Non-monetary incentives to promote Renewable Energy in Liberalized Markets

Nuno Domingues
ISEL, Instituto Superior de Engenharia de Lisboa, Portugal
Rua Conselheiro Emídio Navarro, 1, 1959 – 007 Lisboa; ndomingues@deea.isel.ipl.pt

Abstract
In order to quantify the amount of renewable energy investable in liberalised markets, the impact of incentives in electricity generation costs is used as a valuable economic indicator. To determine the price and generation strategies both the market maximisation problem with technical and economic constraints is solved. This is a problem of high level of complexity. Once the market price is determined the model is solved and the market demand is related. The study considered an elastic demand curve approximated by an affine function. A parameter, the exceptionality maximisation, defines the computer’s reaction between the supply participants. Based on real data from several liberalised electricity markets the simulation model is used to solve the market maximisation problem with technical and economic constraints. In the present study, promoting renewable energy is considered from a global point of view. The results are in line with the expected answers. For illustration, a coal power plant is utilised to show the change of the market price distribution with a normal function as value added by the present study.

Methodology and Formulation

Fig. 1. Demand curve

\[ \hat{\lambda} = e - x(P_s - P_{\text{max}}) \]

- block i supplier: \( m_i(l_i) = m_i(l_i, a_i, \lambda, \alpha_i, P_s, P_{\text{max}}) \)
- block i production cost: \( c_{\lambda} \)
- price strategic behaviour: \( a_i \)
- quantity strategic bid: \( P_i^s \)
- block i selling price: \( P_{\text{sell}}(i) \)
- expected price assuming a rigid demand: \( \hat{\lambda} \)
- maximum expected price assuming a rigid demand: \( \hat{\lambda}_{\text{min}} \)
- expected price assuming an elastic demand: \( \hat{\lambda}_{\text{min}} \)
- maximum expected price assuming an elastic demand: \( \hat{\lambda}_{\text{min}} \)
- minimum expected price assuming an elastic demand: \( \hat{\lambda}_{\max} \)

The maximisation of a coal power plant are 10000kW/MWh [1], thereby the cost of introducing the emission externality is 20 GWh/MWh.

The results were obtained from market simulations with the following data:
- for \( c_{\lambda} = 15 \), coal demand without taking account with the externalities;
- for \( c_{\lambda} = 35 \), coal demand taking account with the externalities;
- \( \hat{\lambda}_{\max} = 22 \), \( \hat{\lambda}_{\min} = 38 \).

Table A.1. Market behaviour without externalities

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<th>Case</th>
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<th>( \theta )</th>
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</thead>
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<tr>
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<tr>
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<td>0.0000</td>
</tr>
<tr>
<td>5</td>
<td>2.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

Fig. 2. Expected market price

\[ \hat{\lambda} = K_s - x(1 + \theta)P_s \]

Fig. 3. Expected market price

For the MCP market:
\[ \hat{\lambda}_{\text{MCP}} = \frac{\alpha_{\text{MCP}}}{\alpha_{\text{MCP}}} \]

For the PAB market:
\[ \hat{\lambda}_{\text{PAB}} = \frac{\alpha_{\text{PAB}}}{\alpha_{\text{PAB}}} \]

Table A.1. Market behaviour with emission externalities

<table>
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<tr>
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<tbody>
<tr>
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Fig. 4. Normal probability price function

\[ \hat{\lambda} = \hat{\lambda}_{\text{MCP}} + x(1 + \theta)P_s \]

References