Effectiveness of Downspout-Mounted Hydroelectric Systems

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This project was performed to determine the effectiveness of various methods for extracting energy from water flow in downspouts using cross-flow hydroelectric turbines. Several factors were evaluated: runner width, directed versus undirected flow, and turbine positioning in height and relative location. Experiments were conducted on a modular downspout simulation system mounted on a PVC-pipe structure. A data-logging wattmeter was connected to terminals on hydroelectric generators and used to record, using a computer, the current, voltage (across a 10-ohm resistor), and power generated by individual turbines. A flow direction device was constructed to produce a hydraulic head and guide water to particular portions of turbines' runners. Results showed various widths of vertically paired turbines behaved similarly under directed flow, although this was only tested with high head (124.5 cm). The highest power generation (1690±0 μW) came from the narrowest design at high head. The greatest power (1361±78 μW) for runners spanning the downspout was produced at medium head (91.4 cm). Undirected-flow experiments (water flowing naturally into downspout from gutter) followed the same pattern, with greatest power production for generators at an intermediate downspout position. A design with two turbines on opposite sides of the downspout showed greater power production (147±72 μW) than vertically paired turbines (69±39 μW). Opposing generators produced maximal power in the lowest downspout position, unlike paired ones. These data suggest that vertically spaced, centrally placed turbines are the best choice under reproducible directed flow conditions, but low-mounted opposed turbines are superior in the less reproducible undirected flow situations.

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