Reducing carbon emissions – where to start?

Manufacturing Innovations

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Overview

- Carbon accounting
  - the facility picture; the product picture
  - allocating accountability over products
  - a simple example
- Process improvement and the bottom line
- The pictures for three Michigan industries
  - materials processing
  - automotive
  - furniture

Carbon accounting

- It’s coming
- Two aspects:
  - regulatory
  - product standards
- Two attitudes:
  - pain
  - opportunity

Carbon accounting (cont'd)

- Goal of today's session is to explore the opportunity side
- I'll lay out something that ***can*** be done
- And we can discuss:
  - how likely it is that it ***will*** be done: costs and benefits to manufacturers
  - whether it ***should*** be done: potential benefits to consumers, regulators, public in general

Carbon accounting (cont'd)

- The two aspects require two different crosscuts of the data
- Regulatory reporting will probably be required on a ***facility*** basis
- Sustainability standards need emissions data on a ***product*** basis (i.e. emissions associated with specific processes)

Carbon accounting (cont'd)

- First some background
- Regulatory:
  - First major new reporting framework since the late 80s and right-to-know reporting
  - Manufacturers are likely, fairly or unfairly, to be caught up in the first wave

Carbon accounting (cont'd)

- What reporting will be required when carbon emissions regulation is instituted?
- Carbon taxes vs. cap-and-trade
  - Carbon tax: fixes price; no limit on emission
  - Cap-and-trade: fixes emission; no limit on price

Carbon accounting (cont'd)

- If carbon is simply taxed at the source:
  - Usage regulated through higher prices
  - May not need to report anything
- If cap-and-trade:
  - Need to report, to ensure enough permits have been acquired
  - Scopes 1, 2 and 3

Carbon accounting (cont'd)

- Greenhouse gas protocol
- Scopes 1, 2 and 3
  - Scope 1: The facility picture
  - Scope 2: Purchased power, and other (e.g. steam from cogeneration)
  - Scope 3: Everything else – LCA-type data

Carbon accounting (cont'd)

- Best guess now:
  - Cap-and-trade
  - Scope 1 reporting: focus on the facility
- If so, where will the data come from?
  - purchasing records (primarily fuel and electric power) and inventory levels
  - cogeneration is a problem

Carbon accounting (cont'd)

- What about carbon accounting for individual products?
- Regulatory requirement? – not likely
- Why would any manufacturer want to go through the effort?

Carbon accounting (cont'd)

- Product standards:
  - already a significant factor in some sectors
  - will work its way up supply chain
- Drivers:
  - government purchasing policies
  - LEED and related standards
  - "carbon footprint" and similar labeling

Carbon accounting for products

- If a manufacturer were to try allocating the total facility emission to individual products, what would be involved?

Carbon accounting (cont'd)

- Allocate over SKUs:
  - raises some of the same questions as in LCA
  - ISO 14040 hierarchy:
    - expand system boundary – not relevant here
    - physical basis – particularly suitable for impacts like energy, GHG
    - economic basis – diamonds and gravel example
- Let's look at a simple example to clarify the procedure

Example -- Winemaking

- Model winery carries out three processes:
  - juice extraction and filtering
  - ageing
  - bottling
- Winery sells four products:
  - Product A: grape juice (no ageing)
  - Product B: premium wine (aged 3 years)
  - Product C: sold in bulk (no bottling)
  - Product D: purchased wine – bottling only

Example (cont'd)

- Our model winery is a growing business – output increases 3% per year
- The winemaker wants to be ready for emissions reporting, ***and*** wants to label product with a credible carbon footprint
- Task: allocate energy and GHG emissions among products
- (Numbers are meant to be illustrative, not necessarily realistic)

Example (cont'd)

- Our winemaker might start by finding the total (Scope 1 and 2) energy used during one accounting period (e.g. one year)
  - Use emission factor to convert total electric power purchased to GHG equivalent emitted
  - Collect data on all fuel purchases, e.g.
    - plant heating
    - boilers and other equipment
    - delivery vehicles
  - Use appropriate emissions factors for fuels

Example (cont'd)

- When carried out for several years, the data might look like this:

Facility picture	Carbon emissions (10^3 kg CO2 equivalent)										Total, all years
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Totals	**14.0**	**14.4**	**14.9**	**15.3**	**17.8**	**18.3**	**15.9**	**16.3**	**16.8**	**17.3**	**160.9**

- Now suppose the winemaker is able to estimate the energy used by each process:

Facility picture		Carbon emissions (10^3 kg CO2 equivalent)										Total, all years
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Operations	Process 1	8.5	8.8	9.0	9.3	9.6	9.9	7.2	7.4	7.6	7.8	85.0
	Process 2	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	11.5
	Process 3	4.0	4.1	4.2	4.4	6.5	6.7	6.9	7.1	7.3	7.5	58.8
All other (non-process specific)		0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	5.7
Totals		**14.0**	**14.4**	**14.9**	**15.3**	**17.8**	**18.3**	**15.9**	**16.3**	**16.8**	**17.3**	**160.9**

- We have included all "overhead" on a separate line

Example (cont'd)

- The winemaker will presumably know:
  - how much product was sold in any given year
  - which products go through which processes
- So now the chart can be expanded like this:

Facility picture			Carbon emissions (10^3 kg CO2 equivalent)										Total, all years
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	34.4
		Product B	2.5	2.6	2.7	2.7	2.8	2.9					16.2
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	34.4
	Process 2	Product B		1.1	2.2	3.5	3.6	3.7	3.8	2.6	1.4	0.0	22.0
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	11.5
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	22.9
		Product B					2.0	2.1	2.1	2.2	2.3	2.3	12.9
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	22.9
All other (non-process specific)			0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	5.7
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**	**182.9**

Example (cont'd)

- But the same data can be sliced and diced to provide ***either*** facility information

Facility picture			Carbon emissions (10^3 kg CO2 equivalent)										Total, all years
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	34.4
		Product B	2.5	2.6	2.7	2.7	2.8	2.9					16.2
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	34.4
	Process 2	Product B		1.1	2.2	3.5	3.6	3.7	3.8	2.6	1.4	0.0	22.0
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	11.5
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	22.9
		Product B					2.0	2.1	2.1	2.2	2.3	2.3	12.9
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	22.9
All other (non-process specific)			0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	5.7
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**	**182.9**

- ***or*** product information

Product picture			Carbon emissions (10^3 kg CO2 equivalent)										Product totals (10^3 kg CO2 equivalent)			
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	A	B	C	D
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	34.4			
		Product B	2.5	2.6	2.7	2.7	2.8	2.9						16.2		
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9			34.4	
	Process 2	Product B		1.1	2.2	3.5	3.6	3.7	3.8	2.6	1.4			22.0		
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3			11.5	
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	22.9			
		Product B					2.0	2.1	2.1	2.2	2.3	2.3		12.9		
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6				22.9
All other (non-process specific)			0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7				
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**	**57.3**	**51.1**	**45.9**	**22.9**

Example (cont'd)

- In fact, we're not done yet

Product picture			Carbon emissions (10^3 kg CO2 equivalent)										Product totals (10^3 kg CO2 equivalent)			
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	A	B	C	D
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	34.4			
		Product B	2.5	2.6	2.7	2.7	2.8	2.9						16.2		
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9			34.4	
	Process 2	Product B		1.1	2.2	3.5	3.6	3.7	3.8	2.6	1.4			22.0		
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3			11.5	
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6	22.9			
		Product B					2.0	2.1	2.1	2.2	2.3	2.3		12.9		
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6				22.9
All other (non-process specific)			0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7				
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**	**57.3**	**51.1**	**45.9**	**22.9**

- With the right choice of accounting category, we can get …

Product picture, expanded			Carbon emissions (10^3 kg CO2 equivalent)									
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
		Product B	2.5	2.6	2.7	2.7	2.8	2.9				
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
	Process 2	B, first year		1.1	1.1	1.2	1.2	1.2	1.3			
		B, second year			1.1	1.2	1.2	1.2	1.3	1.3		
		B, third year				1.2	1.2	1.2	1.3	1.3	1.4	
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
		Product B					2.0	2.1	2.1	2.2	2.3	2.3
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
All other (non-process specific)			0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**

Example (cont'd)

Product picture, expanded			Carbon emissions (10^3 kg CO2 equivalent)									
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
		Product B	2.5	2.6	2.7	2.7	2.8	2.9				
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
	Process 2	B, first year		1.1	1.1	1.2	1.2	1.2	1.3			
		B, second year			1.1	1.2	1.2	1.2	1.3	1.3		
		B, third year				1.2	1.2	1.2	1.3	1.3	1.4	
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
		Product B					2.0	2.1	2.1	2.2	2.3	2.3
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
All other (non-process specific)			0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**

- … information on separate vintage years, if the winemaker deems that useful

	Product B totals (10^3 kg CO2 equivalent)						Total, all years
"Vintage":	'06	'07	'08	'09	'10	'11	
	2.5	2.6	2.7	2.7	2.8	2.9	16.2
	1.1	1.1	1.2	1.2	1.2	1.3	
	1.1	1.2	1.2	1.2	1.3	1.3	22.0
	1.2	1.2	1.2	1.3	1.3	1.4	
	2.0	2.1	2.1	2.2	2.3	2.3	12.9
	7.9	**8.1**	**8.4**	**8.6**	**8.9**	**9.2**	**51.1**
Amount produced each year (thousand gal):	10.0	10.5	11.0	11.6	12.2	12.8	**68.0**
Carbon footprint of Product B, by vintage year (kg CO2 eq / gal):	**0.79**	**0.77**	**0.76**	**0.75**	**0.73**	**0.72**	

Example (cont'd)

- We've carried out the analysis for the premium product – but it's easy now to fill out the chart for the grape juice …

Product picture, expanded			Carbon emissions (10^3 kg CO2 equivalent)									
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
		Product B	2.5	2.6	2.7	2.7	2.8	2.9				
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
	Process 2	B, first year		1.1	1.1	1.2	1.2	1.2	1.3			
		B, second year			1.1	1.2	1.2	1.2	1.3	1.3		
		B, third year				1.2	1.2	1.2	1.3	1.3	1.4	
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
		Product B					2.0	2.1	2.1	2.2	2.3	2.3
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
All other (non-process specific)			0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**

Product A totals		**5.0**	**5.2**	**5.3**	**5.5**	**5.6**	**5.8**	**6.0**	**6.1**	**6.3**	**6.5**

Example (cont'd)

- … the bulk wine …

Product picture, expanded			Carbon emissions (10^3 kg CO2 equivalent)									
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
		Product B	2.5	2.6	2.7	2.7	2.8	2.9				
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
	Process 2	B, first year		1.1	1.1	1.2	1.2	1.2	1.3			
		B, second year			1.1	1.2	1.2	1.2	1.3	1.3		
		B, third year				1.2	1.2	1.2	1.3	1.3	1.4	
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
		Product B					2.0	2.1	2.1	2.2	2.3	2.3
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
All other (non-process specific)			0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**

Product A totals	**5.0**	**5.2**	**5.3**	**5.5**	**5.6**	**5.8**	**6.0**	**6.1**	**6.3**	**6.5**
Product C totals	**4.0**	**4.1**	**4.2**	**4.4**	**4.5**	**4.6**	**4.8**	**4.9**	**5.1**	**5.2**

Example (cont'd)

- … and the bottled only product

Product picture, expanded			Carbon emissions (10^3 kg CO2 equivalent)									
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
		Product B	2.5	2.6	2.7	2.7	2.8	2.9				
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
	Process 2	B, first year		1.1	1.1	1.2	1.2	1.2	1.3			
		B, second year			1.1	1.2	1.2	1.2	1.3	1.3		
		B, third year				1.2	1.2	1.2	1.3	1.3	1.4	
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
		Product B					2.0	2.1	2.1	2.2	2.3	2.3
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
All other (non-process specific)			0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**

Product A totals	**5.0**	**5.2**	**5.3**	**5.5**	**5.6**	**5.8**	**6.0**	**6.1**	**6.3**	**6.5**
Product C totals	**4.0**	**4.1**	**4.2**	**4.4**	**4.5**	**4.6**	**4.8**	**4.9**	**5.1**	**5.2**
Product D totals	**2.0**	**2.1**	**2.1**	**2.2**	**2.3**	**2.3**	**2.4**	**2.5**	**2.5**	**2.6**

Example (cont'd)

- That gives us everything but the overhead
- An economic allocation might be justifiable (and typically easy)

Example (cont'd)

- Here is what it looks like with everything allocated

Product picture, expanded			Carbon emissions (10^3 kg CO2 equivalent)									
			2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Operations	Process 1	Product A	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
		Product B	2.5	2.6	2.7	2.7	2.8	2.9				
		Product C	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
	Process 2	B, first year		1.1	1.1	1.2	1.2	1.2	1.3			
		B, second year			1.1	1.2	1.2	1.2	1.3	1.3		
		B, third year				1.2	1.2	1.2	1.3	1.3	1.4	
		Product C	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3
	Process 3	Product A	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
		Product B					2.0	2.1	2.1	2.2	2.3	2.3
		Product D	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5	2.5	2.6
All other (non-process specific)		Product A	0.13	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.16	0.16
		Product B	0.18	0.18	0.19	0.19	0.20	0.20	0.21	0.22	0.22	0.23
		Product C	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.07
		Product D	0.15	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.20
Totals			**14.0**	**15.5**	**17.1**	**18.8**	**21.4**	**22.0**	**19.7**	**19.0**	**18.2**	**17.3**

Carbon accounting (cont'd)

- So what have we learned?
- The hard part was coming up with the estimates for each individual process
- But once that's done, the rest can be filled in with accounting data
- Do it once, have it available for all products

Carbon accounting (cont'd)

- The winemaker can now (if desired):
  - label the products
  - supply GHG footprint data for the downstream bottlers who purchase the bulk product
- Note that the books are guaranteed to balance – all emissions have been allocated to one product or another

Carbon accounting (cont'd)

- One further note: as data accumulates from successive accounting periods, it's possible to use statistical techniques (e.g. ANOVA) to refine the process-specific energy estimates
- (For example, if the product mix changes from one period to the next, the estimates can be adjusted to provide a best fit)

Carbon accounting (cont'd)

- So hopefully everyone is convinced that allocating total facility energy use (and GHG emissions) over products is a worthwhile task
- Are we all looking forward to those reporting requirements so we can generate the data to process?
- Why wait? – You've already got the totals data …

Questions for discussion

- How feasible would it be to carry out this allocation program in facilities you're familiar with?
- Would the potential benefits be sufficient to justify the effort?

Process improvement and the bottom line

- There is an additional benefit – having a comprehensive overview of energy usage in the facility is a good starting point for planning process improvements
- What does that look like on our table?

Process improvement and the bottom line (cont'd)

- In 2009, the winery introduced an energy efficiency improvement in Process 2
- Instead of:

Facility picture		Carbon emissions (10^3 kg CO2 equivalent)										Total, all years
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Operations	Process 1	8.5	8.8	9.0	9.3	9.6	9.9	7.2	7.4	7.6	7.8	85.0
	Process 2	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.3	1.3	11.5
	Process 3	4.0	4.1	4.2	4.4	6.5	6.7	6.9	7.1	7.3	7.5	58.8
All other (non-process specific)		0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	5.7
Totals		**14.0**	**14.4**	**14.9**	**15.3**	**17.8**	**18.3**	**15.9**	**16.3**	**16.8**	**17.3**	**160.9**

- the carbon emissions table now looks like:

Facility picture		Carbon emissions (10^3 kg CO2 equivalent)										Total, all years
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Operations	Process 1	8.5	8.8	9.0	9.3	9.6	9.9	7.2	7.4	7.6	7.8	85.0
	Process 2	1.0	1.0	1.1	0.6	0.6	0.6	0.7	0.7	0.7	0.7	11.5
	Process 3	4.0	4.1	4.2	4.4	6.5	6.7	6.9	7.1	7.3	7.5	58.8
All other (non-process specific)		0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.7	5.7
Totals		**14.0**	**14.4**	**14.9**	**14.8**	**17.2**	**17.8**	**15.3**	**15.8**	**16.2**	**16.7**	**157.2**

Process improvement and the bottom line (cont'd)

- In our table, process improvements affect a horizontal row
- What do they do to the balance sheet's bottom line?

Process improvement and the bottom line (cont'd)

- Two ways to benefit
- Improve the largest consumer of energy
  - save on taxes (fewer permits needed under cap-and-trade)

  OR
- Improve the process that will make the biggest difference for a particular product

Tags or taxes?

- Taxes: minimize overall facility emissions
- Tags: minimize emissions allocated to specific product lines (enhancing the impression the label will make on the environmentally conscious purchaser)

Tags or taxes? (cont'd)

- What industry sectors might find it advantageous to maximize improvements to a product's carbon footprint in preference to the facility's?
  - value to the customer
  - type of product
  - type of customer

Tags or taxes? (cont'd)

- Other factors?
  - relative importance of manufacturing phase compared to rest of life cycle
  - existence of recognized sustainability certification, label, or equivalent

Tags or taxes? (cont'd)

- How might some of Michigan's industries set their priorities?
- Three examples:
  - materials processing
  - automotive
  - furniture

Materials processing

- Often at top of supply chain, selling to other manufacturers
- Demand for impact information needs to percolate up the chain
- Importance of impact data to customers will depend on fraction of carbon footprint per product unit – for example:
  - higher for bulk resins
  - low for coatings

Automotive

- Use phase dominates
- Mileage sticker likely to carry more weight with consumer than manufacturing information
- May serve to differentiate among models already perceived as environmentally friendly

Furniture

- Sustainability certification already developed
- Becoming a significant factor in some markets
- May be a standard-setter for other sectors

For more information

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