ENVIRONMENTAL POLICY TOOLS AND THEIR USE IN THE ENERGY SECTOR

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Introduction

• The licensees of the energy regulator include the most polluting industrial activities and installations

• Energy sector activities and installations are multi-polluters (local, regional air quality, global atmosphere, water resources, waste, site location, etc.)
1. Pollution causes ‘external cost or damage’
2. Pressure on environmental policy for action is created
3. A new environmental policy instrument is implemented
4. Energy firms incur additional environmental costs
5. The price authority needs to make decisions with regard to eligibility of additional environmental costs; or these costs will end up in end customer prices
Potential environmental issues in the energy sector

- Production siting
- Air pollution of conventional combustion technologies
- Greenhouse gas emissions
- Fuel specific issues
- Water pollutions
- Waste output
- Decommissioning
- Nuclear safety
- Grid asset siting, development
- Non-point source emissions
- Renewable obligations – later during the course
- Electricity labelling
The concept of externality

- Externalities are changes of welfare generated by an economic activity without being reflected in the market prices.

- Energy externalities like those in the electricity, transport or industrial sectors are often negative and considered as a cost which is external because it is not paid by those who have generated it.
Examples of external costs

- **Air pollution increases respiratory illnesses**
  - Costs of healthcare
  - Lost productivity

- **Traffic congestion**
  - Working/leisure time lost
  - Accelerated depreciation of infrastructure

- **Water pollution leads to loss of fish & health damage**
  - Water-borne infective diseases
  - Commercial losses (fishing and recreational)

- **Overexploitation of aquifers**
  - Salinization of wells and resources limits future agriculture activity
  - Accelerates desertification

- **Fossil fuel combustion provokes climate change**
  - Sea level rise
  - Increases rate of extreme events (tornados, draughts and floods)
  - Impact on biodiversity
Energy external costs

- Energy sector: an activity entailing important negative environmental impacts
- Energy externalities: a terminology entered in the European “jargon” after twenty years of European research
- A new way of thinking: taking care of social and environmental damages (“polluter pays” principle, “social and environmental responsibility”)
- Comparison between different fuel-cycles and different types of burden and impact according to their “externalities” are now possible
Quantification of $ external costs – is it possible?

- The *marginal damage function* (MDF) measures the (increasing) external costs of additional emissions.
- Knowing environmental damage function: a basic tool for environmental policy implementation.
European research efforts

- First “external costs” research work at the end of the eighties in the electricity field and with a collaboration EU-USA: ExternE
- Genuine European methodology and approach: Impact Pathway Analysis
- Multidisciplinary research teams: economists, engineers, epidemiologists, etc.
ExternE objectives

- To cover all relevant external effects
- Environment:
  - particles, dust, aerosols
  - energy, noise, radiation, heat
  - carried via air, soil and water
- Global warming:
  - quantifiable damages +
  - precautionary principle about uncertainty
- Accidents:
  - probability x damage/event x monetary valuation
  - extreme severe events to be treated
Impact Pathway Analysis

- **SOURCE**
  - (specification of site and technology)
  - \( \Rightarrow \) emission
    - (e.g., kg/yr of particulates)

- **DISPERSION**
  - (e.g., atmospheric dispersion model)
  - \( \Rightarrow \) increase in concentration at receptor sites
    - (e.g., \( \mu g/m^3 \) of particulates in all affected regions)

- **DOSE-RESPONSE FUNCTION**
  - (or exposure-response function)
  - \( \Rightarrow \) impact
    - (e.g., cases of asthma due to ambient concentration of particulates)

- **MONETARY VALUATION**
  - \( \Rightarrow \) cost
    - (e.g., cost of asthma)
Monetary valuation of external costs

- Willingness to Pay (WTP) and willingness to Accept (WTA): concepts of measuring benefit based on surveys (site-dependent)
- Theory says that these two concepts should match, but empirical evidence is not clear
  - WTP: asks people how much they are willing to pay to prevent an environmental loss.
    - WTP is bounded by income.
  - WTA: asks people how much they are willing to accept in the form of $ compensation to accept environmental degradation
Monetary valuation of health-related external costs

<table>
<thead>
<tr>
<th>Health end-point</th>
<th>Recommended central unit values in € price year 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of a prevented Fatality</td>
<td>1,000,000</td>
</tr>
<tr>
<td>Year of Life Lost</td>
<td>50,000 / year lost</td>
</tr>
<tr>
<td>Hospital admissions</td>
<td>2,000 / admission</td>
</tr>
<tr>
<td>Emergency Room Visit for respiratory illness</td>
<td>670 / visit</td>
</tr>
<tr>
<td>General Practitioner visits:</td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>53 / consultation</td>
</tr>
<tr>
<td>Lower respiratory symptoms</td>
<td>75 / consultation</td>
</tr>
<tr>
<td>Respiratory symptoms in asthmatics:</td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>130 / event</td>
</tr>
<tr>
<td>Children</td>
<td>280 / event</td>
</tr>
<tr>
<td>Respiratory medication use – adults and children</td>
<td>1 / day</td>
</tr>
<tr>
<td>Restricted activity days</td>
<td>130 / day</td>
</tr>
<tr>
<td>Cough day</td>
<td>38 / day</td>
</tr>
<tr>
<td>Symptom day</td>
<td>38 / day</td>
</tr>
<tr>
<td>Work loss day</td>
<td>82 / day</td>
</tr>
<tr>
<td>Minor restricted activity day</td>
<td>38 / day</td>
</tr>
<tr>
<td>Chronic bronchitis</td>
<td>190,000 / case</td>
</tr>
</tbody>
</table>
## Air pollution damages estimates in the EU (€/tonne)

<table>
<thead>
<tr>
<th>NOx</th>
<th>SO$_2$</th>
<th>PM$_{2.5}$</th>
<th>VOC</th>
<th>NH$_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,200 - 11,000</td>
<td>5,400 - 16,000</td>
<td>25,000 - 72,000</td>
<td>920 - 2,700</td>
<td>10,000 - 30,000</td>
</tr>
</tbody>
</table>
Energy external costs (comparison among technologies)

Air pollution impacts (PM$_{10}$) and other impacts

- **Biomass technologies**
- **Nuclear**
- **Wind**
- **Natural gas technologies**
- **Existing Coal technologies (no gas cleaning)**
- **New Coal technologies**

Greenhouse gas impacts

LOW

HIGH
Environmental policy objective: the internalisation of externalities

- External costs (like private costs) should be taken into consideration by energy sector decision makers: **internalisation**

- If properly “internalised”, external costs are perceived by economic agents and provide incentives to move towards a more sustainable electricity, transport or industrial system

- If not internalised, the non-remunerated degradation of public goods (like air, soil, water quality or stable climate) provokes a distortion in the markets favouring non-sustainable industries and technologies

- Alternative technology options can become competitive through the internalisation of external costs
The Marginal Abatement Cost (MAC) function

- Depending of the technological and economic options available, emissions can be cut at different costs
- The marginal abatement cost curve measures the (increasing) costs of reducing emissions

![Diagram showing the Marginal Abatement Cost (MAC) function with costs (€) on the y-axis, emissions on the x-axis, and the total costs of reducing emission from $E_u$ to $E_1$.](image)
Example 1.: Sulphur

Pre-combustion Cycle: FUEL
- domestic coal
- B1
- B2

Combustion Cycle: TECHNOLOGY

Post-combustion Cycle: FLUE GAS
- gasoil
- natural gas
- unchanged
- heavy fuel oil
Example 1.: Sulphur (S)

Alternative desulphurization scenarios

• A: local coal with high S (political pet fuel)
  ▶ A1: change furnace (fluidized bed: desulphurize)
  ▶ A2: treat flue gas (wet lime scrubber)

• B: heavy fuel oil with high S (cheap refinery residue)
  ▶ B1: switch to light diesel or gas turbine oils
  ▶ B2: switch to natural gas (add low-NOx burners)

Alternative cost effects

▶ Justify eligible cost pass-through under tariff regime!
▶ Significant price differences
### Example 1.: Sulphur

<table>
<thead>
<tr>
<th></th>
<th>capital cost</th>
<th>operational cost</th>
<th>fuel cost</th>
<th>net efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>A2</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>B1</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>↑</td>
<td></td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>
The optimal level of pollution

- Optimal level of pollution ($E_1$) is not zero, but depends on the shape of the marginal damage and marginal abatement cost functions.
- $E_3$: MDF > MAC, i.e. the cost of eliminating 1 unit of emission is lower than its additional damage.
- $E_2$: MAC > MDF, i.e. the cost of eliminating the marginal unit of pollution is greater than the damages the unit of pollution would have.
- $E_1$: optimal as at $E_1$ MAC = MDF
- If abatement technology improves, optimal emissions are lower.
Internalisation instruments

- Command-and-control regulations
  - \((\text{Eu} - \text{E1})/n\)

- Market (or incentive-) based instruments
  - taxes
  - subsidies
  - tradable permits.
Command and control regulation

- Command-and-control prescribe emission ceilings, standards for the whole industry
- Does not take into consideration the differences of MAC across the industry (uniform prescriptions for emission reduction)
  - MAC across companies differs
- Room for C&C: when monitoring costs are very high, when optimal levels of emission are very low, under emergency situations
Market based instruments

- The economically optimal abatement is the one that guarantees that all producer face the same marginal costs and these costs are equal to the marginal damages.
- This is not guaranteed by C&C unless all producers have the same MAC or each MAC is perfectly known by the regulator.
- Market based instruments introduce market incentives for market forces move towards the social optimum.
- Environmental taxation introduces a uniform penalty in emissions equal to the theoretically known marginal damage in the social optimum.
Example 2: EU GHG emissions trading scheme

- CO2 emission becomes limited in the EU
- CO2 allowance: perfect commodity
- Price-taking companies
  - 27 Member States
  - More than 12,000 companies
- High liquidity
  - Expected annual turnover: 2-3000 Mt
  - Intermediaries
  - Derivative products
  - No close substitute
- Administrative supply
Cost-efficient emission reduction by tradable emission allowances in case of two companies with different marginal abatement costs.
Concepts to remember

• External cost
• Marginal damage function
• Marginal cost of abatement function
• Command and control regulation
  ▪ Uniform reduction requirement
• Incentive regulation
  ▪ MAC = MDF for each company
• Forms of incentive regulation: taxes, tradeable emission permits