Renewable and Sustainable Energy Reviews 49 (2015) 267–277

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Balancing demand-pull and supply-push measures to support renewable electricity in Europe

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ARTICLE INFO

Article history:
Received 22 December 2014
Received in revised form
26 February 2015
Accepted 23 April 2015
Available online 14 May 2015

Keywords:
Renewable energy
Research and development
Deployment subsidies
Push Pull Framework

ABSTRACT

Increasing the share of renewable energy is deemed essential to reduce the carbon intensity of the current electricity mix. The promotion of renewable energy technologies should thus be as effective and efficient as possible. Therefore, support schemes should explicitly consider the balance between demand-pull (e.g. production subsidies) and supply-push efforts (public RD&D investments). In this paper we estimate the deployment costs for renewable generation technologies between 2005 and 2030 in the EU-27. Then, we relate our findings to public RD&D expenditures (2005–2010) on these technologies. Based on several "lags" between RD&D spending and market impact, we obtained cumulative pull/push ratios between 100 and 190 for wind technologies and between 80 and 210 for PV. For solid biomass, pull/push ratios are lower, in a range of 60–120. The imbalance for biogas is much larger; the cumulative pull/push ratio for biogas is about 700 in the '5 year lag' case and about 1200 in the other cases (10 yr. lag or more).

Although the debate on optimal RD&D efforts is not conclusive and very sector-specific, it is relevant to compare our findings to average pull/push ratios of about 20 in the engineering sector. Overall, we can safely conclude that European governments should critically evaluate current renewables subsidy schemes, and increase public RD&D investments to support next waves of renewable energy technologies.

Contents

1. Introduction

Renewable energy technologies can play a crucial role in the transition towards a low-carbon economy. However, policy frameworks to support the energy transition need to address at least two well-known market failures. Firstly, without a direct price on

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http://dx.doi.org/10.1016/j.rser.2015.04.078
1364-0321/

negative externalities such as CO_2 emissions, economic agents lack incentives to invest in CO_2 abatement. Secondly, private companies tend to underinvest in basic energy R&D because of spill-over effects [1] and the problematic balance between risks and benefits of ambitious innovation projects [2]. This lack of *privately* funded energy R&D is problematic from a welfare perspective since marginal *social* rates of return of R&D are typically in the range of 30–50%, which is considerably higher than *private* marginal rates of return [3].

To overcome the abovementioned market failures most developed economies make use of a variety of policy instruments such as deployment subsidies, energy portfolio standards and public expenditures on renewable R&D [4]. However, there is a large variety in the effectiveness and efficiency of these renewable energy support policies [5]. Even within the EU, a wide variety of support measures can be found [6]. Studying the impact of these policy interventions can help us to improve renewable support policies in the future. However, most studies on renewable energy policies focus only on the deployment incentives (demand-pull) and do not take into account the historical research and demonstration efforts (supply-push).

A successful renewable technology policy should be embedded in an innovation framework, based on a synergistic package of supply-push and demand-pull measures. The timing and sequencing of each measure is of crucial importance [7,8]. Massive deployment of inefficient technologies can be very expensive without delivering welfare gains in a cost-effective way. Before a new technology can be launched, basic R&D efforts dominate supply-push policies. Once new technological concepts are ready to be introduced, demonstration projects and niche markets can be triggered by demand-pull measures such as public procurement policies and fiscal incentives (including market-based incentives such as carbon taxes).

The interactions between technology unit costs and supply-push and demand-pull measures are heavily debated in the literature [7,9–13]. Most authors agree that the appropriate combination and sequencing of pull and push measures depends on the stage of development of the technology [14,15].

We like to contribute to the existing body of literature on renewable energy policies by focusing on the push-pull framework and moving beyond the debate on demand-pull policies. In other words, we would like to combine the insights from the literature on technology innovation with the literature on renewable energy policy design by evaluating the balance between demand-pull and supply-push measures in Europe (EU-27). For this purpose we estimate the past, current and future cost evolution of push and pull measures for electricity generation with wind, PV, biomass and biogas technologies. We present pull/push ratios per technology and draw some conclusions on the policy framework to trigger innovative technologies.

2. How to balance supply-push and demand-pull measures?

In the context of renewable energy policy in Europe, the innovation framework with supply-push and demand-pull measures appears to be complete at first glance. The European Commission specifically mentions push and pull measures in recent communications, stating that "The *push* of such measures (R&D), complemented by the *pull* of market deployment such as support schemes or carbon pricing have generated major advances, brought some key technologies (wind and solar power) to maturity and contributed to achieving today's 12% share for renewable energy. This approach should be enhanced." [16]. Assessments of the combination of push and pull measures are still lacking so it remains unclear how to enhance this approach in the most effective way.

We argue that more assessments on past and ongoing policy schemes are needed. Although climate and energy concerns did strongly increase since UNFCCC 1992 and the Kyoto Protocol of 1997, nominal public spending in energy research, development and demonstration (RD&D) in OECD-countries declined from $ 20 billion in 1980 to only $ 8 billion in 1997. Since 1998, government RD&D expenditures started to recover to $ 16,8 billion in 2011 [17]. On the other hand, the share of energy related RD&D in total RD&D has dropped from 11% in 1980 to only 4% in 2011. This lack of RD&D investments is equally (or even more) problematic for renewable energy technologies. In 1980 total renewable RD&D efforts in OECD countries were two times as high as renewable RD&D efforts in 2005 [17]. Renewable energy technologies are always presented as being of crucial importance in climate and energy policy but OECD countries appear to be reluctant to radically increase renewable RD&D budgets. Only recently, renewable energy RD&D budgets have increased (see Fig. 3).

Another observation relates to the increasing attention to the high deployment cost of renewable energy technologies, and the rent seeking behavior of renewable investors. The information asymmetry between investors and policy makers can result in very high profits for these investors because policy makers are generally less informed in these matters [18]. Such high profits have resulted in criticism to the generous subsidizing schemes in countries like Belgium [19], Germany [20], Denmark, Spain and the Czech Republic. The most remarkable illustration of the consequences of this criticism relates to Spain. The Spanish solar subsidy scheme was drastically downsized in 2008; this dramatically impacted the Spanish solar industry.

We argue that the debate on the optimal deployment trajectory for renewables should explicitly consider the balance between deployment incentives and public R and D support. The massive deployment of premature technologies is very expensive (Table 1).

Deployment strategies should be aligned to the evaluation of ambitious R and D programs to minimize the social cost of the energy transition. Since R and D has the potential to significantly reduce technology costs in the longer run, we risk diffusing too expensive and inefficient technologies if R and D efforts remain at current low levels. In Table 1, we present the types of government failures and successes that can result from an (in-) appropriate sequencing of supply-push and demand-pull measures. A strong diffusion of efficient low-carbon technologies requires high R and D spending in the first phase to be followed by attractive demand-pull measures in the second phase.

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3. Purpose and methodology

With this paper, we want to provide some insights in the balance - or imbalance - between supply push measures (public RD and D budgets in the EU-27 from 2005–2010) and demand pull efforts (costs of the deployment of renewable technologies) for biomass, biogas, wind and PV electricity production in Europe. We first estimate demand pull expenditures for the period 2005–2030