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A Life cycle assessment of energy harvesters in existing European water networks for distributed network monitoring

Bethany Bronkema[1], David C. Finger[1], Bjarnhédinn Gudlaugsson[1], and Dogan Gezer[2]
[1]Reykjavik University, School of Science and Engineering, Menntavegi 1, 102 Reykjavik, Iceland
[2]Scientific and Technological Research Council of Türkiye, Ankara, Türkiye

Recent developments in eastern Europe, increasing climate disasters and the continuous threat of volcanic eruptions have revealed the vulnerability of present energy and water supply systems. To enhance the resistance of existing water and energy infrastructure, holistic monitoring relies on decentralized energy production. Energy harvesters (EH) utilize kinetic energy in existing water pipelines to produce an electric current to power sensors and other components related to water infrastructure monitoring, replacing vulnerable and cost intensive diesel generators. EHs could represent an ideal solution to provide reliable and continuous power to decentralized monitoring systems. To characterize and assess the environmental impacts of EH, a complete life cycle assessment (LCA) was conducted using GaBi software and the ecoinvent database, as well as data collected from various case studies. This LCA focuses on EH in existing water facilities and networks and includes manufacturing, transport, usage, and decommission stages for the EH. In modeling this technology from cradle-to-grave, a more complete understanding of its environmental impacts can be obtained. Special focus in this LCA was given to the allocation of impacts to services provided by water networks, e.g., drinking water supply, heat supply and water purification. Preliminary results suggest that a scale up of these harvesters could bring their global warming potential – measured in g CO2, eq/kWh – down to a level that is competitive with conventional hydropower while having significantly less impacts on surrounding natural areas. Our results focus on the case study in Iceland, the district heating system in Reykjavik. The preliminary results suggest that most impacts stem from the production of the material needed for the harvester, with little coming from the operation phase. As discussed above, EHs could provide a solution to decentralized monitoring systems. One application being explored for these harvesters is to power sensors along the existing water facility network, thus adding not only to the reliability of power supply, but to the overall reliability of the water network and provided a cleaner source of power than traditional diesel generation. If considered as part of an allocation LCA, these emissions savings constitute an additional reduction in the harvesters' impacts. Essentially, the results of this LCA suggest that EH in existing water systems represents a crucial element in the low-carbon energy transition. EH could increase resiliency and energy security, while tapping into already existing water supply networks, ideally without adverse effects on these systems. While our results focus on a case study in Iceland, we plan to apply the approach to drinking water supply systems in Ferlach, Austria and Izmir Turkey, water purification in Padova, Italy and natural currents in the lagoon of Venice, Italy. The ensemble of the results from all case

studies could reveal the full potential of EH across Europe.