The Environmental Footprint of Bitumen

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Global warming and climate change

Can we play our part in addressing the problem?

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3 hard truths

1. Demand for energy is accelerating.

   Energy use in 2050 may be twice that of 2000

   World population is predicted to be 9 billion by 2050

   In 2006 China enlarged its energy capacity by roughly the equivalent of the UK's total stock pf power generation plants

2. "Easy" oil and gas can not keep up with demand

   Demand is increasing as conventional fields go into decline

   However, availability of resources is not the issue. The International Energy Agency IEA suggest there are 20 trillion boe in conventional and unconventional resources (oil shales and oil sands) representing 400 years supply at 2007 consumption rates but only half of it is accessible with current technologies

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3. Increased energy demand = increased emissions

Increased demand will mean more cars on the road and therefore more usage of hydrocarbon fuels and more vehicle emissions

Presently additional power generation energy is coming from coal . The IEA reported that coal became the single biggest source of world CO_2 emissions in 2004 representing 40% of overall emissions.

Coal usage could grow by 60% in 20 years

A key aspect of controlling emissions is to have a ‘coal strategy’

But what does this mean for the asphalt Industry?

- We are moving towards greater environmental scrutiny of Industrial operations
- Reporting of emissions data has moved progressively from voluntary to mandatory
- The National Greenhouse and Energy Reporting Act (NGERs) was passed into law on 29th September 2007
- All Industries will need to quantify and manage carbon emissions
- Whilst this is a good aspiration, for some Industries, it is a highly complex challenge.

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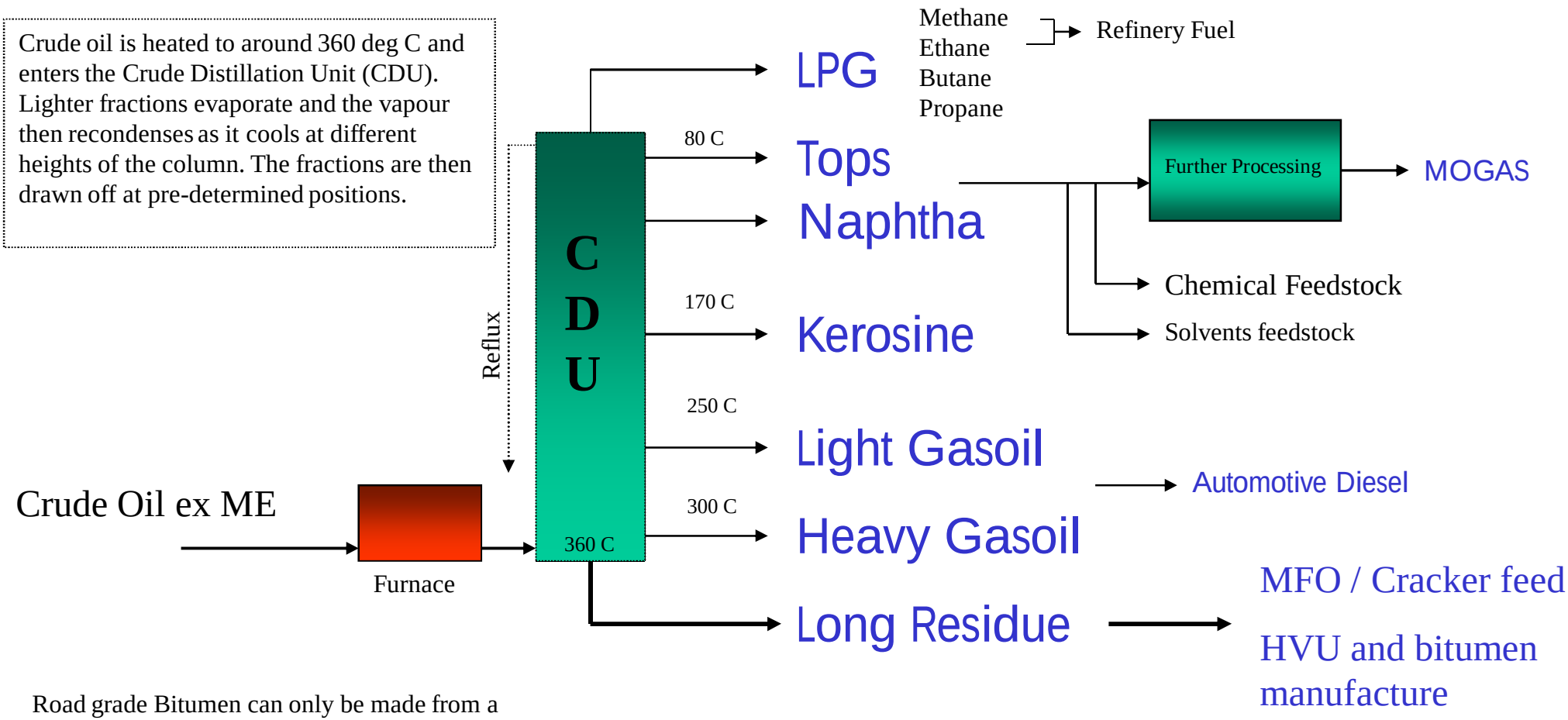
The complexity of the bitumen supply chain

Shell Pulau Bukom
Constructed ~ 1961
processes ~ 500,000 barrels/day

Atmospheric Pressure Fractionating Unit

Crude oil is heated to around 360 deg C and enters the Crude Distillation Unit (CDU). Lighter fractions evaporate and the vapour then recondenses as it cools at different heights of the column. The fractions are then drawn off at pre-determined positions.



Road grade Bitumen can only be made from a limited number of crude oils. For the NZ market these come almost exclusively from the Middle East

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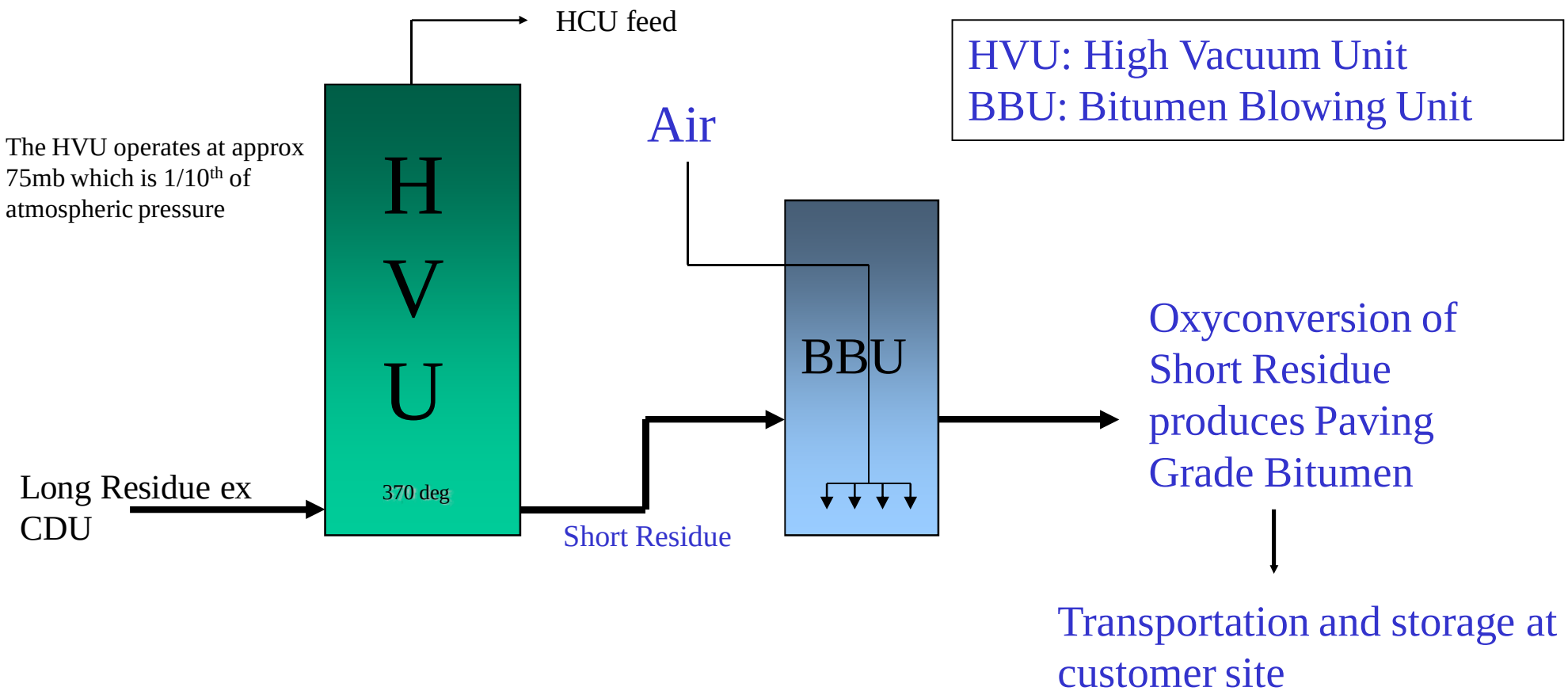
Vacuum Distillation and Bitumen Production



In volume terms, bitumen represents approx 3% of the barrel

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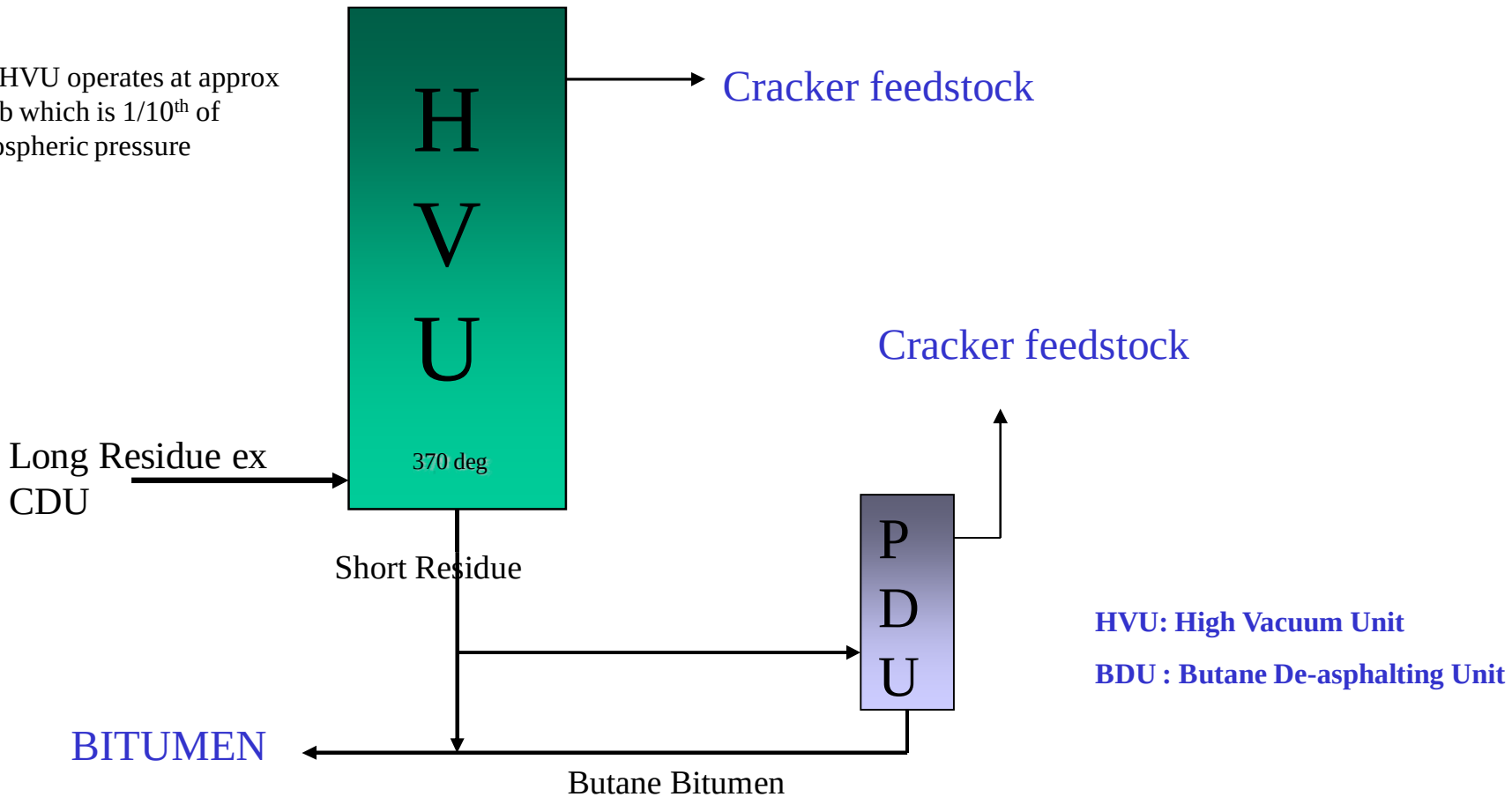
Vacuum Distillation and Bitumen Production

The HVU operates at approx 75mb which is 1/10th of atmospheric pressure



HVU: High Vacuum Unit

BDU : Butane De-asphalting Unit

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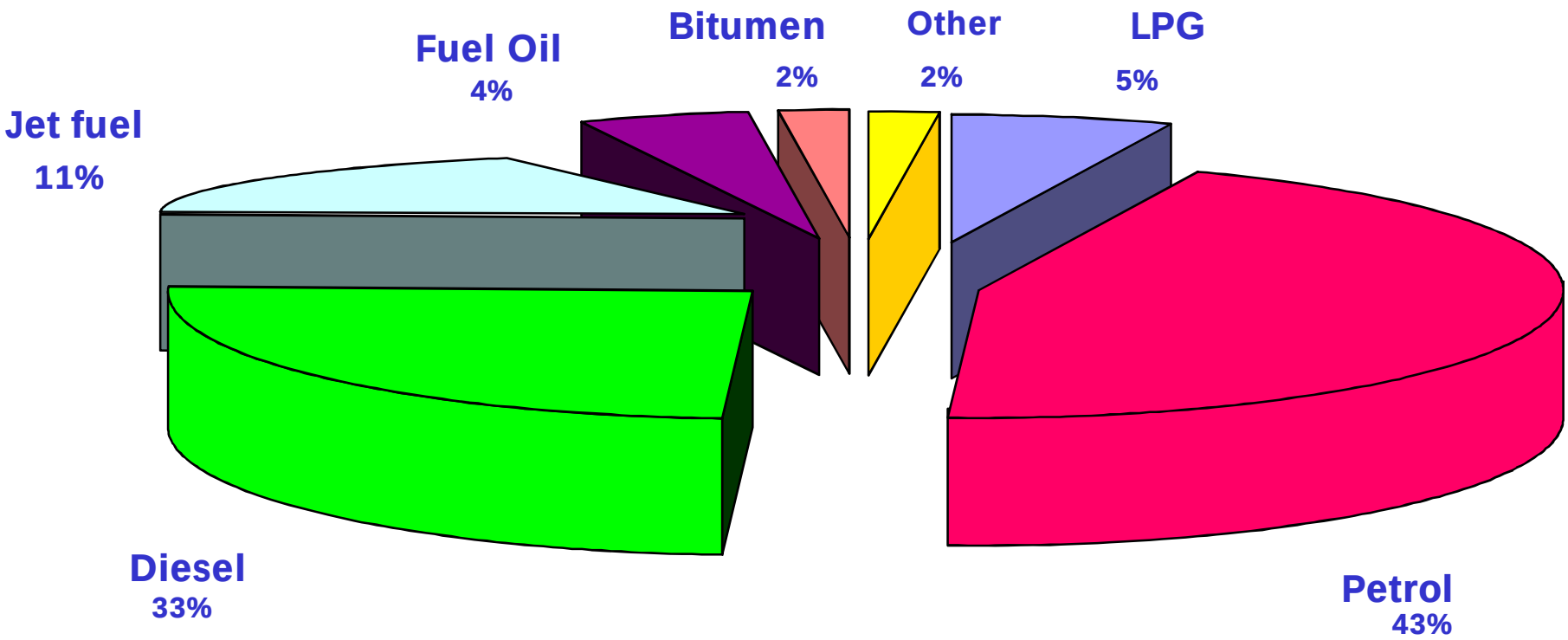
Typical product pie of refinery operations



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Geelong Refinery

Geelong is a small refinery in modern terms. It processes approximately 38 million barrels of crude per annum.

Glg produces:

- 6 billion litres of petroleum products (17 million litres each day) 50% of Victoria's fuel demand and 75% of Tasmania's fuel demand
- Petrol (25% being high octane grades);
- Diesel fuel;
- Jet fuel;
- Bitumen;
- LPG;
- Specialty solvents; and,
- Avgas

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Refinery emissions

- The small refineries operating in Australia can produce up to approx 1 million tonnes of CO2e emissions and 0.4 million tonnes of indirect emissions
- Isolating the bitumen contribution to the refinery emissions requires complex measurement and modelling
- To date, this modelling has not yet been performed
- Initiatives have been implemented at Glg for example reducing annual greenhouse gas emissions by 54.5kt CO_2-e

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Refinery emissions and bitumen

- Estimations suggest that refinery bitumen production will generate 0.13 tonnes CO_2 / tonne bitumen*
- In the context of the previously mentioned refinery in Australia, this equates to approximately 23kt CO_2 or up to 2.3% of the refinery's direct CO_2 emissions

* This estimate will vary from refinery to refinery

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Bitumen in the refinery

- Refinery economics value bitumen in the context of alternative use of the hydrocarbon molecules. Bitumen is generally considered as an alternative to Fuel Oil in oil refining economics and thus must therefore deliver at least equivalent value to the refiner.

- Typically a heavy fuel oil produces 3.1 tonnes of CO2 for every tonne of fuel fired; Therefore when a decision is made to manufacture 1000 kt of bitumen instead of a heavy fuel oil this results in 3.1 million tonnes of CO2 being sequestered.

- Asphalt roads are therefore a means of sequestering CO2

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Industry reporting

The National Greenhouse and Energy Reporting Act [4] (the NGER Act) came into effect on the 29th September 2007 and introduced a national framework for the reporting and dissemination of greenhouse gas emissions. The Act requires that any facility emitting greater than 25kt CO_2 –e or consumes greater than 100TJ of energy, or any business or corporation that collectively emits greater than 125kt CO_2 –e or consumes greater than 500 TJ of energy must report the data within the NGERS framework

Bitumen is reported as embodying 43.2 GJ of energy per tonne of material[7]. This means that any facility (asphalt plant) that 'consumes' more than 2315 tonnes of bitumen in a year, equating to an approximate asphalt production tonnage of 47 kt will be considered to exceed the energy threshold limit on individual facilities and hence will be required to report emission data.

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Can the carbon footprint of bitumen and asphalt be reduced?

Bitumen:

- lower storage temperatures
- improved tank insulation
- move to gas fired heating systems at bitumen facilities
- improved truck insulation
- cold transportation of bitumen
- use bitumen to sequester other materials (sulphur, crumb rubber ?)
- extending bitumen with alternative materials (bio-binders)

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Can the carbon footprint of bitumen and asphalt be reduced?

Asphalt:

- Warm Mixed Asphalt (WMA): through viscosity reduction, foaming, combination of both techniques
- Low temperature asphalt (LTA): through emulsion technology
- Recycling: greater use of RAP
- Stabilisation: in-situ recycling of pavements

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Can the carbon footprint of bitumen and asphalt be reduced?

Sprayed Seals:

- Emulsion seals
- Reduction in the use of cutter in sprayed sealing operations

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Asphalt vs Concrete in road construction

- Cement production is a very energy intensive process
- It is acknowledged that cement production makes a significant contribution to environmental emissions when expressed in CO_2 units
- Cement is used as the binding agent in concrete
- It is possible to compare the carbon footprint of asphalt and concrete road construction

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Construction of 1km of Concrete Pavement generates 2,400 tonnes of CO_2

Construction of 1km of Asphalt Pavement generates 1,750 tonnes of CO_2

Construction of Asphalt Pavements generates 650 tonnes CO_2 / km less compared to construction of Concrete Pavements (27% Reduction)

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Note: This calculation is only valid for the condition mentioned in the Source.

Source: *ILV Report on "Life Cycle Assessment of Road - A Pilot Study for Inventory Analysis"*

Victoria's first carbon neutral road construction project

This $13.3 million State Government funded project extends the duplication of Mickleham Road for 2.4km north from Barrymore Road to Somerton Road at Greenvale, providing two lanes in each direction.

VicRoads has used the project as a pilot to measure the carbon footprint of road construction, and identify ways to potentially reduce and offset the carbon emissions from the roadworks.

Project-generated greenhouse emissions for the Mickleham Road upgrade will be offset with carbon credits sourced from an accredited offset provider, planting around 7,500 trees in the North West of Victoria. This equates to offsetting around 40 million black balloons

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Victoria's first carbon neutral road construction project

How the carbon footprint was calculated

When constructing the 2.4 km road duplication, VicRoads identified greenhouse emissions generated for the road works from materials such as concrete, crushed rock, steel and asphalt.

To accurately calculate the overall carbon footprint, fuel consumed by construction equipment and in trucks delivering materials to the site was also considered, along with the operation of site buildings.

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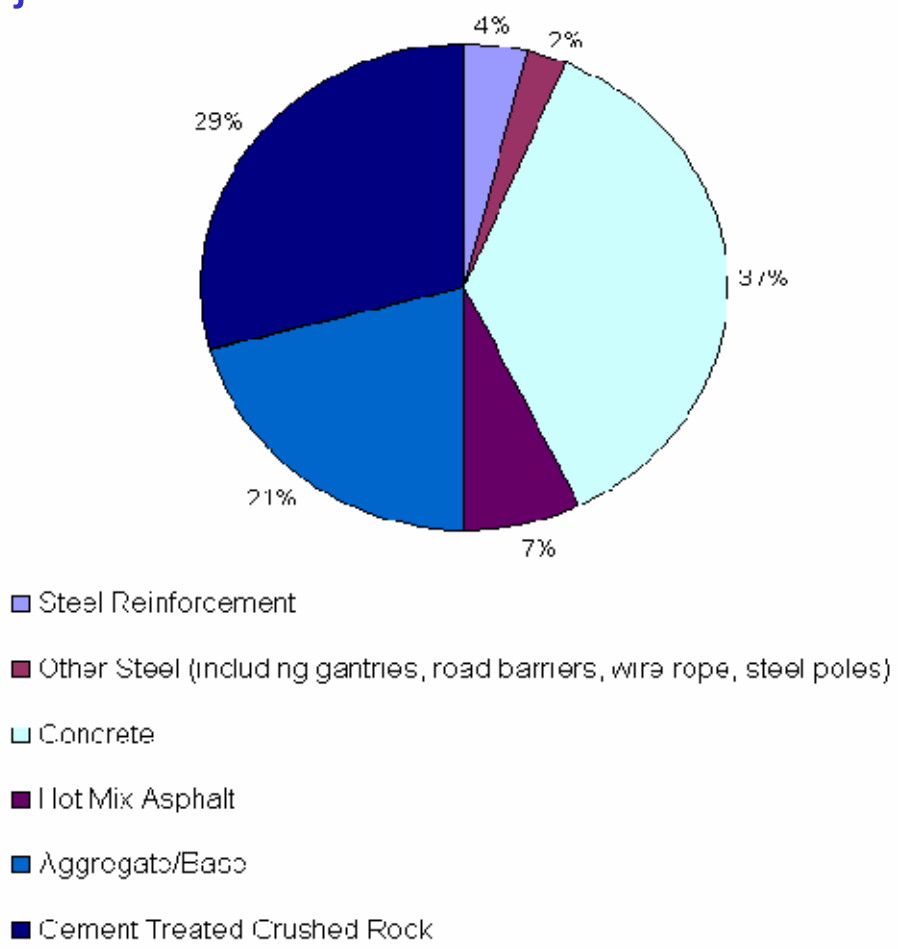
Victoria's first carbon neutral road construction project

$13.3 million Mickleham Road duplication project

Embodied carbon

- Concrete (37%)
- Cement treated crushed rock (29%)
- Aggregate / base (21%).
- Asphalt 7%
- Steel 6%

Source : Vicroads



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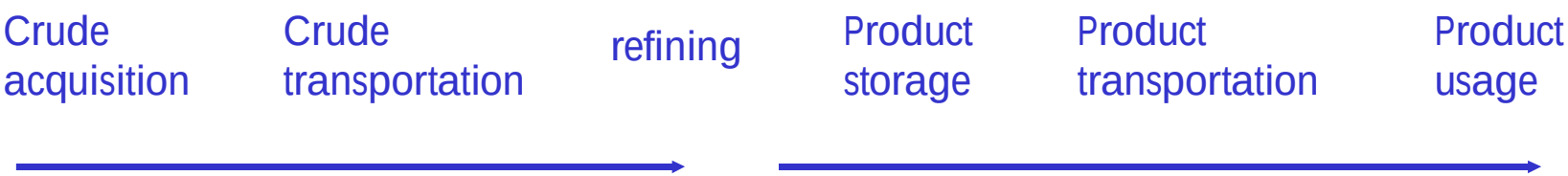
Concluding remarks

- We have approximate figures for the carbon footprint of bitumen at manufacturing and storage sites
- Isolating the precise CO2 value attributable to bitumen along the supply chain is a complex problem



- Further work is required to obtain accurate data in support of the existing values already discussed

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Concluding remarks

Representation from the Industry to have a more realistic classification of bitumen (AAPA working on this)

Quantification of emissions is in early stages

There are a number of initiatives open to the Industry to reduce energy use and greenhouse gas emissions

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“Lives of great men all remind us,

We may make our lives sublime,

And departing leave behind us

Carbon footprints in the sands of time”

Henry Longfellow: Voices of the night. 1839

Thank you for your attention

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