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Challenges in mobilising financial resources for renewable energy—The cases of biomass gasification and offshore wind power

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ABSTRACT

To mitigate climate change, substantial investments are needed in emerging renewable energy technologies. However, developers of the technologies – both capital goods suppliers and utilities – lack the capital to make the required investments, and other investors hesitate because of the high risks and low returns involved. This article analyses the challenges of financing the development and large-scale diffusion of biomass gasification and offshore wind power in Europe. Biomass gasification needs to take the step from public to private finance and find investors willing to make a sizable investment with high risk. Mobilising the amount of capital needed to bring about large-scale diffusion of offshore wind power will require innovative financial solutions. To overcome these challenges, changes are needed in both the financial sector and in firms in the energy sector. Amongst other suggestions this article points to bonds specially designed for renewable energy as one way to increase investment.

1. Introduction

Transformation of the energy system, involving large-scale diffusion of renewable energy technologies, will require enormous investments. As an initial part of this transformation, the European Union (EU) has set targets for 2020, for example of a 20% share of renewable energy (European Commission, 2009). For the same period, the European Commission (2010) has estimated that energy-related investments in the order of €1 trillion are needed.[1] Large investments in renewable energy technologies will continue to be needed for a long time thereafter. For example, the International Energy Agency (IEA) estimates the investment required in Europe to almost €2 trillion for the period 2011–2035 (IEA, 2011).[2] Although huge investments are needed, it appears that we cannot afford to fail: as the European Commission (2010 p. 2) puts it, *"The price of failure is too high"*.

To reach the target for 2020, the rate of investment in renewable energy technologies must be increased. Although the flow of investment into renewable energy in Europe increased by on average 27% annually from 2004 to 2011 (Frankfurt School of Finance and Management, 2012), until 2020 the annual funding gap is estimated at €25–50 billion (De Jager et al.,

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[1] This refers to investment to replace out-dated capacity, modernise and adapt infrastructures and cater for increasing demand for low-carbon energy.

[2] This is an elaboration of the IEA's New Policy Scenarios. The scenario includes investments in renewable energy capacity as well as transmission and distribution infrastructure. In this scenario Europe is defined as the OECD countries in Europe. De Jager et. al. (2011) indicate that total investment of €700 billion is needed in energy supply capacity alone to reach the EU 2020 targets.

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2011; Jacobsson and Jacobsson, 2012).[3] One reason for this is that many investors hesitate to invest since renewable energy technologies are often linked to high risks and low return, while utilities, that are often better suited to assess and handle the risks concerned, do not have the capacity to provide the financial capital needed for large-scale diffusion of renewable energy technologies.

This article focuses on two technologies, biomass gasification and offshore wind power, that can contribute significantly to the targets for 2020 in the short term and climate change mitigation in the long term.[4] If biomass gasification were to contribute to the EU biofuel market in 2030 at a production level equal to 10% of total consumption in 2008 (i.e., 30 Mtoe), it would require investment of €60–120 billion (Hellsmark and Jacobsson, 2012). For offshore wind, the member states' target for 2020 is an installed capacity of 44 GW (Beurskens et al., 2011), requiring investment of €130–140 billion (KPMG, 2010; Rabobank 2011).

The aim of this article is to develop an understanding of the challenges in mobilising the financial resources needed for large-scale diffusion of biomass gasification and offshore wind power in Europe and to suggest how these can be overcome. The conceptual point of departure is the technological innovation system (TIS) framework (Hekkert et al., 2007; Bergek et al., 2008a; Jacobsson and Bergek, 2011). In this framework, seven functions are analysed to understand innovation system dynamics. The functions are interdependent and changes in one function may, therefore, lead to changes in other functions. This type of analysis has successfully been used to study the formative phase of renewable energy technologies (e.g., Jacobsson and Bergek, 2004; Meijer, 2008; Suurs et al., 2010). Lately, the focus has shifted to the growth phase. This article focuses on a key function in this phase, mobilisation of financial resources. Limiting the analysis to one function allows an in-depth analysis needed to understand what structures in the TIS and its context that weaken the function.

The next section outlines the conceptual framework and Section 3 describes the method. Section 4 analyses the mobilisation of financial resources for the case technologies and Section 5 compares these. Section 6 provides suggestions on how to increase mobilisation of financial resources to these technologies and Section 7 contains a concluding discussion.

2. Conceptual framework

The TIS approach is the point of departure for the conceptual framework. It was developed to analyse emerging technologies in order to identify mechanisms that are either blocking or driving the development and diffusion and suggest how policy could intervene (Carlsson et al., 2010). In that approach, it is recognised that the development and diffusion of a novel technology is a complex process plagued by uncertainty (Meijer and Hekkert, 2007). The initial formative phase of a TIS can last for several decades and includes R&D, demonstration and early commercialisation (Wilson, 2012). The formative phase may be followed by a growth phase, during which the technology starts to be diffused on a larger scale and, eventually, a saturation phase.[5] A core feature of the TIS approach is that it identifies a set of functions that need to gain strength for successful development and diffusion of a technology, see Table 1.[6]

Table 1
Functions in a TIS.

Function. . .	is the process of strengthening:
Knowledge development and diffusion...	the breadth and depth of the knowledge base and how that knowledge is developed, diffused and combined in the system
Entrepreneurial experimentation.	the testing of new technologies, applications and markets whereby new opportunities are created and a learning process is unfolded
Influence on the direction of search...	the incentives and/or pressures for organisations to enter the technological field. These may come in the form of visions, expectations of growth potential, regulation, articulation of demand from leading customers, crises in current business, etc.
Resource mobilization...	the extent to which actors within the TIS is able to mobilize human and financial capital as well as complementary assets such as network infrastructure
Market formation...	the factors driving market formation. These include the articulation of demand from customers, institutional change, changes in price/performance. Market formation often runs through various stages, i.e., "nursing" or niche markets, e.g., in the form of demonstration projects, bridging markets and eventually mass markets
Legitimation...	the social acceptance and compliance with relevant institutions. Legitimacy is not given but is formed through conscious actions by organisations and individuals
Development of positive externalities...	the collective dimension of the innovation and diffusion process, i.e., how investments by one firm may benefit other firms 'free of charge'. It also indicates the dynamics of the system since externalities magnify the strength of the other functions

Source: Jacobsson and Bergek (2011).

[3] The funding gap of €50 billion per year is an elaboration of Jacobsson and Jacobsson (2012) total funding gap of €500 billion until 2020.
[4] Through gasification, biomass is processed into energy-rich gas that can be used for different purposes, e.g., biofuels. Offshore wind power is the operation of wind turbines at sea, which have many different characteristics to operation of turbines onshore.
[5] There is no guarantee that a technology will be widely used just because it has materialised, and a TIS has started to take form (Grübler, 1998).
[6] A functional analysis of a TIS can be done in which performance of all functions is assessed. See Hellsmark (2010) and Jacobsson and Karltorp (2013), respectively, for analyses of the case technologies.

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