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Southern African Bitumen Association (SABITA)

Implication of the Proposed Carbon Tax Legislative and Policy Framework on SABITA Members

Executive Summary

The Southern African Bitumen Association (SABITA) is committed towards assisting its members in terms of reducing green house gas (GHG) emissions and conserving energy. SABITA has undertaken to provide its members with the tools to monitor their GHG emissions and energy consumption and to ensure best practice in this regard. This document serves to ascertain the framework for future GHG related legislation which is being developed in South Africa, and the implications of such on the SABITA members.

The objectives of this report are as follows:

- To outline the proposed legislation and policy framework covering carbon emissions management
- To ascertain the cost implications of the proposed carbon tax on the SABITA members
- To outline the carbon reductions strategies which may be applied to reduce the carbon intensity of SABITA member plants

The typical hot mix asphalt plant energy consumption values for drier aggregate heating and drying, electricity consumption and diesel consumption are 85%, 12% and 3% respectively.

The estimated cost implications of the carbon tax on a typical HMA plant and the sector as a whole are presented in the following table.

Parameter	Asphalt Sector	0.18Mtpa[1] Asphalt Plant
Expected CO_2 Emissions (tons/yr)	235 000 – 273 000	5 300 - 6 200
Expected Carbon Tax (at R75/ton CO_2)	R17-20 million/yr	R400 000 – R460 000
Expected Carbon Tax (at R200/ton CO_2)	R47-54 million/yr	R1.0-1.2 million

The technological process/fuel use changes incorporating conversion of a HMA process plant to a HMA process plant as well as fuel change from HFO to natural gas the expected drier/mixer carbon emissions could be halved (as well as the carbon tax cost being reduced from R800 000 to R400 000).

The technological recommendations in terms of reducing plant energy consumption include:

- Stockpiling aggregates under roof on sloped concrete floors (drainage in opposite direction to loading point)
- Counter-current flow design of burner gas and aggregate flow direction in single drum plants
- Frequent replacement of worn flights in drier
- Effective lagging of all vessels and pipelines containing heated materials
- Flue gas heat recovery (if appropriate)
- Asphalt product storage in closed silos
- Use of batch plants for applications requiring large product diversity

[1] Mtpa = Mega ton per annum

The managerial recommendations in terms of reducing plant energy consumption include:

- Training of staff on reducing energy consumption (most relevant for electricity use)
- Control of thermocouple monitoring variables to prevent energy wastage
- Careful monitoring of particularly the flue gas temperature to monitor the efficiency of the drier in terms of heat transfer to input materials and prevention of excess fuel supply into burner
- Continuous monitoring of energy consumption to keep track of performance in this regard and to facilitate continued plant efficiency improvements

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1 Introduction

The Southern African Bitumen Association (SABITA) is committed towards assisting its members in terms of reducing green house gas (GHG) emissions and conserving energy. SABITA has undertaken to provide its members with the tools to monitor their GHG emissions and energy consumption and to ensure best practice in this regard. This document serves to ascertain the framework for future GHG related legislation which is being developed in South Africa, and the implications of such on the SABITA members.

The objectives of this report are presented in the following sub-section.

1.1 Objectives

The objectives of this report are as follows:

- To outline the proposed legislation and policy framework covering carbon emissions management
- To ascertain the cost implications of the proposed carbon tax on the SABITA members
- To outline the carbon reductions strategies which may be applied to reduce the carbon intensity of SABITA member plants

These three objectives are respectively outlined in the sections which follow:

2 Carbon Emissions Management Legislative and Policy Framework

The relevant legislation that applies to carbon dioxide emissions management is outlined in the following table:

Table 1: Outline of key legislative and policy framework for carbon management

Name	Outline	Implication on SABITA Members
National Environmental Management: Air Quality Act (Act No. 39 of 2004)	Governs management of air pollutants, and under GN33064 (31 March 2010) provides limits in terms of specific pollutant emissions (Subcategory 5.8 covers Macadam preparation)	Under Section 29 (1) the Minister or MEC of Environmental Affairs, may identify priority air pollutants, and require specific entities to develop and implement pollution prevention plans for these specific pollutants (eg: carbon dioxide)

Name	Outline	Implication on SABITA Members
Customs and Excise Act (Act No. 91 of 1964)	Framework legislation making provision for customs and excise duty levies, fuel and environmental levies, etc	• The fossil-fuel based electricity generation environmental levy is governed under the framework of this act (currently part of electricity tariff at 2c/kWh) • Under GNR 770 (31 August 2010) the vehicle carbon tax has be promulgated in terms of this act (this may be extended to all commercial vehicles) • Environmental levies and taxes on fuels would be developed under this act
National Climate Change Response Strategy green paper	This framework policy will guide the management of GHG emission mitigation and climate change adaptation within the country, and is expected to be released as a white paper by July 2011	• Section 5.5.3 stipulates the use of AQA S.29(1) as described above to enforce management of GHG emissions from significant industrial sources (i.e. >0.1% of total emissions for the sector) in line with approved mitigation plans • Section 5.5.4 highlights the development of an escalating CO_2 tax on all energy related CO_2 emissions • Section 5.6.7 outlines the commitment to continuing implementation of flat rate specific excise tax related to passenger vehicle carbon emissions • Section 5.6.8 makes mention of the consideration of lowering fuel taxes on cleaner fuels • Section 8.4.2 stipulates the mandatory submission of GHG data by all significant emitters by 2013

As is evident from Table 1 above, the legislation is geared towards managing, reporting and controlling carbon emissions (through the use of taxes and levies). The monitoring of on-site combustion fuel emissions is envisaged to be used to ascertain quantity of carbon tax to be paid, while in the case of electricity and liquid fuels consumption (vehicles) the carbon tax may be implemented through addition of environmental levies onto the tariff charged.

The proposed carbon tax as outlined in the Treasury discussion paper (Reducing Green House Gas Emissions: The Carbon Tax Option – December 2010) has been developed in line with the policy framework covered in the National Climate Change Response Strategy. The cost implication of this proposed carbon tax is highlighted in the following section.

3 Cost Implications

The cost implications of the proposed carbon tax need to be split into three specific categories, namely (i) on-plant electricity use; (ii) on-plant combustion fuel use; and (iii) vehicle liquid fuel use. As per these three categories of energy related carbon dioxide emissions, the same premise applies to ultimately charge a carbon tax of R200/ton CO_2 (2005 prices), and the different formats of this charge are as follows:

- Electricity: charged per environmental levy at 20c/kWh electricity use (this is based on ESKOM current emission factor of 1 kg CO_2 per kWh) – ESKOM may be liable for a portion of this cost since they are the primary emitters, however this is still to be debated and for the purposes of this analysis the cost is assumed to be solely paid by the electricity user
- Liquid fuel: possibly to be charged as environmental levy at 45-60c/l (this is based on calorific value and emission factor of liquid transportation fuels)
- On-site combustion emissions will be monitored either through fuel consumption data or stack measurement and charged at R200 per ton CO_2 emitted

The carbon tax, if approved, will be implemented at an escalated cost possibly starting at R75/ton CO_2 (2005 prices). The exact time period of implementation is unknown, but may be implemented based on the different energy sources, namely electricity use may be levied at the full cost in the short term since this levy is already in place, and may be escalated to the 20c/kWh level. On-site carbon emissions are only envisaged to be mandatorily reported by 2013, and this may serve as the timeframe for the implementation of the on-site plant combustion emissions carbon tax.

The cost implications for the sector as a whole and for an individual plant (producing 180 000 tons asphalt/year) are outlined in the sub-sections below.

3.1 Asphalt Manufacturing Sector Cost Implications

The generic energy use of asphalt production plants was taken to be as follows:

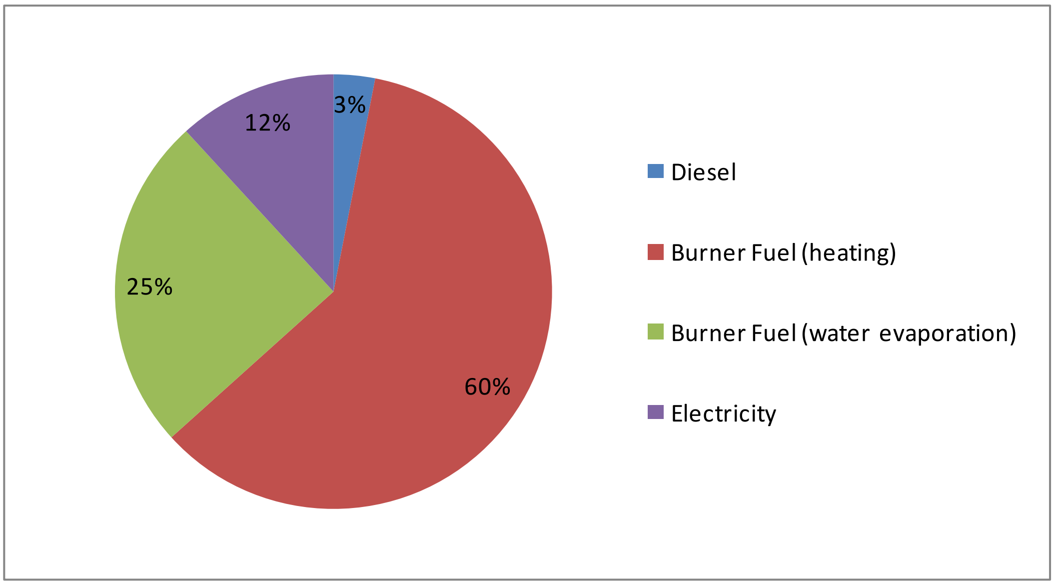

Figure 1: Typical split in terms of asphalt plant energy use

Figure 1 above highlights the split in terms of energy use on a typical hot mix asphalt plant, which has an energy intensity of 0.3-0.35 GJ/ton of asphalt processed. Given the recent figures presented in Asphalt News (April 2010) of 415 000 tons bitumen processed per year, and the average bitumen composition of asphalt being 5%, a rounded figure of 8 million tons asphalt is assumed to be produced by the industry per year. Based on these assumptions the expected energy use of the asphalt sector is presented below:

Table 2: Estimated asphalt sector energy consumption

Energy Source	Energy Use (GJ/yr)	
	Lower Value	Upper Value
Diesel	72 000	84 000
Heavy Fuel Oil (HFO)	2 040 000	2 380 000
Electricity	288 000	336 000
Total	**2 400 000**	**2 800 000**

Based on the expected energy consumption of the asphalt manufacturing sector and the CO_2 emission factor of the various energy sources[2], the overall CO_2 emissions of the sector can be determined as follows:

Table 3: Estimated CO_2 emissions of the asphalt manufacturing sector

Energy Source	CO2e Emissions (tons CO2e/yr)	
	Lower Value	Upper Value
Diesel	5300	6200
HFO	150000	174000

[2] Diesel: 74.1 kg CO_2e/GJ; HFO: 73.3 kg CO_2e/GJ; Electricity: 277.8 kg CO_2e/GJ

Energy Source	CO2e Emissions (tons CO2e/yr)	
	Lower Value	Upper Value
Electricity	80000	93000
Total	**235 300**	**273 200**

It is evident from Table 3 above that the total carbon dioxide emissions for this sector amount to between 235 000 to 273 000 tons CO_2/year. The large range is due to the large difference in the energy intensity of asphalt plants (depending on their energy efficiency level) ranging between 0.3-0.35 GJ/ton of asphalt produced.

Making use of the expected quantity of CO_2 emissions for the sector the expected cost implications of the carbon tax at R75/ton and R200 are highlighted in the following tables.

Table 4: Asphalt manufacturing sector carbon tax cost implications at R75/ton CO_2

Energy Source	Cost (Rand/yr)	
	Lower Value	Upper Value
Diesel	R 397 500	R 465 000
HFO	R 11 250 000	R 13 050 000
Electricity	R 6 000 000	R 6 975 000
Total	**R 17 647 500**	**R 20 490 000**

It is evident that even at the phase in level of R75/ton of CO_2 emissions the financial implication on the asphalt manufacturing sector amounts to R17-20 million/year (2005 prices). The cost implication of the full charge rate of R200/ton of CO_2 is presented in the table below:

Table 5: Asphalt manufacturing sector carbon tax cost implications at R200/ton CO_2

Energy Source	Cost (Rand/yr)	
	Lower Value	Upper Value
Diesel	R 1 060 000	R 1 240 000
HFO	R 30 000 000	R 34 800 000
Electricity	R 16 000 000	R 18 600 000
Total	**R 47 060 000**	**R 54 640 000**

It is evident from Table 5 above that at R200/ton of CO_2 emissions the financial implication on the asphalt manufacturing sector amounts to R47-54 million/year (2005 prices).

The cost implications at plant level are presented in the following sub-section.

3.2 Hot Mix Asphalt Plant Cost Implications Example

Based on the expected energy consumption of a 180 000 ton/year asphalt manufacturing plant and the CO_2 emission factor of the various energy sources[3], the overall CO_2 emissions of the plant can be determined as follows:

Table 6: Estimated CO_2 emissions of an asphalt plant (180 000 tons/year)

Energy Source	CO2e Emissions (tons CO2e/yr)	
	Lower Value	Upper Value
Diesel	120	140
HFO (HMA)	3360	3930
Electricity	1800	2100
Total	**5 280**	**6 170**

It is evident from Table 6 above that the total carbon dioxide emissions for a typical HMA plant amounts to between 5 300 to 6 200 tons CO_2/year. The large range is due to the large difference in the energy intensity of asphalt plants (depending on their energy efficiency level) ranging between 0.3-0.35 GJ/ton of asphalt produced.

Making use of the expected quantity of CO_2 emissions for a typical plant the expected cost implications of the carbon tax at R75/ton and R200 are highlighted in the following tables.

Table 7: Asphalt plant (180 000 tons/year) carbon tax cost implications at R75/ton CO_2

Energy Source	Cost (Rand/yr)	
	Lower Value	Upper Value
Diesel	R 9 000	R 10 500
HFO	R 252 000	R 294 750
Electricity	R 135 000	R 157 500
Total	**R 396 000**	**R 462 750**

It is evident that even at the phase in level of R75/ton of CO_2 emissions the financial implication on the asphalt manufacturing plant amounts to R400 000 – R460 000/year (2005 prices). The cost implication of the full charge rate of R200/ton of CO_2 is presented in the table below:

Table 8: Asphalt plant (180 000 tons/year) carbon tax cost implications at R200/ton CO_2

Energy Source	Cost (Rand/yr)	
	Lower Value	Upper Value
Diesel	R 24 000	R 28 000
HFO	R 672 000	R 786 000
Electricity	R 360 000	R 420 000
Total	**R 1 056 000**	**R 1 234 000**

[3] Diesel: 74.1 kg CO_2e/GJ; HFO: 73.3 kg CO_2e/GJ; Electricity: 277.8 kg CO_2e/GJ

It is evident from Table 8 above that at R200/ton of CO_2 emissions the financial implication on a asphalt manufacturing plant amounts to R1.0 – 1.2 million/year (2005 prices).

4 Carbon Reduction Strategies

This final chapter provides several recommendations for both technological and management changes to provide improvements in terms of energy usage and green house gas reduction. These proposed technological and management recommendations are respectively presented in the following three sub-sections.

4.1 Technological Process/Fuel Changes to Reduce CO_2 Emissions

The implications in terms of CO_2 emission reductions through conversion of a hot mix asphalt (HMA) process to a warm mix asphalt (HMA) process as well as fuel change from HFO to natural gas are highlighted in the following figure.

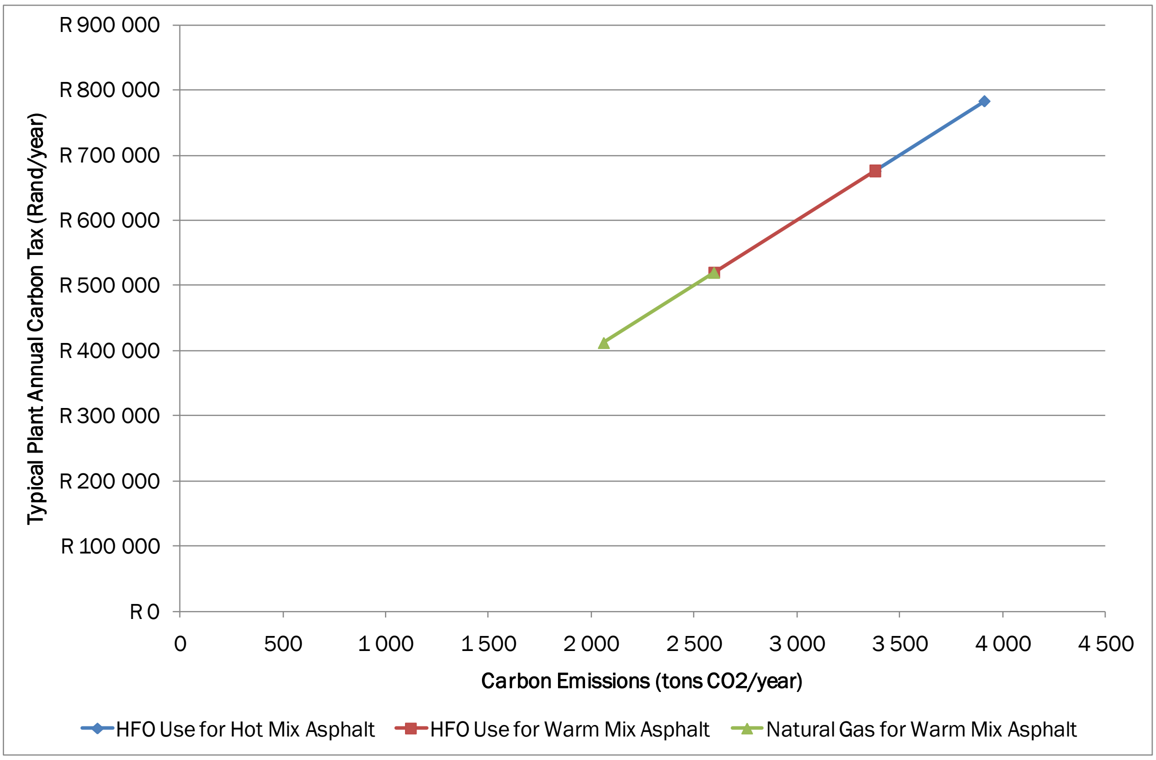

Figure 2: Reducing dryer/mixer CO_2 emission via switch to WMA & burner fuel changes

From Figure 2 above it is evident that through conversion of a hot mix asphalt (HMA) process plant (180 000 tons/yr) to a warm mix asphalt (HMA) process as well as fuel change from HFO to natural gas the expected drier/mixer carbon emissions could be halved (as well as the carbon tax cost being reduced from R800 000 to R400 000).

4.2 Technological Improvements to Facilitate Energy Usage Reduction

The following technological improvements in terms of plant equipment and layout provide possible practical solutions to reduce energy consumption and associated GHG emissions.

Table 9: Identified Employed Plant Drier and Mixer Technology

Energy Reduction Measure	Technology
Stockpiling Aggregate Under Roof on Sloped Concrete Floors	The storage of aggregates under roof on sloped concrete floors to allow drainage out of stockpile from the deposition side (i.e. opposite the loading side) has been observed to realise large fuel reduction. This is because for every increase of 1% in aggregate moisture content the fuel consumption increases by 10% *(NAPA, 2007)*.
Counter Flow Arrangement of Single Drum Plants	These are designed in a counter-flow design whereby hot burner gases flow in the opposite direction to the aggregate entering the drier. The counter flow arrangement allows for decreased exit temperature of gases and more efficient heat transfer due to greater Temperature Difference ΔT. The arrangement requires that the burner nozzle is extended through the mixing compartment of the drum and into the drier section by means of tubing. The burner tube is extended well into the drier drum, providing some distance between the flame and the RAP/RA/Bitumen addition to the drum. This allows for indirect pre-heating of the RAP/RA/Bitumen from the heat provided by the burner. Careful management of the heating of RAP/RA/ Bitumen needs to be carried out to prevent production of brittle (low quality) asphalt product *(EAPA; 2007)*.
Frequent Replacement of Worn Flights in Drier	Worn out flights, which lift the aggregate in the drier to ensure maximum surface area exposure for heating, must be frequently replaced to ensure good heat transfer between drier gases and aggregate. Inefficiencies will be noticed in the flue gas temperature, and hence it is vitally important that flue gas temperature is properly monitored. A reduction in flue gas exit temperature by 22ºC could reduce fuel consumption by 4% *(NAPA; 2007)*.

Energy Reduction Measure	Technology
Lagging	The following equipment insulation is recommended as a minimum guideline (http://oee.nrcan.gc.ca; accessed 19/06/2009) : • Bitumen Storage Tanks: 10cm thick mineral fibre (basalt/steel slag type) with aluminium cover • Bitumen Transfer Pipelines: 5cm thick mineral fibre (basalt/steel slag type) with aluminium cover • Drier/Mixer: 15-20cm thick mineral fibre (basalt/steel slag type) with aluminium cover. Lagging of the drier alone has been observed to realise 5-10% fuel reduction *(NAPA; 2007)* • Asphalt Storage Tanks: 10cm thick mineral fibre (basalt/steel slag type) with aluminium cover
Flue Gas Heat Recovery	Heat recovery from flue gas through the pre-heating of combustion gases is only applicable in the case where thermal heating is provided by a boiler, unless the hot flue gas provides sufficient thermal energy for a gas/water heat exchanger. The heated water or boiler steam is used to heat thermal oil which runs through the heating coils of the bitumen and asphalt storage vessels. The issue associated with flue gas heat recovery is that during times when the plant is shutdown the bitumen storage tanks require an alternative heating source, which would be provided by electricity. Electrical heating of thermal oil for tank heating is most commonly used in Southern Africa.
Asphalt Product Storage in Closed Silos	The design of closed asphalt storage silos could reduce the requirement for recycling of asphalt since effective heating and insulation is possible in these cases. However effective demand side management of required asphalt product could be used as an alternative if asphalt storage silos are designed as open systems.
Use of Batch Plants for Applications Requiring Large Product Diversity	Drum plants require a considerable amount of recycling of asphalt product since changes to different product mixes generate a significant amount of off-spec product. Batch plants are more flexible in this regard, and hence reduce recycling reheating energy requirements *(EAPA; 2007)*.

From Table 9 above it is evident that a number of possible technological measures are possible to reduce energy consumption of hot mix asphalt plants and their associated green house gas emissions. Among these include:

- Stockpiling aggregates under roof on sloped concrete floors (drainage in opposite direction to loading point)
- Counter-current flow design of burner gas and aggregate flow direction in single drum plants
- Frequent replacement of worn flights in drier
- Effective lagging of all vessels and pipelines containing heated materials
- Flue gas heat recovery (if appropriate)

- Asphalt product storage in closed silos
- Use of batch plants for applications requiring large product diversity

4.3 Management Interventions to Reduce Energy Consumption

The main recommendations in terms of management interventions to reduce plant energy consumption involve the following:

- Training of staff on reducing energy consumption, which has most relevance in terms electricity consumption on the plant
- Control of thermocouple monitoring variables to prevent energy wastage
- Careful monitoring of particularly the flue gas temperature to monitor the efficiency of the drier in terms of heat transfer to input materials and prevention of excess fuel supply into burner
- Continuous monitoring of energy consumption to keep track of performance in this regard and to facilitate continued plant efficiency improvements (which should be communicated to staff on a regular basis)

5 References

- European Asphalt Pavement Association (2007); “Environmental Guidelines on Best Available Technology for the Production of Asphalt Paving Mixes”; Brussels; June 2007
- Intergovernmental Panel for Climate Change (2006); “Guidelines for National Greenhouse Gas Inventories”, Volume 2: Energy
- National Asphalt Pavement Association (2008); “National Asphalt Pavement Association Comments to the Midwest Regional Planning Organisation: Interim White Paper on Candidate Control Measures to Reduce Greenhouse Gas Emissions from Hot Mix Asphalt Plants”; 5 December 2008
- National Asphalt Pavement Association (2007); “Energy Conservation in Hot Mix Asphalt Production”; TJ Young; QIP126; December 2007
- Southern African Bitumen Association (2008); “Introduction to SABITA’s HSE Certification Scheme”; March 2008
- http://www.treasury.gov.za/public%20comments/Final%20Press%20Release%20Carbon%20Tax%20Discussion%20Paper.pdf; accessed 07/02/2011
- http://www.treasury.gov.za/public%20comments/Discussion%20Paper%20Carbon%20Taxes%2081210.pdf; accessed 07/02/2011
- www.climateresponse.co.za; accessed 07/02/2011
- www.ladco.org/reports/control/white_comments/**asphalt/napa**.pdf; accessed 07/02/2011
- http://oee.nrcan.gc.ca/publications/industrial/cipec/bitumar-case-study.cfm ; accessed 07/02/2011