Common Sense Sustainability for Concrete, including Cement and Aggregates

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With acknowledgements to Dr Peter Taylor

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Background

- Concrete is the most commonly used building material on the planet
  - Modern civilization is built on concrete
  - The positive social impacts are immense
- Therefore, it has a relatively large environmental footprint
- Sustainability provides a way to balance the various economic, environmental, and social factors

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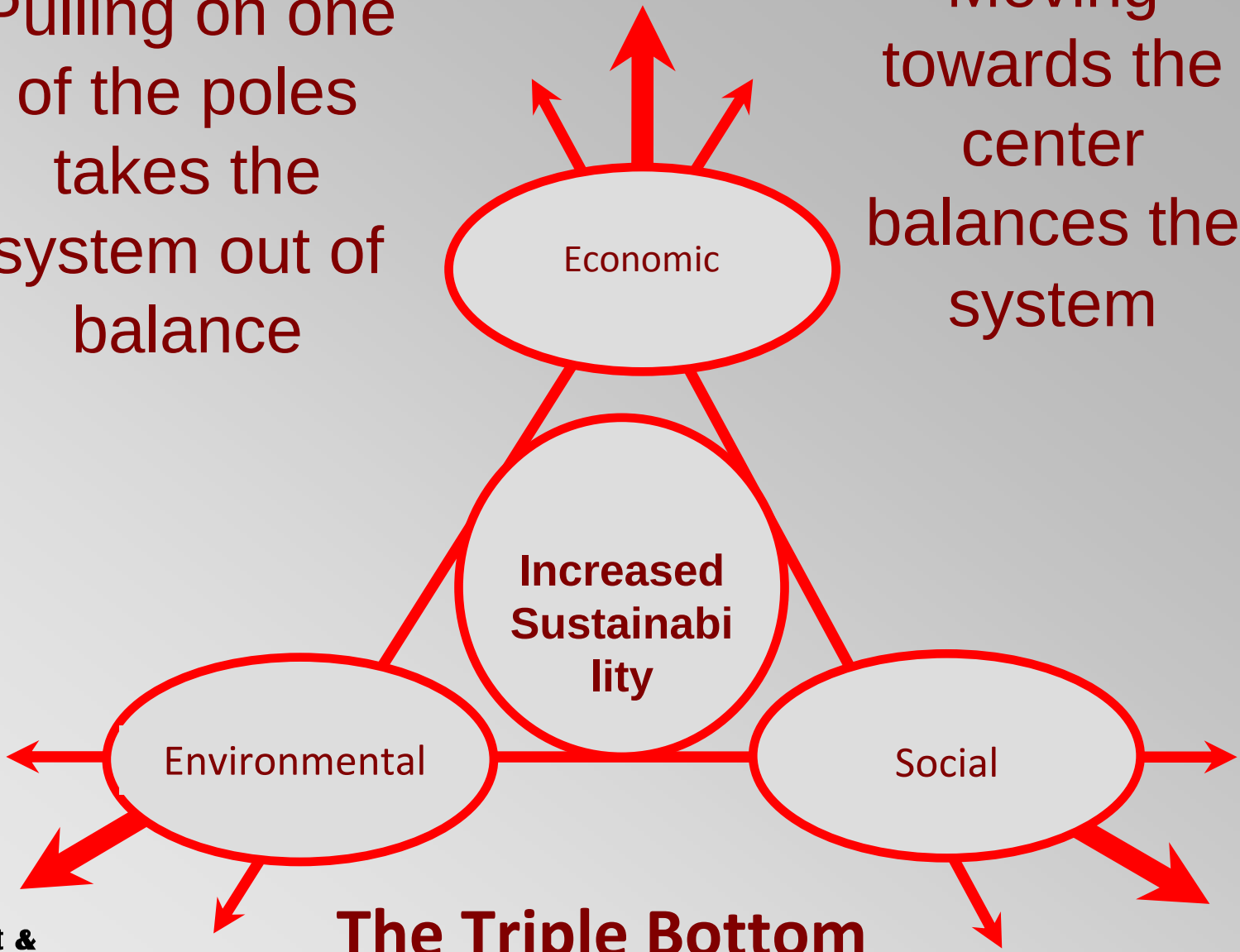
Pulling on one of the poles takes the system out of balance

Moving towards the center balances the system



The Triple Bottom Line

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Sustainable Pavements

- It is simply good engineering
  - Using limited resources to achieve design objectives
  - Not about perfection, but about balancing competing, and often contradictory, interests
- Considers life-cycle economic, environmental and societal factors
- It's complicated – get over it

Common Sense Principles of Sustainability – v 1.0

1. Get smart
2. Design to serve the community
3. Choose what you use
4. Less is more
5. Minimize impact
6. Take care of what you have
7. Innovate

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No. 1: Get Smart

- Design for what you need
  - No more and no less
  - Don’t sacrifice engineering quality
- Ensure that relevant design criteria are met
  - Holistic approach to design – it is not just thickness

No. 2: Design to Serve the Community

- Listen to the communities being affected
- Design to address the specific needs of the community…
  - Ride quality
  - Delays

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No. 3: Choose What You Use

- Recycle – zero-waste
- Local first – minimize transportation
- Select the materials to use – don't let the materials select themselves
  - Understand what is available
  - Import only what you need

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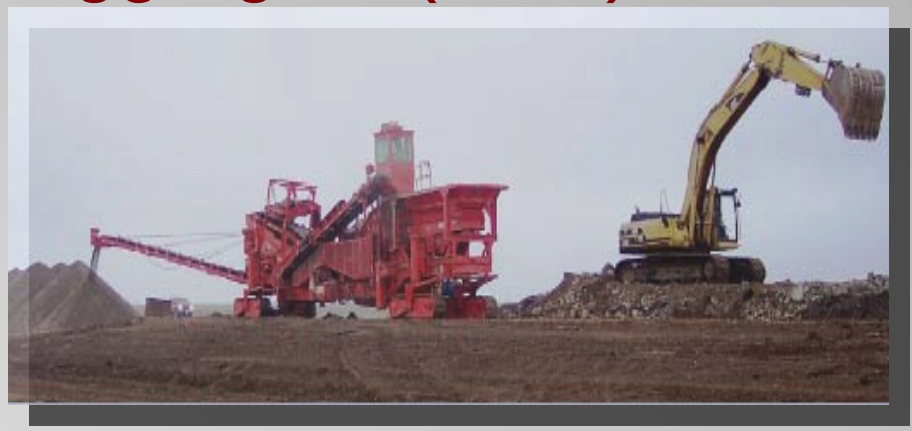
Recycling and Reuse

- Concrete is 100% recyclable
- Recycled concrete aggregate (RCA) can be used in:
  - new concrete
  - subbases
  - granular fill



- On-site recycling reduces time, energy, pollution, and can make money

Waste or Resource?

CEM I	3 320 000
CEM IIA	3 176 000
CEM IIB	3 439 000
CEM III/CEM IV/CEM V	3 477 000
GGBS	507 000
Flyash	302 000
Other	586 000
Total	14 700 000

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No. 4: Less is More

- All things equal, less material means less impact
- Using less portland cement can improve sustainability
  - Blended cements
  - Supplementary cementitious materials (SCMs – fly ash, slag, etc.)
  - Aggregate grading
  - Optimized mix design

Why Does Cement Matter?

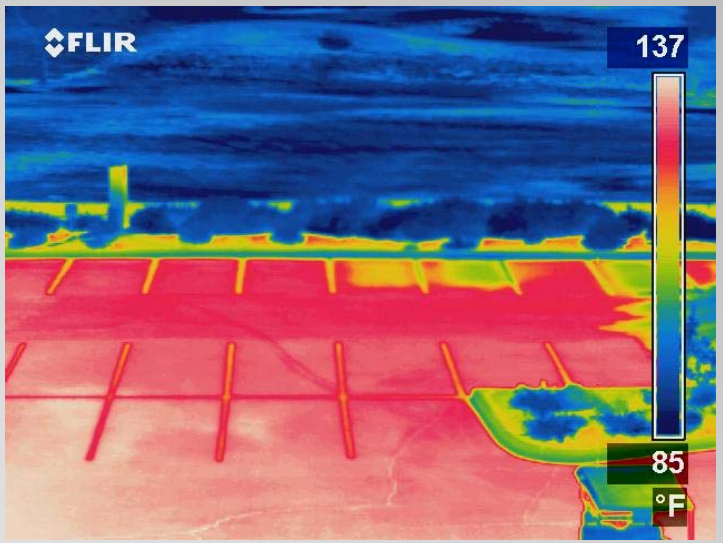
- Worldwide, cement industry is responsible for approximately 5% of man-made CO_2
- 40% from burning coal and 60% from calcination of limestone

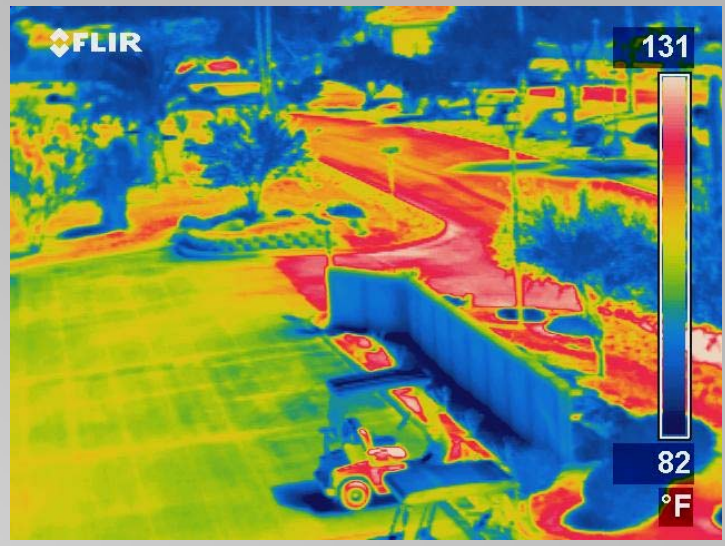
No. 5: Minimize Impact

- Noise – Construction and traffic
- Safety
  - Splash and spray
  - Lighting
- Delays – During construction and rehabilitation
- Emissions
  - Green house gases
  - Pollution
  - Particulates

No. 5: Minimize Impact

- Energy efficiency –
  - Construction
  - Operation
  - Lighting
- Urban heat island effect





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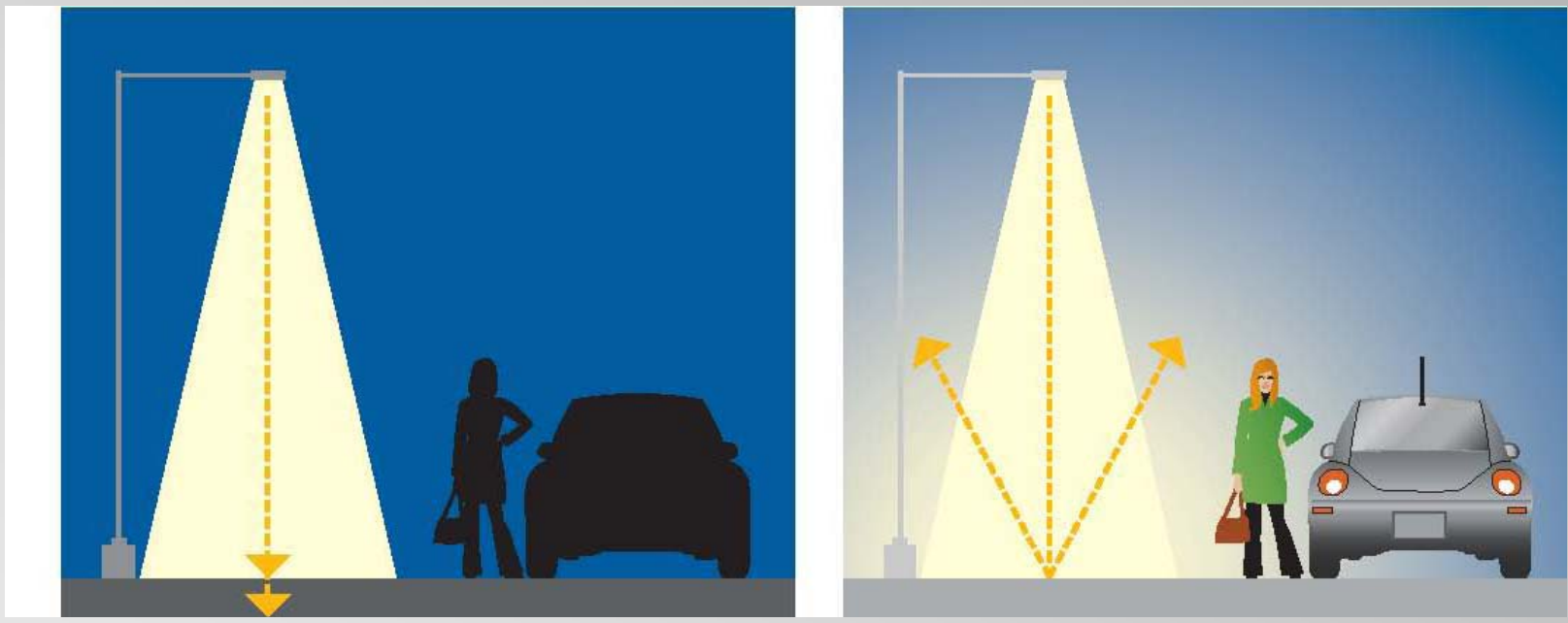

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Phases of a Pavement's Life

- Design
- Construction
- Operation
- Rehabilitation
- Recycling, Removal

Factors Affecting Sustainability

Design

Cut and fill

Design life

Construction method

Drainage

Thickness

Life cycle Cost

Materials selection

Capacity

Factors Affecting Sustainability Construction

CO_2

Virgin materials

Dust

VOC's

Delay time

Energy

Noise pollution

Life cycle Cost

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Factors Affecting Sustainability

Operation

Maintenance

Capacity

Water runoff

Noise pollution

Reflectivity

Heat island

Safety

Friction to vehicles

Longevity

Factors Affecting Sustainability
Repair/Rehabilitation/Removal

Removal = waste disposal

Repair/ Rebuild = similar issues to construction

Recycling

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No. 6: Take Care of What you Have

- Use the equity already in the existing pavement
- Well timed maintenance and rehabilitation is essential
- Design to maintain
  - For high volume concrete roadways, accommodate future diamond grinding to extend pavement life

No. 7: Innovate

- Identify problems/opportunities, generate solutions, implement, and reiterate
- Learn from mistakes
- Good specifications
- Evaluate emerging technologies and adopt those with demonstrated promise
- Educate and challenge yourself and your workforce

Quantification

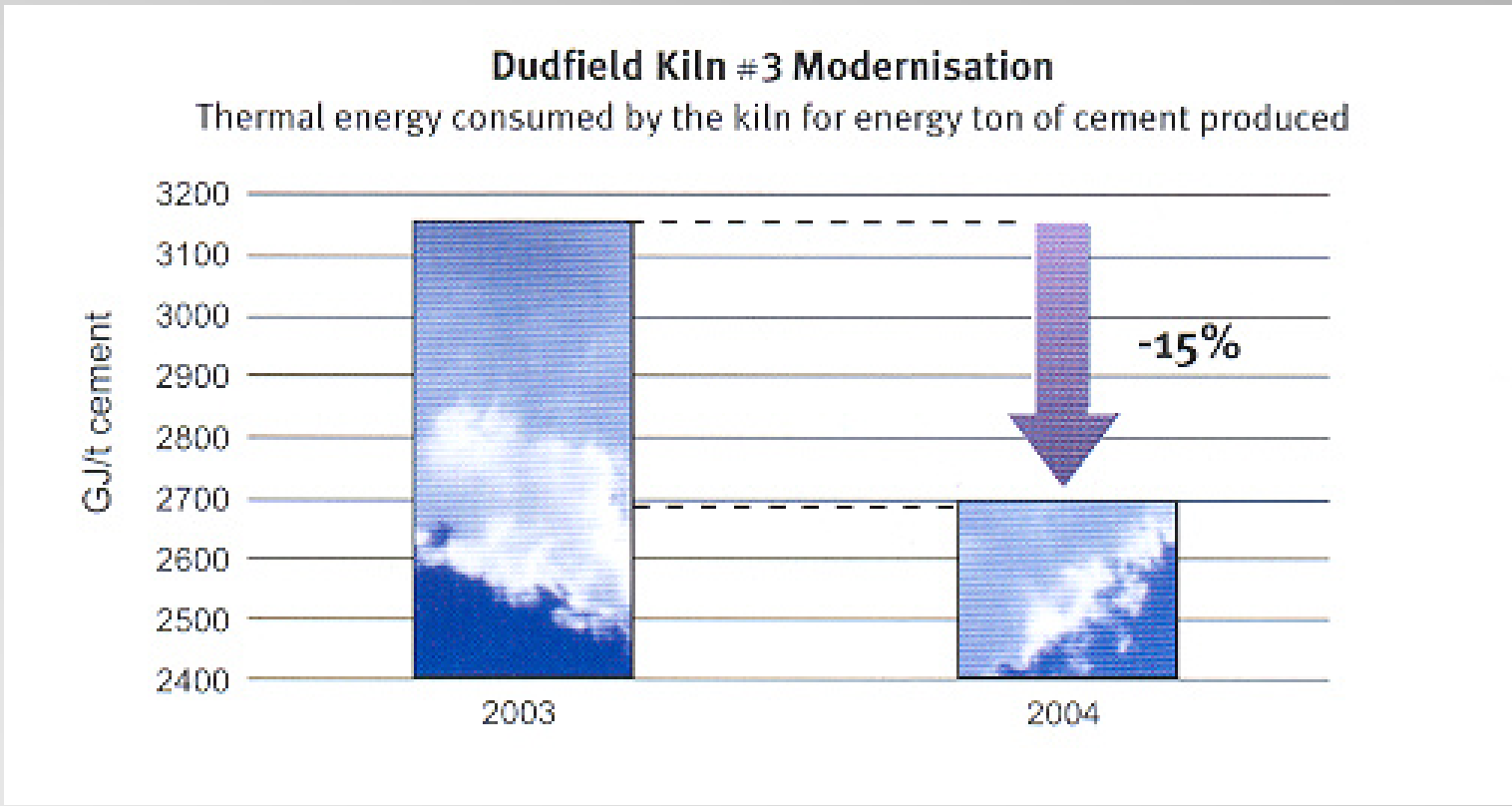
- Rating systems
  - Green Roads, GreenLITES
  - LEED
- Life cycle inventory (LCI)/life cycle assessment (LCA)
  - The future is now (ISO 14000)
  - Need to establish regional data and usable software tools

What is the Cement Industry (ACMP) doing…

- Reducing usage of raw materials
  - Use of blended cements can reduce clinker factor by 40%
  - Use of extenders such as ggbs, flyash, slica fume, ground limestone
  - Synthetic gypsum from fertilizer and sulphuric acid industries

What is the Cement Industry (ACMP) doing…

- Reducing energy consumption
  - Reduce use of non-renewable fossil fuels (> 1 million tpa)
  - Introduction of modern technology and equipment



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What is the Cement Industry (ACMP) doing…

- Reducing energy consumption
  - Reduce use of non-renewable fossil fuels (> 1 million tpa)
  - Introduction of modern technology and equipment
  - Target reduction in energy used for mining by 15% by 2015 (>50% by end 2007)
  - Use of alternative fuels including Hazardous waste

What is the Cement Industry (ACMP) doing…

- Reducing energy consumption (cont.)
  - Use of waste tyres in kilns
    - Coal – 96 kg CO2 per GJ energy consumed
    - Tyres - 85 kg CO2 per GJ energy consumed
    - Steel provides source of iron
    - No ash

What is the Cement Industry (ACMP) doing…

- Reducing emissions
  - Particulate emissions
    - Use of bag house filters – equivalent to world best practice
  - Greenhouse gas emissions

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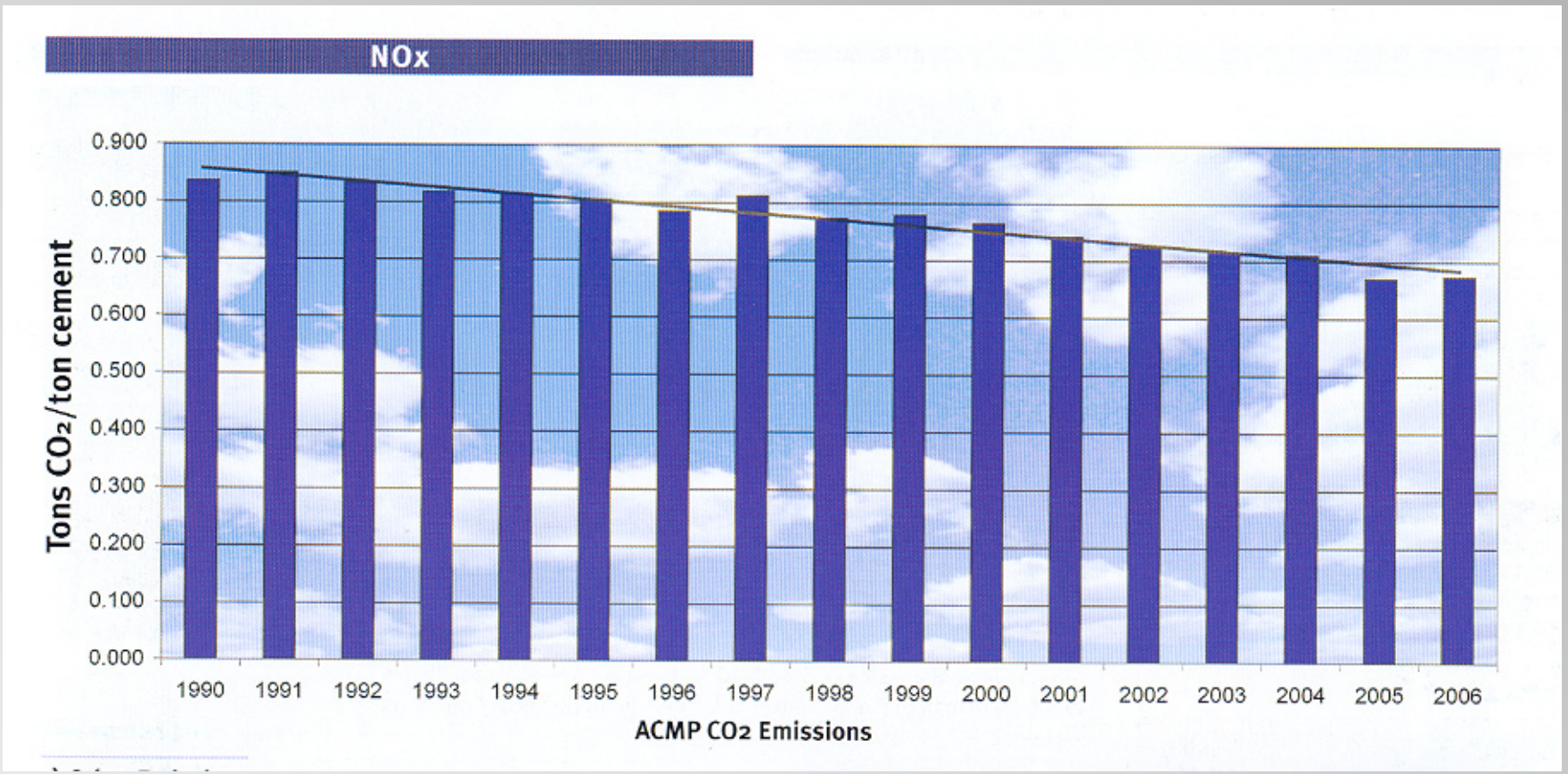

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What is the Cement Industry (ACMP) doing…

- Reducing emissions
  - Particulate emissions
    - Use of bag house filters – equivalent to world best practice
  - Greenhouse gas emissions
  - Other emissions
    - Reduced by good technology, pre-calciners, pre-heaters, etc.

What is the Cement Industry (ACMP) doing…

- Rehabilitation of mines and quarries
- CSI programmes

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What is the Aggregate Industry (ASPASA) doing…

In addition to Minerals Act and Health and Safety, committed to

- The National Environmental Management Act (NEMA);
- Environment Conservation Act (ECA);
- National Water Act (NWA)
- Air Quality Management Act (AQMA);
- Atmospheric Pollution Prevention Act (APPA);
- National Veld and Forest Fire Act (NVFFA); and
- The National Forest Act (NFA).

What is the Aggregate Industry (ASPASA) doing…

- Support of the “Triple Bottom Line” management approach
- “About Face” Environmental audits and “Fish Eagle Grading System” based on ISO 14001

What is the Concrete Industry doing…

- Conducting a survey
- Quantify embodied energy/CO_2 emissions
- For all ingredients in concrete
  - Cement
  - Extenders
  - Aggregates
  - Admixtures
  - Reinforcement
- From cradle to grave

- Includes all energy sources:
  - Electricity
  - Coal
  - Diesel
  - Blasting
  - Transport
- Conduct research to fill the gaps in knowledge (Fellowship for PhD at UCT)

Thank you

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