New York State Hydrokinetic Resource and Techno-Economic Assessment

Final Report | Report Number 26-04 | February 2026

NEW YORK STATE

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New York State Hydrokinetic Resource and Techno-Economic Assessment

Final Report

Prepared for:

New York State Energy Research and Development Authority
Albany, NY

Jennifer Guia
Senior Project Manager

Juliana Hanle
Senior Business Analyst

Prepared by:

National Laboratory of the Rockies (NLR)
Golden, CO

Michael Lawson
Waterpower Senior Scientist and R&D Group Manager

Tina Ortega
Waterpower Techno-Economic Researcher

Andrew Simms
Waterpower Data Scientist

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Abstract

This report evaluates the theoretical and technical potential, techno-economic characteristics, and strategic relevance of tidal and river hydrokinetic energy resources in New York State (NYS). Using established national resource assessment methodologies and a comparative techno-economic framework, the analysis estimates that New York State possesses approximately
2.75 TWh per year of technically extractable hydrokinetic energy, equivalent to about 2.2% of statewide electricity generation in 2023. While modest in statewide scale, these resources may provide targeted value in specific locations and applications. The tidal energy resource is estimated at 1.55 TWh/year and is highly concentrated in eastern Long Island Sound near Fishers Island. Whereas the river current energy resource is estimated at 1.19 TWh/year, the resource is more dispersed, with the Niagara (250 GWh/year) and Hudson (190 GWh/year) rivers showing the largest potential.

The techno-economic assessment (TEA) indicates that both tidal and river current energy technologies currently exhibit levelized costs of energy (LCOE) well above those of mature renewable technologies. However, cost reductions may occur with increased deployment, technology learning, and supportive policy environments. It is crucial, however, to frame these costs in the context of value. Despite higher costs than other renewables, both tidal and river current energy projects are predictable, low-emission resources that can be cost-competitive with other predictable, low-emission options such as battery energy storage or hydrogen combustion.

Overall, the findings suggest that hydrokinetic energy is unlikely to materially alter New York State’s statewide electricity supply, but strategically targeted investment in high-value locations could enable hydrokinetic technologies to contribute to grid resilience, predictability, and system-level benefits. Advancing this sector will require targeted research and development (R&D), high-resolution site-specific assessments, environmental monitoring, and pilot-scale demonstrations to reduce technical uncertainty, demonstrate reliability, and drive cost reductions.

Keywords

hydrokinetic energy, marine energy, tidal energy, river energy, tidal currents, river currents, techno-economic assessment

Acknowledgments

This report provides information on New York State's tidal and river current energy resources and techno-economic information on hydrokinetic technologies based on the published and unpublished work of many hydrokinetic energy scientists and researchers. Accordingly, the development of this report would not have been possible without the underlying resource characterization and techno-economic assessment work from the hydrokinetic energy research and development (R&D) community, as acknowledged here and throughout the report. The authors would like to particularly acknowledge Vince Neary for support in developing and refining the river resource numbers reported herein, Elena Baca and Jonathan Colby for providing their unpublished report on the techno-economics of tidal energy technologies, and Levi Kilcher for his consultation.

The authors would also like to thank Jennifer Guia and Juliana Hanle of NYSERDA for their insights and guidance, which helped shape this report.

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Acronyms and Abbreviations

ADCP	acoustic Doppler current profiler
ARL	adoption readiness level
CfD	contracts for difference
DOE	U.S. Department of Energy
FERC	Federal Energy Regulatory Commission
GIS	geographic information system
IEC	International Electrotechnical Commission
IECRE	IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications
LCOE	levelized cost of energy
NLR	National Laboratory of the Rockies
NRCAN	Natural Resources Canada
NYISO	New York Independent System Operator
NYPA	New York Power Authority
NYS	New York State
NYSERDA	New York State Energy Research and Development Authority
ORPC	Ocean Renewable Power Company

OLPC	Orcas Power & Light Cooperative
R&D	Research and Development
RITE	Roosevelt Island Tidal Energy
TRL	technology readiness level
TEA	techno-economic assessment
USGS	U.S. Geological Survey
U.K.	United Kingdom

Symbols and Units of Measurement

\$/MWh	dollars per megawatt-hour
<	less than
>	greater than
±	plus or minus
ΔH	height delta
GWh	gigawatt-hour
km	kilometer
kW/m	kilowatt per meter
kWh	kilowatt-hour
m	meter
m/s	meters per second
m^3/s	meters cubed per second
MW	megawatt
MWh	megawatt-hour
s	second
TWh	terawatt-hour
TWh/year	terawatt-hours per year
TWh/year-km	terawatt-hours per year-kilometer

Executive Summary

This report was developed by the National Laboratory of the Rockies (NRL) at the request of the New York State Energy Research and Development Authority (NYSERDA) to provide a concise and consolidated assessment of the location, magnitude, and characteristics of hydrokinetic energy in New York State (NYS). The total technical hydrokinetic resource in New York State is estimated at 2.75 TWh/year, comprising 1.55 TWh/year from tidal energy and 1.19 TWh/year from river energy. The tidal energy resource is highly concentrated, with the potential to support 490 MW of installed capacity (1.29 TWh/year) around Fishers Island in eastern Long Island Sound (Kilcher et al. 2021). In contrast, the river current energy resource is more spatially distributed, with the Niagara River (0.25 TWh/year) and Hudson River (0.19 TWh/year) representing the largest individual river resources. Wave energy was excluded from this report because the available wave energy densities in NYS waters are insufficient for utility-scale generation applications.[1]

Tidal and river energy deployments today are more costly than solar or wind and are projected to remain so through 2050. The levelized cost of energy (LCOE) of tidal energy is estimated at \$360/MWh, with projected reductions to \$170/MWh by 2050 (Baca and Colby, in progress). River current energy LCOE is estimated to be \$450/MWh, declining to \$210/MWh by 2050. However, both tidal and river energy projects are currently cost-comparable with other reliable low-emission power generation resources considered by New York State such as hydrogen or batteries. Fishers Island tidal projects, in particular, may approach cost parity with offshore wind if deployed at scale and if opportunities for shared infrastructure, permitting efficiencies, and coordinated environmental studies are realized with planned offshore wind projects.

To advance hydrokinetic energy toward commercial viability, this report identifies several priority actions:

1. Conduct robust community engagement and education
2. Perform grid integration and system value analysis
3. Conduct high-resolution, site-specific resource assessments for key tidal sites
4. Conduct high-resolution, site-specific resource assessments for key river sites
5. Deploy pilot and demonstration projects to prove technology reliability, reduce performance uncertainties, and address environmental considerations
6. Conduct environmental monitoring and mitigation research

1. Tidal and River Hydrokinetic Resource Assessment

Hydrokinetic (or marine energy) technologies harness the kinetic energy of moving water in waves, river currents (riverine), or tides (tidal) to generate electricity, distinguishing them from conventional hydropower, which relies on water impoundment or elevation differences. The hydrokinetic resources of New York State are characterized by highly concentrated tidal currents in narrow straits and a more geographically dispersed energy potential across the State's river systems.

This report provides estimates of the State's hydrokinetic resources based on the U.S. Department of Energy (DOE)-funded tidal and river resource assessment studies from Kilcher et al. (2023) and Jacobson (2012), respectively. The National Research Council has published a technical review of the DOE-funded resource assessment studies that provides a detailed discussion on the implications of the assumptions of the resource assessment methods used (2013). Wave energy potential has not been considered in this assessment because NYS offshore wave resources are not sufficiently energetic for utility-scale power generation based on the previous national assessment from Kilcher et al. (2021, 2023).

This section presents the theoretical and technical hydrokinetic energy resources available in New York State, with a focus on tidal and river current energy. The results presented here are intended to inform State-level planning by identifying the relative magnitude, spatial concentration, and uncertainty associated with NYS hydrokinetic resources, rather than to define deployable project capacities.

1.1 Summary of Statewide Resource Potential

The total hydrokinetic technical resource in New York State is 2.75 TWh/year, equivalent to approximately 2.1% of the State's total electricity generation of 130.6 TWh/year in 2024 (NYISO 2025), as presented in Table 1. This total comprises:

- 1.55 TWh/year of tidal energy
- 1.19 TWh/year or river energy

Although the theoretical river current energy resource exceeds the theoretical tidal resource, the technical tidal resource offers a larger, more attractive opportunity for utility-scale development due to its strong spatial concentration and favorable flow characteristics. In contrast, the river resource is geographically dispersed across the State, making capturing a substantial fraction of its theoretical potential challenging. These challenges are discussed in Section 1.5, River Current Energy Resource Potential.

Table 1 summarizes the theoretical and technical resource estimates and the equivalent installed capacity required to capture the technical resource, assuming a 30% capacity factor.

Table 1. New York State Tidal and River Energy Resources

Resource	Theoretical Resource (TWh/year)	Technical Resource (TWh/year)	Technical Resource as a Percentage of NYS Electricity Generation in 2023 (%)	Installed Turbine Capacity to Capture Technical Resource (MW)
Tidal	3.11	1.55	1.25%	591
River	11.93	1.19	0.96%	454
Total	**15.04**	**2.75**	**2.21%**	**1,045**

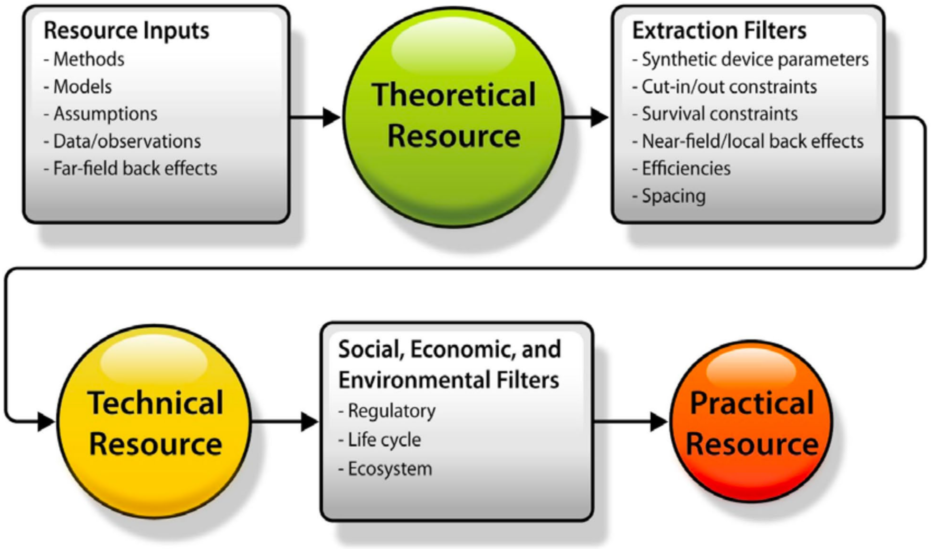
1.2 Terminology

This report follows the resource assessment methodology developed by Kilcher et al. (2021). It uses the terminology defined by the International Electrotechnical Commission (IEC) Technical Committee 114 (2019) as described below and shown in Figure 1:

- **Theoretical resource:** The energy contained within the resource.
- **Technical resource:** The amount of theoretical resources that can be extracted using existing technologies.
- **Practical resource:** The amount of technical resource that can be captured after considering externalities such as socioeconomic, environmental, regulatory, and other competing-use constraints that create practical limitations to resource extraction.

The technical and theoretical resource estimates are provided in this report, while practical resource estimates are not. Estimates of available practical resources would require more extensive site-specific studies to account for relevant social, economic, and environmental factors. As illustrated in Section 1.5, the presence of dams, rapids, or other competing uses on a river can dramatically reduce the technical resource to a much smaller practical resource.

Figure 1. Classification of Hydrokinetic Resource Estimates



In this report, hydrokinetic resources are evaluated along three metrics:

1. **Terawatt hours per year:** The amount of energy that the hydrokinetic resource could generate per year. It indicates the average amount of energy the resource can provide per year.
2. **The technical resource as a percentage of NYS electricity generation in 2023:** This metric compares the resource to the amount of electricity generated in New York State. It allows State and regional planners to consider opportunities and benefits related to developing hydrokinetic energy resources. Total electricity generation in New York State in 2023 was 124.04 TWh (NYISO 2025).
3. **The Installed Capacity of Turbines in Megawatts:** The amount of capacity needed to capture the technical resources. Utility operators, policymakers, and the public commonly use it. It allows for comparing specific hydrokinetic resources to demand and non-hydrokinetic resources. An equivalent installed capacity for each resource is calculated using Equation 1:

Equation 1.
$$\boldsymbol{Capacity\ (MW) = \frac{TR}{Cf} * \frac{1000000\ (MW/TW)}{8760\ (hours/year)}}$$

where:

- Cf = capacity factor
- TR = technical resource estimate in TWh/year.

A 30% capacity factor was assumed for both tidal and river resources based on the work of Jenne et al. (2015). The capacity estimates indicate the potential scale of future deployment of tidal and river technology. Importantly, however, these estimates are a first approximation, and further studies are needed to provide detailed estimates of how much capacity could be installed based on the site-specific practical resource considerations identified earlier and in Figure 1.

1.3 Resource Data and Methods

1.3.1 Tidal Resource Estimation

The tidal resource estimates adopted in this report are based on the methodologies developed by Kilcher et al. (2021) and Hagerman et al. (2023), which:

- Identify tidal channels meeting minimum criteria for turbine operation (flows exceeding 0.5 m/s, depths greater than 5 m, and sufficient spatial extent) (Kilcher et al. 2021, 2023).
- Estimate the theoretical resource using the Garrett and Cummins framework for maximum extractable power in tidal channels, where maximum extractable power is defined as the point above which adding more turbines constricts flow to the extent that total energy extraction decreases (Garrett and Cummins 2005).

The technical resource is assumed to be 50% of the theoretical resource, accounting for physical constraints of siting equipment and mechanical to electrical conversion efficiencies, consistent with prior national assessments by Kilcher et al (2012, 2023). This assumption represents a simplified, optimistic approximation of achievable extraction using current technologies. As tidal energy technologies evolve, particularly with respect to turbine performance at lower flow speeds or in more complex bathymetric environments, the technical resource could increase modestly.

1.3.2 River Resource Estimation

The resource assessment data used in this report are from Jacobson (2012) and are supplemented by custom calculations for the Niagara and St. Lawrence rivers.[2] The Niagara and St. Lawrence rivers are significant NYS river resources that were not considered by Jacobson and required custom calculations to estimate their resources.[3] More information about the custom calculations performed and the river data discovered through the literature review can be found in Appendix A, River Energy Resource Assessment. River segments with flow rates less than 1,000 cubic feet per second were omitted from the analysis, as were river segments with existing hydroelectric plants or nonpowered dams (Jacobson).

The theoretically available power is calculated according to the standard hydrologic engineering equation shown in Equation 2:

Equation 2. $$\boldsymbol{Theoretical\ Resource = \gamma Q \Delta H}$$

Where:

- γ is the specific weight of water
- Q is volume flux
- ΔH is the elevation drop

This measure of theoretical resource represents the total potential energy contained within a river or a river segment. The theoretical resource does not account for frictional losses along the riverbed or other parasitic losses and should therefore be considered an absolute upper limit of the energy in a river.

The technical resource is the theoretical resource that can be captured using existing technologies, accounting for required water velocity and depth under low-flow conditions, device packing density, device efficiency, and flow characteristics (channel slope, flow rate, and variability). Accordingly, high-resolution estimates of the technical resource are not possible for sites without site-specific analysis. In alignment with NLR's experience with river hydrokinetic projects, this study uses a conservative recovery factor of 10% to estimate the NYS technical river resource across the state's diverse river resources.

River resource estimates are subject to substantial uncertainty, and the results should be interpreted as order-of-magnitude indicators rather than deployable energy estimates.
Two primary factors contribute to this uncertainty:

1. Low spatial resolution of underlying datasets, which limits the ability to resolve dams, spillways, rapids, and other obstructions
2. Challenges in accounting for natural and human-made barriers, including waterfalls, non-powered dams, and hydraulic structures that preclude turbine deployment or would detract from the available resource (Jacobson 2012).

As a result, the practical river current energy resource is likely to be significantly smaller than the technical resource for rivers with extensive infrastructure or competing uses, or possibly larger for rivers with high flow rates where the theoretical resource could be significantly higher that 10% of the technical resource. More detailed, river-specific desktop studies and field investigations would be required to refine these estimates and assess feasibility at individual sites. River-specific studies would be of particular interest for NYS rivers that have high theoretical resource potential, such as the Niagara, Hudson, and St. Lawrence.

1.4 Tidal Energy Resource Potential

The technical tidal energy resource in New York State is estimated at 1.55 TWh/year, corresponding to approximately 1.2% of statewide electricity generation in 2024 (NYISO 2025). The tidal resource is highly concentrated, with 83% (approximately 1.29 TWh/year) located near Fishers Island Sound in eastern Long Island Sound (Kilcher et al. 2021). Notably, the south-central entrance to Fishers Island Sound is the fourth-largest tidal energy resource in the continental U.S., based on prior national assessments (Kilcher et al.). Capturing the resource potential of the three Fishers Island Sound sites would require approximately 490 MW of installed tidal turbine capacity. Tidal energy from around Fishers Island could provide a meaningful amount of energy to the Long Island region, which generated 10.2 TWh of electricity in 2024 (NYISO 2025).

Table 2 presents the 11 NYS tidal energy resources that met the minimum criteria defined in the previous section, and Figures 2 and 3 show their locations.

Table 2. New York State Tidal Energy Resources Ranked by Resource Potential

Source: Data from Kilcher et al. (2023).

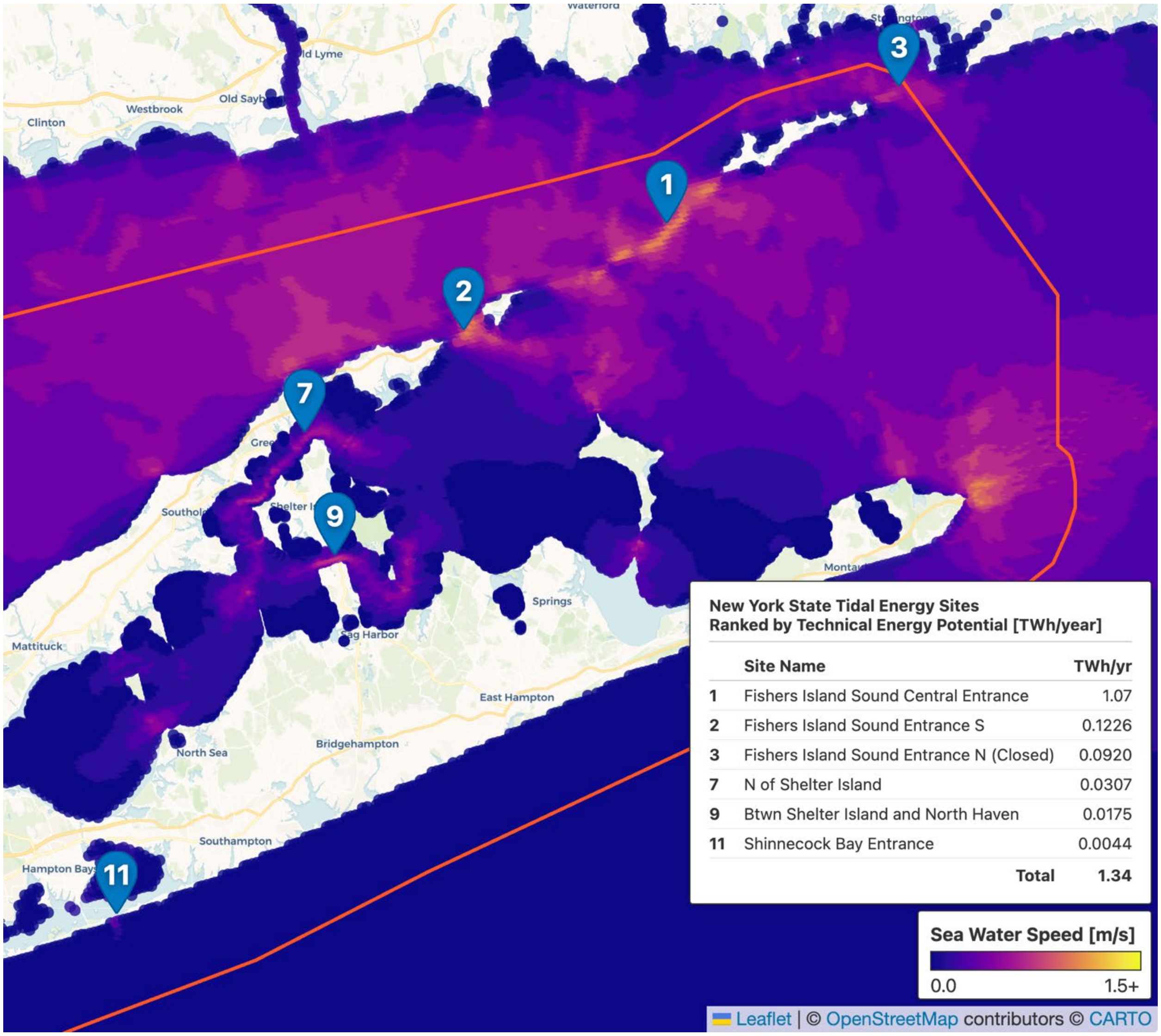
Rank	Site Description	Latitude	Longitude	Theoretical Resource (TWh/year)	Technical Resource (GWh/year)	Technical Resource (% of NYS Generation in 2023)	Installed Turbine Capacity to Capture Technical Resource (MW)
1	Fishers Island Sound Central Entrance	41.2234	-72.0758	2.15	1,070	0.87%	408.3
2	Fishers Island Sound Entrance South	41.1647	-72.2234	0.25	120	0.10%	46.7
3	Fishers Island Sound Entrance North	41.2985	-71.9061	0.18	90	0.07%	35.0
4	East River	40.7757	-73.9398	0.14	70	0.05%	25.8
5	Hudson River	40.8085	-73.9769	0.13	70	0.05%	25.0
6	Martine Parkway Bridge	40.5758	-73.8764	0.08	40	0.03%	15.0
7	North of Shelter Island	41.109	-72.3388	0.06	30	0.02%	11.7
8	Wards Island Bridge	40.7885	-73.9357	0.05	30	0.02%	10.0
9	Between Shelter Island and North Haven	41.1915	-72.3175	0.04	20	0.01%	6.7
10	Point Lookout	40.5831	-73.5768	0.03	10	0.01%	5.0
Total				**3.11**	**1,550**	**1.25%**	**590.8**

The other NYS tidal energy resources have significant potential to be harnessed for pilot projects or to serve as sites for tidal energy technology development and testing. An example of this is the Roosevelt Island Tidal Energy (RITE) project, which is discussed in detail in Section 2, Techno-Economic Assessment.

Figure 2. Map of the Top Tidal Energy Sites on the East End of Long Island

The orange line represents the NYS border.

Source: Data from Kilcher et al. (2023).



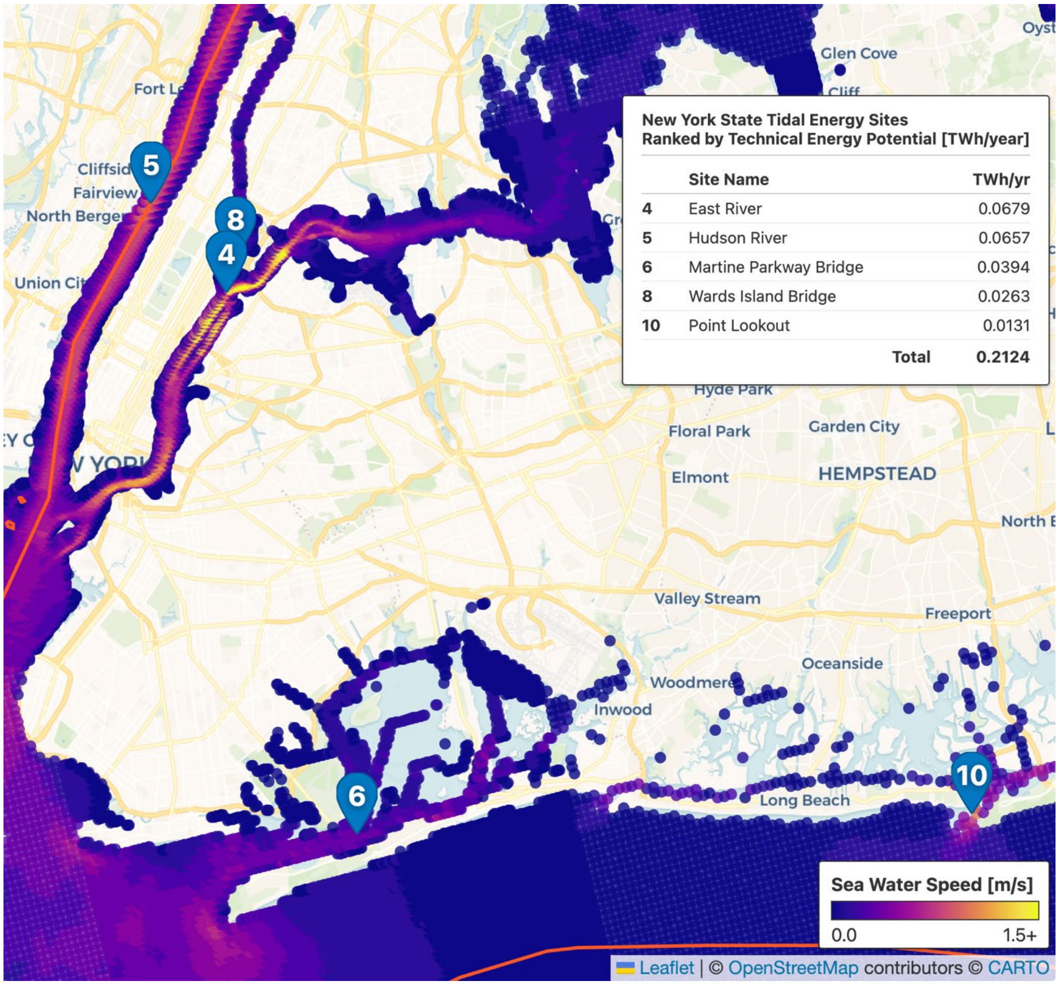
New York State Tidal Energy Sites
Ranked by Technical Energy Potential [TWh/year]

	Site Name	TWh/yr
1	Fishers Island Sound Central Entrance	1.07
2	Fishers Island Sound Entrance S	0.1226
3	Fishers Island Sound Entrance N (Closed)	0.0920
7	N of Shelter Island	0.0307
9	Btwn Shelter Island and North Haven	0.0175
11	Shinnecock Bay Entrance	0.0044
	Total	**1.34**

Figure 3. Map of the Top Tidal Energy Sites on the West End of Long Island and in the Hudson River

The orange line represents the NYS border.

Source: Data from Kilcher et al. (2023).



New York State Tidal Energy Sites
Ranked by Technical Energy Potential [TWh/year]

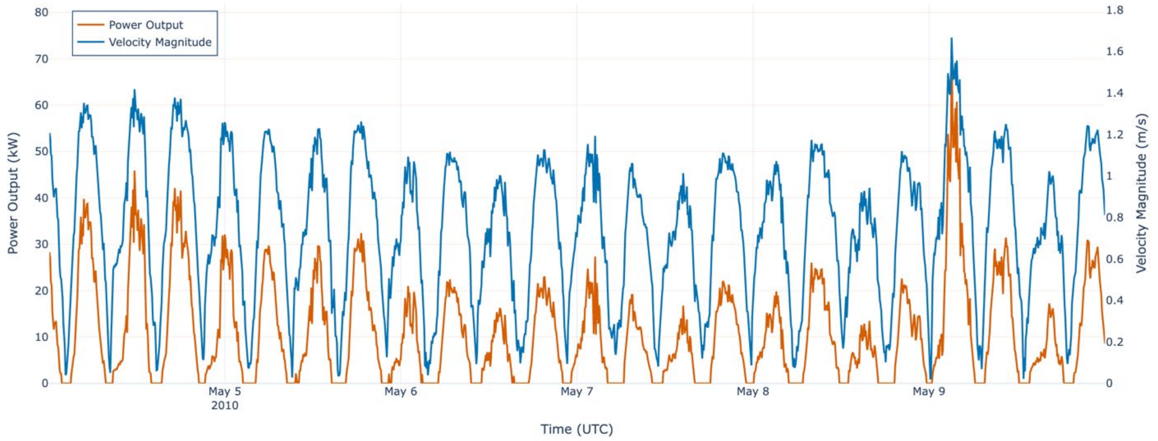
	Site Name	TWh/yr
4	East River	0.0679
5	Hudson River	0.0657
6	Martine Parkway Bridge	0.0394
8	Wards Island Bridge	0.0263
10	Point Lookout	0.0131
	Total	**0.2124**

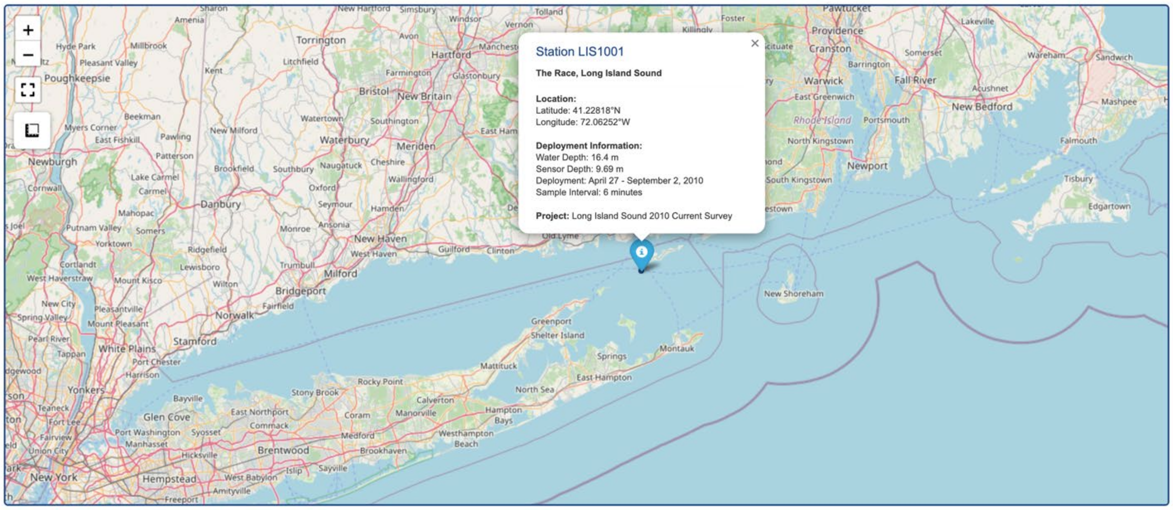
1.4.1 Tidal Energy Resource Forecasting

Although tidal power is a renewable resource, unlike wind or solar energy, tidal energy remains highly predictable and forecastable. Tidal power is primarily driven by the astronomical configurations of the Sun, Moon, and Earth, which can be known far in advance, enabling highly accurate long-term predictions (Monahan et al. 2023). Tidal energy researchers have been working to increase the granularity of their predictions to better support grid integration and enable efficient dispatching of grid resources. Monahan et al. demonstrated tidal energy algorithms capable of real-time online forecasting with up to 99.4% accuracy for 3-day combined forecasts at both 6-minute and 1-hour granularity (NOAA and U.S. Department of Commerce n.d.) at tidal sites across the globe. To illustrate the consistency and predictability of tidal energy, Figure 4 presents the power output of a hypothetical 1 MW turbine that is representative of today's leading technologies. The power output is calculated for a deployment site near Fishers Island using data from a 2010 NOAA acoustic Doppler current profiler measurement campaign. As Figure 4 shows, the highly predictable and cyclical nature of tidal power lends itself well to grid planning because storage needs can be planned around a reliable resource, and its shorter-duration cycles pair more effectively with existing lithium-ion battery technologies than the longer-duration other intermittent energy sources, such as wind and solar.

Figure 4. Hypothetical 1-MW Turbine Power at a Site near Fisher's Island over 1 Week in May 2010.

(Top) Hypothetical power output of a 10-m-diameter turbine at a site near Fishers Island, NY, over the course of one week in May 2010. The power output was calculated assuming a turbine coefficient of performance of 0.4, a turbine cut-in current speed of 0.5 m/s, and a rated turbine current speed of 1.9 m/s using acoustic Doppler current profiler flow measurements from the NOAA Tides and Currents Database (n.d.) at a water depth of 9.69 m. (Bottom) Map of Long Island Sound showing the location of the NOAA acoustic Doppler current profiler measurements.





Station LIS1001

The Race, Long Island Sound

Location:
Latitude: 41.22818°N
Longitude: 72.06252°W

Deployment Information:
Water Depth: 16.4 m
Sensor Depth: 9.69 m
Deployment: April 27 - September 2, 2010
Sample Interval: 6 minutes

Project: Long Island Sound 2010 Current Survey

1.5 River Current Energy Resource Potential

The technical river current energy resource in New York State is estimated at 1.19 TWh/year, equivalent to approximately 0.96% of statewide electricity generation in 2023. Unlike tidal resources, river current energy potential is widely distributed across numerous river systems throughout the State.

The largest individual river contributions to the technical resource include:

- Niagara River, approximately 250 GWh/year
- Hudson River, approximately 190 GWh/year
- St. Lawrence River, approximately 120 GWh/year

Together, these rivers account for a substantial fraction of the statewide river resource. However, each is subject to significant site-specific constraints that limit the fraction of the technical resource that could ultimately be realized.

Table 3 presents the top 10 NYS river current energy resources, ranked by the magnitude of the resource potential. As described in Jacobson (2012), river segments with flow rates less than 1,000 cf/s, existing hydroelectric dams, or centroids in other states, were excluded from the analysis. Details on the resource potential for all the rivers listed in Jacobsen are provided in Appendix A.3.3.

Figure 5 shows the location and energy density of the rivers for each river segment used in the resource assessment, barring the Niagara and St. Lawrence rivers, which are not shown on the map due to the method (see Section 1.3.2) used to estimate the resource.

Numerous rivers around New York State offer opportunities to deploy smaller projects (i.e., <5 MW) that could provide significant energy and other benefits to local communities. Detailed analysis of potential deployment sites is needed across NYS rivers to determine promising locations for these deployments, but the high-energy regions, identified in Figure 5, provide an initial indication of where these promising sites in New York State are located.

Table 3. New York State River Hydrokinetic Resources

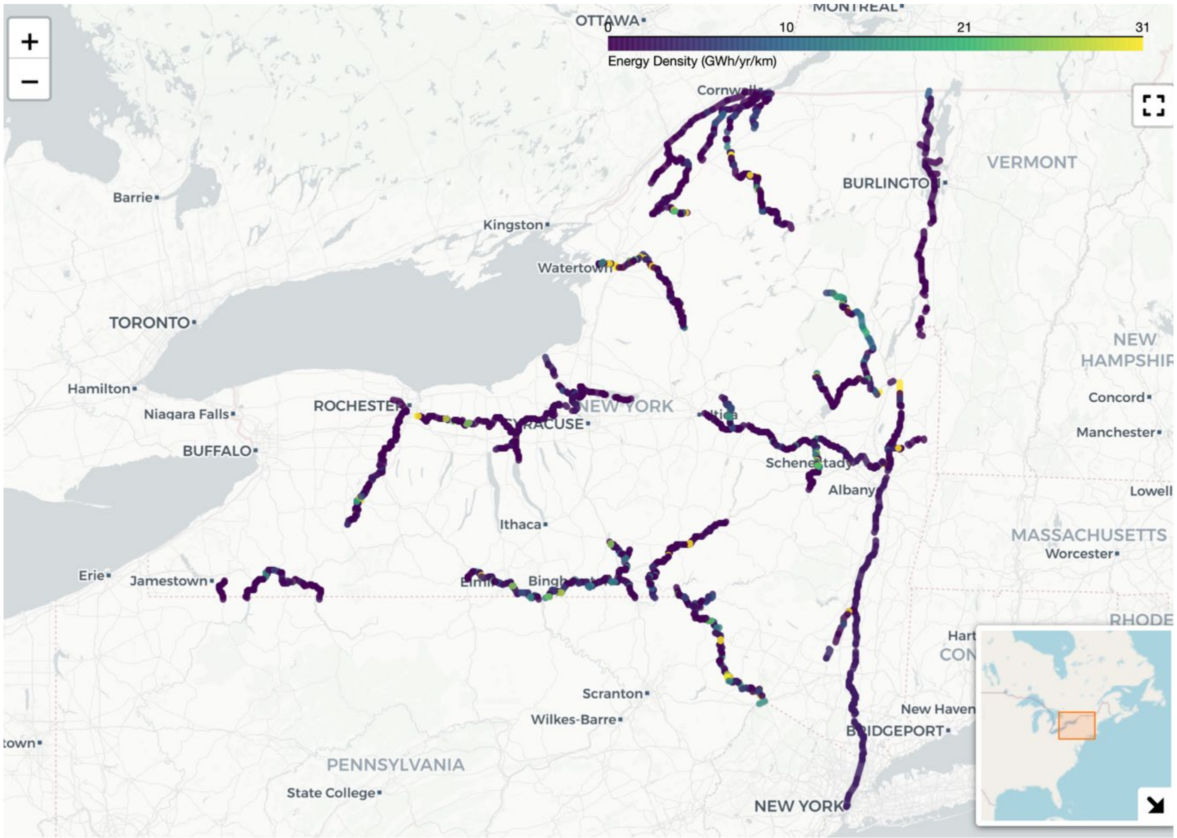
The river length provided is not the total length of the river, but the length of the river segments as listed in Jacobson (2012). River segments with dams and those whose centroids are in other states were excluded.

Source: Kilcher et al. (2021).

Rank	River	Assessed Length (km)	Theoretical Resource (TWh/year)	Technical Resource (GWh/year)	Technical Resource as (% of State Electricity Generation)	Potential Installed Turbine Capacity (MW)
1	Niagara River	39	2.52	250	0.20%	96
2	Hudson River	325	1.92	190	0.15%	73
3	St. Lawrence River	123	1.15	120	0.09%	44
4	Susquehanna River	189	0.75	70	0.06%	28
5	Black River	101	0.71	70	0.06%	27
6	Delaware River	58	0.67	70	0.05%	26
7	Mohawk River	149	0.64	60	0.05%	24
8	Genesee River	146	0.54	50	0.04%	20
9	Raquette River	126	0.47	50	0.04%	18
10	Schoharie Creek	52	0.36	40	0.03%	14
Total			**11.93**	**1,190**	**0.96%**	**454**

Figure 5. Theoretical River Resource Potential along New York State Rivers

The annual average theoretical power per kilometer of river length colors the river segments. River segments with dams and those whose centroids are in other states were excluded, as described in Jacobson (2012). Data were extracted directly from the *Marine Energy Atlas* (n.d.). The high-energy-density river segments shown in the lighter colors identify river resource hotspots that would likely be attractive for River technology deployments. Note that the Niagara River and the St. Lawrence River are not shown because spatially resolved data were not available.



The Niagara River is the largest river resource in New York State, with more than 250 GWh/year of technical resource with the potential to deploy 96 MW of turbines over 39 km of river. Due to its high potential and exceptionally high energy density per kilometer of river length, the Niagara River represents the most attractive opportunity for river hydrokinetic development in New York State. The Niagara River's commercial potential is already being explored, as evidenced by a preliminary Federal Energy Regulatory Commission (FERC) permit issued for a 5 MW project in the river (also detailed in Section 2.3.4). Importantly, both the Niagara and St. Lawrence rivers flow into existing hydroelectric dams and are located on the border between the U.S. and Canada. Accordingly, any large-scale turbine farm deployments would require coordination with the New York Power Authority (NYPA) and Canadian stakeholders.

The Hudson River is the next-largest resource at 190 GWh/year. Detailed site characterization is needed to determine where turbine deployments are practical, as illustrated in Figure 7. The top frame of Figure 7 shows the distribution of river resources along the northern portion of the Hudson River, highlighting two locations with high potential for river current energy. However, satellite imagery of these locations near Hudson Falls and Warrensburg (Figure 7, bottom) shows that they contain dams, spillways, waterfalls, rapids, and other flow obstructions, making turbine deployment difficult. This example illustrates why the river resource potential in Table 3 is an estimate and why detailed river-specific analysis is required to yield more accurate resource estimates.

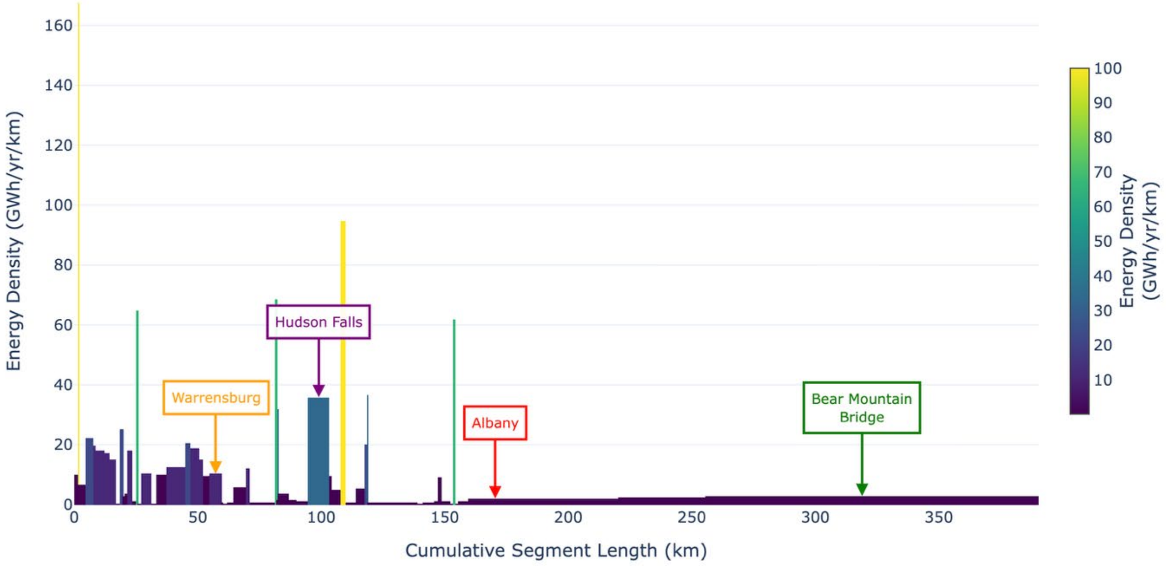
Another useful way to visualize the energy density contained within NYS rivers is to plot the energy distribution along the length of a river, as presented in Figure 6 for the Hudson River. This type of visualization helps illustrate the relative energy density of the rivers in New York State. Figures 4 to 6 show that many rivers in the State have high-energy resources that could be attractive for developing a local river turbine farm. However, additional desktop and field studies are needed to determine whether turbines could be deployed in regions with high resource potential or whether the characteristics or pre-existing infrastructure (e.g., Figure 6) would make turbine deployment difficult.

Figure 6. Theoretical River Resource Potential along the Upper Section of the Hudson River

Colored by annual average power. River segments with dams or with centroids in other states were excluded Jacobson (2012). Data was extracted directly from the *Marine Energy Atlas* (NREL n.d.). In the bottom two satellite images, a dam, waterfall, and rapids are visible, which would reduce the estimated river resource.

Figure 7. The Cumulative Theoretical Energy Distribution along Hudson River

The cumulative distance is calculated from the river segment lengths reported by Jacobson (2012).



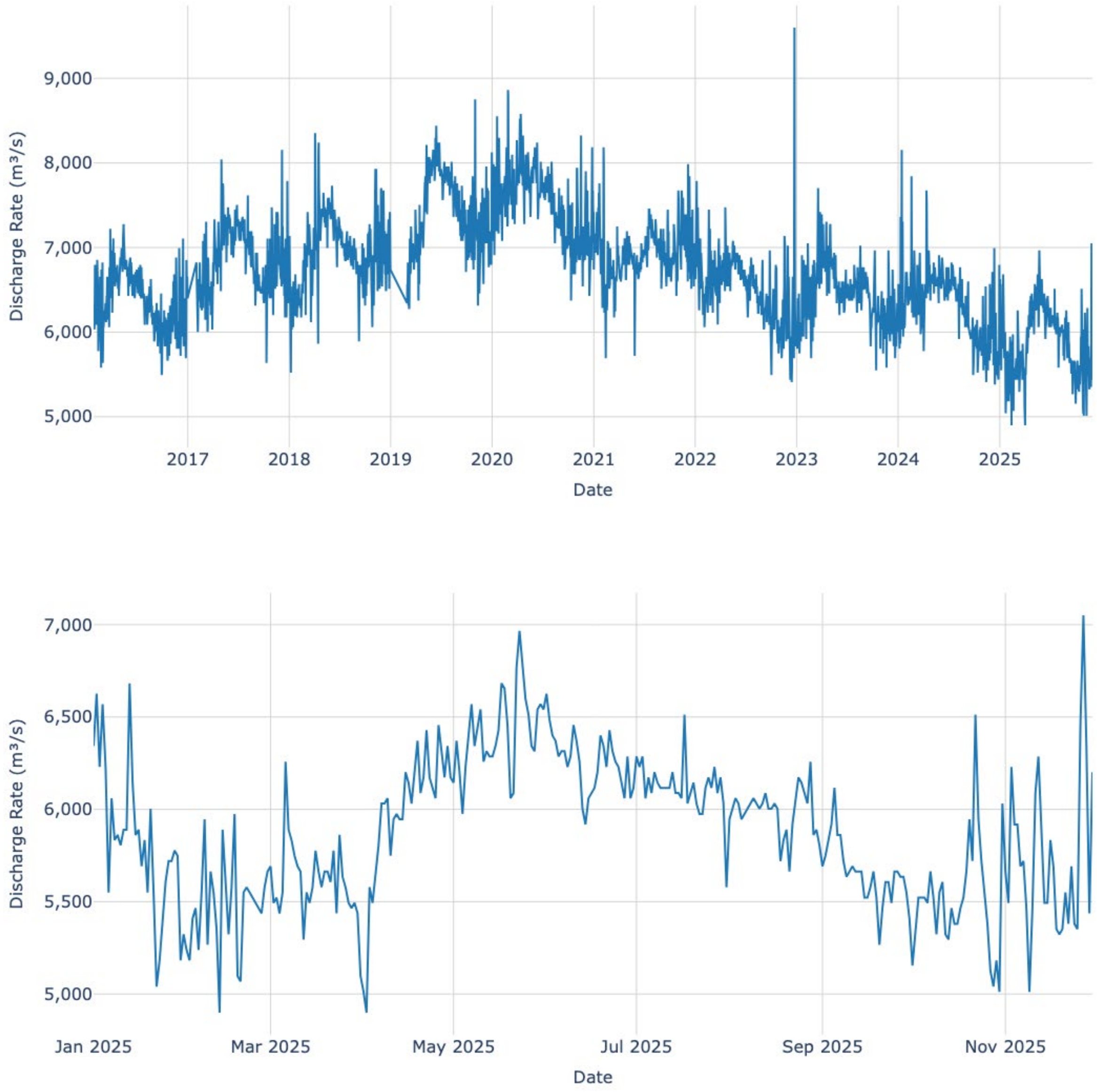
1.5.1 River Current Energy Resource Forecasting

Limited resources exist for forecasting river hydrokinetic power generation. However, river hydrokinetic energy projects do benefit from using the same river resources as traditional hydroelectric production, and inferences about energy potential can be drawn from flow rates. In New York State, NYPA has extensively studied the Niagara and St. Lawrence rivers and mapped their flows to inform its power generation planning (Watts and Locks 2025). In Figure 8, the daily flow rate of the Niagara River near Buffalo, NY. As shown in the figure, the flow rates are historically consistent (USGS n.d.). The consistent flows seen over the year imply that a river current energy project on the river would produce a similarly consistent power output.

Figure 8. Niagara River Daily Discharge Flows as Measured at Buffalo

Top, record over the last 10 years; bottom, 2025 data only.

Source: USGS (N.d.).



2. Techno-Economic Assessment

This section presents a techno-economic assessment (TEA) of tidal and river hydrokinetic energy technologies relevant to New York State. This section reviews state-of-the-art tidal and river current energy technologies. It presents levelized cost of energy (LCOE) estimates for representative tidal and river systems, along with their cost trajectories under assumed technology learning and deployment scenarios. The TEA is intended to provide order-of-magnitude cost benchmarks and to identify the primary cost drivers and uncertainties influencing future project viability.

Consistent with the resource assessment, the TEA emphasizes relative cost trends and decision-relevant insights, rather than precise cost predictions for specific sites. All cost estimates should therefore be interpreted as indicative and subject to substantial uncertainty.

2.1 Framework and Assumptions

The TEA framework presented in this analysis is based on prior DOE and National Laboratory of the Rockies (NLR) analyses of hydrokinetic energy technologies. Generic cost models were adapted for application to NYS resources. Generic tidal and river cost models were adapted to reflect NYS resource characteristics, deployment scales, and infrastructure context.

Key assumptions include:

- Representative project scale: Utility-scale tidal arrays and smaller-scale river installations
- Technology maturity: Early commercial for tidal energy and pre-commercial for river current energy
- Learning effects: Cost reductions driven by cumulative deployment and technology improvement
- Financing structure: Standardized assumptions consistent with prior DOE-funded TEA studies

These assumptions are intentionally conservative, particularly regarding deployment scale and technology readiness, to avoid overstating cost competitiveness.

2.2 Hydrokinetic Technologies

2.2.1 Technology Readiness Levels

Technology readiness levels (TRLs) are used to assess the maturity and commercialization readiness of a technology. Table 4 presents TRL definitions. While TRLs indicate the progression of a technology toward commercialization scale, additional metrics can be used to complement TRL, such as technology performance level, adoption readiness level (ARL), and manufacturing readiness level (Snowberg, Philip, and Weber 2024), when managing a technology's risk. This report uses TRL as a comparative metric to describe various hydrokinetic devices.

Table 4. Technology Readiness Level Definitions

Source: DOE Office of Energy Efficiency and Renewable Energy (2009).

TRL	Definition
1	Basic principles observed and reported.
2	Technology concept and/or application formulated.
3	Analytical and experimental critical function and/or characteristic proof of concept.
4	Component and/or process validation in a laboratory environment.
5	Component and/or process validation in relevant environment.
6	System/process model or prototype demonstration in a relevant environment.
7	System/process prototype demonstration in an operational environment.
8	Actual system/process completed and qualified through test and demonstration.
9	Actual system operated over the full range of expected mission conditions.

2.2.2 Tidal Turbine Technologies

Numerous tidal technologies are in development across the globe. The majority are fully submerged systems, rigidly connected to the seafloor, or floating systems moored to the seafloor. Several kite-like systems extract energy using a turbine as they “fly” through the water column (IEA-OES 2025). Most of today's technologies use an axial-flow rotor architecture, similar to utility-scale wind turbines, as shown in Figures 9 and 10. In the U.S., the Ocean Renewable Power Company (ORPC) is also developing a floating cross-flow turbine that was briefly tested in 2025 in Cobscook Bay, ME (ORPC n.d.).

To describe the TRL of state-of-the-art tidal turbine technologies, three representative technologies from three technology developers were selected: Proteus, Orbital, and Verdant Power. Proteus and Orbital have developed megawatt-scale turbines that have been demonstrated and derisked through several deployments in Europe, and Verdant

Power represents one of the most advanced U.S. technologies deployed and tested to date. Other U.S. tidal and river current energy technology developers include Aquantis (N.d.) and Blade Runner Energy (N.d.), but technologies are still low (<6) on the TRL scale.

The tidal turbines in Proteus's AR series (N.d.) are bottom-mounted, fully-submerged, axial-flow turbines with rotor diameters up to 24 m and power output ranging from 1.5 MW to 3 MW (Figure 9). The AR1500 (1.5 MW) has a TRL of 9 and has been deployed in Scotland's Pentland Firth since 2018 as part of the MeyGen array. Plans for Proteus Technologies include the 2028 deployment of four AR3000 (3 MW) turbines in the Alderney Race in France and an additional 58 MW buildout of the MeyGen tidal energy farm through the United Kingdom's (UK) contracts for difference (CfD) scheme (Energy Global 2024). The deployment of an AR series turbine is also under consideration for deployment as part of the proposed American Tidal Energy Project (N.d.) in Cook Inlet, AK (see FERC Permit Application P-15116).

Orbital's O2 tidal turbine device is a 74 m long floating substructure with dual 1 MW horizontal-axis turbines, as shown in Figure 10, with a total rated capacity of 2 MW. The Orbital O2 device is currently being tested at the European Marine Energy Centre in Scotland and is connected to the grid on the Orkney Islands (IEA-OES 2025). The current iteration of the turbine device has a TRL of 9; plans for Orbital include a 9.6 MW array using the next-generation 2.4 MW O2-X system. In addition, the O2-X system is being considered for deployment as part of the Rosario Strait Tidal Energy Project east of the San Juan Islands along the coast of Washington (OPLC 2025) (see FERC Permit Application P-15368).

Verdant Power's Gen5 tidal turbine is also a fully submerged axial-flow technology, but is deployed on a substructure called a TriFrame Mount (Figure 9, right). The Gen5 turbine rotors are 5 m in diameter, and each rotor has a rated power of 35 kW. In 2020, the Gen5 turbines' performance was officially assessed using the IEC System for Certification to Standards Relating to Equipment for Use in Renewable Energy Applications (IECRE), making them the first tidal turbines to be verified under international technical specifications (EMEC n.d.). Verdant Power first deployed its Gen5 turbines in New York State's East River, which is further detailed in Section 2.2.4. Since the East River deployment ended in 2021, no further testing of the system has been undertaken.

Figure 9. Deployment of Tidal Turbines

Proteus’ AR1500 tidal turbine being lowered into the ocean at the MeyGen site, Scotland (left); Verdant Power Gen5 is being towed in the East River in New York State for deployment.

Photo source Left, Lockheed Martin (2017); right, NLR (2021).

Figure 10. Deployment of Orbital O2 Tidal Turbine

Orbital’s O2 tidal turbine anchored at the European Marine Energy Centre, Scotland.

Photo source: IEA-OES (2025).

2.2.3 River Current Turbine Technologies

Compared to tidal energy technologies, far fewer river current energy systems are under development or deployed globally. Two successful technologies in the TRL 8–9 range that have been developed and deployed in the U.S. are the ORPC's RivGen system (Figure 11) and Emrgy's canal micro hydrokinetic turbine (Figure 12). Notably, both are cross-flow turbines with rotor designs that enable deployment in shallow rivers or narrow channels.

ORPC's RivGen units are fully submerged cross-flow turbines with a rated capacity of 35 kW. They are specifically designed for rivers and are 15.7 m long with a pontoon-style structure for towing to deployment sites. ORPC has deployed several variations of the RivGen turbine in the U.S. and internationally, including at sites in Igiugig, AK, and Maine. The project in Igiugig is ORPC's longest-running project in the U.S., consisting of two 35 kW turbines, with the first deployed in 2019 and the second in 2023. No publicly available data exists on the power performance or reliability of the Igiugig turbine systems. Recently, ORPC announced plans to deploy two additional units in the lower Mississippi River. The RivGen system's rotor has a high aspect ratio, enabling deployment in shallow rivers where axial-flow turbines with large rotor diameters cannot be used due to water depth constraints. The RivGen power system has a TRL of 9 (Malali, Ding, and Villavicencio 2025).

Emrgy's 10–40 kW micro-hydrokinetic devices are cross-flow turbines designed for deployment in canals and other confined channels, but they could be adapted for small rivers. Emrgy's pilot project in Colorado was designated the first distributed hydropower project in the U.S. and successfully connected to the grid (DOE 2023). Emrgy's hydrokinetic devices are estimated to have TRLs of 8–9.

Figure 11. Deployment of ORPC's RivGen Technology

ORPC's RivGen technology is anchored in the Kvichak River in Alaska before deployment.

Photo source: NLR (2026).

Figure 12. Deployment of Emrgy's Micro Hydrokinetic Device

Emrgy's micro hydrokinetic device is installed in the South Boulder Canal in Colorado.

Photo source: Denver Water (2022).

2.2.4 Hydrokinetic Energy in New York State

New York State was an early leader in tidal power generation development, starting in 2002 with Verdant Power and the RITE project. With significant support from New York State Energy Research and Development Authority (NYSERDA) and DOE, Verdant Power was able to make headway in hydrokinetic project permitting, leading to FERC's "Verdant Exception" ruling in 2005, which allows developers to pilot technologies without a license if:

1. The technology is experimental
2. The proposed facilities are to be used for a short period for the purpose of conducting studies necessary to prepare a license application
3. Power generated from the test project will not be transmitted into, or displace power from, the national energy grid (FERC n.d.)

From 2010 through 2021, the Verdant team operated in New York City's (NYC) East River, gaining valuable information on turbine performance and the impacts of turbine deployments on wildlife and the environment. The project culminated in Verdant Power installing a 105-kW tidal power array comprising three 35 kW turbines at the RITE site in 2020. During the following 13-month test, the turbines delivered 312 MWh of energy to the grid before being decommissioned in 2021.

Several research and development (R&D) technology advancements were achieved during the 2020–2021 testing campaign in the East River. The most notable accomplishments of the project included:

1. Verdant Power and NLR collaborating to test and demonstrate the benefits and quantify the performance of thermoplastic turbine blades for marine turbine operations (Murray 2022, NREL 2021).
2. Verdant Power and EMEC collaborating to perform the first internationally accredited power performance assessment of a turbine array using IECRE standards (EMEC n.d., 2021).

New York State remains a region of interest for the development and deployment of tidal and river current energy technologies. Currently, three developers have FERC preliminary permits to evaluate tidal and river current energy in New York State, as presented in Table 5. Two of these applications are for the development of utility-scale resources in Long Island Sound, and the other is for the deployment of a small, pilot-scale project in the Niagara River. Importantly, a preliminary permit is issued for up to 4 years and does not authorize deployment activities, but it maintains the priority of a party's license application while preliminary studies are conducted and the applicant prepares to submit the license application (see FERC [n.d.] for more information). Additionally, FERC preliminary permits are not a prerequisite for filing for a full operational permit (FERC n.d.).

Table 5. Active Federal Energy Regulatory Commission Hydrokinetic Preliminary Permits

Source: Adapted from FERC (n.d.).

FERC Docket Number	Project Name	Issue Date	Expiration Date	Authorized Capacity (kW)	Permittee	Waterbody	State	Description
P-15116	East Foreland Tidal Energy	07/26/2021	06/30/2025	5,000	Ocean Renewable Power Company, Inc	Cook Inlet	AK	Hydrokinetic Tidal
P-15283	Filter Bend HK Energy	12/07/2022	11/30/2026	1,500,000	C-MACC, LLC	Mississippi River	MS, LA	Hydrokinetic Inland Current
P-15285	Western Passage Tidal Energy Project	02/03/2023	01/31/2026	5,000	Ocean Renewable Power Company, Inc	Atlantic Ocean	ME	Hydrokinetic Tidal
P-15317	Upper Cook Inlet Tidal Energy Project	04/02/2024	03/31/2028	2,000	Littoral Power Systems, Inc.	Cook Inlet	AK	Hydrokinetic Tidal
P-15320	Deep Ocean Pressure Project	07/24/2025	06/30/2029	16,700	Stirling T. Hebenstreit	Puget Sound	WA	Hydrokinetic Ocean Current
P-15329	Buffalo-Niagara Hydrokinetic Project	07/29/2024	06/30/2028	5,000	Ocean Renewable Power Company, Inc	Niagara River	NY	Hydrokinetic Inland Current
P-15340	Pembroke Tidal Power Plant	09/19/2024	08/30/2028	25,600	Pembroke Tidal Power Project, LLC	Pennamaquan River	ME	Hydrokinetic Tidal
P-15349	Eastern Long Island Sound Tidal Energy Project	09/12/2024	08/31/2028	100,000	At-Sea Development, LLC	Long Island Sound	NY	Hydrokinetic Tidal
P-15368	Rosario Strait Tidal Energy Project	01/13/2025	12/31/2028	2,400	OPLC	Pacific Ocean	WA	Hydrokinetic Tidal
P-15385	Long Island Sound Tidal Energy Project	09/22/2025	08/31/2029	200,000	Verdant Power, Inc.	Long Island Sound	NY	Hydrokinetic Tidal
P-15400	Yellow Bend Hydrokinetic Project	12/04/2025	11/30/2029	40,000	Issaquena Green Power	Mississippi River	AR, MS	Hydrokinetic Tidal

2.2.5 U.S. Tidal and River Project Pipeline

Currently, the U.S. has only two fully FERC-licensed tidal or river turbine sites, as shown in Table 6. The only FERC-permitted river turbine operating in the U.S. is a joint project between the Igiugig Village Council and ORPC in Igiugig, AK. Most tidal and river current energy R&D in the U.S. today is supported by the DOE. The largest DOE investment to date is the $45 million U.S. Tidal Energy Advancement Funding Opportunity Announcement (Hydropower and Hydrokinetic Office 2023). The opportunity provides $45 million in funding to support the development of a utility-scale tidal energy demonstration project. To date, a total of $6 million has been allocated to two tidal energy projects to develop plans for deploying 1–5 MW of tidal energy. The planning phase of the project was completed in 2025, and DOE is expected to select one of the two projects to receive the final $29 million to complete the project buildout. Both projects had submitted FERC preliminary permits, as shown in Table 5. The two funded projects are:

1. **Rosario Strait Tidal Energy Project:** See FERC Permit Application P-15368. Based in Eastsound, WA, Orcas Power & Light Cooperative (OPLC) proposes to deploy a tidal energy turbine in Rosario Strait in the San Juan Islands. The turbine is expected to produce about 2 MW of power and will provide a local power supply for residents of the San Juan Islands (OPLC n.d.).
2. **American Tidal Energy Project:** See FERC Permit Application P-15116. This project, led by ORPC, plans to deploy Proteus and ORPC tidal energy devices in Cook Inlet in Alaska. Cook Inlet has the largest tidal energy resource in the U.S. (Kilcher, Fogarty, and Lawson, 2021). The devices are expected to have a capacity of 1–5 MW.

Under the same funding opportunity, the DOE awarded $9.5 million to the University of Alaska Fairbanks' Alaska Center for Energy and Power. The funding supports a river current energy R&D project on the Yukon River in Galena, AK (Hydropower and Hydrokinetic Office 2023). This project will accelerate the development of river current energy technologies and promote resilience and economic development in the Yukon River and Alaska Native communities.

Table 6. Federal Energy Regulatory Commission Fully Permitted Hydrokinetic Energy Sites in the U.S.

Source: Adapted from FERC (n.d.).

FERC Docket Number	Project Name	Issue Date	Expiration Date	Authorized Capacity (kW)	Permittee	Waterbody	State	Description
P-13511	Igiugig	04/30/2029	05/23/2019	70	Igiugig Village Council	Kvichak River	AK	Hydrokinetic Inland Current
P-14616	PacWave South Hydrokinetic	02/28/2046	03/01/2021	20,000	Oregon State University	Pacific Ocean	OR	Hydrokinetic Wave
P-14775	Bourne Tidal Hydrokinetic Test Site	03/31/2032	04/17/2024	50	Marine Renewable Energy Collaborative of New England	Cape Cod Canal	MA	Hydrokinetic Tidal

The longest-operating river hydrokinetic project in the U.S. is the Igiugig Village Council and ORPC project mentioned earlier (TETHYS n.d.). Located in the Kvichak River, the first modular RivGen turbine was installed in 2019 and a second in 2023, bringing the project's total installed capacity to 70 kW. The project provides renewable electricity to the village of Igiugig, aiming to offset diesel fuel requirements while serving as a demonstration project for how river current energy can be harnessed across Alaska and in other remote locations.

2.2.6 United Kingdom Hydrokinetic Energy Pipeline

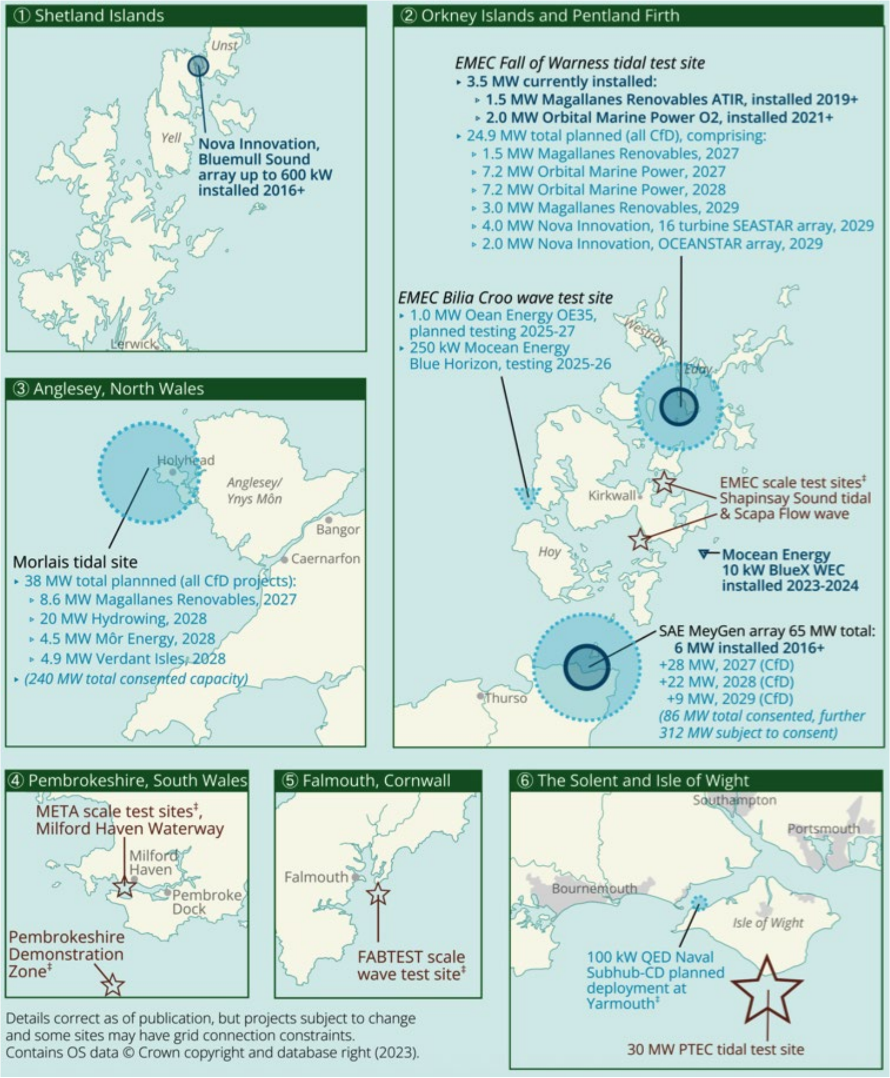
The U.K. is leading the world in hydrokinetic energy commercialization with government financing support through its CfD scheme. CfDs are policy instruments that guarantee a set electricity price for electricity generation, specifically from low-carbon and emerging technologies (Ason and Dal Poz 2024). The latest CfD allocation round added 28 MW of new tidal energy to the UK pipeline, bringing the total UK tidal energy project pipeline to 130 MW. Figure 13 illustrates the pipeline of UK tidal energy projects. All 130 MW, which include all axial-flow technology archetypes, are expected to be installed by 2029 (Grattan, Noble, and Jeffrey 2025). The current set electricity price, also known as a strike price, for the CfDs awarded to tidal energy projects was £172–£198/MWh ($234–$269/MWh) (Department for Energy Security and Net Zero 2024). The CfD strike price indicates the price that will be paid for each megawatt-hour of electricity generated and does not necessarily indicate the

LCOE at which a project is financially profitable. Unfortunately, limited publicly available information exists on the financial structure of planned UK tidal projects. If proven successful, these projects will help the UK tidal energy industry become a leading exporter of utility-scale turbine technologies, likely providing economic benefit and employment to the UK.

The UK is also the home to the first and only commercial tidal stream array. The MeyGen project (5 MW), owned by SAE Renewables and located in northern Scotland, consists of four horizontal-axis, 1.5 MW tidal stream turbines (Figure 9). Since its connection to the grid in 2018, the project has generated 80 GWh of electricity. After being awarded CfDs in Allocation Rounds 4, 5, and 6, the MeyGen array is planned to increase capacity to a total of 59 MW by 2029.

Figure 13. Map of the United Kingdom's Contracts for Difference Deployment Projects, Updated to Allocation Round 6

Source: Grattan, Noble, and Jeffrey (2025).



2.3 Levelized Cost of Energy

2.3.1 Tidal Technologies

The estimated LCOE for tidal energy is $360/MWh, declining to approximately $170/MWh by 2050 under assumed learning rates and deployment growth. These estimates are broadly consistent with recent national and international tidal energy cost assessments.

Major contributors to tidal energy costs include:

- Capital expenditures, particularly turbine manufacture, subsea foundations, and installation
- Operations and maintenance costs, driven by marine access and harsh operating environments
- Balance-of-system costs, including electrical infrastructure and grid interconnection

Projected cost reductions depend on increased deployment scale, component standardization, improved installation methods, and learning-by-doing across the supply chain. The magnitude and timing of these reductions remain uncertain and are contingent on sustained investment and policy support.

The LCOE estimates provided are from a forthcoming NLR report on tidal energy (Baca and Colby, in progress), based on a literature review, UK CfD strike prices, and expert elicitation. They found that cost estimates in the literature are generally based on deployments at high-energy tidal sites and for large arrays, resulting in optimistic estimates. Similarly, the expert elicitation study by Baca and Colby asked industry experts to report tidal energy prices in 2022 and 2050 for high-energy sites and a 100 MW array (Baca and Colby). Results are shown in Table 7 and Figure 14. The mean estimated cost of tidal energy, as given by 13 industry experts surveyed, was $360/MWh ± $110/MWh in 2022. In a conservative scenario, those prices are estimated to fall to $170/MWh ± $80/MWh by 2050.

Table 7. Levelized Cost of Energy Estimations for 100-MW Tidal Energy Arrays

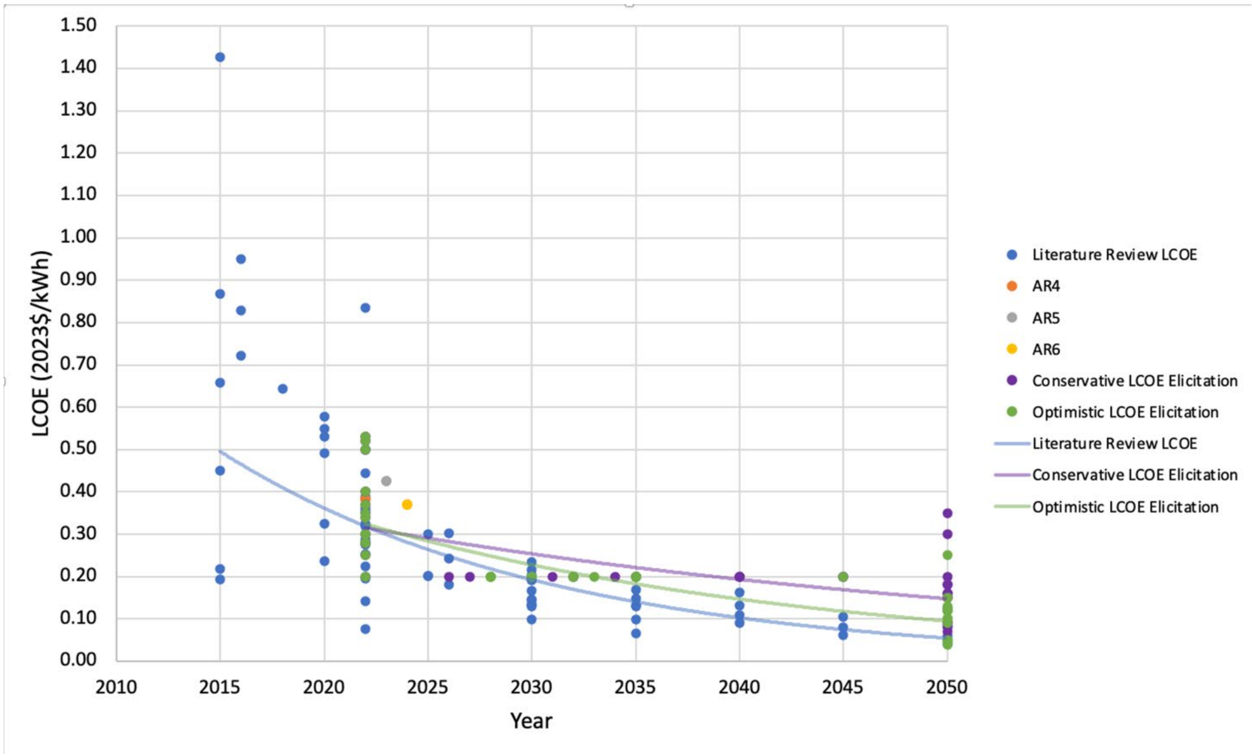
Source: Data from Baca and Colby (in progress).

LCOE Estimation	2022	2050
Mean LCOE ($/MWh)	360	170
Variance ($/MWh)	110	80

Figure 14. Estimated Levelized Cost of Energy over Time

As presented in the literature, CfD, and tidal energy LCOE expert elicitation.

Source: Figure adapted from Baca and Colby (in progress).



2.3.2 River Technologies

The estimated LCOE for river current energy is $450/MWh in 2022, declining to approximately $210/MWh by 2050 under assumed learning rates and deployment growth. Publicly available cost data for river hydrokinetic technologies are limited. As a result, for this analysis, river current energy LCOE is conservatively assumed to be 1.25 times higher than tidal energy LCOE across the analysis period.

This assumption reflects:

- Smaller deployment scales
- Lower technology readiness levels
- Reduced opportunities for economies of scale

This multiplier is not intended to represent a precise cost prediction, but rather to provide a reasonable bounding estimate for comparative analysis.

Few river turbine deployments exist worldwide, and no pilot arrays have been deployed to date at a meaningful scale. As a result, a high level of uncertainty exists in river turbine LCOE estimates, and a general scarcity of publicly available data on them. The only two public cost estimates available are for ORPC's RivGen 1.0 (Salmon 2016), and DOE's reference model river turbine, RM2 (Neary et al. 2014). Results from these early LCOE studies of river turbines are provided in Table 8.

ORPC's RivGen 1.0, demonstrated in the Kvichak River in Alaska in 2015, is a 35 kW, bottom-mounted, horizontal-axis river turbine (see Figure 11). The LCOE for the RivGen 1.0, which was a first-of-a-kind single device, was estimated at $273/MWh (Salmon 2016). These costs were high for many reasons, including the one-off nature of the deployment and the costs associated with transporting and installing a device in a remote Alaskan village. Accordingly, this LCOE number is of limited relevance to the deployment of river turbines in New York State because:

1. Projects in New York State will be much larger
2. The cost of deploying turbines in remote Alaska is not comparable to deploying in the continental U.S.
3. River turbine technologies have improved since the 2015 OPRC deployment in Igiugig

DOE's RM2 is an 89 kW, dual-rotor, vertical-axis, cross-flow river turbine modeled in the lower Mississippi River near Baton Rouge, LA. The reference model's costs were modeled for a single device and a larger 100-device array.

Table 8. Levelized Cost of Energy Estimations for the ORPC's RivGen 1.0 and DOE's RM2 River Current Energy Devices

Source: Derived from Salmon (2016) and Neary et al. (2014).

Parameter	RivGen 1.0 (2016) Single Device	DOE RM2 (2012) Single Device	DOE RM2 (2012) 100-Unit Array	Estimate Based on Tidal LCOE (2022)	Estimate Based on Tidal LCOE (2050 Projection)
Rated Power (kW)	50	89	8,951	—	—
Capital Expenditures ($ thousands)	2,386	3,188	50,255	—	—
Operational Expenditures ($ thousands/year)	258	201	1,701	—	—
LCOE ($/MWh)	2,730	2,670	350	450	210

The usefulness of the LCOE numbers reported in Table 8 is limited, as the $2730/MWh figure reflects a single-device, first-of-a-kind deployment in a remote Alaskan village, and the $350/MWh figure is from a 2012 conceptual model (RM2) for a large array. Neither estimate includes location, financial, or regulatory assumptions consistent with projecting costs in New York State, and neither serves as a reliable basis. Therefore, for this analysis, these data are acknowledged, but a conservative assumption is made that the LCOE for utility-scale river turbine technologies is 1.25 times that of tidal energy. LCOE for utility-scale river turbine technologies is estimated at $450/MWh ± $140/MWh in 2022. In a conservative scenario, those prices are estimated to fall to $210/MWh ± $100/MWh by 2050.

This assumption is based on three key factors:

1. River current energy projects will likely be smaller than tidal energy arrays, limiting economies of scale
2. River velocities are generally lower than in prime tidal streams, impacting energy capture
3. The global market for large-scale river current energy projects is smaller than for tidal energy projects, which will slow cost reductions from global learning

Most river energy projects offer attractive attributes, such as proximity to shore and substations, which limit the need to build transmission infrastructure. Further, depending on the resource and site characteristics, turbines might be deployable without special equipment, and it could be cheaper to install small arrays close to specific electricity loads. Another important consideration is whether the river's seasonal flow is well timed with the local electricity demand cycle. As mentioned throughout this document, site-specific analysis will be needed to determine the technoeconomic viability at sites across New York State.

2.4 Cost Comparisons to Other Renewable Projects

Current analysis suggests that both tidal and river current energy technologies will likely remain more expensive than utility-scale wind and solar projects through 2050. However, given the early stage of development of tidal and river hydrokinetic technologies, potential exists for advancements that could drive costs toward parity with other renewable energy sources.

Framing these costs in the context of value remains crucial. While tidal and river current energy are projected to have a higher LCOE than other renewables, they offer unique advantages over intermittent renewables such as utility-scale solar and land-based wind. As discussed earlier, tidal energy is highly predictable and forecastable, supporting grid stability. River current energy provides a consistent, localized power source that can enhance energy security and resilience for inland communities. Compared with other reliable, low-emission power generation systems, such as battery energy storage or hydrogen combustion turbines, tidal and river current energy technologies are currently cost-competitive and are projected to become more competitive by 2050.

In its 2025 Energy Plan, New York State indicates a broad spectrum of costs for different generation technologies across locations in the State (New York State Energy Planning Board 2025). Specifically, Table 9 details the LCOE of renewable technologies in areas suitable for tidal energy, Table 10 presents costs for regions where river current energy is feasible, and Table 11 shows the LCOE for new low-emission generation resources in New York State. The LCOE values are segregated by operating zones, shown in Figure 15, which are defined by the New York Independent System Operator (NYISO). Zones K and J, which include New York City and Long Island, are relevant to tidal energy, while Zones A and E, which include the western tip of the State and the Mohawk Valley, are areas of interest for river current energy. In both scenarios, utility-scale solar consistently emerges as the most affordable option, followed closely by land-based wind and distributed solar. However, compared with the costs of new low-emission generators such as hydrogen combustion, tidal and river current energy are cost-competitive.[4] Costs are presented for projects developed in 2025, with projections for 2050.

Table 9. Costs of Wind and Solar Energy in Zones J and K, New York State

Excludes transmission upgrades. Costs are compared with projected tidal energy costs for 2025 and 2050 (see Figure 15).

Technology	2025 Costs ($/MWh)		2050 Costs ($/MWh)	
	Zone K	Zone J	Zone K	Zone J
Utility Solar	60–66	N/A	45–51	N/A
Distributed Solar, Commercial	100	175	75	131
Distributed Solar, Residential	231	260	228	257
Land-based Wind	73–88	N/A	74–89	N/A
Offshore Wind	115–139		83–117	
Tidal Stream	250–470		90–250	

Table 10. Costs of Solar and Wind Energy in Zones A and E, New York State

Excludes transmission upgrades. Costs are compared with estimated river current energy costs.

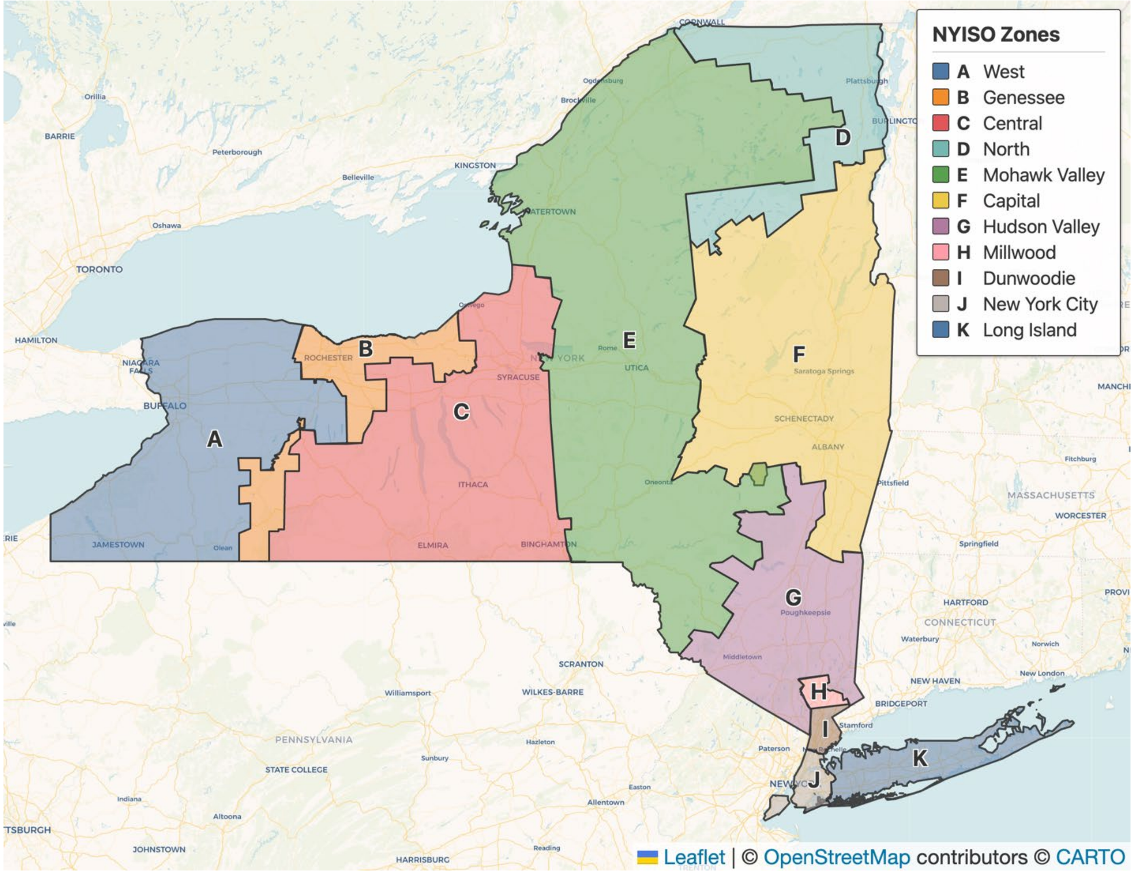
Technology	2025 Costs ($/MWh)		2050 Costs ($/MWh)	
	Zone A	Zone E	Zone A	Zone E
Utility Solar	63–67	60–64	48–50	45–46
Distributed Solar, Commercial	69		52	
Distributed Solar, Residential	214		211	
Land-Based Wind	72–76	77–79	74–77	79–81
River Current	313–588		113–313	

Table 11. Costs of New Dispatchable Energy Resources, New York State

Compared with the estimated river and tidal energy costs.

Technology	2025 Costs ($/MWh)	2050 Costs ($/MWh)
Tidal Stream	250–470	90–250
River Current	313–588	113–313
New Nuclear, Greenfield	139	146
New H2 Combustion Turbine (Upstate, at 85% Capacity Factor)5	323	210
New H2 Combustion Turbine (Upstate, at 5% Capacity Factor)	796	628
New H2 Combustion Turbine (Downstate, at 5% Capacity Factor)	842	670

Figure 15. Map of NYISO Boundaries and Operational Regions of the New York State Electric Grid



2.5 Summary

The TEA results indicate that hydrokinetic energy is unlikely to achieve cost parity with the lowest-cost renewable energy options in New York State in the near term without significant technological breakthroughs. Nevertheless, hydrokinetic technologies could provide benefits for New York State, where:

- Predictable generation provides grid or resilience benefits
- Local generation offsets transmission constraints or reliability challenges
- Pilot- or demonstration-scale deployments generate learning value that informs future decisions

As illustrated in Table 11, compared with other low-emission grid resilience resources such as hydrogen gas turbines, tidal and river resources have the potential to be cost-competitive. These findings reinforce the potential for targeted, strategic investment in technology R&D

and pilot deployments in high-value locations to advance technology to the point where commercial-scale deployments are cost-competitive with other forms of low-emission technologies in New York State.

2.6 Opportunities for Advancing Hydrokinetic Energy in New York State

New York State has established ambitious clean energy goals, including a mandate for 70% renewable electricity by 2030 and 100% zero-emission electricity by 2040 (NCSL 2021). Achieving these targets requires a diversified portfolio of renewable energy sources, including hydrokinetic energy. The initial resource assessment presented in this report indicates a technical tidal and river current energy resource of 2.75 TWh/year in New York State, equivalent to 2.1% of 2024 electricity generation (NYISO 2025).

Fully achieving the potential of hydrokinetic energy technologies and meeting New York State's renewable targets will require:

- Robust community engagement and stakeholder involvement
- Detailed site-specific resource assessments to quantify the characteristics and magnitude of the most promising tidal and river energy resources
- Targeted analysis of grid integration, transmission constraints, and system-level value to evaluate predictability, congestion relief, and coordination opportunities with offshore wind infrastructure
- Pilot and demonstration projects to advance technology and reduce costs
- Project development strategies and technologies that mitigate environmental impacts, increase community acceptance, and accelerate deployment

Finally, if New York State demonstrates commercially successful projects, successful experience and technologies could be exported both domestically and internationally.

2.6.1 Potential Contributions of Tidal Energy to New York State Electricity Needs

Tidal energy represents the most significant hydrokinetic energy opportunity in New York State due to the magnitude, predictability, and geographic concentration of the available resource. Unlike solar and wind, which are intermittent and depend on weather conditions, tidal generation is precisely forecastable for decades in advance. The predictability of tidal energy could enhance grid stability, help balance the intermittency of wind and solar, and create a more reliable and resilient electricity system. Although tidal energy cannot supply a large share of statewide electricity demand, it may provide meaningful contributions in select high-value locations where other renewable options are constrained.

The concentration of tidal resources around Fishers Island (1.29 TWh/year or 490 MW of installed capacity) presents a clear opportunity for utility-scale development that could provide substantial clean energy to the Long Island region. This region faces challenges in expanding transmission infrastructure. At 490 MW of potential capacity, tidal energy could complement the electricity generated from Long Island's offshore wind projects, South Fork Wind (132 MW) and Sunrise Wind (924 MW COD in 2027), providing the ability to balance intermittent renewables and enhance grid stability (NYSERDA 2023). These grid-firming benefits, as well as the potential for shared infrastructure, could make pairing tidal energy with offshore wind particularly attractive. A more detailed analysis is required to determine the costs, benefits, and challenges of developing a utility-scale tidal energy project around Fishers Island.

2.6.2 Potential Contributions of River Current Energy to New York State Electricity Needs

River current energy resources in New York State, while more dispersed, can offer consistent power at scales relevant to local communities (approximately 10–100 MW). While significant utility-scale river current energy development is unlikely in New York State, smaller utility-scale projects in the Niagara River may have potential. While the LCOE for such projects may be higher than that of other renewables, their primary value proposition is not to compete but to enhance local energy security and resilience, particularly for upstate or remote communities.

Localized river current energy projects could provide predictable generation to specific communities, reducing reliance on long-distance transmission and enhancing local energy independence. River current installations could benefit various communities across the State. As Table 3 illustrates that numerous rivers, including the Hudson, Susquehanna, and Black rivers, possess technical resource potential that could increase local electricity generation and energy security for small communities along the rivers. These localized projects could provide rural or remote communities with a reliable, renewable power source, fostering energy independence and economic development by creating jobs in manufacturing, installation, and maintenance.

2.6.3 Environmental and Siting Considerations

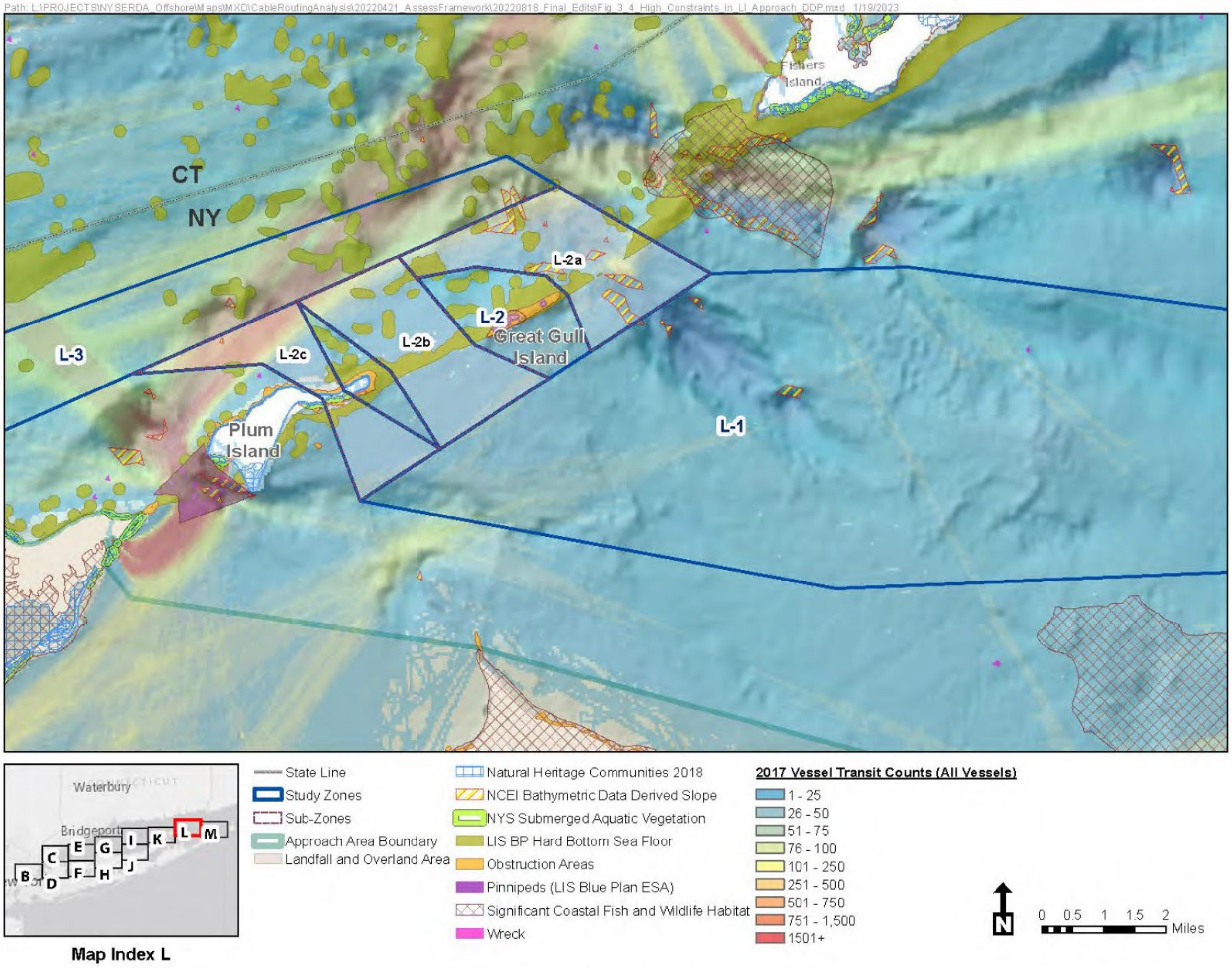
Tidal and river current energy have potential environmental advantages over large-scale hydropower dams because river impoundment is not necessary. In-stream river and tidal turbines generally have a much smaller ecological footprint, with minimal impacts on water quality, fish migration, protected marine mammals, sea turtles, and cold water corals (Copping et al. 2021, 2024). Properly sited and designed, these technologies can generate electricity with little to no greenhouse gas emissions, contributing directly to New York State decarbonization goals. While environmental monitoring and mitigation strategies are crucial, hydrokinetic energy systems can potentially integrate into existing aquatic ecosystems with relatively low impact.

Tidal and river turbines offer an additional advantage in terms of visual aesthetics and minimal surface impact as they are typically floating, yet fully submerged. Unlike many other forms of renewable energy, they have no visible surface expression and minimal impact to seafloors or riverbeds, preserving the natural landscape, wildlife habitats, and waterways, which can be particularly beneficial in scenic or environmentally sensitive areas. This characteristic helps to mitigate potential visual objections, making them a more publicly acceptable option in certain locations and reducing conflicts with other water-based activities.

Prior environmental assessment work undertaken by New York State in the development of offshore wind can be relevant to the deployment of tidal power near Long Island. NYSERDA (2023) provides an overview of identified constraints to cable installation in the Long Island Sound, including potential biological impacts, vessel traffic, and fishing concerns. Figure 16 shows a mapping of the identified cable installation constraints in the Long Island Sound. Areas L-2a and L-2b in Figure 16 correspond to the top two sites for tidal power potential in New York State, with potential for installed turbine capacity of 408 MW in L-2a and 47 MW in L-2b. In the assessment, NYSERDA notes that L2-a was selected as a potential cable route for the Beacon Wind project, which could indicate lower constraints to development in the area and the potential for co-location of tidal power resources into offshore wind infrastructure.

Figure 16. Constraints within Long Island Sound

Source: NYSERDA (2023).



2.6.4 Impact of Communities and Competing Uses

As seen in the development of New York State's Empire Wind 2 project, gaining community support is crucial to the success of any new infrastructure project (NYSERDA 2023). Many coastal communities in New York State, such as the community around Fishers Island, rely on their waterways for a variety of uses, including such as shipping, fisheries, ferry transport, and recreation. Given the importance of New York State's waterways to their communities, prospective project developers should engage with communities early and often and develop sufficient risk mitigation strategies to avoid impeding the communities' use of the waterways.

3. Conclusions and Opportunities

The technically extractable river and tidal energy resources in New York State are estimated at 2.75 TWh/year, equivalent to approximately 2.1% of the State's electricity generation in 2024 (NYISO 2025). Currently, both tidal and river current energy technologies remain more expensive than mature renewable technologies, and cost parity is unlikely in the near term. Accordingly, their value proposition should be evaluated primarily on system-level and location-specific benefits rather than energy-only cost metrics. When deployed strategically, tidal and river current energy may provide benefits that extend beyond energy production alone, including highly predictable generation, enhanced resilience, and potential grid support in constrained regions.

Tidal energy represents the most significant hydrokinetic opportunity in New York State due to its magnitude, predictability, and spatial concentration, particularly in the Fishers Island region of eastern Long Island Sound. This resource, estimated at over 1.29 TWh/year, could make a meaningful contribution to meeting utility-scale electricity demand on Long Island, where transmission expansion and land availability constrain alternative renewable energy development. Additional techno-economic and grid integration studies are needed to evaluate how tidal energy generated from Fishers Island could complement offshore wind, reduce congestion, and provide grid-firming value in the Long Island region.

In addition to tidal opportunities, river current energy resources across New York State may offer targeted opportunities to support local or community-scale energy needs. The Niagara River is the most energy-dense river resource in the State and therefore represents the strongest candidate for large-scale river current energy deployment. Beyond the Niagara River, small-scale river current energy projects are unlikely to contribute significantly to the statewide electricity supply, but they may enhance local energy resilience, reduce reliance on long-distance transmission, and support community energy objectives.

Realizing the potential of tidal and river current energy in New York State will require coordinated advancement across technology development, resource characterization, environmental research, and stakeholder engagement. Several priority opportunities have been identified to advance hydrokinetic energy in New York State, including:

- **Robust community engagement and education:** Early and sustained engagement with local communities, Tribal governments, and regulatory agencies is essential to reduce project risk and improve outcomes. Special care must be taken to minimize the impact new projects may have on local communities that rely on their waterways for shipping, fisheries, ferry transport, and recreation. Outreach and education efforts that clearly communicate potential benefits, limitations, and environmental considerations are essential for building trust and ensuring projects align with community priorities.
- **High-resolution tidal resource and environmental assessment at Fishers Island:** More than 80% of the State's tidal energy resource is concentrated in and around Fishers Island. The absence of high-resolution flow, turbulence, and environmental baseline data remains a key barrier to development. A detailed resource assessment following IEC TS 62600-201 would reduce uncertainty, inform preliminary array design, and support early-stage environmental studies needed to derisk commercial development (IEC 2015).
- **Grid integration and system value analysis:** Targeted analysis of grid integration options, transmission constraints, and system-level value is particularly important for potential utility-scale tidal projects in Long Island Sound. Such studies should explicitly evaluate predictability, congestion relief, and coordination opportunities with offshore wind infrastructure.
- **High-resolution, site-specific river resource assessments:** Although large (>100 MW) river current energy deployments are unlikely, improved screening using higher resolution bathymetry, flow characterization, and comprehensive mapping of nonpowered dams and other obstructions is required to refine resource estimates and identify deployable sites.[6] These assessments should follow the National Research Council (2013) recommendations and the IEC TS 62600-301 guidance on river resource characterization (IEC 2019).
- **Pilot and demonstration projects:** Strategically selected pilot projects are essential for reducing technical, cost, and environmental uncertainty. Such projects can provide real-world data on installation, operations, and maintenance, environmental interactions, and permitting processes. As discussed earlier and shown in Table 5, three developers have shown interest in developing first-of-a-kind projects near Fishers Island and along the Niagara River. Development of these projects would advance tidal and river current energy technologies and the industry, and would help derisk future projects in New York State and across the U.S.

- **Environmental monitoring and mitigation research:** Long-term, site-specific environmental monitoring is critical to understanding and mitigating potential impacts on aquatic species and habitats. Continued research into fish-friendly turbine designs, advanced sensing technologies, and adaptive management protocols will be necessary to support responsible deployment.

In summary, hydrokinetic energy is unlikely to become a major contributor to New York State's statewide electricity supply. However, carefully targeted development focused on high-value locations and applications could enable tidal and river current energy to play a complementary role within the state's broader clean energy strategy.

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Appendix A. River Energy Resource Assessment

A.1 Estimating the Niagara River Resource

The theoretical energy for the Niagara River was calculated using Equation 2 (Section 1), in which Q (6,509 m3/s) was taken as the average river flow rate over the last 10 years. ΔH was taken to be 4.5 m, which counts only the approximately 3 m drop between Lake Erie and the Upper Rapids and the approximately 1.5 m drop between Lewiston and Lake Ontario. The approximately 15 m elevation drop in the Upper Rapids, the 57 m drop of Niagara Falls, and the 24 m drop in the Lower Gorge were not counted because turbine deployments are likely not possible in these regions of the river due to rapids and waterfalls. Because the elevation drops considered were from regions before the intakes for the U.S. Robert Moses Niagara Power Plant and the Canadian Sir Adam Beck I and II hydropower dams, and after the dam tailraces rejoin the river, the full river flow rate could be used to calculate the theoretical power.

A.2 Estimating the St. Lawrence River Resource

The theoretical resource for the St. Lawrence River was calculated using the same method. The river's flow rate (7,880 m^3/s) is by far the largest of any river in New York State, and the ΔH is just 1–2 m between Lake Ontario and Lake St. Lawrence. The remainder of the 25 m elevation drop along the St. Lawrence River along the NYS border occurs at the Robert Moses–Robert H. Saunders Power Dam near Massena, and this elevation drop was therefore not considered. Clearly, the method used to calculate the theoretical resource for the Niagara and St. Lawrence rivers is a rough first-order estimate, which should be kept in mind when interpreting the results. However, the calculations use a methodology similar to Jacobson (2012) and provide a reasonable estimate of the potential of these border rivers. Further work that is beyond the scope of this report is recommended to refine these estimates.

A.3 Other River Resource Data Sources in Literature

While researching for this report, two other notable sources of river resource data were PNNL (Kim et al. 2024) and NRCAN (Kirby et al. 2026).

A.3.1 PNNL Resource Data

The U.S. river resource estimates from the PNNL (Kim et al. 2024) were not publicly available at the time of writing and did not significantly impact the estimates for New York State.

The Jacobson (2012) resource assessment included only rivers with flow rates higher than 28.3 m^3/s (1,000 cubic feet per second). Kim et al. (2024) updated the U.S. resource assessment study to include rivers below this 28.3 m^3/s cutoff and found a modest (<10%) increase in the overall resource in the mid-Atlantic states. A breakdown of the NYS resource was not provided, and the raw data from this study were not available for analysis at the time of writing. Accordingly, the Kim et al. data were determined not to significantly change the results presented in this report, and the older river dataset from Jacobson was used.

A.3.2 NRCAN Resource Data

The available NRCAN resources data for the Niagara and St. Lawrence rivers were not used because the NRCAN data from Kirby et al. (2026) provide point estimates of kinetic energy flux, and thus do not assess the resource potential that is comparable to the assessment numbers from Jacobson (2012) and Kim et al. (2024). The data from the NRCAN (2015) geographic information system (GIS) database were not used because the numerical methods employed for resource characterization are undocumented in the publicly available literature.

A.3.3 New York State River Resources

The river current power generation potential was estimated for all the river resources in New York State. In the report, only the top 10 resources were listed. The following table presents the resource estimates for all New York State rivers found in Kilcher et al (2021, 2023).

Table A-1. Comprehensive Resource Energy Potential of New York State Rivers

Source: Kilcher et al. (2021).

Rank	River	Length (km)	Theoretical Resource (TWh/year)	Technical Resource (TWh/year)	Technical as a % of state electricity generation (%)	Potential Installed Turbine Capacity (MW)	Energy Density (TWh/year-km)
1	Hudson River	325	1.92	0.19	0.15%	73	0.00059
2	Susquehanna River	189	0.75	0.07	0.06%	28	0.00040
3	Black River	101	0.71	0.07	0.06%	27	0.00071
4	Delaware River	58	0.67	0.07	0.05%	26	0.00116
5	Niagara River	39	N/A*	0.06	0.05%	24	0.00165

Table A-1. (continued)

Rank	River	Length (km)	Theoretical Resource (TWh/year)	Technical Resource (TWh/year)	Technical as a % of state electricity generation (%)	Potential Installed Turbine Capacity (MW)	Energy Density (TWh/year-km)
6	Mohawk River	149	0.64	0.06	0.05%	24	0.00043
7	Genesee River	146	0.54	0.05	0.04%	20	0.00037
8	Raquette River	126	0.47	0.05	0.04%	18	0.00037
9	St. Lawrence River (Upper)	94	N/A*	0.04	0.03%	15	0.00043
10	Schoharie Creek	52	0.36	0.04	0.03%	14	0.00070
11	Chemung River	63	0.35	0.03	0.03%	13	0.00055
12	Sacandaga River	63	0.18	0.02	0.01%	7	0.00029
13	West Canada Creek	30	0.17	0.02	0.01%	7	0.00057
14	Oswegatchie River	99	0.17	0.02	0.01%	6	0.00017
15	Erie Canal	37	0.15	0.02	0.01%	6	0.00041
16	Allegheny River	86	0.15	0.02	0.01%	6	0.00018
17	East Branch Delaware River	29	0.14	0.01	0.01%	5	0.00047
18	Seneca River	96	0.13	0.01	0.01%	5	0.00013
19	Oswego River	21	0.12	0.01	0.01%	4	0.00057
20	Chenango River	30	0.12	0.01	0.01%	4	0.00039
21	St. Regis River	31	0.11	0.01	0.01%	4	0.00035
22	Grass River	65	0.11	0.01	0.01%	4	0.00017
23	St. Lawrence River (Lower)	77	0.07	0.01	0.01%	3	0.00009
24	Hoosic River	20	0.07	0.01	0.01%	3	0.00034
25	Tioughnioga River	16	0.05	0.01	0.00%	2	0.00033
26	Clyde River	19	0.05	0.00	0.00%	2	0.00026
27	West Branch Delaware River	13	0.04	0.00	0.00%	2	0.00033
28	Oneida River	30	0.02	0.00	0.00%	1	0.00007
29	Conewango Creek	22	0.01	0.00	0.00%	0	0.00005
30	Lake Erie	43	0.00	0.00	0.00%	0	0.00002
31	Tioga River	7	0.00	0.00	0.00%	0	0.00003
32	Ganargua Creek	4	0.00	0.00	0.00%	0	0.00004
Total		**1,278**	**6.06**	**0.71**	**0.57%**	**270**	**—**

Endnotes

[1] Kilcher et al. (2021) consider a minimum energy density of 8 kW/m required for a wave energy resource to be recoverable and estimate zero technical wave resource potential off NYS shores.

[2] The data from the study by Jacobson (2012) are publicly available on the NREL's Marine Energy Atlas site (N.d.).

[3] The Niagara River and St. Lawrence River data were published in Kim et al. (2024) and Natural Resources Canada (NRCAN 2015, Kirby et al. 2026), but were not used for this study because of low resolution near large dams on the rivers, and the numerical methods used were inconsistent with other methods adopted for this study.

[4] The levelized costs of energy (LCOEs) for tidal and river current energy are both estimated at a national level and are likely an underestimate when considering the higher regulatory and development costs for New York State.

[5] New H2 Combustion Turbine at 85% Capacity factor was calculated from New York State Energy Plan data using the formula [New CCGT (85% CF; upstate)]+ [New CT burning H2 (5% CF; upstate) - New CT burning gas (5% CF; upstate)].

[6] For example, the Hudson River is well mapped south of Troy (DEC n.d.), providing the opportunity to develop more accurate technical resource estimates and identify optimal deployment sites.

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New York State
Energy Research and
Development Authority

17 Columbia Circle
Albany, NY 12203-6399

toll free: 866-NYSERDA
local: 518-862-1090
fax: 518-862-1091

info@nyserda.ny.gov
nyserda.ny.gov