Policies promoting decarbonization of energy supply under uncertainty: Looking for efficient allocation of carbon neutral "scarce" renewable energies

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Overview

This paper deals with policies aimed at promoting efficient allocation of "scarce" (carbon neutral) renewable sources of energy. To better clarify this topic, it is worth to firstly focus on the title of the paper. "Policies" recalls that markets alone are not able to pursue social welfare maximization mainly (but not only) because of the existence of environmental externalities. "Scarce" means that, although the resource is not exhaustible over time, its available amount is limited year by year in a specific geographical context ("over space" constrained) and/or even the amount financial funds (e.g. public subsidies) finalised to its deployment is limited. "Allocation" means to choose (or to create a related scale of priority of) the different sectors where the use of the "scarce" resource might be supported. "Efficiency" implies that we are looking for the allocation assuring the minimization of social cost of decarbonization (social cost of CO2 abatement). Finally, "under uncertainty" means that efficient allocation is set by accounting for volatility of the most relevant inputs (first of all, energy prices and costs) and by simulating different mechanisms to promote the deployment renewable energies.

This latter point (looking for efficient allocation) requires further considerations as two kinds of interpretations are possible namely "not constrained allocation" and "constrained allocation". The first interpretation is similar to the traditional approach in economic theory to the extent to there is no policy target (in terms of CO2 abatement) to be achieved in each sector separately (marginal costs of abatement will be the driver of allocation in the context of a "neutral" inter-sectorial supporting policy). The only constraint is given by the available amount of resource which, consequently, should be allocated where the abatement cost is the lowest (including no or partial allocation if there is a better alternative of decarbonization). The second interpretation means that efficient allocation is constrained as policymakers decide in advance the target (in terms of CO2 abatement) to be met in each sector and consequently the efficient resource allocation will be driven by how such targets combine with abatement costs.

The paper focuses on the allocation of biomethane production and, in both cases (both the interpretations), the research question is the following: The available amount of "scarce" resource to which sector should it be allocated, when biomethane is not the only way of abating emissions?

Methods

In order to answer this question and given the premises and clarifications above, we proceed by implementing a simulation model based on three assumptions. Firstly, regarding the final uses, the sectors to be analysed are those potentially competing for the consumption of biomethane. In this respect we focus on thermal sector and transport sector. Secondly, on the energy supply side, two kinds of alternative abatement solutions are compared, namely green electrification (based on electric renewable energies) and utilization of biomethane. Finally, for the purposes of this paper, we assume that electric renewable energy is not "scarce" whereas biomethane is so. As a consequence, our attention is focused on the efficient allocation (constrained or not constrained) of biomethane

With regard to thermal sector, we consider either industrial or residential heat consumptions, investigating the case where a medium-large-sized industrial user is located close to a small-medium large sized urban district. This application, constituting the reference scenario (without abatement), allows us to simulate the technical solution based on the operation of a CHP (combined heat and power) plant simultaneously providing heat and power to the industrial customer and heat to the urban area through a district heating grid.

Regarding transport sector, the reference scenario (without abatement) is based on natural gas fired vehicles whose fleet is able to absorb the entire potential of biomethane production. Furthermore, natural gas fired vehicle is one of the conventional option assuring lower CO2 emissions (per km of road transportation).

These two applications (without abatement) have to be compared to the scenarios (with abatement) using renewable energies (electric renewables and biomethane) whose supply is based on the development of "virtual markets". Such markets can be defined as those economic contexts in which a transaction (preferably of a commodity) does not imply a physical direct exchange between producers and purchasers. The latter consume the product independently on its origin and pay producers without necessarily consuming their product. Nevertheless, consumers can "prove" that they are using renewable energy by purchasing the GO (Guarantee of Origin) allocated by the public authority to producers of these resources.

To estimate the abatement cost a specific methodology has been implemented based on the calculation of the "levelized cost" of abatement while uncertainty is internalized by using normal and lognormal distributions (and their combinations) of energy prices and costs, combined with different possible mechanisms to support renewable energies (namely, "pricing" and "quantity" mechanisms or hybrid solutions).

Finally, the analysis carried out in this paper is a social cost-benefit analysis. This means that all the economic variables are corrected (by using specific coefficients) in order to account for possible inefficiencies deriving from market imperfections (e.g. lack of adequate competition). In addition, they are net of inefficient taxation (namely taxes not related to external costs) and net of other inefficient components, except for the subsidies which are considered as the extra-costs due to the renewable production.

Results

The paper points out that: 1) Without specific targets for each sector (first interpretation) only 30%-50% of the biomethane potential production should be subsided and allocated to thermal sector; 2) With separated targets for each sector, the entire potential of biomethane production should be subsided with 70-80% allocation to transport sector and the remaining part to thermal sector.

Conclusions

Given that general policies about decarbonization at national level establish separated target for each sector, the specific provisions promoting biomethane production should share out biomethane supply between thermal and transport sector (and not only allocating this resource to the transport sector as it occurs or occurred in several countries). The results reported above might be a proposal of allocation, possibly implementable through hybrid regulatory mechanisms of supporting based on separated tenders (for transport and thermal sectors).

References

Gullì F., Repetto M., Comparing social costs of energy supply decarbonization in thermal uses: electrification versus green-fuels (biomethane), AIEE symposium, 15 December, 2021, Milan (Italy).