Deploying Hydrokinetic Turbines in Ice-Affected Rivers: Risks, Insights, and Mitigation

Authors:
Denise Sudom, National Research Council of Canada

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Presenter Name: Denise Sudom
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Implementation of hydrokinetic turbine technology in rivers represents a promising renewable energy option for remote and northern communities. These turbines offer flexibility in deployment and are an attractive alternative to conventional hydroelectric dams, due to their relatively low environmental impact and minimal disruption to aquatic ecosystems. However, seasonal ice cover in rivers introduces technical and operational challenges for turbine systems.

This presentation summarizes key findings from a technical review examining river ice processes and their relevance to hydrokinetic turbine design, deployment, and operation. River ice forms both at the surface and below it, with each type presenting different risks to turbine performance. Surface processes include border ice formation, complete ice cover, drifting ice, and ice jams. These ice processes can alter flow conditions or interact with turbine platforms, mooring systems, or surface equipment. Subsurface processes, particularly frazil ice and anchor ice formation, are more difficult to observe and can result in ice adhesion to turbine blades, housings, and sensors, potentially affecting efficiency and reliability.

Understanding site-specific ice conditions is critical for successful deployment of hydrokinetic turbines in rivers. Historical observations, local knowledge, field monitoring and remote sensing data can help identify freeze-up and break-up timing and locations prone to ice jams.

Mitigation strategies include careful turbine siting and operational planning, the use of ice booms to promote stable surface ice covers and reduce frazil production, and design measures that limit ice adhesion and protect exposed components. These insights support safer and more reliable deployment of hydrokinetic turbines in cold-region rivers.