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Improving the European Commission's analytical base for designing instrument mixes in the energy sector: Market failures versus system weaknesses

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ABSTRACT

To limit global warming to 1.5–2 °C, EU needs to eliminate emissions of CO_2 equivalents over the next decades, which necessitates that a range of new technologies develop, mature and diffuse on a massive scale. To create conditions for this, effective instrument mixes have to be designed and implemented. However, the choice of such mixes depends on the analytical rationale for policy intervention. The purpose of this paper is, therefore, to scrutinize the analytical base of the EU Commission, contrast it with the work of classical economists and recent innovation scholars, and draw lessons for how effective mixes of policy instruments may be identified. We show that the Commission's focus on market failures, static efficiency and technology neutrality does not cover all possible obstacles and leads it to neglect the centrality of dynamic efficiency and the structural build-up of innovation systems around new technologies.

1. Introduction

At the current rate of CO_2 emission reduction, it would take over 70 years for the European Union (EU) to be free from carbon emissions. In order to meet the goal of the Paris agreement, EU policy makers need to make sure that major transformations take place over the next decades, or EU member states will either continue to burden next generations with costs of climate change or be forced to limit economic growth to one that is consistent with the desired reductions, with consequences for employment and welfare [1].

Realising a full decarbonisation involves large-scale, transformative changes in the energy and transport systems as well as in agriculture and manufacturing of, e.g., steel and cement [2]. In the electricity sector a complete substitution of fossil fuels by 2050 may entail adding about 2400 TWh of new annual renewable electricity generating capacity over a period of roughly 35 years.[1] This would require that the annual increase in renewable supply in the period of 2011–2014, which so far has involved the greatest increase in EU history, not only has to be maintained but actually increased by more than 25% [4].

Large-scale transformations constitute a formidable challenge for policy-makers, who need to design and implement a portfolio of policy instruments that together can handle a wide variety of obstacles to the development and diffusion of the technologies required for transforming many industries in only a few decades. In recent theorizing about innovation and transition policy, it has been emphasized that the choice and calibration of such "instrument mixes" are dependent both on the underlying policy strategy and on the policy processes through which strategies and instrument mixes evolve [5,6]. In addition, it has been acknowledged that instrument mixes have to be compatible with the dominant governance modes of the concerned sector, including what kind of goals policy makers typically set up and what instruments they prefer [6,7]. In the same vein, it has been suggested that the evaluation of policy mixes should include the underlying policy rationale [8]. This is the focus of this paper. The overall argument is that the analytical rationale guiding policy makers, e.g. market failures or systemic weaknesses, has a direct influence on what problems policy makers acknowledge and what instruments they see as appropriate for solving those problems.

The European (EU) Commission explicitly advocates market failures and static cost-effectiveness as guides to the selection of policy instruments to support the development and diffusion of renewable energy technologies, in line with a static equilibrium approach [e.g. 9]. In the following, we will show that there are weaknesses in the Commission's approach, which may lead to ineffective instrument mixes, threatening

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[1] Assuming 1) that electricity demand increases by 0.5% p.a. (630 TWh in total 2050) (which may be a gross underestimation [3]) and 2) that current nuclear power stations are closed down and new nuclear power stations supply 500 TWh by 2050 [cf. 4].

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our ability to meet the goals of the Paris agreement. It is, therefore, important to compare the EU approach with alternative frameworks guiding interventions.

Indeed, technical change and industrial transformation has been subjects of research ever since the classical economists, e.g. Smith [10] and Marshall [11]. Their focus on industrial dynamics leads to an awareness that large-scale transformative change necessitates structural changes in the capital goods industry. Such changes are complex and uncertain in their outcomes, but may lead to learning processes in the value chain and, eventually, large-scale diffusion of technologies that replace incumbent technologies. Building in part on their work, more recent scholars developed innovation system approaches aiming to provide an analytical base for identifying mixes of policy instruments to foster industrial dynamics. Their focus on system weaknesses (instead of market failures) that obstruct dynamics, motivates an analysis of these as an alternative (or complement) to the current EU approach. The purpose of this paper is, therefore, to scrutinize the analytical base of the EU Commission, contrast it with the work of classical economists and recent innovation scholars, and draw lessons for how effective mixes of policy instruments may be identified.

Section 2 introduces the analytical elements used by the EU Commission in its static cost-effectiveness approach. Section 3 discusses three classical economists' understanding of the dynamics of technical change and industrial development and how it relates to the static approach of the Commission. Section 4 proceeds to outline the innovation system dynamics approach, as an alternative framework. This generates a broader instrument mix than the EU Commission's approach, a greater focus on dynamic rather than static efficiency and a stronger emphasis on technology-specific instrument mixes. Section 5 contains an illustrative case study in which the innovation system and market failure approaches are applied to propose (partly different) instrument mixes for offshore wind power in Sweden. Finally, Section 6 draws lessons for policy in the EU and points to a key area for further research.

2. The analytical elements of the EU Commission approach

The EU Commission's approach to renewable energy policy is based mainly on analytical elements from static equilibrium theory, which is concerned with an efficient allocation of resources and related welfare issues. A major characteristic of this perspective is that it ignores the dynamics of technological change and industrial development. The economic system is instead seen to be in a steady state equilibrium, characterized by decreasing returns (rising marginal costs). Firms and other actors are assumed to be perfectly informed about all relevant factors and capable of instantly arriving at an optimal choice [12]. Additionally, there are no uncertainties about the future and prices are set so that all markets are in equilibrium. With some additional assumptions, prices then reflect consumers' marginal valuations and producers' marginal costs [13].

In this approach, government interventions are justified if markets fail to meet these conditions, resulting in an inefficient allocation of resources. This policy rationale is explicitly referred to in the EU Guidelines on state aid for environmental protection and energy 2014–2020 (henceforth "the Guidelines") [14,p. 13]: "Whereas it is generally accepted that competitive markets tend to bring about efficient results in terms of prices, output and use of resources, in the presence of market failures state intervention may improve the efficient functioning of markets." Member states are directed to specify the market failures that motivate a proposed policy intervention. These failures are of various kinds:

- *Positive externalities* imply that an activity (e.g. R & D) by one actor benefits other actors without charge, i.e. the marginal social revenue of an economic activity is higher than marginal private revenue. Since the full value of an activity cannot be appropriated, actors will underinvest compared to the optimal level.
- *Negative externalities* refer to costs that accrue to other actors without these being compensated, i.e. marginal social costs are higher than marginal private costs. Since these costs are not reflected in prices they might lead to overinvestment in activities that benefit individual actors, but are undesirable from a social point of view.
- *Information asymmetries* refer to a situation when the assumption of actors having full (and equal) information does not hold. This makes it difficult for actors to assess the quality of goods and services and observe other actors' knowledge and actions, which results in non-equilibrium prices and inefficient transactions [15].
- *Coordination failures* imply that if there are interdependencies among firms but these do not coordinate their investments, optimal decisions are not taken. For instance, car manufacturers and biofuel firms may have to coordinate their decisions to develop engines and new types of fuel.
- *Increasing returns in the form of economies of scale for individual firms* imply that the marginal unit cost decreases with increasing production volumes. This creates entry barriers and can, therefore, lead to a monopolistic market structure and imperfect competition. Moreover, if increasing returns prevail, marginal cost pricing is unlikely to take place.
- *Capital market failures* may occur due to different propensities to take risks between individual firms and society at large as well as to different private and social discount rates. This leads to underinvestment in technologies for which risks are high and for which the learning process is so long that the time required to break even is beyond the planning horizon of the individual firm whereas it is not beyond the horizon of the state [16].[2]

With regard to appropriate instruments to remedy market failures in the energy sector, the EU Commission's approach is based on two main components: 'technology push' and 'market pull' [18]. The technology push component mainly consists of various types of (financial) support to R & D and innovation, derived from the FP7 and Horizon 2020 programs and administrated through the so-called Strategic Energy Technology (SET) Plan [18].[3] While the underlying rationale of the SET Plan is not explicit, key documents emphasize the general importance of "tackling the barriers that hold back private investment" (e.g. through improving the patenting system) [18] and overcoming the "valley of death" between demonstration and commercialization (e.g. through loans and loan guarantees for first-of-a-kind commercial-scale industrial demonstration projects) [19], which indicates that the focus is on handling positive externalities and capital market failures. Considering that the SET Plan includes technology-specific RD & D agendas, we assume that there is some awareness that these market failures might differ between technologies.

With regard to 'market pull', the EU Commission [14] mainly discusses the negative environmental externalities associated with fossil fuels and puts forward regulation and market-based instruments, in particular the EU ETS and CO_2 taxes, as the most important instruments to remedy this market failure.[4] However, since it presumes that these instruments are not able to fully correct the negative environmental externalities associated with fossil fuels, it allows its member states to complement them with different forms of aids to renewable energy [14]. Such aids can come in the form of investment or operating aids, where the former imply grants to cover part of the investment cost of new plants and the latter production premia (e.g. feed-in premia or green certificates [20]) paid in addition to the wholesale price for electricity to compensate for the higher production costs of renewables.

[2] See Gawell et al. [17] for a more detailed explanation, pointing to underlying reasons for differences between social and private discount rates.

[3] The EU only contributes about 10% of the funding of the SET Plan [2].

[4] It also acknowledges that soft instruments, such as voluntary eco-labels, can play an important role [14].