Attributes that may (or may not) be Indicative of the Level of Hydropower Facility Ecological and Social Impacts

A LIHI Case Study[1]

1. Introduction

There is a common perception that small hydropower facilities have fewer or smaller adverse ecological and social impacts than large facilities; and that the larger a facility is, the greater its adverse impacts. But, as Lydia Grimm, the first Executive Director of the Low Impact Hydropower Institute (LIHI) wrote (Grimm, 2002):

> *The underlying assumption that a "small" project is necessarily less damaging than a "large" project is not accurate. A small dam on a tributary stream that prevents migratory fish from accessing miles of spawning habitat can be more damaging than a large dam on a stream without migratory fish. A small dam may be operated in "run of river" mode where inflow to the project equals the outflow on an instantaneous basis, but "run of river" also generally means the water from the river is either partly or entirely diverted into a penstock, and little to no water may be left in the natural river channel for hundreds of yards, or even multiple miles (i.e., the "bypassed reach"). This can be more damaging to the ecosystem than a large dam that operates in run of river mode, but which does not divert any water from its natural course. Worse, the "small hydro" standard is based on a facility's capacity rather than the actual size of the dam, the size of any impoundment, the length of any bypassed reach, or how the facility is operated.*

LIHI's goal is to reduce the impacts of hydropower generation through the certification of hydropower projects that have avoided or reduced their impacts pursuant to the Low Impact Hydropower Institute's criteria. LIHI is the only US-based organization to define low impact hydropower and set science-based criteria for meeting that definition in eight categories including flow regimes, water quality, upstream and downstream fish passage, shorelines and watershed, threatened and endangered species, cultural and historic resources, and recreational, public and traditional cultural access. A facility that achieves LIHI Certification, by definition, has lower impacts than a facility that fails to satisfy the LIHI criteria or one which is unwilling to take necessary actions to reduce its impacts sufficiently to achieve certification. LIHI Certification can therefore be seen as a proxy for assessing the level of a facility's impact.

This investigation is intended to help shine a light on facility attributes that may or may not indicate a facility's level of environmental and social impact. The following analysis is based on the Low Impact Hydropower Institute Certification applications received and evaluated over the organization's 25-year history up to November 2025.

Recommended citation: Fischer, M. and S.B.J. Ames (2026). Attributes that may (or may not) be Indicative of the Level of Hydropower Facility Ecological and Social Impacts – A LIHI Case Study. Low Impact Hydropower Institute, Boston MA.

The primary research questions explored through this analysis are:

1. Are there trends in the proportion of facilities that are LIHI Certified® and facilities that applied for certification but failed to achieve or maintain certification due to an inability to satisfy the LIHI criteria or unwillingness to comply with LIHI-imposed conditions?
2. Are there discernable differences between these facility categories that are related to facility size, operational type, or to other attributes, and if so, to what degree?

Defining Small and Low Impact Hydro

Definitions of "small hydropower" and "low impact" facilities vary across the hydropower industry in the U.S., and even more so, globally (Kelly et al., 2017). In the U.S. where LIHI currently operates, "small" hydro is often based on installed capacity in megawatts (MW), although there is no widely agreed-upon U.S. definition of the term "small hydropower" (see Hadjerioua and Johnson, 2025; Curtis et al., 2017). Individual states use different capacity thresholds for hydro facilities to qualify in Renewable Portfolio Standard (RPS) categories for purposes of selling Renewable Energy Credits (RECs). Generally, either 10 MW or 30 MW is a commonly used threshold.

Others define "low impact" as being limited to run-of-river operations meaning that inflow to the facility equals outflow at all times and there is little to no active water storage.[2,3] Still others define "small" or "low impact" as being only new hydro facilities constructed at existing non-powered dams or locks and dams where the dam-related infrastructure is already in place.[4]

Some also define "low impact" by design features such as modular dam construction or fish-friendly turbines. Because there are so few of these advanced designs in the LIHI portfolio, technology type is not included in this analysis. Also, not addressed are closed loop pumped storage facilities, which some consider to be "low impact," since this facility type is currently ineligible for LIHI Certification.

Kelly et al., (2017) suggests that system design may be more important than facility size and acknowledges (like LIHI does) that each hydro facility is unique and its impacts are site specific. The system design attributes that may contribute to a facility's level of impact include:

- Height of the dam or weir

---

[2] LIHI defines run-of-river facilities as those with outflow from the facility maintained within reasonable measurement accuracy (plus or minus 10 percent) of the inflow to the facility, measured on an hourly basis.
[3] Outside of the U.S. the term "run-of-river" often refers to a diversion only, with no associated dam.
[4] The 1978 Public Utilities Regulatory Policy Act (PURPA, 16 U.S.C. § 2708(a)(1)) encouraged the development of "small hydroelectric facilities," so long as they were sited in connection with existing dams that were not already being used to generate power. PURPA specifically defined "small hydroelectric facilities" to be those having up to 30 MW of installed capacity.

- Length of the diversion
- Mitigation measures adopted (e.g. use of fish ladders)
- Amount of water diverted relative to the natural streamflow
- Ancillary infrastructure associated with the facility

Mitigation measures play a critical role in reducing a facility's level of impact. This analysis does not include a comparison of the presence or absence of specific mitigation measures at different facilities, but it is clear that for two similarly sized facilities located at similar sites with similar impacts (e.g., to migratory fish), mitigation measures implemented at one facility (e.g., a fish ladder) could reduce the impact at that facility such that it satisfies the LIHI criteria versus another facility that did not implement such measures. LIHI also considers the effectiveness of the mitigation measure, for instance, a fish ladder that is ineffective at safely passing fish does not reduce the facility's impact and would have difficulty achieving LIHI Certification.

LIHI's low impact definition is not based on facility design, operational type, MW capacity, or other attributes. Every facility is carefully evaluated based only on its ability to satisfy each of the LIHI criteria. LIHI does not track detailed information on a facility-by-facility basis for the amount of water diverted or ancillary infrastructure, although those may also be valid attributes worthy of investigation. This analysis includes attributes for which there is available data and which may (or may not) be a factor in a facility's relative level of impact:

- Facility capacity
- Dam/weir height
- Dam ownership
- Presence and length of a bypassed river reach
- Facility operational mode and owner type
- Status of Federal Energy Regulatory Commission (FERC) license or exemption

LIHI also considers the facility's location on a river in relation to other dams and hydro facilities on the same river. For instance, a facility located upstream of a natural waterfall or a barrier dam constructed earlier would not be the cause for the absence of migratory fish, therefore would not have an adverse impact on migratory fish species, and thus would satisfy the upstream fish passage criterion.

<u>Notes on Data and Limitations</u>

This analysis uses a small sample of 287 LIHI Certified® individual powerhouses ("certified facilities") and 44 individual powerhouses[5] that withdrew their LIHI applications due to being unable to meet the LIHI criteria or willing to comply with certification conditions needed to

[5] These are individual facilities although some LIHI Certificates and some withdrawn applications cover multiple powerhouses and dams. One withdrawn application included 3 powerhouses but is considered one for this analysis since the individual powerhouse attributes could not be separated out based on the information provided in the LIHI application.

achieve or confirm satisfaction of the LIHI criteria ("withdrawn facilities"). It is important to note that LIHI applicants may withdraw their application or existing certification for economic or other reasons unrelated to the LIHI criteria. Those account for 19.5% of all applications processed and are excluded from this analysis.

Withdrawn applications or certifications that are based on criteria account for 20.5% of all applications processed, and 13% of all individual powerhouse facilities over LIHI's 25-year history. The small number of withdrawn facilities leads to some skewing of data points, for instance where an average of data in a particular category of analysis is based on only one or two facilities.

Two of the 44 withdrawn facilities re-applied later and were able to be certified based on newly provided information needed for certification.[6] These are included in both the certified and withdrawn facility categories with adjustments made to the data (e.g., FERC license age) based on the dates of their initial LIHI application withdrawal and their subsequent successful LIHI certification.

Another five facilities decided not to apply at all after initial discussion with LIHI staff whose initial review indicated these facilities would likely fail certification on a criteria basis and are not included in this analysis. Three facilities that had been certified, had their certifications revoked, or are currently suspended due to criteria issues and these are also excluded from the analysis, but one other facility that was suspended was subsequently reinstated and is included as a certified facility. Also excluded are four storage-only dam facilities without associated powerhouses that are part of multi-development LIHI Certificates.

2. Facility Capacity

Prior to 2015, FERC defined "small hydro" that was eligible for exemption from licensing to include conventional facilities up to 5 MW and conduits up to 15 MW for non-municipal installations, and up to 40 MW for state or municipally owned conduits in municipal water supply systems. In 2015, FERC issued regulatory revisions under the Federal Power Act (Docket RM14-22) that were required by the Hydropower Regulatory Efficiency Act of 2013. The changes increased exemption eligibility to 10 MW for conventional facilities and 40 MW for all conduits.

Without specifying a MW threshold for "small" versus "large" hydro, most data in this analysis are presented for seven classes of capacity from less than 1 MW to greater than 100 MW. The capacity of all certified facilities ranges from 10 kilowatts (kW) to 450 MW while for all withdrawn facilities, capacity ranges from 260 kW to 843 MW.

Figure 1 compares the proportion of certified and withdrawn facilities within each of the various MW size classes. A larger percentage of withdrawn facilities than certified facilities are

[6] American Tissue, LIHI #191 and Lower Great Falls, LIHI #202.

in the less than 1 MW class (29.5% vs. 19.5%) and in the greater than 100 MW class (15.9% vs. 4.2%). In addition, a slightly larger percentage of withdrawn facilities are in the 10 to 30 MW class and 50 to 100 MW class. Table 1 summarizes the data numerically.
Typically, more adverse comments are received from resource agencies and interested parties for large facility LIHI applications than for small facility applications, regardless of whether the facility ultimately becomes certified. This may be due to the general perception that large projects are not inherently low impact, and/or that they are often subject to more local controversy than small facilities. All withdrawn LIHI applications greater than 100 MW received negative comments during the LIHI review process. However, thirty percent of LIHI Certificates greater than 100 MW also received negative comments during their most recent application reviews but were still able to be certified or recertified since they satisfied the LIHI criteria.

Overall, the average MW capacity of withdrawn facilities is much larger (64.3 MW) than certified facilities (15.6 MW), but the overall median values are much closer: 4.14 MW for withdrawn facilities versus 3.54 MW for certified facilities. Proportionally more withdrawn facilities are scattered throughout MW classes and higher in both the smallest (< 1 MW) and the largest (>=100 MW) classes. Therefore, these data suggest that defining level of impact by facility capacity alone is misleading.

Figure 1. Certified and withdrawn facilities by MW class

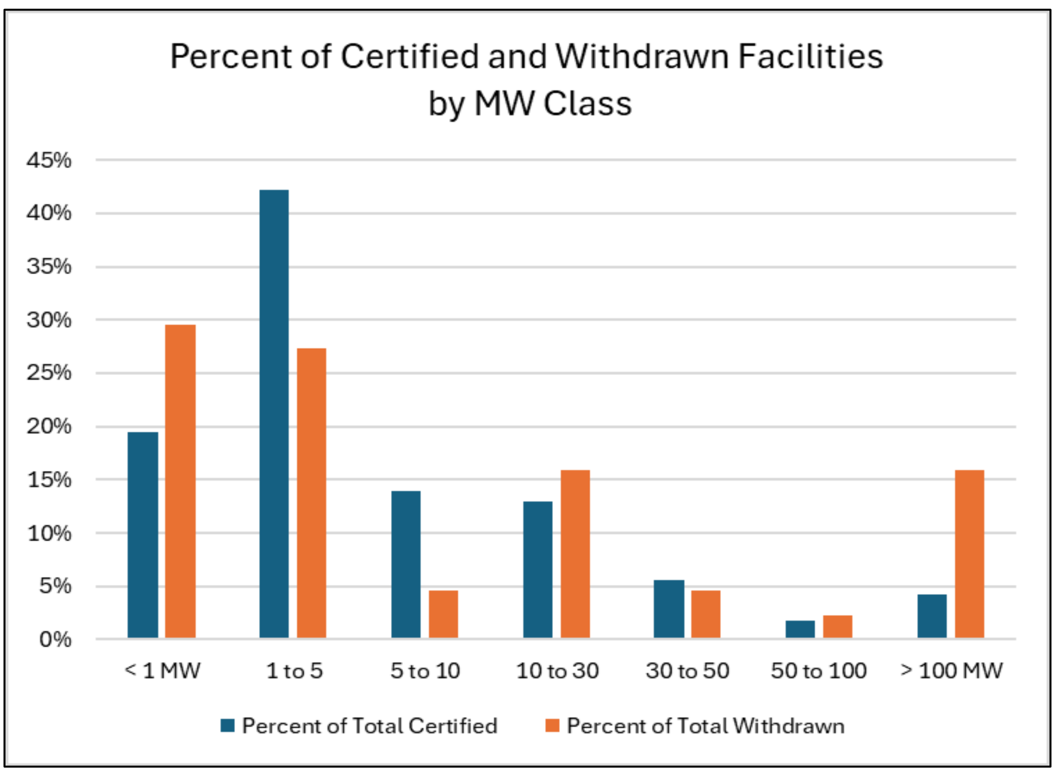


Table 1. Number of facilities and average capacity by MW class

MW category	Certified Facilities			Withdrawn Facilities		
	Number	Ave MW	Percent of Total Certified	Number	Ave MW	Percent of Total Withdrawn
< 1 MW	56	0.46	19.5%	13	0.6	29.5%
1 to 5	121	2.71	42.2%	12	2.24	27.3%
5 to 10	40	6.7	13.9%	2	5.65	4.5%
10 to 30	37	17.6	12.9%	7	17.24	15.9%
30 to 50	16	36.1	5.6%	2	42.37	4.5%
50 to 100	5	60.1	1.7%	1	70.27	2.3%
> 100 MW	12	193.2	4.2%	7	358.2	15.9%
Total	**287**	**15.6**	100%	**44**	**64.3**	100%

3. Dam Height and Dam Ownership

As with definitions of "small hydro", definitions of "small dams" and "large dams" can differ widely. Two examples are the US Society on Dams which defines a large dam as one with a height of 15 meters (49.21 feet) or greater or a dam between 5 meters (16 feet) and 15 meters impounding more than 3 million cubic meters (2,400 acre-feet). Wisconsin Department of Natural Resources (WDNR) uses a much lower threshold which defines large dams as those over 6 feet high and impounding 50 acre–feet or more, or those 25 feet or higher and impounding more than 15 acre–feet.

This analysis uses a simple 50-foot threshold to distinguish small from large dams. LIHI does not have complete data on reservoir storage capacity, but taller dams are typically associated with larger storage and with store/release or peaking operations which are reflected in the LIHI data. A larger percentage of withdrawn facilities (36.4%) than certified facilities (22%) are located at dams 50 feet or taller. Of those, 68.8% of withdrawn facilities and 61.9% of certified facilities operate as store/release or peaking facilities.

All of the withdrawn facilities are associated with dams which range in height from 8 to 412 feet, with an average of 70.5 feet and a median value of 29.5 feet. Only 89% of certified facilities are associated with a dam, the remaining 11% are conduit facilities or have a reservoir formed by a natural lake. For the certified facilities with dams, the height ranges more broadly than for withdrawn facilities - from 5 up to 540 feet, but the average and median values are lower than for withdrawn facilities (50 ft average, 24 ft median).

Some dams or diversions and their reservoir or canal operations are not controlled by the hydro owner/operator (e.g., those at federal or state-owned dams) and those dams can be quite tall even if the hydro facility's capacity is small. LIHI does not evaluate reservoir operations at non-hydro-owned or operated dams, and those dams are often associated with multiple uses of the dam (e.g., irrigation, municipal water supply, flood control, navigation)

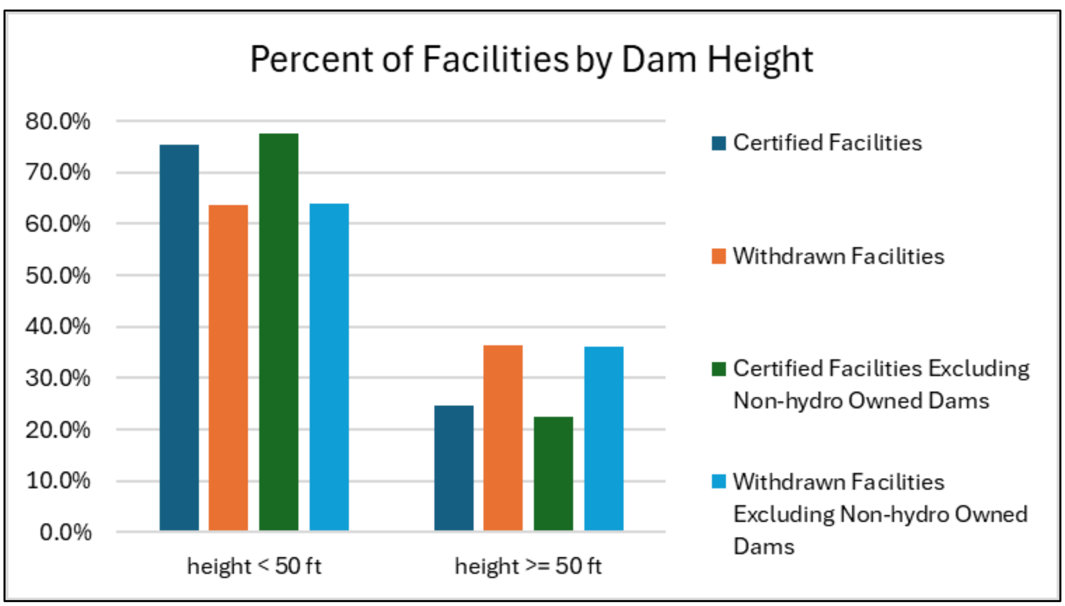
There are eight withdrawn facilities (18.2% of withdrawn facilities) and eleven certified facilities (3.8% of certified facilities) where the hydro operator does not own or control the dam or diversion. The average and median dam heights and MW capacities for these facilities are shown in Table 2. Interestingly, certified facilities in this category have taller dams and larger MW capacities than withdrawn facilities. Also, a much larger proportion of certified facilities than withdrawn facilities located at non-hydro-owned dams are at dams > 50 ft tall (72.7% vs. 37.5%).

Table 2. Non-hydro-owned dam height and MW capacity

Non-hydro-owned Dams	Certified Facilities	Withdrawn Facilities
Number of Facilities	11	8
Average Dam Height (ft)	181.0	58.6
Median Dam Height (ft)	174.5	37.0
Average MW Capacity	32.7	18.0
Median MW Capacity	13.0	5.1

Figure 2 illustrates the percentage of certified and withdrawn facilities that have a "small" dam (less than 50 ft) or a "large" dam (50 ft or taller). Most facilities, whether certified or not and whether owned or controlled by the hydro operator or not, are associated with small dams, although a somewhat larger percentage of withdrawn facilities than certified facilities are located at large dams. Thus, these data suggest that dam height could be a factor in a facility's level of impact as determined by the LIHI criteria.

Figure 2. Percentage of facilities at small and large dams



4. Presence and Length of Bypassed Reach

The presence and length of a bypassed river reach at a hydropower facility is thought by Kelly et al., (2017) to contribute to the facility's level of impact since more aquatic habitat is affected by a bypassed reach, especially if it is long and if flows through the reach are insufficient to support that habitat. Similar proportions of certified facilities (64.8%) and withdrawn facilities (61.4%) have a bypassed river reach.

Figure 3 shows the percentage of all facilities with a bypassed reach broken out by MW class. A higher percentage of all withdrawn facilities than certified facilities in the less than 1 MW class have bypassed reaches, while the opposite is true in all other MW classes (note that there are no withdrawn facilities with bypassed reaches in the 50 MW or larger classes). This result suggests that the presence of a bypassed reach, if it has an impact at all, may only impede LIHI certification for the smallest facilities.

Certified facility bypassed reaches range in length from only a few feet to 10.9 miles (average = 0.84 miles, median = 0.25 miles). Withdrawn facility bypass lengths range from .03 miles to 10.2 miles with nearly the same average length as certified facilities (0.83 miles) and a slightly smaller median value of 0.18 miles. Therefore, the length of a bypassed river reach does not appear to factor in a facility's level of impact as determined by the LIHI criteria.

Table 3 shows these data numerically and indicates that the average length of a bypassed reach is relatively similar for certified and withdrawn facilities across most MW classes except in the 30 to 50 MW class for which there is only one withdrawn facility which has a very long bypassed reach. Similarly, the average bypass length is greater for certified facilities in the 5 to 10 MW class, but again withdrawn facility data is based on only two facilities.

Figure 3. Percentage of facilities with a bypassed reach by MW class

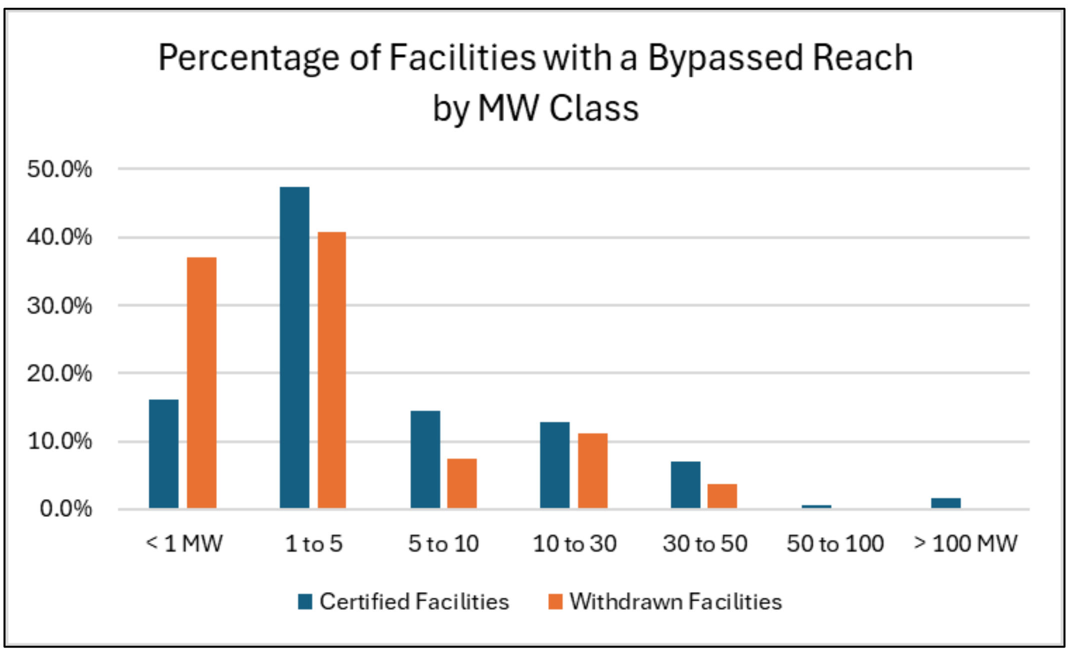


Table 3. Average bypassed length by MW class

MW category	Certified Facilities			Withdrawn Facilities		
	Number with Bypass	% of Total with Bypass	Ave Bypass Length (mi)	Number with Bypass	% of Total with Bypass	Ave Bypass Length (mi)
< 1 MW	30	16.1%	0.17	10	37.0%	0.24
1 to 5	88	47.3%	0.36	11	40.7%	0.33
5 to 10	27	14.5%	1.03	2	7.4%	0.32
10 to 30	24	12.9%	1.48	3	11.1%	1.84
30 to 50	13	7.0%	3.71	1	3.7%	10.2
50 to 100	1	0.5%	1.9	0	0.0%	n/a
> 100 MW	3	1.6%	1.72	0	0.0%	n/a
Total	**186**	**64.8%**	**0.84**	**27**	**61.4%**	**0.83**

5. Operational Mode and Owner Type

Kelly et al., (2017) suggests that system design is a more significant attribute than facility size in determining a facility's level of impact. This perspective has been echoed throughout LIHI's history by those who believe that only run-of-river facilities can be considered low impact. Facilities that store and later release water for electricity generation are more likely to have larger reservoirs that inundate more land, fluctuate water levels more often and over a wider range, and may alter water quality in discharged water or create impactful downstream flow surges when generation does occur.

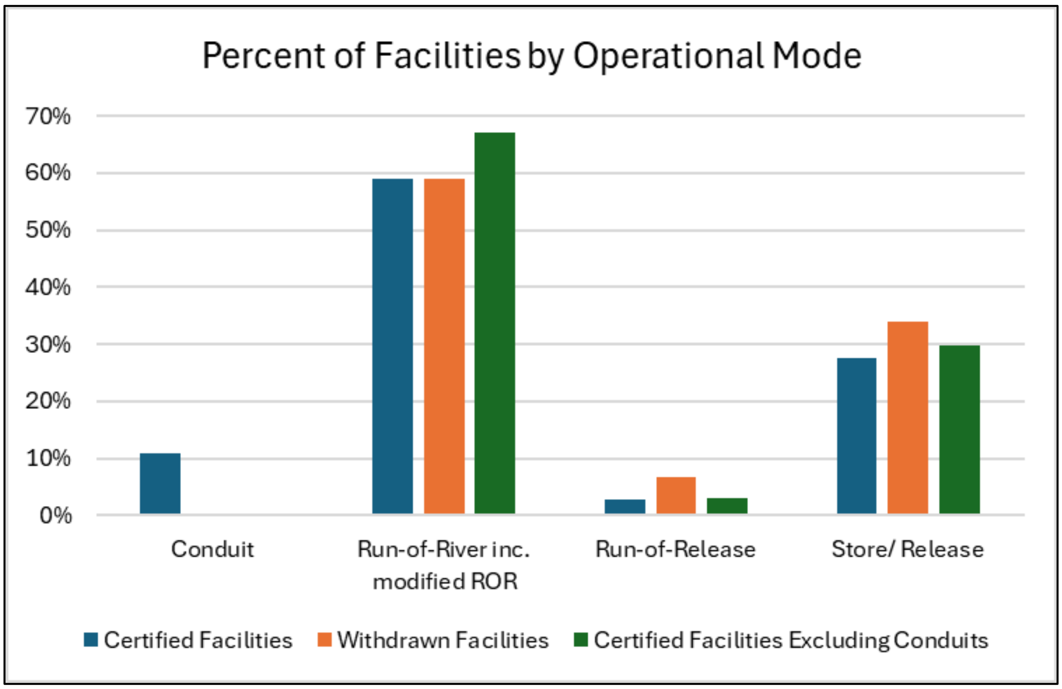
For this analysis, facility operational mode is used as a proxy for system design. LIHI defines four categories of operation:

- Conduit facilities that are typically located in water supply pipes or canals and not on rivers.
- Run-of-river and modified run-of-river facilities where inflow generally equals outflow on a sub-daily basis (hourly basis for true run-of-river per the LIHI definition) or the reservoir may have a small amount of useable storage and a small water level fluctuation allowance (modified run-of-river).
- Run-of-release facilities where the hydro facility does not control the flow of water released from the dam or lock and dam.
- Store-and-release or "peaking" facilities where a dam is present and water is stored for later use or for seasonal flood control. Water usage depends upon inflow from the reservoir or upstream storage and/or on electricity demand, and flows and reservoir storage vary on a daily, weekly, or seasonal basis.

As shown in Figure 4, there are no withdrawn conduit facilities in the dataset while 11% of certified facilities are conduit facilities. In other words, all conduit facilities that have applied for LIHI certification have been certified. It is true that, by design, most (but not all) conduit facilities have minimal impacts. However, these facilities must still go through the full LIHI criteria evaluation in order to become certified. Conduits are not necessarily very small facilities either, ranging from 10 kW to 22.5 MW for LIHI Certified® facilities.

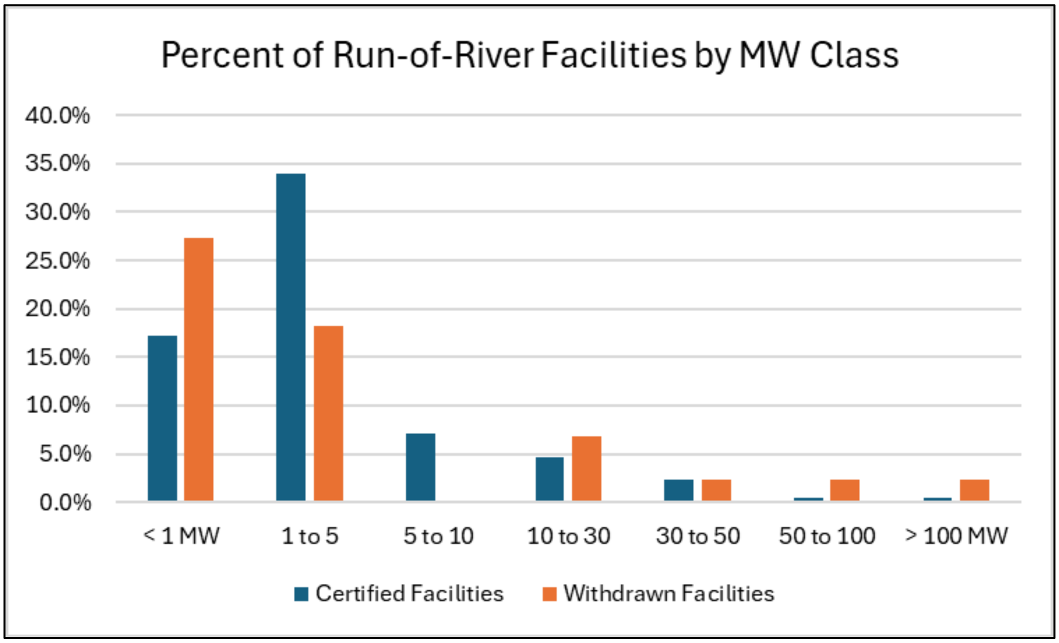
Data for certified facilities in Figure 4 are presented based on all certified facilities (in blue) and for certified facilities excluding conduits (in green) as well as for withdrawn facilities (orange). The majority of both certified and withdrawn facilities are run-of-river or modified run-of-river although slightly more of them are certified when conduits are excluded. Around 30% of both certified and withdrawn facilities are store-and-release and a very small percentage of each are run-of-release, with slightly more withdrawn facilities than certified facilities in both of those categories. This result might suggest that facilities that are not run-of-river may have slightly more difficulty achieving LIHI certification.

Figure 4. Percent of facilities by operational mode



However, Figure 5 (which excludes conduits) shows that even run-of-river facilities can have difficulty achieving LIHI certification across all MW classes except in the 1 to 5 MW class (there are no such withdrawn facilities in the 5 to 10 MW class).

Figure 5. Percent of run-of-river facilities by MW class



One additional research question was whether there is a difference between independent power producer facilities (IPPs) and regulated utilities or government-owned facilities. Table 4 illustrates that there is only a small difference in this attribute with slightly more withdrawn facilities than certified facilities being independently owned.

Table 4. Ownership Type

Ownership Type	Certified Facilities	Withdrawn Facilities
IPP	75.6%	79.5%
Utility or Government	24.4%	20.5%
Total	**100.0%**	**100.0%**

6. FERC License/Exemption Status and Age

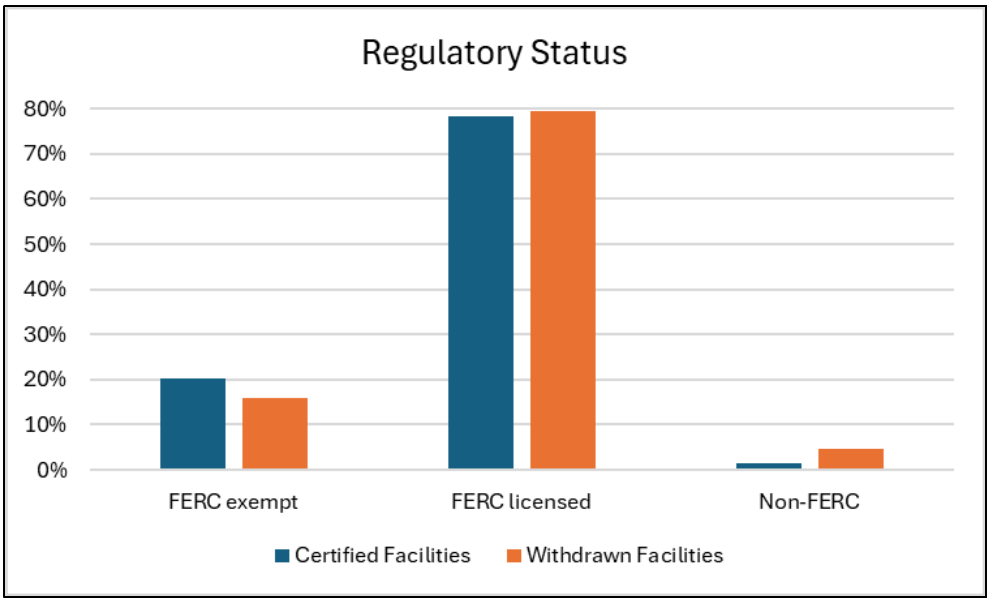
FERC issues both licenses and exemptions to non-federally owned hydropower facilities and 84% of all hydro facilities in the US are FERC-regulated (Johnson et al., 2025). Non-federally owned hydropower facilities that are also not FERC regulated include facilities with a valid pre-1920 federal permit as long as they are:

- Not located on navigable waters of the United States;
- Do not occupy public lands or reservations of the United States;
- Do not utilize surplus water or waterpower from a federal dam; and
- Are not located on a body of water over which Congress has Commerce Clause jurisdiction, where project construction occurred on or after August 26, 1935, and the project affects the interests of interstate or foreign commerce

As discussed in Section 2, since 2015 FERC has issued exemptions for "small hydro" up to 10 MW capacity, and for conduits up to 40 MW. Exempt conduit and conventional hydro facilities are required, under Section 30 of the Federal Power Act, only to comply with any formal terms and conditions that the United States Fish and Wildlife Service, National Marine Fisheries Service, and state fish and wildlife agencies have determined are appropriate to prevent loss of, or damage to, fish or wildlife resources or otherwise to carry out the purposes of the Fish and Wildlife Coordination Act. FERC implements this requirement through the exemption's standard articles (usually Standard Article 2).

As shown in Figure 6, most facilities whether certified or not, hold FERC licenses; and overall, the relative proportions of certified and withdrawn facilities across all FERC categories are similar with slightly more withdrawn facilities being licensed or unregulated by FERC and slightly fewer being FERC exempt.

Figure 6. Percentage of facilities by FERC status



In 1986 the Electric Consumers Protection Act (ECPA) (16 U.S.C. § 791a) was enacted. It amended the Federal Power Act, requiring FERC to give, and also document in environmental assessments, "equal consideration" to developmental and environmental values. These environmental values include fish and wildlife resources and their spawning grounds and habitat, visual resources, cultural resources, recreational opportunities, and other aspects of environmental quality. Developmental values include power generation, irrigation, flood control, and water supply (FERC 2004).

Importantly, FERC is not required to adopt the most environmentally protective conditions identified by resource agencies for a particular facility in the licensing process. A critical part of LIHI's evaluation considers all terms, conditions, and recommendations made by resource agencies, tribal governments, and the public in certification decisions even if FERC does not adopt them through licensing. That means that even pre-ECPA licensed facilities are evaluated by LIHI on the same basis as post-ECPA licensed facilities. FERC exempt facilities including conduits are subject to the same rigorous LIHI evaluation process as licensed facilities.

Also, as of mid-2005, FERC mandated the Integrated Licensing Process (ILP) as the default licensing process. The ILP is intended to streamline licensing, encourage agency and stakeholder engagement, and identify issues early in the licensing process through resource studies conducted with agency, and stakeholder input and FERC oversight prior to filing of a license application.[7] Prior to this change, the Traditional Licensing Process (TLP) was the default process. The TLP entails filing of a license application first and then conducting studies with or without external input on the design and scope of resource studies. Even since that time, facility owners can still request use of the TLP, which FERC often grants for small or less complex facilities especially if resource agencies support that approach. The ILP is typically a more rigorous process than the TLP with more in-depth analysis of resource issues, more agency and stakeholder input, and more FERC oversight in the pre-application stage.

Table 5 shows that while most certified facilities (76.6%) have post-ECPA licenses or exemptions, less than half of withdrawn facilities do (43.2%). Overall proportions of facilities with licenses or exemptions issued since 2006 are similar (16.3% to 18.2%) but there are no FERC exempt withdrawn facilities in that category as opposed to 19.1% of certified facilities with FERC exemptions. There are also a small number of non-FERC regulated facilities in both categories.

Table 5. FERC vintage of certified and withdrawn facilities at the time of LIHI application

License/Exempt Date	Certified Facilities	Withdrawn Facilities
< 1987	**22.0%**	**52.3%**
exempt	61.9%	26.1%
license	38.1%	73.9%
1987 - 2005	**60.3%**	**25.0%**
exempt	5.8%	9.1%
license	94.2%	90.9%
>= 2006	**16.3%**	**18.2%**
exempt	19.1%	0%
license	80.9%	100%
Non-FERC	**1.4%**	**4.5%**

The average FERC license or exemption year at the time of LIHI certification is later than ECPA (1996 for certified facilities, 1989 for withdrawn facilities). But strikingly, the median year is 1984 for withdrawn facilities (pre-ECPA), while it is 1997 (post-ECPA) for certified facilities.

There is a common perception that FERC exempt facilities can have a more difficult time

[7] See https://ferc.gov/industries-data/hydropower/licensing/licensing-processes/integrated-licensing-process-ilp.

demonstrating that they meet the LIHI criteria and standards. These facilities often have few, if any, regulatory requirements related to the LIHI criteria and they typically have less supporting documentation available, particularly if the exemption is an older one (e.g., from the early to mid-1980's).[8] However, this is not borne out by the LIHI data which show that most pre-ECPA certified facilities hold exemptions rather than licenses (61.9% to 38.1%) while the converse is true for withdrawn facilities (26.1% to 73.9%).

Overall, older FERC licenses or exemptions may correlate with unsuccessful LIHI Certification, but this is confounded by the fact that there are similar proportions of certified and withdrawn facilities with even newer licenses or exemptions issued since 2006 (16.3% to 18. 2%) and all of those withdrawn facilities have licenses rather than exemptions.

For FERC licenses alone, Figure 7 shows that the vast majority of certified facilities were certified with post-ECPA licenses, while barely half of withdrawn facilities had post-ECPA licenses at the time of the unsuccessful LIHI application.

Figure 7. Percentage of facilities by FERC license issuance at initial LIHI application

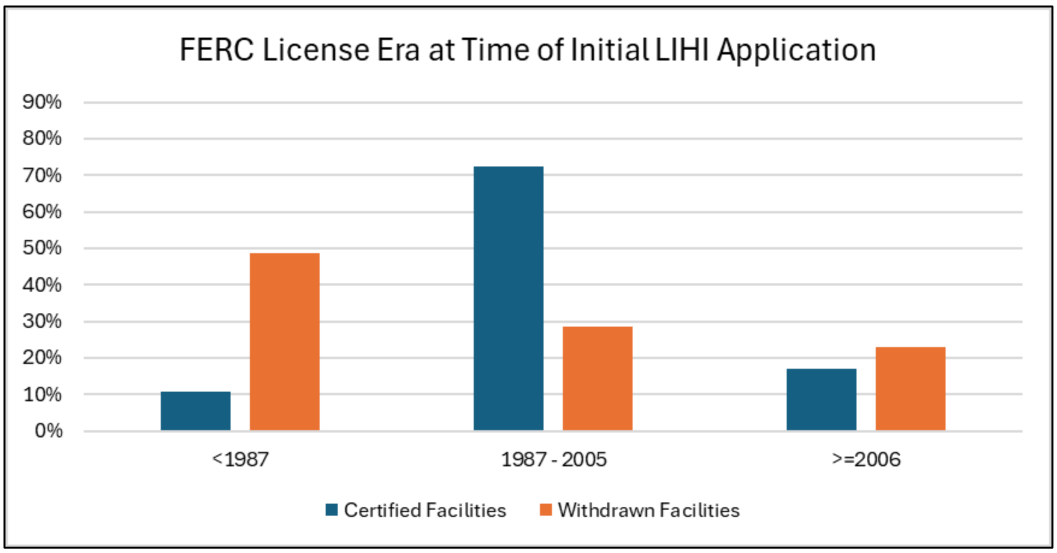
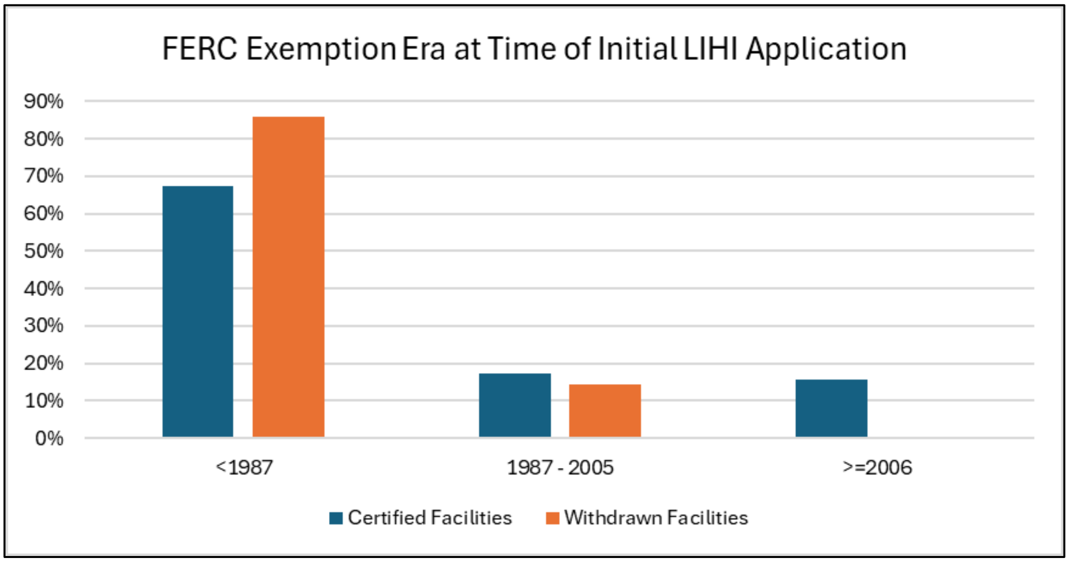


Figure 8 illustrates the same for FERC exemptions. A majority of both certified and withdrawn facilities have older exemptions although more withdrawn facilities fall into this category. There are no withdrawn facilities with exemptions issued since 2006.

---

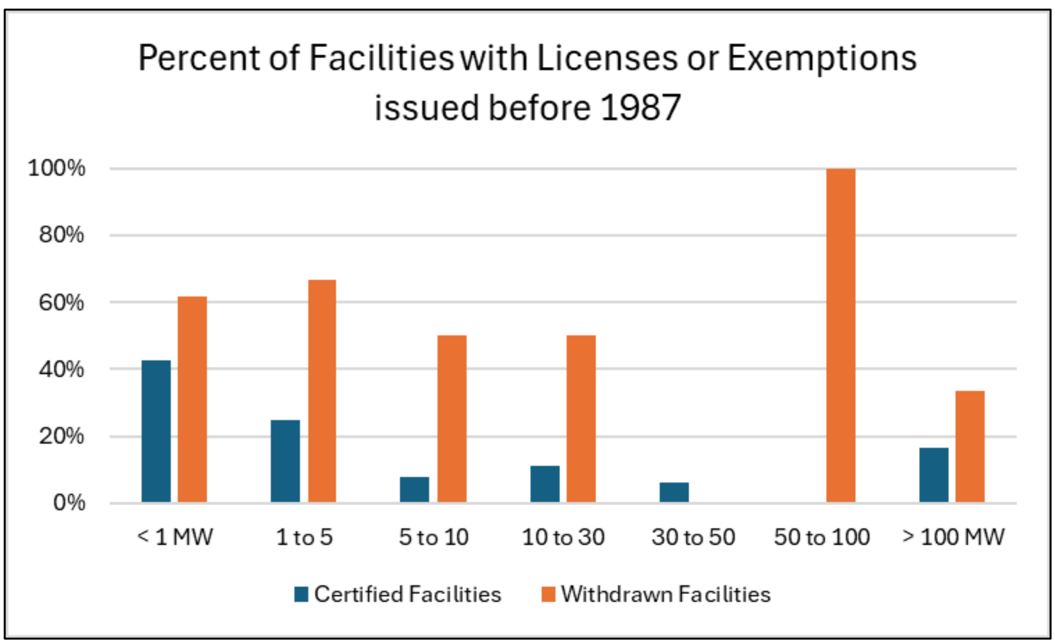
[8] LIHI may require an applicant to conduct additional agency consultation and/or conduct studies to develop new information if only old information exists; or the facility may be subject to conditional certification with requirements for taking additional actions to confirm that the facility meets the LIHI criteria.

Figure 8. Percentage of facilities by FERC exemption issuance at initial LIHI application



This tendency for withdrawn facilities to have older licenses or exemptions also holds true across all MW classes (Figure 9). Note that there are no withdrawn facilities with licenses or exemptions older than 1987 in the 30 to 50 MW class and no such certified facilities in the 50 to 100 MW class.

Figure 9. Percentage of facilities with older licenses and exemptions, by MW class



7. Summary and Conclusion

The sections above looked separately at various facility attributes that may influence the level of a hydro facility's impact as determined by the ability of the facility to achieve LIHI Certification. Key findings of this analysis show that:

- Proportionally more withdrawn facilities than certified facilities are in both the smallest and the largest MW classes, suggesting that defining "low impact" by facility capacity alone can be misleading.

- A somewhat larger percentage of withdrawn facilities than certified facilities are located at large dams (>= 50 ft tall). Thus, dam height may be a possible factor contributing to a facility's level of impact as determined by the LIHI criteria. However, this result can also be misleading on its own. At non-hydro-owned dams which are typically multi-use dams, a larger proportion of certified facilities (80%) than withdrawn facilities (37.5%) are associated with large dams. Additionally, at large dams, a higher proportion of certified facilities (54%) than withdrawn facilities (25%) also have a bypassed reach.

- The presence of a bypassed river reach, if it has an impact at all, may only impede LIHI Certification for the smallest facilities - those less than 1 MW capacity. Proportionally fewer certified facilities than withdrawn facilities have a bypassed reach in this MW class, yet across all MW classes the proportions are similar (64.8% certified facilities vs. 61.4% withdrawn facilities) . The range in length of bypassed reaches for both certified and withdrawn facilities is similar, suggesting that this metric is not associated with the ability to achieve LIHI Certification.

- Facilities that operate as store/release facilities may have slightly more difficulty achieving LIHI Certification but even run-of-river facilities can have difficulty achieving LIHI Certification given that both categories have similar proportions of run-of-river operations (58.9% of certified facilities vs. 59.1% of withdrawn facilities).

- Facilities with licenses or exemptions issued before 1987 may have more difficulty achieving LIHI Certification; however, even those with newer licenses or exemptions (2006 or later) may also have difficulty given that similar proportions of certified facilities (16.6%) and withdrawn facilities (19.0) have newer licenses or exemptions.

Table 6 summarizes all attributes for all certified and withdrawn facilities.

Table 6. Attribute comparison for all facilities

Attribute	Certified Facilities	Withdrawn Facilities
Number of Facilities	287	44
Average MW Capacity	15.6	64.3
Median MW Capacity	3.54	4.14
Percent of facilities < 1 MW	19.5%	29.5%
Percent of facilities < 10 MW	75.6%	61.4%
Percent of facilities > 10 MW	24.4%	38.6%
Percent of facilities >=100 MW	4.2%	15.9%
Percent IPP-owned facilities	75.6%	79.5%
Percent store/release facilities	27.5%	34.1%
Percent run-of-river facilities	58.9%	59.1%
Percent with bypassed reach	64.8%	61.4%
Percent of facilities with dam >= 50 ft*	24.6%	36.4%
Percent of facilities at a non-hydro dam	3.8%	15.9%
Percent of FERC licenses/exemptions < 1987**	22.3%	54.8%
Percent of FERC licenses/exemptions >=2006**	16.6%	19.0%
Average FERC age	1996	1989
Median FERC age	1997	1984

* for facilities with dams (N=256 certified facilities, N=44 withdrawn facilities)
** for FERC regulated facilities (N=283 certified facilities, N=42 withdrawn facilities

It is tempting to identify a single attribute such as MW capacity as the leading indicator of the level of facility impact. Such simplicity is easier to enact into policy or to focus attention and action on impact reduction. However, this approach could potentially distract from more impactful facilities or provide rewards to facilities that do not meet the spirit and intent of the term "low impact."

As this analysis demonstrates, virtually every size of dam, MW capacity, operational mode, license or exemption age, dam and hydro facility ownership type, or bypass length associated with a facility, can have higher or lower impacts than a facility with similar attributes. Each facility is unique and is best evaluated on its own merits and on a case-by-case basis, against a comprehensive set of criteria rather than against any single metric.

8. References

Curtis, T., Levine, A., & Johnson, K. (2017). State Models to Incentivize and Streamline Small Hydropower Development. (NREL/TP-6A20-70098), National Renewable Energy Laboratory, Golden, CO (2017). https://doi.org/10.2172/1407466.

FERC (Federal Energy Regulatory Commission) (2004). Handbook for Hydroelectric Project Licensing and 5 MW Exemptions from Licensing. April 2004. https://www.ferc.gov/sites/default/files/2020-04/licensing-handbook.pdf.

Grimm, Lydia T. (2002). Certifying Hydropower for "Green" Energy Markets: The Development, Implementation, and Future of the Low Impact Hydropower Certification Program. May 2002. Report to the U.S. Department of Energy Hydropower Program from the Low Impact Hydropower Institute, Portland, OR.https://lowimpacthydro.org/wp-content/uploads/2020/07/Lydia-Grimm-on-LIHI-formation-2002.pdf.

Hadjerioua, Boualem and Johnson, Kurt (2015). Small Hydropower in the United States. September 2015. https://doi.org/10.2172/1237617.

Sarah Kelly-Richards, Noah Silber-Coats, Arica Crootof, David Tecklin, Carl Bauer (2017). Governing the transition to renewable energy: A review of impacts and policy issues in the small hydropower boom. Energy Policy, Volume 101, 2017, Pages 251-264, ISSN 0301-4215, https://doi.org/10.1016/j.enpol.2016.11.035.

Johnson, Megan, Kao, Shih-Chieh, & Uria-Martinez, Rocio (2025). Existing Hydropower Assets Plant Dataset FY25. Oak Ridge National Laboratory. https://doi.org/10.21951/EHA_FY2025/2568751.