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A promising niche: waste to energy project in the Indian dairy sector

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ABSTRACT

The dairy sector is known to have significant local and global environmental impacts; but it also has proven renewable-energy generation potential. This paper analyzes a specific niche experiment in the Indian dairy industry, wherein cattle waste management is carried out by a multitude of stakeholders. These include the waste collectors, local technology adopters, research institutions, multilateral donor agencies, the Indian government, technology suppliers and operation and maintenance teams who have managed an uninterrupted 1 MWe energy production over the past 4 years. This analysis uses the sociotechnical regime framework to study the interaction of social, technological, economic and policy-related aspects relevant to the niche experiment. The analysis shows a potential to contribute to the development of two complementing regimes—one related to cooperative waste management and the other related to grid-connected renewable-energy-based electricity generation. Key factors for a successful development are not only a long-term financing protection through government subsidies to cover higher capital cost and a preferential tariff related to energy throughput, but also the adaptation of technology, the embedding in the local cooperative structure and the removal of regulatory barriers.

1. Introduction

Livestock, the world-over, accounts for 18% of total of global greenhouse gas (GHG) emissions. Therefore, the global production of meat and dairy products has a substantial the environmental impact (FAO, 2006). The dairy sector in India also is an important source of livelihood for the rural population given the conventional agrarian economy. India's milk production has increased five-fold from 21.2 mMT in 1968–1969 to almost 100 mMT in 2006–2007 (FAO, 2006). The organized sector accounts for 13% of milk production while the rest comes from the marginal land holding farmers, which has been aggregated into a cooperative ownership and management model. The livestock sector contributes to around 6.8% of Indian gross domestic product (GDP) and employs 8% of the labor force (FAO, 2006). As such, the dairy industry sector and its future growth potential hold critical value for the Indian economy.

With growing urbanization, the application of cattle waste for cooking is on the decline. Hence, the treatment and management of cattle waste is becoming a matter of concern. Typically, untreated cattle waste (manure) adds to the local environmental pollution (mainly wastewater and solid waste) as well as global GHG emissions (methane). Abetting the local wastewater pollution is a cost-intensive proposition when treated in smaller plants. Also, decentralized wastewater treatment plants, though reducing the burden on the large facilities, do not receive government support, making their management a challenge. However, centralized large capacity treatment schemes not only need lower investments, but also, when combined with energy recovery, potentially offer two

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main benefits—(a) providing a renewable source of energy from methane capture, thus resulting in more reliable, low-carbon energy infrastructure and (b) abetting global warming impact of an otherwise untreated cattle waste remaining in the environment.

While untreated manure is a waste stream, the cattle waste can also serve as a source of energy, either through direct combustion or by conversion into biogas (methane). Distributed generation opportunities using cattle waste have been tried out over the past several years. Direct combustion of cattle dung as a fuel has serious implications for indoor air quality, and the GHG impacts have been estimated at 377 g CO_2/MJ. On the other hand, the biogas produced through a controlled anaerobic digestion process has different environmental implications, and the GHG impact for this route has been reported as 2 g CO_2/MJ of biogas (Smith, 2002).

Recognizing the huge energy generation potential from cattle waste, the Ministry of New and Renewable Energy (MNRE) of the Government of India (GOI) launched a program titled Khadi & Village Industries Cooperative. The program targeted small size biogas plants through government subsidy resulting in an uptake of over 200,000 small units (MNRE, 2007). While this program still continues with varying levels of success, GOI, through a multilateral donor agency, the United Nations Development Program (UNDP) and with financial support from the Global Environmental Facility (GEF) launched a waste to energy (WTE) initiative targeting high-rate anaerobic digestion in several large industrial sectors in early 2000. The GOI/UNDP initiative resulted in 16 anaerobic digestion plants spread across industrial sectors including pulp and paper, municipal solid waste and food/fruits.

One such intervention in the agro-industrial sector is the waste to energy project at Haebowal dairy complex in Ludhiana (Deodhar and Van Den Akker, 2005). This paper analyzes the experiment carried out at this complex in Ludhiana, a medium-sized city in Punjab, India. The experiment captures relevant interaction between the stakeholders. The project was set up as a protected experiment with funding support from multilateral donors; it also benefited from specific local cooperatives and government actions. The experiment received an international accolade of the ''Best Green Power Plant in Asia'' at the Asian Power Awards 2007.

The dairy sector in India is organized around village and district level cooperatives. This mode of operation has evolved over the past several decades, and it is now the dominant organizational form with regard to the collection, transportation, processing and marketing of milk (Ramdas et al., 1998). While the cooperative structure supports the product quality and distribution, energy and waste management requirements in the milk-processing value chain have not been successfully integrated into the structure so far. Responsibility of providing energy/electricity in the milk-processing and other village-level activities remains in the domain of the regulated electricity market in India. Waste management is governed by local disposal norms that are seldom adhered to.

The niche experiment described here has been analyzed within the multi-level framework on technological transitions, proposed by Geels (2002). A technological transition is a transformation in the way a societal function is fulfilled; it is a process of sociotechnical change as it involves not only technical changes but also changes in user practices, regulations, social networks, infrastructure and culture. Central in the multi-level perspective, is the concept of a sociotechnical regime, the semi-coherent set of rules carried by different social groups. These groups form a multi-actor network consisting of a financial network, suppliers, user groups, societal groups, a producer network, public authorities and a research network (see Fig. 1). These different groups represent the relevant dimensions of the experiment.

By providing orientation and co-ordination, the regime accounts for stability. In the multi-level framework, radical innovations are generated in niches, spaces where radical novelties are (partially) protected against normal selection pressures in the prevalent regime (Geels, 2002). The experiment described in this paper is one of the experiments within the biogas niche. We seek answers to the questions in regard to the experiment such as who implemented the experiment; how was it implemented, and what has been the role of electricity, environmental and other sectoral policies relevant to its implementation. In this analysis we will pay attention to the social network supporting the experiment, the expectations of the stakeholders and the lessons learned. In the system innovation literature the development of experiments and niches usually is analyzed in relation to one dominant regime. However, the experiment described in this paper involves not one, but two regimes—one related to waste management in with links to the existing cooperative structure in the dairy and the other related to electricity generation. We refer to current waste management in the dairy sector and grid-connected electricity generation as regimes, because they represent the rule and dominant practices the new technology has to deal with.

The next section describes the niche experiment in detail. Aspects of the experiment such as the technology, the stakeholders involved, the underlying economics and the relevant policy context are described here. This is followed by the analysis of the relation of the experiment to the two different regimes to understand the implications for scaling-up, primarily focusing on barriers and opportunities for replication of the experiment. The concluding section assesses the importance of the sociotechnical experiment and its relevance to understanding sociotechnical experiments of a similar kind.

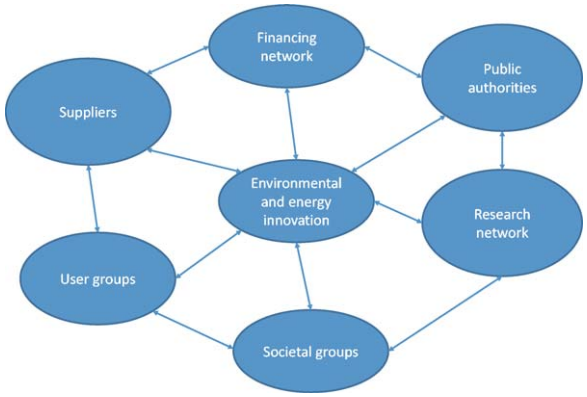

Fig. 1 – The multi-actor network involved in the sociotechnical regime of an environmental innovation.