Pricing greenhouse gas emissions

Larry Hughes
Energy Research Group
Electrical and Computer Engineering
Dalhousie University
Halifax, Nova Scotia, Canada
larry.hughes@dal.ca

Presented to
Halifax Chamber of Commerce Energy Security Committee

23 September 2008
Pricing greenhouse gas emissions

Larry Hughes, PhD
Energy Research Group
Department of Electrical and Computer Engineering
Dalhousie University
http://lh.ece.dal.ca/enen
Background

• What are GHGs?
  – Gases that help keep the planet from freezing
  – Water vapour, carbon dioxide, methane

• Sources of anthropogenic GHGs:
  – Transportation: oil
  – Industrial processes: cement production
  – Electrical generation: coal, oil, natural gas

• How to stop the build-up of GHGs that are changing the planet (with minimal economic impact)?
Cap-and-trade: Basics

• A ceiling on emissions is determined by some national (?) body
• Emission limits are allocated to (major) emitters (the cap)
• At the end of the year, emitters are either under or over their cap (trade):
  – Under: Sell (or bank) remaining emissions
  – Over: Purchase necessary emissions to meet cap
Cap-and-trade: Examples

• EU (2004)
  – Caps too high in most countries
• Western Climate Initiative (2008)
  – US and Canadian jurisdictions (initially west coast)
  – Focus on transportation
  – Stationary emitters of CO$_2$ given a break
• Federal NDP (Bill C-377)
  – Large final emitters only
  – Allocation auctioned at start of year
  – 25% below 1990 by 2020 and 80% below by 2050
Cap-and-trade: Comments

• Large emitters are easiest to identify and “cap”
• Costs must eventually be passed on to consumers
• Small emitters are harder to cap and trade
• Caps and penalties must be sufficient to make real change
Carbon taxes: Basics

• Most energy sources are carbon based
• Put a price on carbon (or CO$_2$) and price this into sales of all energy products
• Example:
  – $10/tonne CO$_2$ (or 1,000¢ per tonne or 1¢/kg)
  – 1 litre of gasoline emits 2.36kg CO$_2$/litre
  – Tax is: 2.36¢/litre
• What are the tax revenues used for?
Carbon tax: Examples

• Norway
  – Minor benefits

• BC:
  – All consumption (eroding due to public pressure)

• Federal Liberals (Green Shift)
  – All end-use *plus* 700 largest emitters
  – Cost is to increase over time
  – 20% below 1990 levels by 2020 (estimate)
  – Revenue neutral (consumption tax)
Carbon tax: Comments

• No actual emission target
• Assumes rising prices will encourage switching to lower- or non-carbon fuel sources
• Rebound effect and overly optimistic targets mean reductions usually don’t meet expectations
Intensity targets: Basics (1)

• Many economic activities produce CO$_2$
• Carbon (CO$_2$) intensity:

$$\frac{\text{CO}_2 \text{ emitted}}{\text{Production}}$$

• Intensity targets attempt to reduce emissions by reducing the allowable intensity
• Ideal: Intensity declines as CO$_2$ emitted declines and production increases...
# Intensity targets: Basics (2)

<table>
<thead>
<tr>
<th>Production</th>
<th>CO₂ emissions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decrease</td>
<td>Unchanged</td>
<td>Increase</td>
</tr>
<tr>
<td>Decreases</td>
<td><strong>Intensity:</strong> Decreases if emissions fall faster than production. Increases if production falls faster than emissions.</td>
<td>Intensity increases</td>
<td>Intensity increases</td>
</tr>
<tr>
<td>Unchanged</td>
<td>Intensity decreases</td>
<td>No change</td>
<td>Intensity increases</td>
</tr>
<tr>
<td>Increases</td>
<td>Intensity decreases</td>
<td>Intensity decreases</td>
<td><strong>Intensity:</strong> Decreases if production increases faster than emissions. Increases if emissions increase faster than production.</td>
</tr>
</tbody>
</table>
Intensity targets: Example

• LFEs must reduce (target year is 2006):
  – 18% by 2010 (over 2007, 2008, 2009)
  – 2% per year to 28% by 2015
• Penalties: $1 million/day or 3 years imprisonment
• Target: 20% below 2006 emissions by 2020
Intensity targets: Comments

• Emissions will eventually start to decrease
• Emissions trading (i.e., cap-and-trade) will be allowed
• Higher costs are inevitable:
  – Fines
  – New technology
Contraction and convergence

- Bring down emissions with annual limits (contraction)
- Equalize world per capita emissions (convergence)
- Each adult receives a CO$_2$ emissions permit:
  \[
  \text{Total world emissions} \quad \frac{\text{Total world adult population}}{}
  \]
- Permits can be sold or discarded
- Fails to acknowledge that some regions require more energy than others
Ireland’s cap-and-share

1. **THE CAP**
   - An independent trust decides the cap on greenhouse gas emissions using the best scientific advice.

2. **THE SHARE**
   - The trust shares out Production Authorisation Permits (PAPs) equally to every citizen (with a % to Transition Funds).

3. **THE SALE**
   - Citizens sell their PAPs via post offices and banks (or destroy them to take the carbon out of the system).

4. **THE BUY**
   - Primary oil, gas and coal companies need to buy PAPs to cover the emissions for all the fuels they sell.

5. **THE ENFORCEMENT**
   - Customs and excise inspectors match PAPs with fuels and potential emissions to enforce the cap.
<table>
<thead>
<tr>
<th></th>
<th>Cap and trade</th>
<th>Carbon taxes</th>
<th>Intensity targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Settable targets?</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Higher prices?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Prices hidden?</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Targets</td>
<td>Production</td>
<td>Consumption</td>
<td>Production</td>
</tr>
<tr>
<td>All sectors?</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Canada</td>
<td>NDP</td>
<td>Liberals</td>
<td>Conservatives</td>
</tr>
<tr>
<td>2020 target</td>
<td>25% below 1990 levels</td>
<td>20-25% below 1990 levels</td>
<td>20% below 2006 levels</td>
</tr>
</tbody>
</table>
Pricing greenhouse gas emissions

Larry Hughes, PhD
Energy Research Group
Department of Electrical and Computer Engineering
Dalhousie University
http://lh.ece.dal.ca/enen