"An Option Analysis of the European Union Renewable Energy Support Mechanisms" (EEEP-2015-039)

In this article we examined the economic efficiency of incentive mechanisms used to promote Renewable Energy (RE). Reducing the usage of fossil fuels through supporting RE has now become a key objective of energy policies of most countries. Although the EU schemes were effective in promoting investment in RE, the nature and scale of such expenditure has raised concerns about their affordability and economic efficiency. Could the same level of investment and output have been achieved more cheaply? Were the costs to consumers, business and industry fully appreciated? Were the greater system costs effects of relying upon random intermittent energy supply understood? More fundamentally, were the methods used to inform how incentives were designed and subsidies were set, appropriate or should alternative ones been employed? The most common metrics in setting RE support, such as the Levelized Cost of Energy or the Levelized Avoided Cost of Energy, were helpful in theory but difficult to apply in practice: many countries of the EU, including Germany, Italy and Spain, revised the design of their support schemes, adjusting downwards their subsidies and acknowledged that various schemes were overly generous. We hereby addressed the issue of economic efficiency in the setting of incentives and the limitations of existing methods and introduced alternative metrics to (i) quantify the performance enjoyed by investors in making investment in RE and (ii) capture the indirect costs ultimately passed through to consumers, business and society. For the latter, we provided a fresh perspective by relying on financial option theory to quantify the costs faced by conventional dispatchable fossil fuel generators required to accept RE under dispatch priority.

We evaluated the widely used RE support mechanisms of the six largest EU economies excluding the United Kingdom (which has been covered in our previous research) to address the economic efficiency of such support schemes as manifested in returns to investors in RE, as well as the externalities in the form of social costs resulting from their variable output under dispatch priority. We used technical specifications for representative plants, costs, localized operating characteristic such as solar irradiance and historic country electricity price data from 2009 through 2013. To assess the indirect costs of RE we applied financial option theory to quantify the costs of hedging against the exposure faced by conventional fossil fuel generators required to accept variable RE output under dispatch priority. Measuring the indirect costs upon incumbent fossil fuel plants (ultimately passed forward to consumers, business and society) allowed us to make comparisons with the private benefits earned by investors in RE. We also considered how changes in parameters affect the costs faced by incumbent generators in accommodating the random output from wind turbines and solar photo-voltaic installations.

Based upon empirical analysis we reached two sets of observations. Firstly, the financial performance of various renewable technologies across countries (calculated using the return on capital employed (ROCE) approach) was very high at a time when Europe's major utilities were earning less than their cost of capital. Investors in RE earned stellar returns while taking little, if any, risk. Secondly, our research into the indirect costs of variable RE output for conventional generators (using option theory on the grounds that through purchasing options

the cost of random RE output to a purchaser could be neutralised or hedged), showed that hedging against having to accept RE is expensive because the feed-in tariff prices have been set at a large premium to the wholesale price, making the theoretical price of options to hedge the resulting exposure very expensive. Moreover a lot of options are needed as wind turbines can generate at any time of the day, while solar facilities at any time during day-light hours. If a utility were to hedge entirely against the cost of taking RE output in full, it would cost nearly twice as much as what the RE owner-operators received as measured using ROCE. This difference represents the external costs of RE imposed upon utilities (ultimately passed through to consumers and society). By implication, if such costs were shifted back to RE investors, it would have been unlikely for any investment in such forms of green electricity generation to have occurred.

As a Pigouvian means of redressing the social costs of $CO_2$, the above results might be acceptable in whole or in part, but issues around how the burden has been shared remain. Although sensitivities to specific parameters were not run, from the insights of option theory, if electricity markets were to become more volatile through the growing presence of RE, the cost imposed upon incumbent dispatchable generators would increase. Further, with variable costs of operating RE practically zero, the output of RE may depress wholesale prices, increasing the difference to the feed-in tariff, further raising the cost upon incumbent generators. Lastly, we conjectured that, as the presence of RE output in any market grows, the scope for diversification across the greater system will fall imposing yet further costs upon all stakeholders.

Our research led to some general policy observations on EU schemes in support of RE. It appears that the potential for economic inefficiency may have been given secondary consideration to the first priority of encouraging investment in RE to satisfy European targets. Investment in RE gained traction as a form of industrial policy as it was frequently argued that green jobs will be created; yet, the cost imposed upon consumer in reduced purchasing power and upon the international competitiveness of European industry appears to have been ignored. In addition, the indirect costs imposed upon incumbent utilities (and ultimately all stakeholders) in having to accept variable RE output under dispatch priority may not have been fully conceptualized for methodological reasons as already highlighted. Waste and inefficiency were also encouraged through setting RE investment and output targets at national levels rather than pan-European levels. This piecemeal approach was reflected in the myriad of incentive schemes as countries vied for new investment through offering the most favourable returns. Instead of investing for example in PV in countries and regions with the greatest solar irradiance, virtually every country attempted to meet targets without regard for comparative or absolute advantages. Had Brussels been able to rationalise RE investment across the EU, a similar level of investment may have been achieved for a great deal less. The various schemes across the EU were clearly effective in delivering in RE investment and output, but were altogether economically inefficient and wasteful. Returns to investors were overly generous and the greater system costs, ultimately borne by society, appear to have been inadequately conceptualized.