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# Micro-hydro power in the UK: The role of communities in an emerging energy resource

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## HIGHLIGHTS

- Analysis of micro-hydro schemes in the UK demonstrates a recent rapid expansion.
- We propose a third dimension to renewable energy developments: the environmental dimension.
- The environmental dimension of micro-hydro determines how resources are realised.
- Environmental features underpin the controversy which can emerge around schemes.
- The ownership of micro-hydro schemes is highly 'community based'.

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## ABSTRACT

Research around micro-hydro power is focused on technical aspects with limited understanding of the social organisation and environmental implications. We examine the ways in which micro-hydro is engaged by people and organisations as a means of contributing to the UK's policy ambition for renewable energy. We bring to the fore the way in which expertise is used and contested. A web based review of micro-hydro schemes in the UK was undertaken and a detailed evaluation of two schemes in the North of England was conducted to determine how expertise and contestation figures in community schemes. Results demonstrate a rapid expansion of micro-hydro in the UK. Ownership/control is highly 'community based'. Until now research around micro-hydro has been dominated by technical approaches with schemes defined in terms of hardware. We propose a third dimension to Walker and Cass's (2007) classification of renewable energy developments: the environmental dimension. We suggest this dimension of micro-hydro is critical, both in terms of the extent to which resources can be realised but also the ways in which it might attract controversy, in particular around how expertise is used and valued.



## 1. Introduction

The UK has committed to an ambitious target of generating 15% of its energy from renewables by 2020 (Ward and Inderwildi, 2013). Responding to this target has proven far from straightforward, with significant contestation arising over which might be the most appropriate renewable energy resources to deploy where, as well as concern over the ways in which the benefits and costs of such a transition are being distributed (Walker, 2012; Ward and Inderwildi, 2013). In the midst of this contested debate, one key dimension of the drive towards renewable energy targets has been the increasing interest in 'community' level developments. Often regarded as a means through which to address public concerns about the impact of renewable energy and as a way of recouping benefits to particular places, community-based renewable energy projects have been championed by a range of government and commercial interests over the past decade (Walker et al., 2007; Haggett, 2009; Walker and Devine-Wright, 2008). Such initiatives, and the research that has accompanied them, have tended to focus on wind, wood, and solar energy. In this paper, we turn to a seemingly neglected resource – hydro power – and examine the ways in which 'micro-hydro' is being engaged by governments, private companies and communities as a means of contributing to the UK's policy ambition for renewable energy. In so doing, we provide the first UK survey of the development of micro-hydro schemes and provide new insights into their social and environmental dimensions.

Engaging with the social and environmental dimensions of micro-hydro is particularly important, we suggest, because previously published research on micro-hydro power generation has focused on technological advances in energy production to exploit hydro-power effectively and efficiently (e.g. Singh, 2004) and how

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to assess potential sites where schemes may be located (e.g. Larentis et al., 2010; Cyr et al., 2011; Punys et al., 2011). Yet whilst the potential of micro-hydro has been noted (Paish, 2002; Roberts, 2008), there has been little consideration of the challenges and consequences of developing this energy resource. Micro-hydro is often portrayed as a relatively benign technology, particularly in relation to on-shore wind, which has received significant levels of political and academic attention given the controversies which have accompanied the development of different projects. Moving beyond the technical assessment that has dominated studies of micro-hydro to date, to consider in addition its social organisation and environmental implications, we find that the development of micro-hydro resources is highly complex and controversial.

The purpose of this paper is to explore the role of the community in developing micro-hydro schemes in the UK. Through case-studies of two projects in the North of England, we then examine the ways in which issues around community led schemes have unfolded, and their implications for future research in this field. In particular we focus on the role of expertise and how this is contested in community initiatives around micro-hydro. In Section 2 we evaluate the environmental and social dimensions of micro-hydro as an energy resource. Section 3 outlines the approach taken in this study and introduces the case studies: micro-hydro schemes at Settle and at Ruswarp, both in the North of England. Section 4 presents an assessment of the development of micro-hydro in the UK focusing on the range and number of schemes in the UK. The findings of the assessment of the two case studies are then presented in Section 5. In this section we draw out themes around the software, hardware and environmental concerns of developing micro-hydro in the UK. We conclude by highlighting key themes emerging from the analysis and outline implications for future research.

## 2. Micro-hydro as an energy resource: conceptualising the technical, environmental and social dimensions

Micro-hydro is a well-established technology that has been implemented for rural electrification throughout the world (Nouni et al., 2009; North, 2010). As Walker and Cass (2007: 459) argue, however, micro-hydro technologies should be viewed "not simply as a series of engineered artefacts performing energy conversions, but as configurations of the social and technical which have emerged contingently in particular contexts and which mirror wider social, economic and technical relations and processes." To this end, Walker and Cass (2007: 459) characterise the "meshing of the technological and the social within evolving infrastructures of renewable energy provision" as a matter of the "'hardware' of engineered artefacts as being utilised within and through the co-dependent and co-evolving 'software' of its social organisation." Operating at different scales and sites, and comprising multiple relations between technical 'hardware' and forms of social organisation 'software' micro-hydro can be readily characterised in these terms. This framework provides a starting point for considering how, why and with what implications micro-hydro is being developed as an energy resource. However, such an approach neglects the important *environmental* dimension of micro-hydro (and other renewable energy socio-technical systems). Rather than consider renewable energy resources only in sociotechnical terms, attending to their important environmental dimensions we suggest that there is a need to regard them as simultaneously sociotechnical and socioecological systems (Monstadt, 2009). Below, we consider the hardware, software, and environmental issues of micro-hydro.

### 2.1. Technological hardware: physical capacities and system design

The definition of micro-hydro varies between countries to include systems with a capacity of a few megawatts up to approximately 100 kW capacity (Table 1). The limit tends to be set to 100 kW because this is considered to be the maximum size for most stand-alone hydro systems not connected to the grid, and suitable for "run-of-the-river" installations. The term 'Pico-hydro' is also used as a term to denote size of scheme, with a maximum power output of 5 kW (Haidar et al., 2012).

**Table 1**
Different definitions used for hydro power.

| Country | Micro (kW) | Mini (kW) | Small (MW) | Source |
|---|---|---|---|---|
| UK | | | < 5 | Paish (2002) |
| United States | < 100 | 100–1000 | 1–30 | Moreire and Poole (1993) |
| China | – | < 500 | 0.5–25 | Moreire and Poole (1993) |
| USSR | < 100 | – | 0.1–30 | Moreire and Poole (1993) |
| France | 5–5000 | – | – | Moreire and Poole (1993) |
| India | < 100 | 101–1000 | 1–15 | Moreire and Poole (1993) |
| Brazil | < 100 | 100–1000 | 1–30 | Moreire and Poole (1993) |
| Norway | < 100 | 100–1000 | 1–10 | Moreire and Poole (1993) |

By examining the hydraulic head and river flow at existing in-channel structures in rivers 13,000 sites have been deemed practical and technically feasible for the development of micro-hydro power in Scotland and 26,000 potential sites have been identified in England and Wales (EA, 2010). Construction details of a micro-hydro plant are site-specific, but the common elements of all micro-hydroelectric schemes include a supply of water to provide a minimal flow of water to be available year-round; a settling pond to remove sediment from the flow so as not to damage the turbine; an intake structure to screen out floating debris and fish; a pipe or canal to route water to the turbine; a controlling valve to regulate the flow and the speed of the turbine; a turbine to convert the flow and pressure of the water to mechanical energy; and finally a tailrace to transfer the water emerging from the turbine to the natural watercourse (Khennas and Barnett, 2000; Paish, 2002). Existing research has explored ideal conditions for micro-hydro development and how to maximise investment returns (Punys et al., 2011; Catalao et al., 2012).

Most schemes in the UK are designed as 'run-of-the-river' systems. This means they do not require a dam or storage facility to be constructed, but simply divert water from the stream or river (with relevant permission), channel it in to a valley and 'drop' it in to a turbine via a pipeline. There are two main types of design; low-head schemes where in-stream structures are used and high-head schemes where water is diverted using pressurised pipes over longer distances to take advantage of changes in elevation. The variety of different micro-hydro installations that can be found in the UK is explained by characteristics of the local water resource, the availability of local structures/construction materials, and the technical capacity of installers (Catalao et al., 2012; Susanto and Stamp, 2012). Such analyses start to demonstrate the inherent geographical variation of micro-hydro, and point to the ways in which its success and failure are not simply technically determined but also relate to the social and environmental context in which it is deployed.

### 2.2. Multiple softwares: expertise and community engagement in the system of provision

Rather than being simply a technological artefact, the development of micro-hydro has enabled different forms of social organisation and engagement than in the conventional provision of energy through large scale forms of energy production. In this sense, the development of micro-hydro involves establishing new systems of provision, dependent on new forms of interaction between the providers and users of energy in which intermediaries emerge and new patterns of co-production can come to the

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