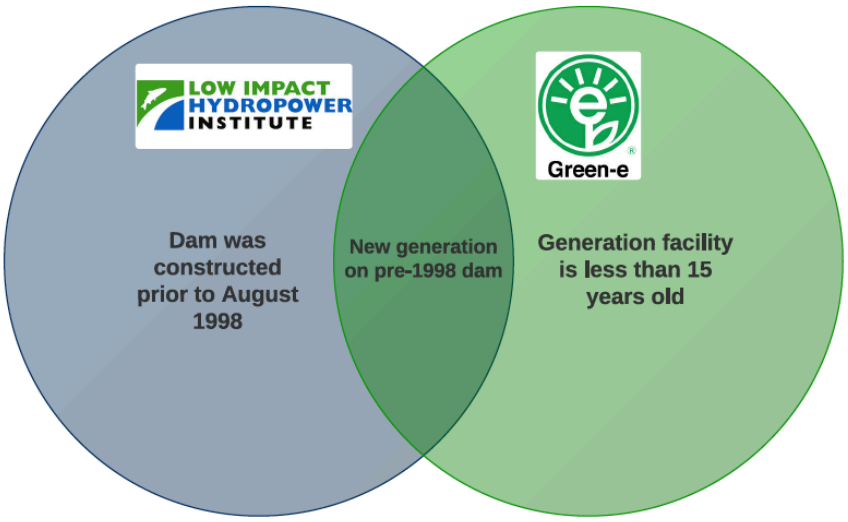

Figure 4. Relation between eligibility requirements for LIHI and Green-e certifications.

[4] World Wildlife Fund, World Resources Institute and other organizations have created the Corporate Renewable Energy Buyer's Alliance, with a set of principles to guide large corporations (http://buyersprinciples.org/principles/).

criteria were designed to be applicable to any and all types of hydropower. Now that the LIHI certification approach has been proven successful, and after the new handbook has been fully implemented in 2016, there are good reasons why the Board may consider expanding the LIHI certification business by making changes in its eligibility requirements. Public comment on some of these potential changes was solicited in 2014 when revised criteria were proposed.

One potential change would be to revise the cutoff date for dam construction, either to a date later than 1998 or to drop this cutoff date all together and rely on the existing criteria and standards to identify certifiable facilities. Another change would be to allow applications from outside the U.S., such as Canadian facilities that export electricity into the U.S. Requests from industry to allow applications from small hydropower facilities located in Canada have been increasing over the past three or four years. The LIHI Board has been unwilling to make such changes until the revised criteria and new handbook have been fully implemented.

One other eligibility change might be related to dam removal recommendations. Public comments have requested that applicable recommendations be allowed to come from other public sources. In order to accommodate this idea, some way would be required to ensure that such recommendations were fully vetted through public review and comment, plus likely be connected to a legally enforceable process.

3.3 Potential improvements in the LIHI Criteria

As required in its bylaws, the LIHI Board and staff will continue to monitor the performance of its certification program and make improvements where and when they are needed. If changes are made in the program's eligibility requirements, then it may also be necessary to add one or more new criteria to address environmental issues associated with new types of hydropower facilities. For example, if new construction is allowed to apply for certification, the Board may decide to add a new criterion to evaluate sensitive aquatic or terrestrial habitats that would be altered by that construction. Alternatively, sensitive or protected areas may be excluded from consideration via new eligibility requirements.

Two other issues that have been proposed for new criteria are sedimentation and reservoir-based resource protection (e.g., waterfowl nesting). To date, there have been no specific proposals made for sedimentation or facility effects on fluvial geomorphology, but these subjects may come up in the future. The challenge would be to develop practicable, cost-effective standards that could be applied to them. The issue of reservoir-based resources is being partially addressed in the 2nd Edition handbook through exploratory data collection in designated impoundment zones. Management practices for reservoir ecosystems must be described for impoundment zones under the new handbook, but for the time being, the NA/DME standards can be used for these zones. In the future, more specific standards may be developed for impoundment zones, subject to information collected over the next year or two.

LIHI will maintain an adaptive strategy for updating its certification program to achieve continuous improvements.

3.4 Technical advances

The hydropower industry in the U.S. is a global leader in the development of advanced hydropower technology that increases the environmental performance of facility design and operation. The U.S. Department of Energy (DOE) has been making substantial investments in this area since the 1990s (Sale et al., 2006), and these research and development investments have been increasing more recently. DOE will be releasing a new document in 2016 that describes a vision for new hydropower development over the next several decades, including a technology roadmap for the types of advanced hydropower needed to achieve this vision.

The new hydropower technologies and assessment approach associated with DOE's new Hydropower Vision will fit well with the adaptive nature of LIHI's certification program. For example, there are multiple places among the new alternative standards where best practices (BPs) and best available technologies (BATs) can be used to satisfy the LIHI criteria. The application of well-documented and accepted BPs and BATs in hydropower will help both the regulatory processes and LIHI's certification program operate more efficiently. Hopefully, the DOE-supported efforts in this direction will provide the documentation and acceptance needed for this to work.

4. Core Concepts of the LIHI Certification Program

The results from LIHI's first decade and a half of operations prove that a voluntary, independent certification program for hydropower can work in the U.S., especially where there are strong state polices that recognize the value of hydropower. LIHI's experience has established the following certification concepts:

- Many hydropower facilities are environmentally acceptable, renewable power sources that deserve to be part of the preferred, clean energy future.
- While all hydropower is renewable energy, those hydropower facilities that are certified as low impact deserve to be treated the same in renewable portfolio standards as other preferred renewables, such as wind or solar.
- Size and facility age are not effective metrics for determining which hydropower facilities are environmentally preferable – use of these metrics for eligibility detract from the effectiveness of renewable energy markets.
- A standards-based approach for evaluating certification criteria is more effective in identifying environmentally preferred facilities, compared to size or age – furthermore, the standards-based, LIHI approach has proven feasible.
- A pass/fail approach is the appropriate way to evaluate hydropower facilities – alternative approach, such as the tradeoffs between power and nonpower resources used by FERC or graded systems such as the Power Scorecard (http://www.powerscorecard.org/) do not adequately distinguish green energy from hydropower.
- LIHI certification annual fees should be set with sensitivity to the markets in which certified projects sell their energy products.
- Sustainable energy is about more than just new energy, and existing vintage hydropower assets should be recognized in RPSs for their ongoing contributions to our growing renewable supply.

It should be expected that the standards and methods by which low-impact hydropower is evaluated will continue to evolve as science, technology, consumer needs, and government policies on renewable energy change (Leon, 2013; Penndorf, 2015). Nevertheless, LIHI certification is returning real value to hydropower owners and to river ecosystems as it stands now, in 2016.

For additional information about LIHI and its current certification program, see our website at: www.lowimpacthydro.org.

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