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An Evaluation of a Prototype System for Harvesting Energy from Pressurized Pipeline Networks

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Abstract : There is an increasing desire for renewable and sustainable energy sources to replace fossil fuels. This desire is the result of several factors. First, is the role of fossil fuels in climate change. Scientific data clearly shows that global warming is occurring. It has also been concluded that it is highly likely human activity; specifically, the combustion of fossil fuels, is a major cause of this warming. Second, despite the current surplus of petroleum, fossil fuels are a finite resource and will eventually become scarce and alternatives, such as clean or renewable energy will be needed. Third, operations to obtain fossil fuels such as fracking, off-shore oil drilling, and strip mining are expensive and harmful to the environment. Given these environmental impacts, there is a need to replace fossil fuels with renewable energy sources as a primary energy source. Various sources of renewable energy exist. Many familiar sources obtain renewable energy from the sun and natural environments of the earth. Common examples include solar, hydropower, geothermal heat, ocean waves and tides, and wind energy. Often obtaining significant energy from these sources requires physically-large, sophisticated, and expensive equipment (e.g., wind turbines, dams, solar panels, etc.). Other sources of renewable energy are from the man-made environment. An example is municipal water distribution systems. The movement of water through the pipelines of these systems typically requires the reduction of hydraulic pressure through the use of pressure reducing valves. These valves are needed to reduce upstream supply-line pressures to levels suitable downstream users. The energy associated with this reduction of pressure is significant but is currently not harvested and is simply lost. While the integrity of municipal water supplies is of paramount importance, one can certainly envision means by which this lost energy source could be safely accessed. This paper provides a technical description and analysis of one such means by the technology company InPipe Energy to generate hydroelectricity by harvesting energy from municipal water distribution pressure reducing valve stations. Specifically, InPipe Energy proposes to install hydropower turbines in parallel with existing pressure reducing valves in municipal water distribution systems. InPipe Energy in partnership with Oregon State University has evaluated this approach and built a prototype system at the O. H. Hinsdale Wave Research Lab. The Oregon State University evaluation showed that the prototype system rapidly and safely initiates, maintains, and ceases power production as directed. The outgoing water pressure remained constant at the specified set point throughout all testing. The system replicates the functionality of the pressure reducing valve and ensures accurate control of down-stream pressure. At a typical water-distribution-system pressure drop of 60 psi the prototype, operating at an efficiency 64%, produced approximately 5 kW of electricity. Based on the results of this study, this proposed method appears to offer a viable means of producing significant amounts of clean renewable energy from existing pressure reducing valves.

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