



ANALYSIS

Social choice, uncertainty about external costs and trade-off
between intergenerational environmental impacts:
The emblematic case of gas-based energy
supply decentralization

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Abstract

The performance of the small natural gas-fired power technologies has improved remarkably over the last decade. This has aroused the interest of operators, regulators and legislators in natural gas-fired distributed generation (gas-fired DG), namely, the integrated or stand-alone use of small, modular gas-fired power generation close to the point of consumption as an alternative to large power generation and electricity transport over long distances. Gas-fired DG can provide an important benefit from the environmental point of view. Customer proximity, in fact, greatly increases the potential for combined heat and power generation, involving energy saving and reduced greenhouse gas (GHG) emissions. Unfortunately this kind of decentralized supply also determines higher non-GHG emissions (mainly NO_x, compared to the best available central power technology) which occur in urban areas (high populated) instead of extra-urban areas (where large power plants are generally located). It is therefore difficult to make a reliable evaluation of gas-fired DG environmental benefits without comparing centralized and decentralized models in terms of external costs, that is without an analysis which allows us to compare the extent of global and local–regional impacts in terms of monetary damage. If, on the one hand, this underlines the (potential) importance of the methods adopted to assess the economic value of environmental externalities (even for policy decisions that are binary, i.e. the choice between different energy technologies), on the other, it raises the crucial question of the uncertainty about the economic estimates. This article aims at demonstrating that the uncertainty about external costs, even if large, does not undermine the possibility of verifying whether gas-fired DG is preferable (or not) to centralized supply. The paper compares centralized and decentralized models in terms of the external environmental costs which are calculated by using the results of the available studies in this field (in particular the results of the dissemination process of the so-called ExternE project, one of the most recent and accurate methodologies, and the results of a meta-analysis, with regard to the marginal cost of GHG emissions). The uncertainty about external costs is substantial but not so large that it is not possible to say anything about the environmental ranking of alternative technology solutions involving trade-off between the impacts of

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different pollutants (or between different kinds of impacts). The literature on external costs provides several studies accounting for a large part of uncertainty by means of appropriate statistical and sensitive analysis. By using and elaborating these results, the analysis described in this paper seems to support the conclusion that centralized supply, and especially the completely electric solution (based on the reversible electric heat pump), is still preferable to natural gas-fired CHP distributed generation. This is not a definitive conclusion but, we hope, a useful (scientific based) contribution for policy decisions under the state of the art.

In fact, this result has an interesting policy implication. It suggests unless questioning the current enthusiasm on natural gas-fired CHP distributed generation deployment (e.g. the European Commission is indeed advocating DG as a contribution to GHG emission reduction) and helps us to reflect upon gas-fired DG supporting environmental policies which focus on the reduction of GHG emissions and totally disregard the possible trade-off between the impacts of global and local-regional pollutants. Unless one denies the rationality attributed to making tradeoffs, on the basis of ethical limits of economic valuations. Even in this case, however, cost-benefit analysis seems to be legitimate and a necessary step of the public discourse. We think that the results of this paper are emblematic, from this point of view.

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1. Introduction

The performance of the small natural gas-fired power technologies¹ (reciprocating engine and gas turbine) has improved remarkably over the last decade. This has aroused the interest of operators, regulators and legislators in natural gas-fired distributed generation (gas-fired DG), namely, the integrated or stand-alone use of small, modular gas-fired power generation close to the point of consumption as an alternative to large power generation and electricity transport over long distances (centralized supply).

Gas-fired DG involves (internal) costs higher (on average) than those of centralized supply but can provide important benefits from the environmental point of view.² Customer proximity, in fact, has two important advantages. On the one hand, it greatly increases the potential for combined heat and power generation³ (CHP or cogeneration) and, on the other,

it avoids electricity transmission losses. Therefore, compared to centralized supply, natural gas-fired CHP distributed generation can provide energy saving and, consequently, can involve reduced greenhouse gas (GHG) emissions.

Nevertheless, the realization that gas-fired DG could provide energy saving and lower GHG emissions does not mean that decentralization is undoubtedly preferable to large power generation from the environmental point of view, for two reasons.

First, despite the higher overall energy efficiency, gas-fired DG technologies might involve higher non-GHG emissions (compared to the best available central power technology).

Second, there are considerable differences between centralized and decentralized technologies in terms of the impact of non-GHG emissions (SO_x, NO_x, particulate, etc.). These differences might be due to micro-localization effects. Unlike large power plants (high stack and extra-urban location), gas-fired distributed technologies have low stacks and are generally located in densely populated urban areas. Because of low stacks (emissions at extremely low altitudes), pollutant atmospheric dilution could be lower so that the increases in pollutant concentration close to the plant could be higher than those of a large power plant. Due to location, these high increases in pollutant concentration occur in highly populated areas and seriously damage human health. These combined effects might cause an environmen-

¹ Ackermann et al. (2001) consider distributed generation an electric power source connected directly to the distribution network or on the customer site of the meter. They suggest the following categories: micro DG (1 Watt < 5 kW); small DG (5 kW < 5 MW); medium DG (5 MW < 50 MW); large DG (50 MW < 300 MW). In this article, we refer to conventional small gas-fired technologies. Therefore we do not take into consideration the fuel cells.

² As regards DG benefits and the relationship between technological change and market organization, see Arthur D. Little Inc. (1998) and Pfeifenberger et al. (1997).

³ The high costs of transporting heat even over short distances make large-scale cogeneration unattractive.

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