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Original research article

# Demystification and localization in the adoption of micro-hydro technology: Insights from India

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ABSTRACT

The phrase 'small is beautiful' holds true for the micro-hydro plants discussed in this article. Micro-hydro plants can convert the energy of falling water into electricity. In India, access to electricity cannot be taken for granted, especially in rural areas, which do not yet have grid extension or where it is too costly or infeasible. In these cases, micro-hydro plants are a welcome solution. Here I discuss the efforts of two non-governmental organizations, a private company, and a government agency, to facilitate micro-hydro projects in India, thereby increasing the socio-economic empowerment of rural inhabitants without electricity access. Based on extensive ethnographic data and constructivist conceptualizations of scale and consequences I find that these projects can indeed be described as "beautiful" technology interventions. In line with the common discourse on "small is beautiful," the projects emphasize community engagement, control, and locality. Yet, importantly, they are "beautiful" in diverse ways. The actors set different priorities when implementing their small-scale technology interventions. Highlighting these priorities is important because they can empower people to acquire different roles, ranging from engaged consumers to prosumers. Instead of solely concentrating on the (small) scale of a technology I plead to consider the significance of implementing these interventions.



## 1. Introduction

This article analyses the efforts of various actors addressing energy poverty in India's countryside by facilitating micro-hydro plants, which convert the power of falling water into electricity. But instead of detailing the main challenges, opportunities, enabling or disabling implementation factors, and quantitative impact, as many articles have (rightly) done, I unfold a different argument [1–3]. The actors presented here are all seen as experts in their field, enabling projects that are widely considered best practice examples. However, it struck me that the actors all had different priorities when implementing small-scale interventions. There was not just one way to put the small scale into practice. This led me to use these different micro-hydro cases to explore issues of (small) scale and their consequences.

Many scholars of technology and development sympathize with the statement "small is beautiful". Typically, a "small is beautiful" technology intervention emphasizes community engagement, control and locality–aspects that gel well with the development practice or even "development orthodoxy" [4], which aims to engage local people and enable control.

My argument generally supports the "small is beautiful" concept, yet emphasizes that critical discussions should not stop once the choice for small-scale has been made. We should not take the (small) scale of a technology and its assumed characteristics at face value. Small-scale is not per se beautiful just because of its small size. In addition, small scale is beautiful in more ways than one: just as there are different ways of implementing the small scale, there are different consequences of implementation.

My argument pleads for an analytical shift away from solely concentrating on the (small) scale of a technology towards the significance of different approaches when implementing these technology interventions. A focus on implementation helps to avoid a type of thinking that relates the scale of a technology to certain consequences or outcomes in a linear way. Moreover, the numerous approaches to implementing small-scale enable different consequences and outcomes. A linear understanding, relating scale to certain outcomes, does not account for this.

The aim of this article is thus two-fold: Empirically, it explores differing priorities and likely consequences of micro-hydro project implementation in India. Theoretically, it aims to explore more nuanced conceptualizations of scale and consequences, whereby implementation (rather than scale) issues seem a fruitful start-

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ing point. Consequently, the article will yield worthwhile insights for developing and establishing micro-hydro projects in India and other parts of the world; it provides empirically grounded insights into implementation approaches and their likely outcomes; furthermore, it contributes to a more sophisticated interpretation of the "small is beautiful" debate, critically unpacking both aspects of small (scale) and beautiful (consequences).

The article is organized as follows: After Section 2 elaborates on the theoretical embedding and contribution, Section 3 introduces the article's focus, research question and methods. The subsequent empirical part (Section 4) details the case study, its context, relevant policies and actors, followed by a rich description of the empirical findings in Section 5. The article ends with a discussion and conclusions featured in Section 6.

## 2. Theoretical embedding

For a more nuanced understanding of scale and consequences, especially in the context of sustainable energy technologies for development, two elaborations are required: First, a brief background on "small is beautiful" and appropriate technology discussions; and second, a brief elaboration on the assumed linear relationship between scale and outcomes – and the usefulness of constructivist accounts of scale for a more nuanced theorization of this.

### 2.1. "Small is beautiful" and appropriate technology discussions

"Small is beautiful" is an often-heard phrase, often forming the ideological framework for developing sustainable energy technologies. E.F. Schumacher coined this phrase in his book "Small is Beautiful: A Study of Economics as if People Mattered" [5] and evoked a debate centered around the need for small, local resource-based, i.e. "appropriate" technologies. Schumacher's book was published at a time when the neo-classical framework and conceptualizations of innovation and technological change were increasingly questioned, recognizing "that much of global technological progress was [mainly] directed to meet the needs of the global rich, and was best suited to operation in high-income environments [only]" [6]. Besides, societal trends such as technocratization and unchecked expert influence, the growing military-industrial complex, the energy crisis and ecological destruction were increasingly perceived as worrisome by Western industrialized societies of the late 1960s and 70s [7].

This helped set the agenda for a debate on "appropriate technology" which describes "the use of technology and materials that are environmentally, economically, culturally, and socially suitable to the location in which they are implemented and conducted" [8]. For example, appropriate technology resonated well with the alternative energy movement, rooted in the Western counterculture of the 1960s and 1970s [9]. The conventional energy system was rejected due to its centralized, large-scale, elitist, profit-oriented, militaristic, environment-polluting, and antisocial characteristics. Instead, the proposed alternative was based on renewable energy technologies. These would enable small-scale, locally managed, decentralized, pollution-free, and democratic alternatives to the conventional energy system [9]. An influential thinker and practitioner for the appropriate technology movement, especially in the US, was Amory Lovins, with his work on soft energy paths and vision of alternative energy strategies [10,11]. Nevertheless, the energy movements in the West were geared to progressing appropriate technology for developing countries, and, in the spirit of the 60s and 70s, aimed to change the world through more "appropriate energy provision" [12,13].

Although perceived as "alternative technology" in developed nations, appropriate technology in developing countries was labeled "intermediate technology" [14]. Schumacher suggested this term to capture the notion of a technology that uses methods "which are compatible with local economies, and intermediate in costs and their sophistication, being placed between simple and complex technologies" [14]. While discussed under two labels, in practice, neither concept differed fundamentally [12]. To advance, implement and institutionalize his ideas, Schumacher and like-minded colleagues founded the Intermediate Technology Development Group (ITDG) in 1966, which has operated under the name Practical Action since 2005 [15]. ITDG/Practical Action's main focus is small-scale innovation in developing countries.

Especially in India, "appropriate technology" thinking corresponded well with existing schools of thought, especially the Gandhian tradition of decentralization and self-rule. Believing that "if villages perish, India perishes, too" Gandhi promoted a self-sufficient village-based moral economy, making the Charka (the spinning wheel) a symbol for these ideals. Besides Gandhi's philosophy, also the work of JC Kumarappa foreshadowed the appropriate technology discourse that would later rise in the West. Building on Gandhi's ideas, Kumarappa developed an economic school of thought that "would ensure permanence and harmony with nature by using smaller and softer technologies as opposed to economic principles and values that compelled the West into a consumerist and imperialistic technology culture" [14]. In the field of rural electrification, Indian scholars have adopted the idea of appropriate technologies, stressing that these should: satisfy basic human needs by starting from the needs of the poorest; ensure social participation and control; and be environmentally sound [3].

### 2.2. Scale, outcomes and constructivist accounts of scale

Since around 2010, "small is beautiful" and appropriate technology thinking seem to have merged with discussions on green, sustainable technologies and grassroots-innovations [14]. Especially in the field of energy, debates focus on small-scale, decentralized energy solutions, in which the users' roles are increasingly pivotal [16]. Such technologies seem to be endowed with a seal of approval that implicitly renders further critical investigation of their socio-technical performance unnecessary. For example, we generally assume small-scale energy technologies are uncontested in light of their "benign" small-scale features, whereas empirical studies on the ground suggest more nuanced realities [17,18].

For development practice and policy, studies that relate the scale of a technology to a certain development outcome are important and helpful, as they can give us insights about the likely effects of certain development interventions (and investments). The flipside of such accounts is, however, that they reinforce a linear, one-dimensional understanding whereby one scale of a technology intervention is attributed to (only) one likely development outcome. For example, in their article "Electrification and rural development: issues of scale in distributed generation" Baldwin et al. [19] provide an insightful overview of the causal effects of different scales of electricity access on development outcomes. Generally, they find a correlation between increasing electricity access and long-term development outcomes. They stress that electricity is not the only factor fostering socio-economic development, and more research is needed on assessing long-term outcomes. Despite the importance of their findings, the authors' notion of scale demonstrates an understanding focusing on a linear input-output relationship, in which different scales of distributed generation "reflect [. . .] different needs, inputs, and opportunities" [19].

Such linear accounts often go hand in hand with a concept of scale in absolute terms as an ontologically "given" category. In