Intermittency and taxes, what efficiency?

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Résumé

lectricity production from fossil fuel is one of the main causes of global warming due to green house gas emissions. With the rise of social awareness and the importance given to the environment at national and European levels, this sector has attracted considerable attention in the debate on climate change mitigation. Indeed, several environmental policy instruments have been put in place aiming to decarbonate electricity production by reducing the share of fossil fuels in the energy mix and substituting it by renewable energy such as wind or solar power.

To reduce greenhouse gas emissions and promote technological development and diffusion of renewable energy, recent policies and proposals employ a broad range of incentives. Some policies create disincentives for pollutants energy sources by taxing their users or by making pollution expensive, such as with tradable emissions permit, tax on carbon, or emissions intensity standard for generation. Alternatively, others try to ensure viable markets for the environmentally desirable technology, such as a generation subsidy for renewable energy or a portfolio (market share) requirement for renewable sources. Effectively, regulators worldwide, do not lack efforts to promote the diffusion and the development of renewable energy. In fact, the introduction of intermittent and non-storable sources of energy in the energy mix, is a new challenge for the operators and regulators of the electricity industry. The intermittent nature of renewable, necessarily imposes complex trade-offs for regulatory objectives, such as resource adequacy (and system reliability) versus reductions in green house gas emissions. Electricity storage can be a solution to reconcile the intermittent supply and stable demand. However, this solution is still expensive and inefficient especially for wind and solar power.

In this paper we are mainly interested in two problems. The first is the efficient mix of intermittent sources (wind, solar) and conventional sources such as fossil fuel (coal, oil, natural gas). The second is to analyze the efficiency of a carbon tax to decentralize the optimal energy mix.

We examine the impact of public policies that aim to decarbonate electricity production by replacing fossil fuel energy by intermittent renewable sources, namely wind or solar power. We consider a model of energy investment and production with two sources of energy: one is clean but intermittent (e.g. wind), whereas the other one is reliablebut polluting (e.g. coal). We show that even a Pigovian tax decreases electricity production while simultaneously increasing investment in wind power, we fail to decentralize the optimal state with this instrument. In fact, we show that the tax rate should vary with cimate conditions which seems unrealistic. Intermittency does not prevent achieving effciency with Pigouvian taxation. So in an other section we determine the tax rate which decentralize the optimal state. Analysis shows that the optimal tax rate which decentralize the optimal state, depends not

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only on the marginal environmental damage but also on intermittent capacity, the availability of these sources and the willingness of consumers to pay for electricity. So the bigger the amount of installed intermittent capacity is, more often these sources are available and more consumers are reactive to price, the lower the tax rate should be.
The paper is organized as follows. Section 2 introduces the model. Section 3 describes the first-best energy mix. Pigovian Tax is analyzed in Section 4.In section 5 we determine an optimal tax which allow to decentralize the optimal energy mix. Finally, section 6, concludes.

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