Water vs. energy – Finding hidden energy potential to provide clean water

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1 Introduction

Water and energy are two of the most fundamental resources driving civilization; both human development and industrial growth. They are also intrinsically interlinked. Energy is consumed at every stage of the water supply chain (Plappaly and Lienhard 2012) and water is a key resource in energy generation (Rio Carrio and Frei, 2009). Both resources are limiting the other, and both are running short (Webber 2008). The suggestion is that the scarcity issues need to be solved in concert.

2 Objectives of the research

The objective of the Water Asset Renewable Energy Solutions (WARES) project, which this research is part of, is to map hidden, renewable energy potential in water utilities across the Northern Periphery. The nine pilot sites participating in the project explore opportunities for micro-hydro, small and medium-scale wind energy solutions as well as for the utilisation of solar power, energy from biosolids and waste heat from wastewater. The project intends to provide practical solutions to utilise these assets in order to reduce the carbon footprint of water.

3 Results

Electricity is a critical input for delivering municipal water and wastewater services and electricity costs can contribute up to 30 % of the operating costs of water and wastewater utilities. The largest energy consumer in providing drinking water is the pumping of water to customers, which consume up to 70 – 80 % of the overall electricity usage of water utilities. Also in wastewater management, a considerable amount of electricity is needed for pumping the wastewater from households and industries back to the wastewater treatment plant (Liu et al., 2012). In wastewater treatment, sludge aeration process is the largest energy consumer, but also ultraviolet disinfection and membrane processes add substantially to electricty consumption costs (Tchobanoglous, et al., 2004). Although heating costs in Tchobanoglous are cited to contribute to only some 7% of wastewater tretament plan energy needs, in Northern Finland, heating costs were reported to be up 35% of total energy costs (Mikkonen).

3.1 Providing energy services in the Northern Periphery

The Northern Periphery is an area defined by the Northern Periphery Programme (NPP). The programme covers parts of Sweden, Finland, Norway, Scotland, Northern Ireland and the Republic of Ireland, as well as all of the Faroes, Iceland, and Greenland. Much of the area is situated north of the Arctic Circle, and includes some of the world's northernmost communities (Figure 1).

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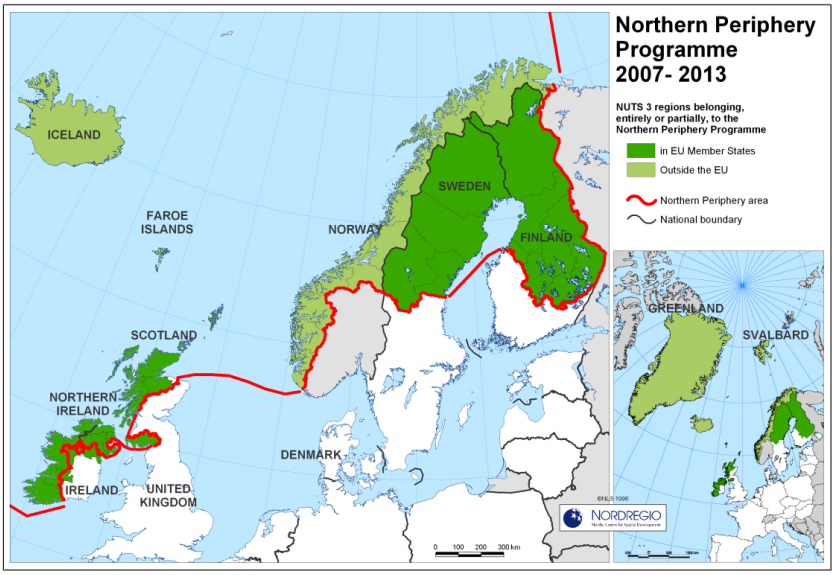

Figure 1 *The Northern Periphery area as defined by the Northern Periphery Programme*

NPP is a European Union-funded scheme to promote cooperation amongst the people living in this northern fringe of Europe. This provides the opportunity to work together on shared concerns and problems related to living and working in the far north. Within this programme, the WARES partnership works to provide a service that creates innovative renewable energy solutions for remote areas by finding unused or hidden opportunities for renewable energy generation within the activities and property of the water industry sector. The overall objective is to provide a new model for maximising community, socio-economic benefits from the hidden potential within the water sector, and secure local sustainable development.

The model for water services is rather varied in the NPP areas. For example in Scotland, Scottish Water is a state-owned, statutory provider of water services and has more than 2 000 water treatment works and assets (Scottish Water, 2013). Currently, Scottish Water is the largest consumer of electrical power in Scotland but aims to be one of the largest generators of renewable electricity (Salmond 2010). Scottish Water already has 10 hydro-turbine schemes in operation and 40 other sites in development or construction. There are also some 140 turbines sited on Scottish Water land. In total, Scottish Water produce 7% of the energy they use. The charges that cover the water and wastewater services in Scotland are included in the Council Tax bill and, currently, account for less than £1 a day for the water services Scottish consumers receive (Scottish Water, 2013).

In Ireland, water supply and sanitation services are provided free of charge to domestic users. Water services are the responsibility of local authorities, which receive a subsidy from central government. The bulk of the costs of service provision is met from tax revenues. The delivery of water services in Ireland is currently going through significant changes. From 2014 on, there will be a new national utility called Irish Water that will take over responsibility for providing water and wastewater services. A system of water metering will be introduced and the Commission for Energy Regulation will devise a scheme of water charges (Citizens Information, 2012).

In Finland, water utilities have traditionally been owned and run by municipalities responsible for providing water and wastewater services. The government does not subsidise water and wastewater services in urban areas. All users have water meters and pay according to the volume of water used. In 1974, also a wastewater fee was introduced (Pietilä et al. 2007). The Finnish Water Services Act (119/2001) enables water utilities to define their tariff structures in order to comply with their actual cost structure. In rural areas, water and wastewater services have been operated by cooperatives and other consumer organizations such as partnerships and shareholders (Pietilä et al 2007). According to Hukka et al. (2007) there are more than 1000 co-operatives running rural water services. Partnerships cover more than 400 utilities and around 160 utilities are shareholder companies (Pietilä, et al. 2007). Due to the sparsely populated nature of Finland, the percentage of public water coverage is rather low in a European context. However, owing to the abundance of water resources, according to the Water Poverty Index, Finland is the highest ranking country in the world (World Resource Institute 2006).

3.2 Public-Private Partnership in water services

Even though water utilities in Finland are often owned and operated by municipalities and co-operatives, private sector can be involved in order to achieve economic and operational benefits and adding the know-how of a particular sector of the water utility. The agreement between public and private sector is generally called as Public-Private-Partnership (PPP). The WARES project intends to promote the formation of PPP's to implement and maintain renewable energy installation in water utilities. The partnerships are planned between the utility, the local community, and private investors. In Finland, PPPs have been used often by domestic water utilities. Outsourcing non-core services of public water utilities is rather common and the cash flow from water utilities to private operators has been reported to be some 40% on average (Pietilä et al. 2007).

3.3 Social Impact Assessment of renewable energy installations

Within the WARES project, the social impacts of investments in renewable energy solution (RES) are analysed and the potential of sharing benefits and re-investment of profits is explored. Social Impact Assessment (SIA) includes the process of analysing, monitoring and managing the intended and unintended, positive and negative social consequences of planned interventions and any social change processes invoked by those interventions (Vanclay 2003). SIA is a proactive method (Sairinen & Kohl 2004) and intends to ensure that benefits are maximised and costs are minimised (Vanclay 2003). Surveys are conducted at the municipalities where RES investments are planned and the perceived impacts of RES in the municipality are investigated. While the Environmental Impact Assessment Directive has been codified (2011/92/EU) since 2011, SIA has lagged being but is expected that its significance will grow in the future.

4 Relevance of the research

This project and the research and development work conducted within will contribute to reducing the carbon footprint of water services in the Northern Periphery. The solutions and results can be replicated in other regions and countries as well. The project will provide the benefits of increased renewable energy generation, reduced energy costs for the water sector, enterprise and job creation for the local community, renewable energy for the local community and, finally, increased prosperity of local community. The project pays particular

attention to analysing the social impacts of renewable energy investments and, in order to maximize benefits, will promote re-investment in social projects. The WARES project is a strategic NPP project, which also means that the results are policy relevant and will contribute to improving renewable energy policy.

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References
Citizens Information (2012) Water supply. Pubic Servie Information service in Ireand. URL: http://www.citizensinformation.ie/en/environment/water_services/water_supply.html

Hukka JJ, Katko T and Pietilä P (2007) Public-Private Partnership in Finnish Water Services. s.l. : CESifo DICE, 2007

Liu F, Ouedraogo A, Manghee S, and Danilenko A (2012) A Primer on Energy Efficiency for Municipal Water and Wastewater Utilities. Energy Sector Management Assistance programme (ESMAP), Technical Report 002/12. The International Bank for Reconstruction and Development, The World Band Group. Available online at: http://water.worldbank.org/sites/water.worldbank.org/files/publication/ESMAP-EECI-WWU.pdf.

Mikkonen L. The utilization of renewable energy potential in water utilties in Northern Finland. Diploma work. Manuscript.

Pietilä P, Hukka JJ, Katko TS and Seppälä O (2007) Water services in Finland: Competition for non-core operations - not for monopolies. Tampere University of Technology. Prepared for the UNRISD project on Commercialization, Privatization and Universal Access to Water. UNRISD. Available at: http://URN.fi/URN:NBN:fi:tty-2011041513224

Plappaly AK and Lienhard VJH (2012) Energy requirements for water production, treatment, end use, reclamation, and disposal. **Renewable and Sustainable Energy Reviews** 16(2012): 4818-4848

Rio Carrio AM and Frei C (2009) Water: A key resource in energy production. **Energy Policy**. 37(2009): 4303-4312.

Salmond A (2010) Statement of Scotland's First Minister to the Scottish Parliament. Quoted by Energy Efficiency news at: http://www.energyefficiencynews.com/articles/i/3348/

Scottish Water (2013) Energy. http://www.scottishwater.co.uk/investment-and-communities/investment-programme/energy

Webber ME (2008) Catch-22: Water vs. Energy. **Scientific American Earth 3.0** 18(4): 34-41.

World Resources Institute. 2006. EarthTrends - Freshwater indices: Water Poverty Index. http://earthtrends.wri.org/searchable_db/index.php?