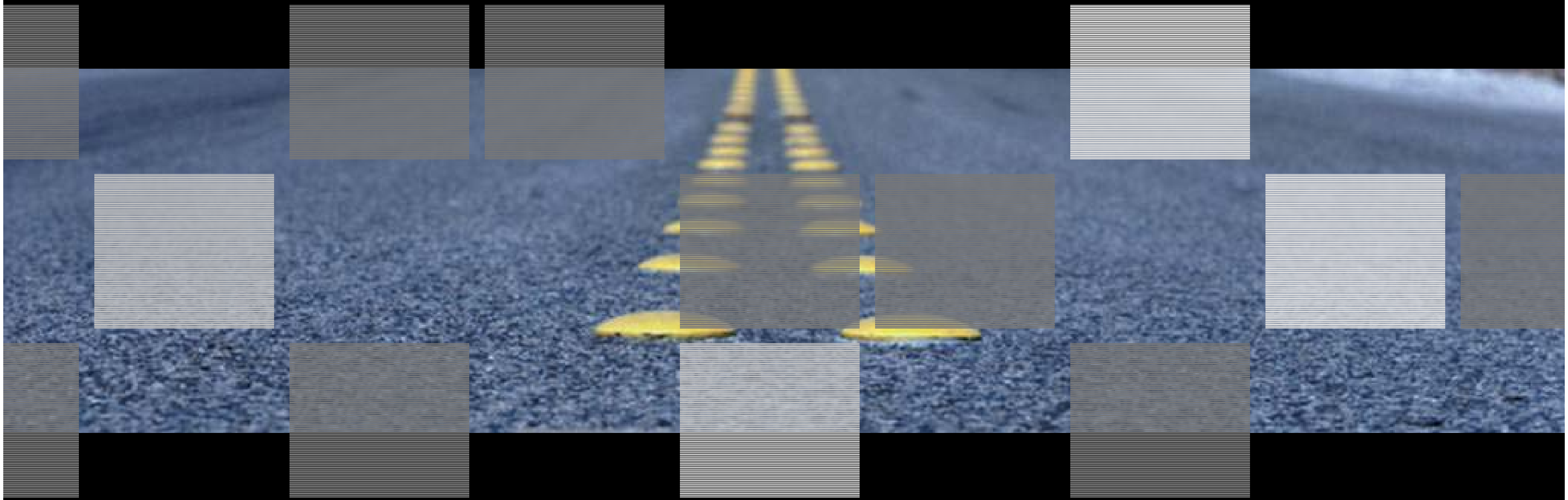


Environmentally Friendly Pavements by, Reducing Overall Energy Consumption

Christopher Holt Ph.D., P.Eng.– AMEC Earth and Environmental

Outline of Presentation

- Introduction – Energy Consumption
- Sustainable alternatives
- Reduced energy consumption resulting from road recycling – CO_2 gas reduction calculation
- Conclusions

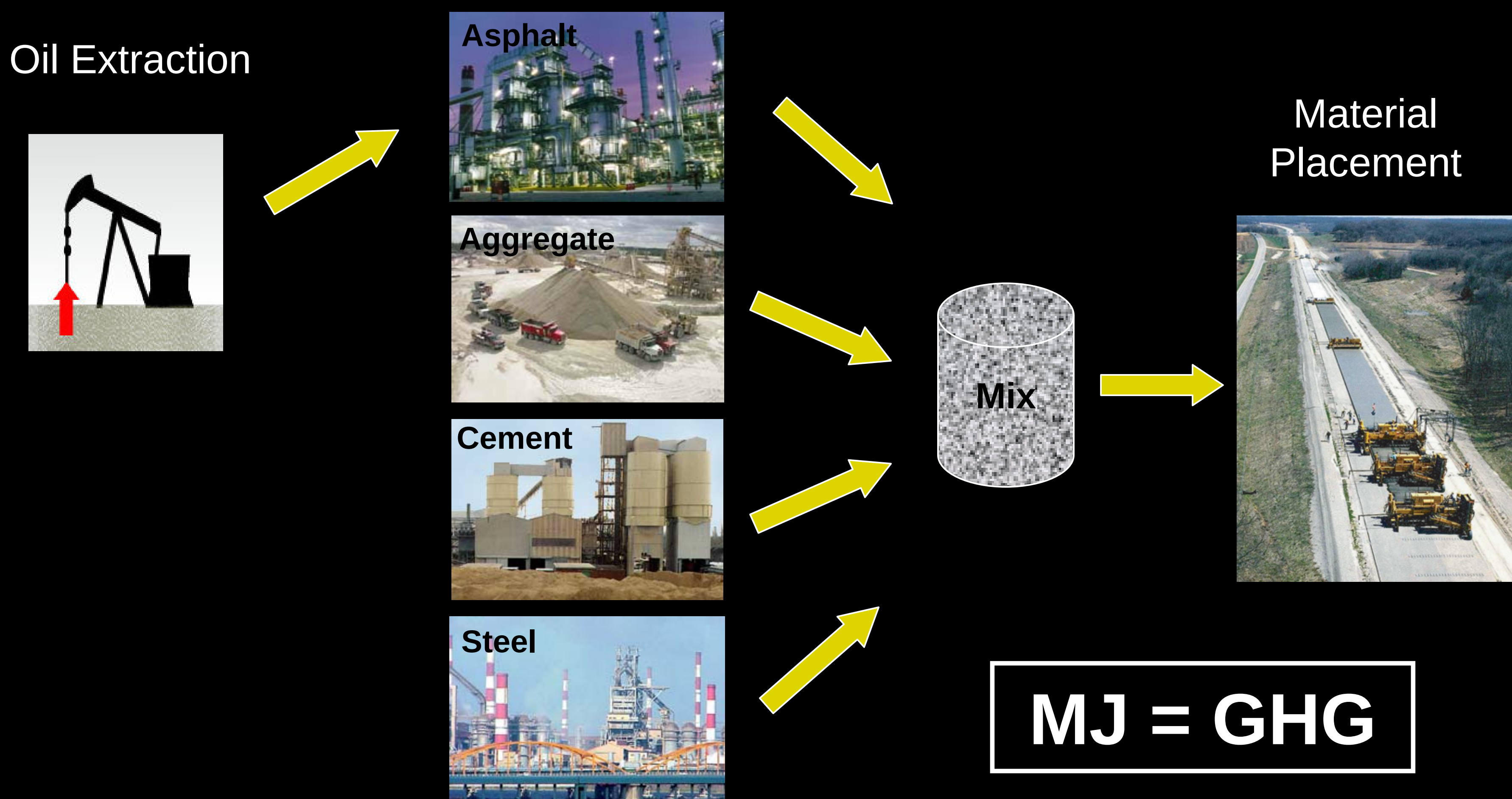
Introduction

Two distinct road types consistently utilised

- Flexible Asphalt pavements (quarried aggregates, refined oil)

- Rigid Concrete (manufactured cement and steel)

Material Production



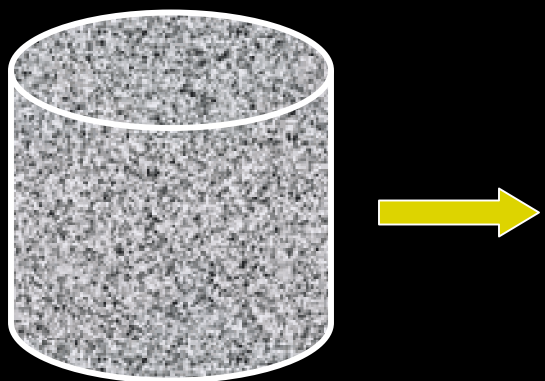
Energy Consumption

- During the construction/maintenance of a section of highway the energy consumption can be categorized as
  - Material Extraction
  - Material Production
  - Transportation of Material
  - Placement of Material (at project site)

Energy consumption at time of construction and every 7-10 years

for major maintenance activities during life cycle

Energy Requirements – HMA Production



Oil Extraction

Extraction operations

Transportation to Refinery (possibly 1000s kms)

Oil Refining

Refining operations

Transportation of refined AC (possibly 100s kms)

Aggregate Extraction

Extraction operations

Transportation ???

Mix Production

Batch/Drum plant operations

Energy Requirements – HMA Placement

Removal Pavement
Removal of failed pavement layer - operations Removal of millings (10s – 100s kms) Stockpile or Landfill
Transportation of New Material
From HMA plant to site (10s – 100s kms)
Placing new HMA
Mobilisation/demobilisation (10s – 100s kms) Energy requirement during operations

Sustainability

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

Brundtland 1987, UN

"Durable, safe and environmentally friendly pavement construction/maintenance processes that meets the needs of present users without compromising the safety and needs of future users"

Common Sustainable Approaches to Highway Construction/Maintenance

- Cold-in-Place Recycling (using bituminous stabilizers)
  - Partial depth
  - Full depth (rehabilitation)
- Cold-in-Place Recycling (using cementitious stabilizers)
  - Full depth (rehabilitation)
- Hot-in-Place Recycling
- Cold Central Plant Recycling (similar to CIP)
- Central Plant Recycling (RAP included in HMA)

Partial Depth (CIR)

Full Depth (FDR)



Hot in Place Recycling (HIR)

Cold Central Plant Recycling

GHG Reduction – Recycling vs Traditional

- Certain environmental benefits are associated with established road recycling processes
  - Reduced aggregate demand
  - Reduced aggregate/material processing
  - Reduced transportation of raw and processed material
  - Reduced energy consumption (oil, electricity, diesel, etc)

REDUCTION IN GREEN HOUSE GASES

GHG Reduction – Recycling vs Traditional

- AMEC E&E (Nova Scotia) currently developing in-house software to calculate costing and environmental benefits of highway rehabilitation strategies.
- Software considers both cost and environmental life cycle. Also analyses one-off benefit.
- Software utilises current state-of-the-art emission relationships and databases (e.g. FIRE – EPA)
- Currently investigating possibility of CO_2 off-sets from highway recycling schemes (i.e. can they be traded, sold, etc.)
- Additional modules being considered/developed for other construction activities.

Nova Scotia Case Studies

- FDR (foam) – Route 209, Cumberland County

- CIR partial depth – Main Street, Dartmouth

FDR Rout 209 – Maintenance Strategy

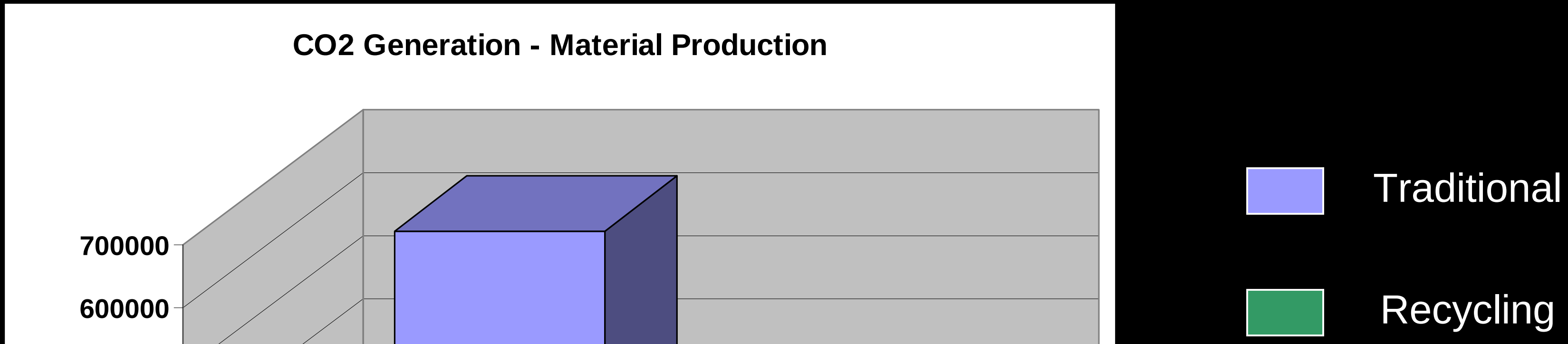
Adopted Strategy

Recycle (pulverise) existing pavement and granular base to a depth of 250mm – mix 2.5% foamed asphalt – Compact to achieve appropriate density – Apply 50mm surface course

Alternative Traditional (not adopted)

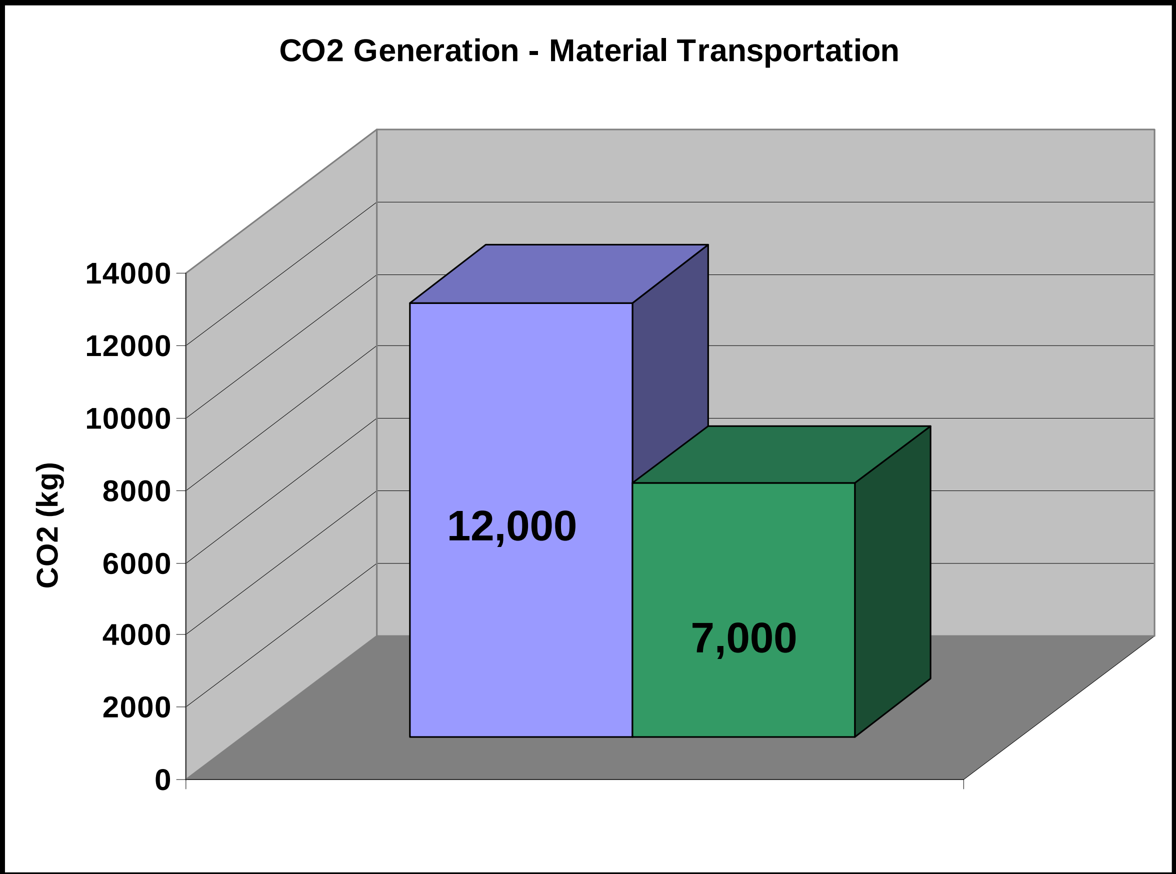
Cold mill existing surface/wearing course to an approximate depth of 100mm (milled pavement to be transported to the nearest TPW depot) – Apply base course (50-60mm) and surface course (45-50mm)

Environmental Results (Route 209)



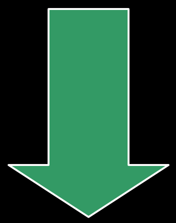
41%

Environmental Results (Route 209)

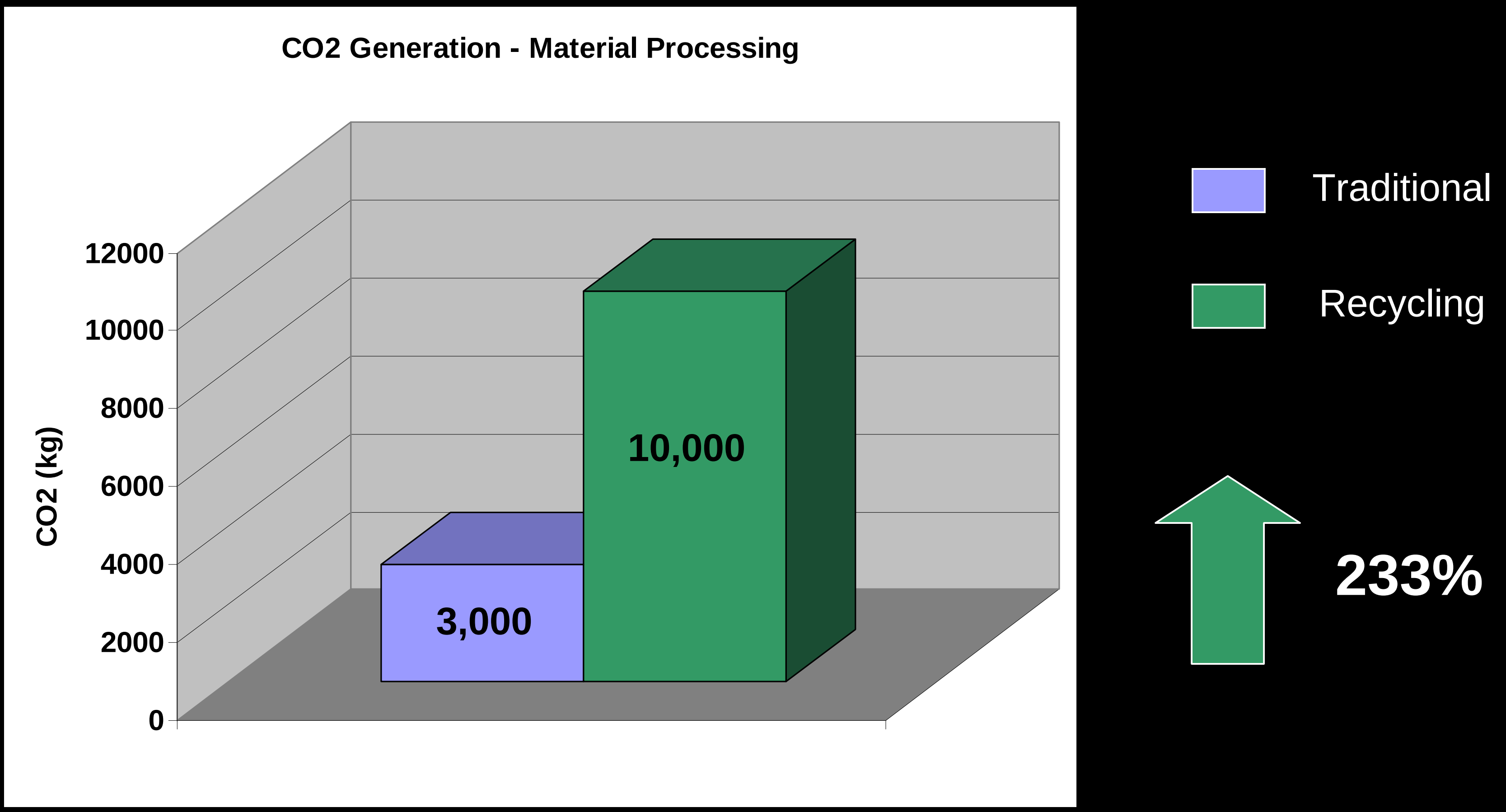


Traditional

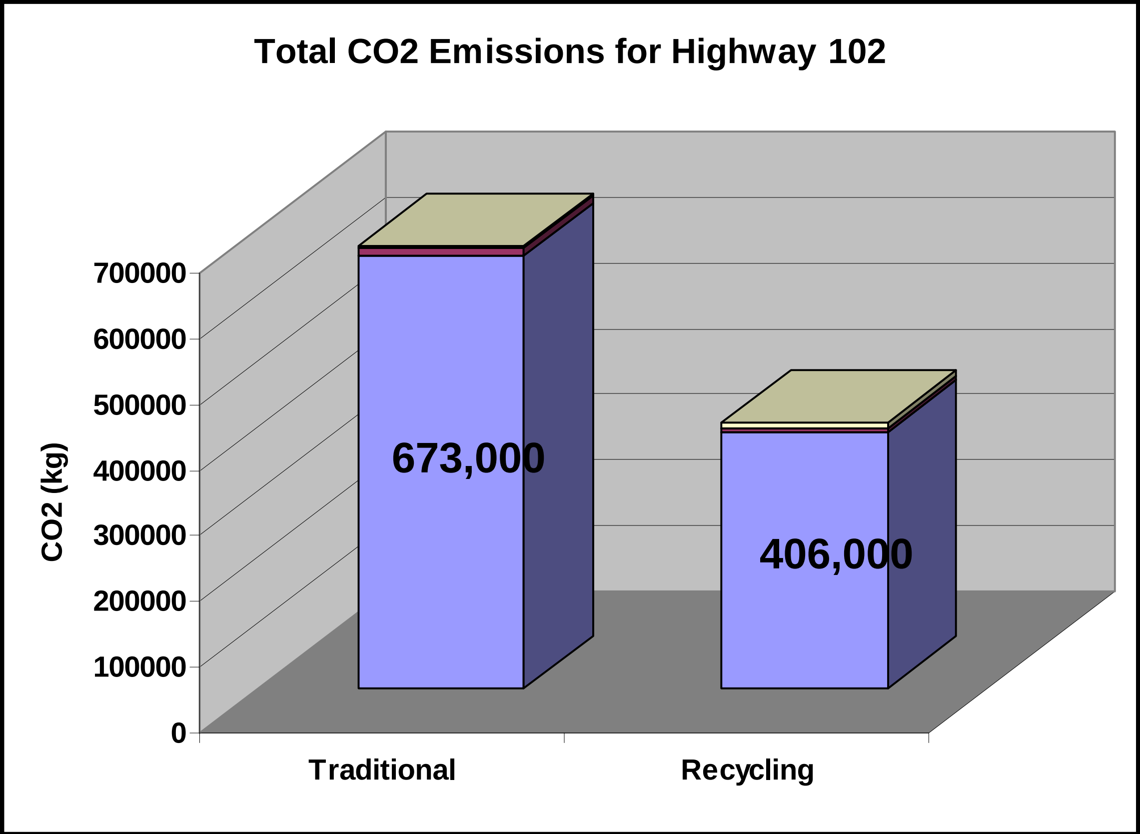
Recycling



Environmental Results (Route 209)



Environmental Results (Route 209)



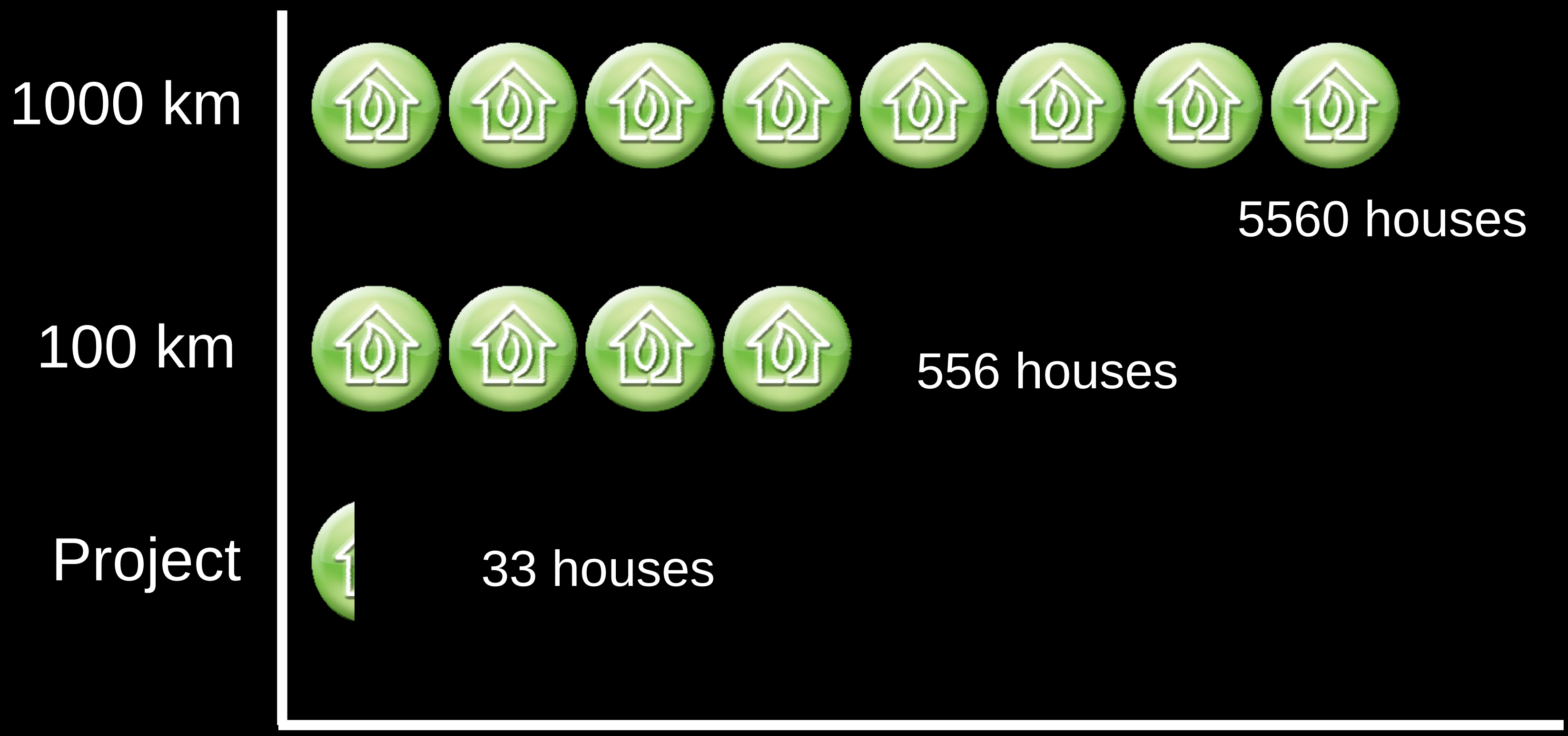
Production

Transportation

Processing

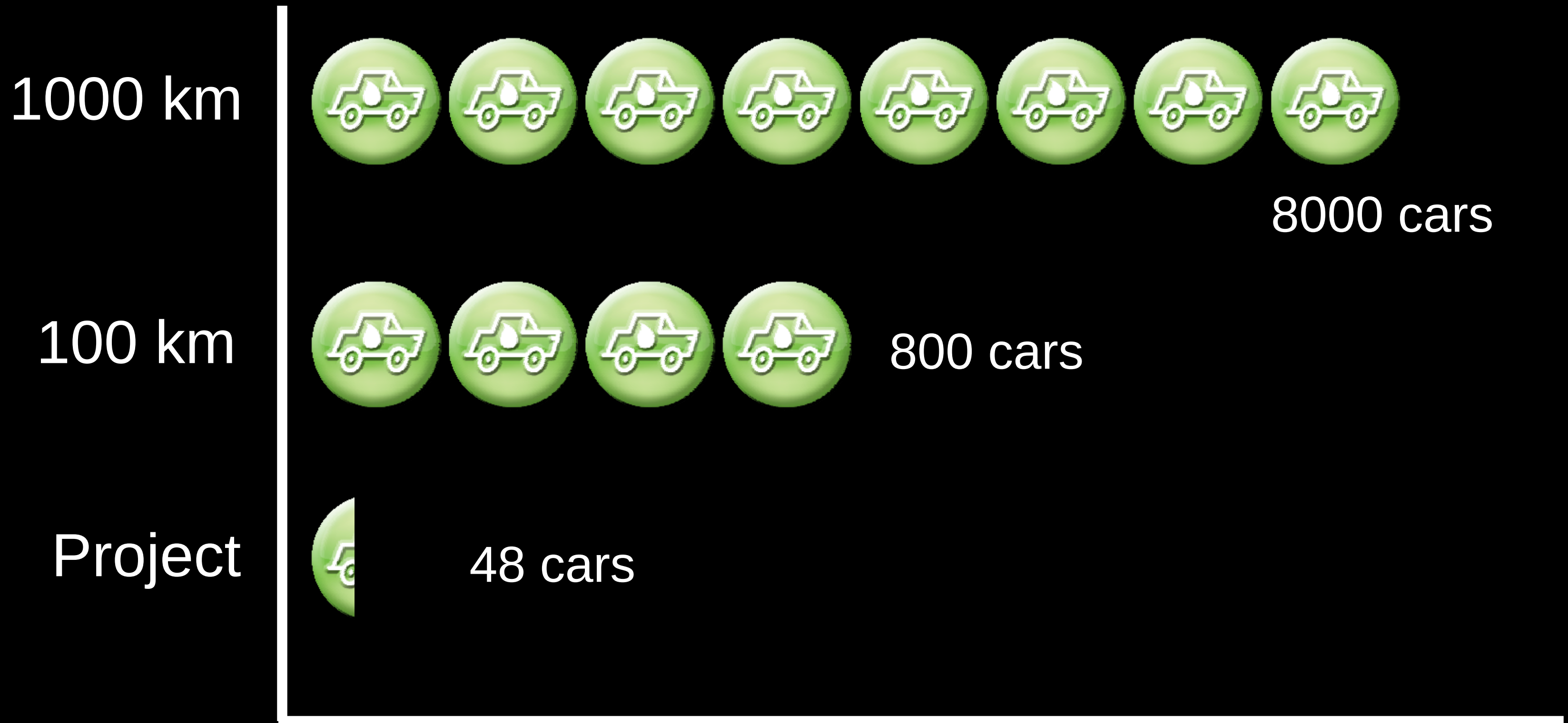
40%

Equivalent emission reduction (home emissions)



Based on average consumption of 8 tonnes of CO_2 per household – Stats Canada 2004

Equivalent emission reduction (car emissions)



Based on consumption of 5.6 tonnes of CO_2 for an average passenger car traveling 25,000 km per year – National Energy Foundation, UK

CIR Main Street – Maintenance Strategy

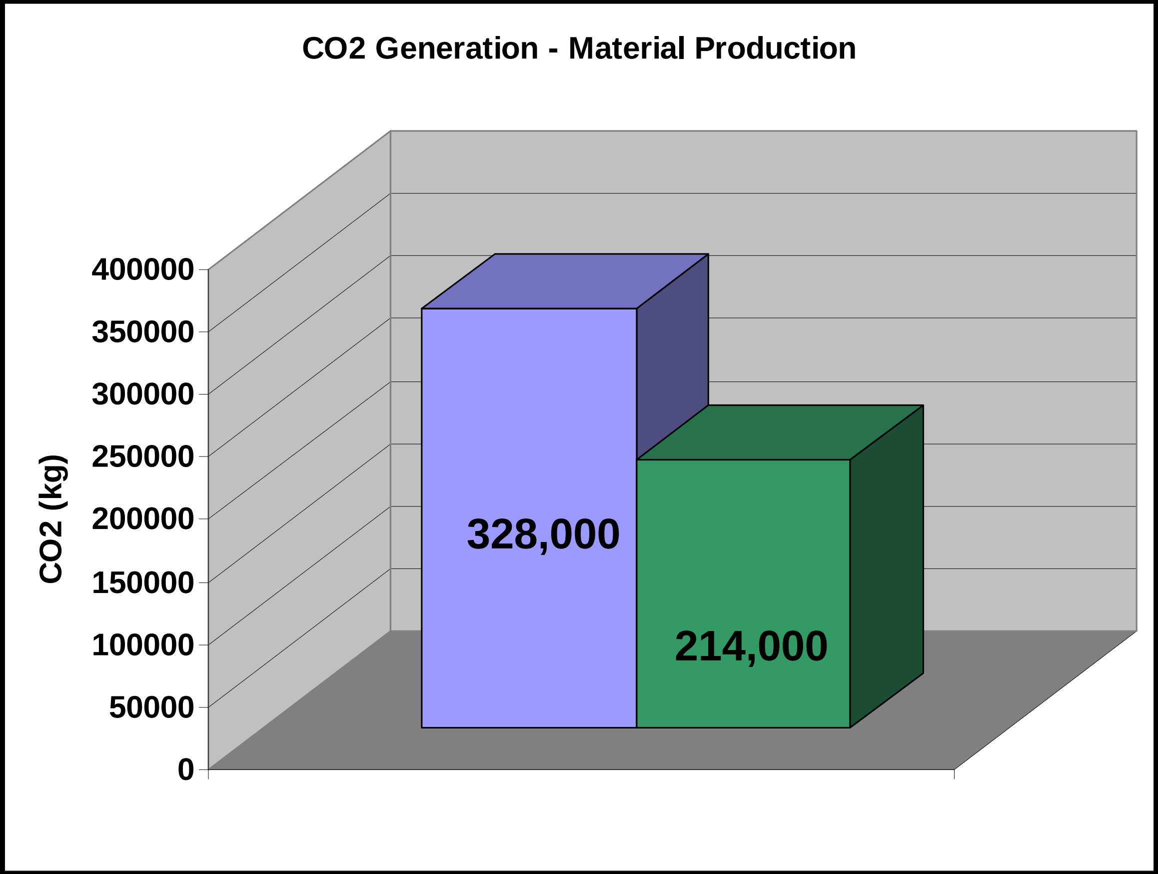
Adopted Strategy

Minimal milling (gutter reveal) – Partial depth recycling to 100mm depth with emulsion (2.5%) - Compact to achieve appropriate density – Apply 50mm surface course

Alternative Traditional (not adopted)

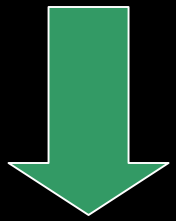
Cold mill existing surface/wearing course to an approximate depth of 100mm (milled pavement to be transported to the nearest HRM depot) – Apply base course (50-60mm) and surface course (45-50mm)

Environmental Results (CIR Main Street)



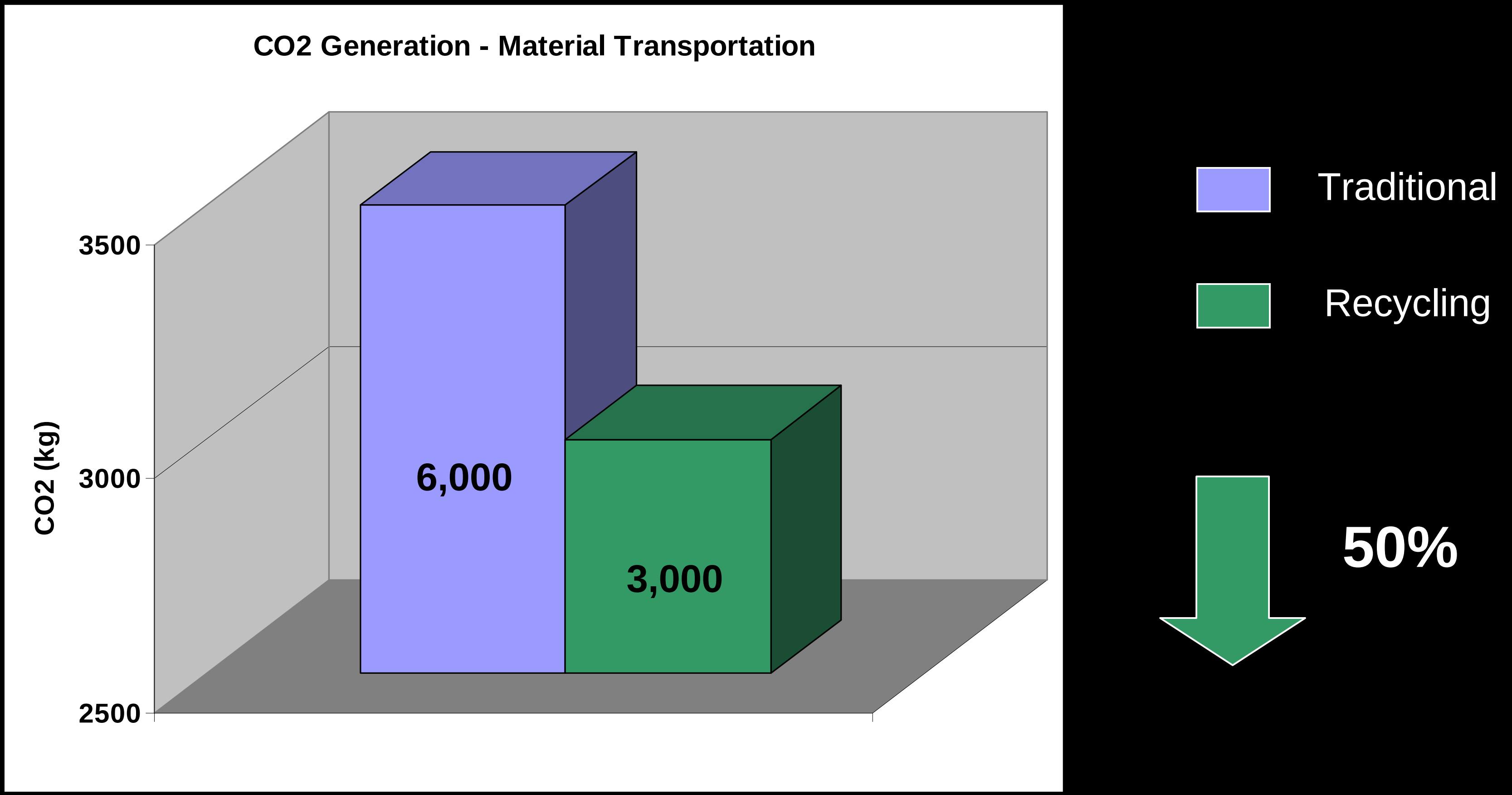
Traditional

Recycling

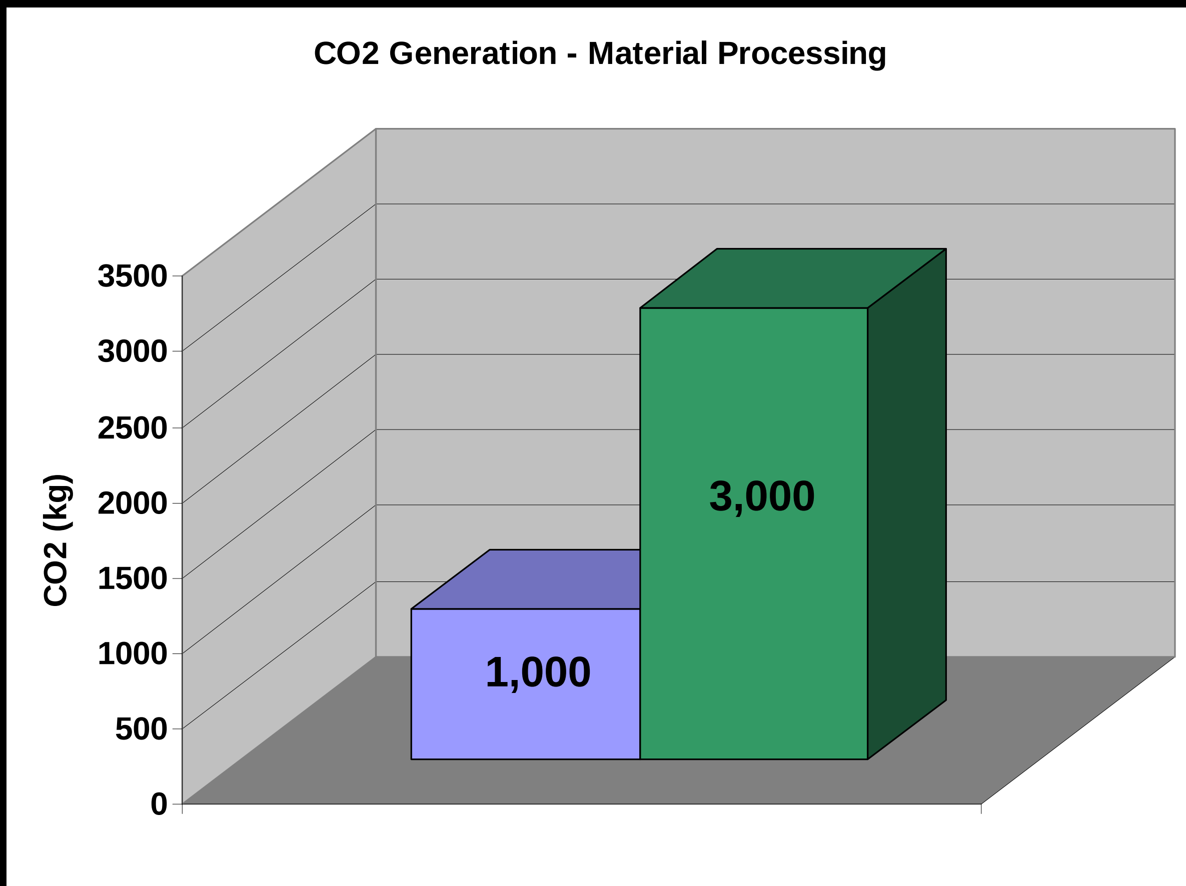


35%

Environmental Results (CIR Main Street)



Environmental Results (CIR Main Street)

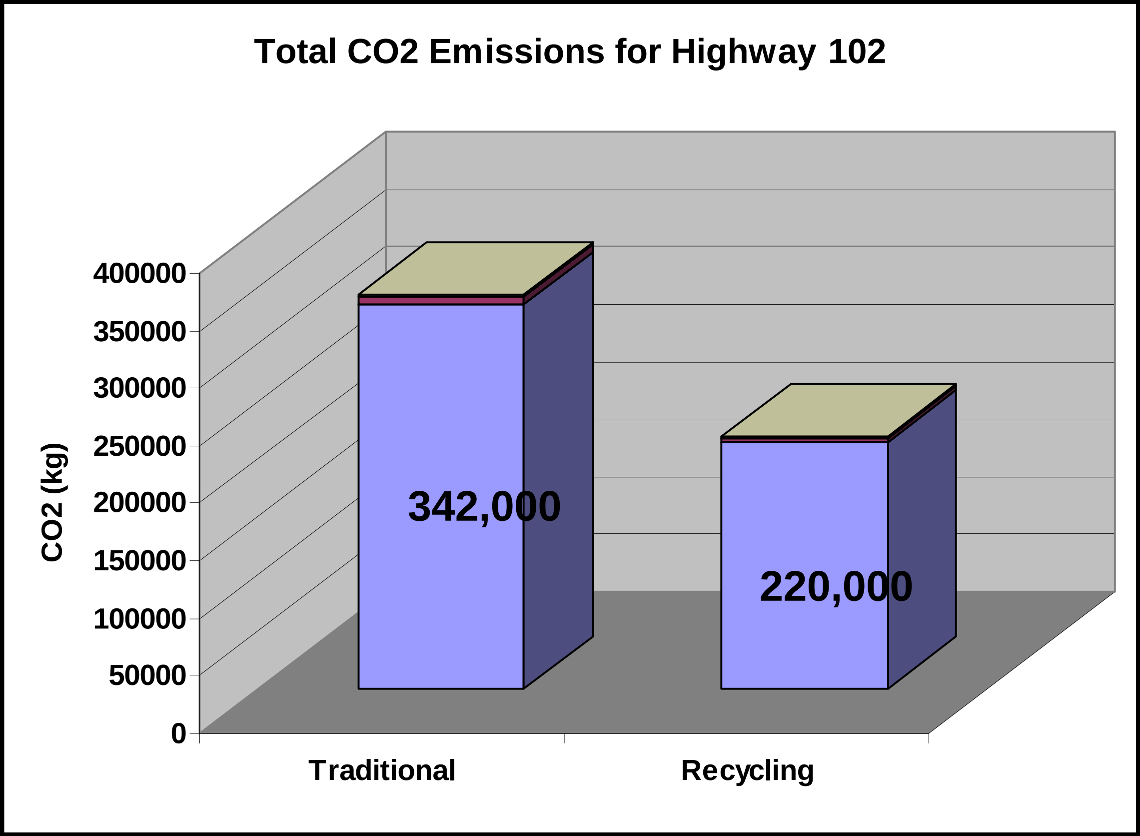


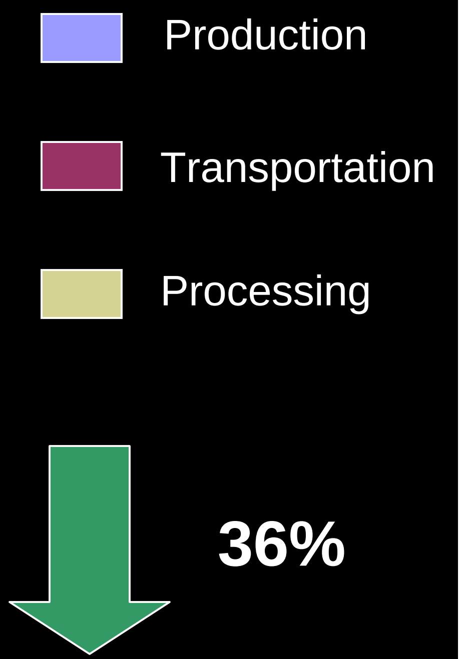
Traditional

Recycling

200%

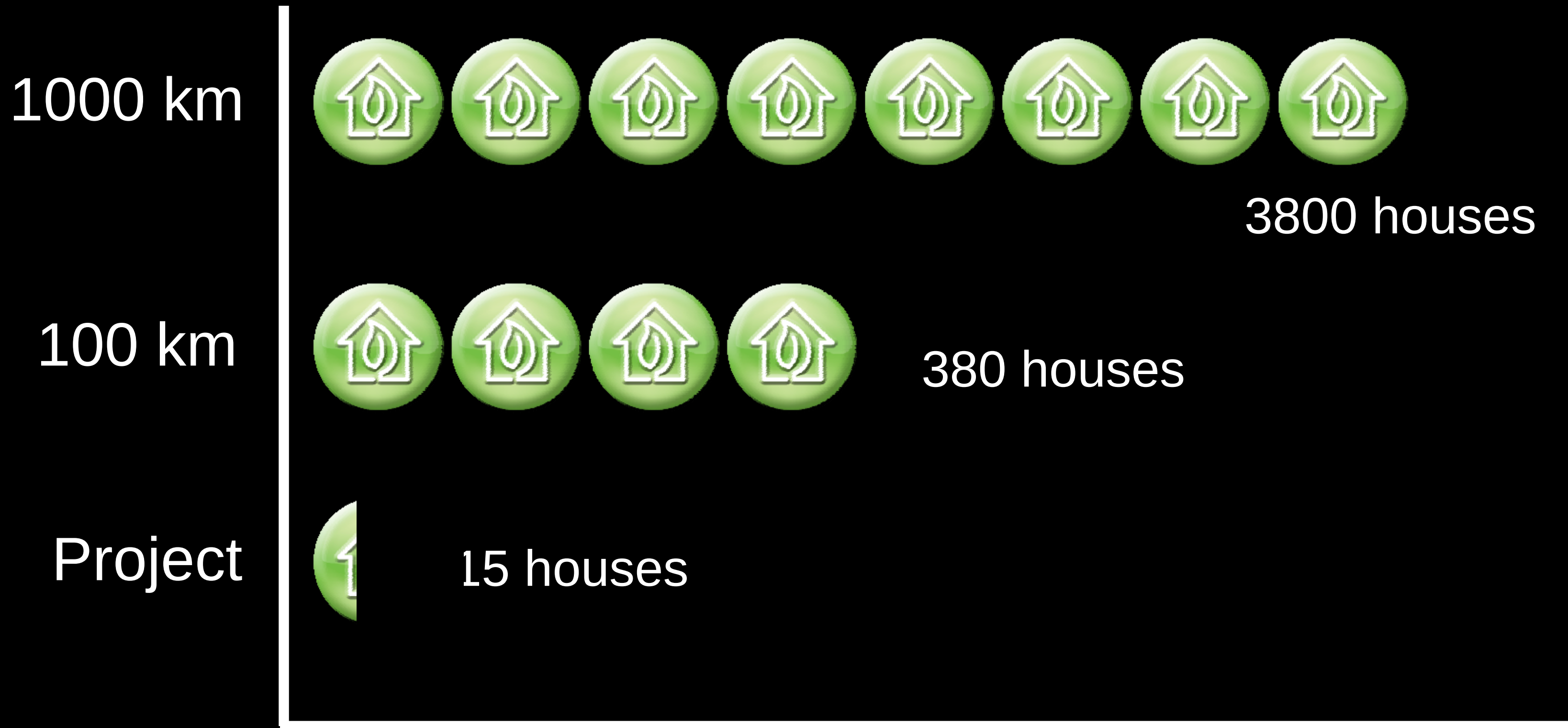
Environmental Results (CIR Main Street)





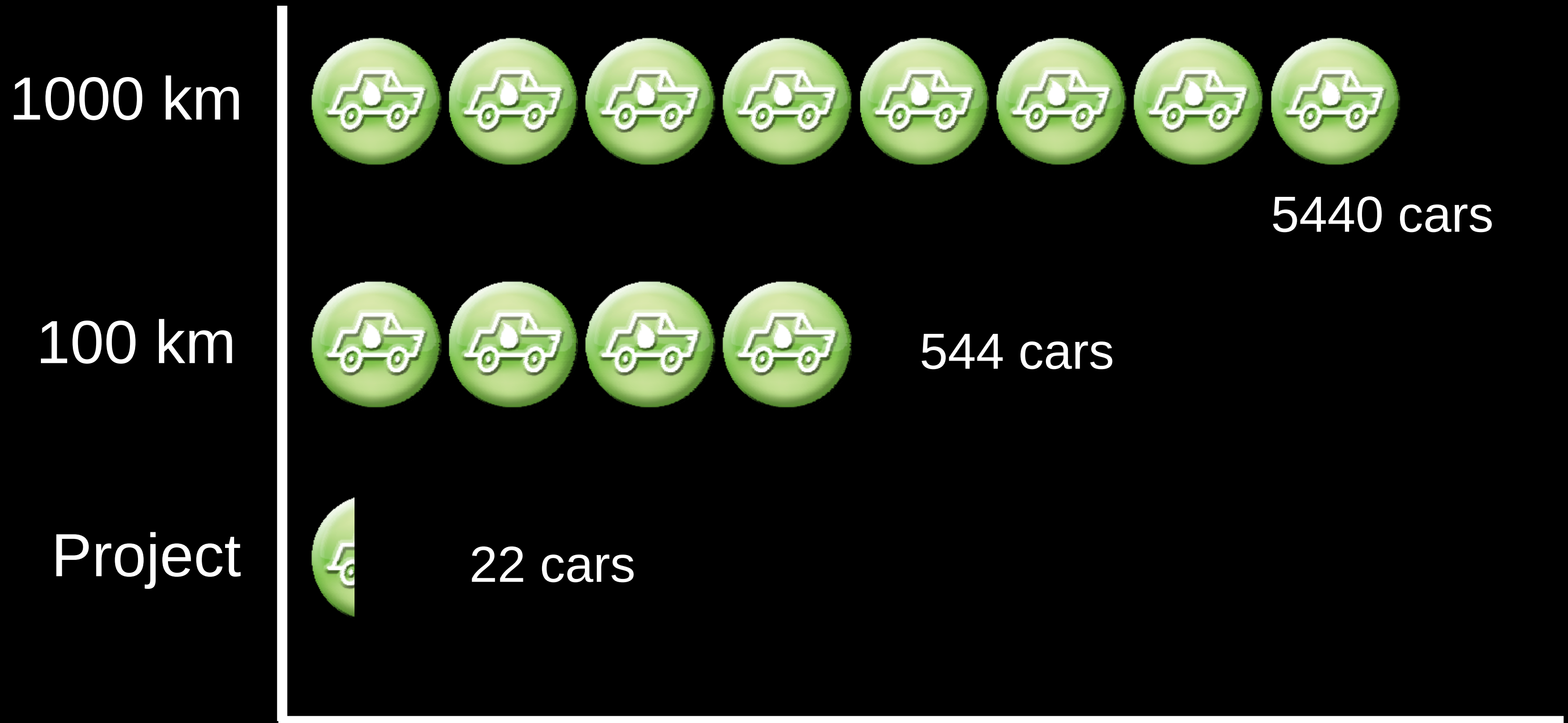
amec

Equivalent emission reduction (home emissions)



Based on average consumption of 8 tonnes of CO_2 per household – Stats Canada 2004

Equivalent emission reduction (car emissions)



Based on consumption of 5.6 tonnes of CO_2 for an average passenger car traveling 25,000 km per year – National Energy Foundation, UK

Conclusions

- Conventional pavement construction/maintenance activities utilises significant energy
- Commonly utilised road recycling processes reduce energy consumption significantly
- Model currently being developed by AMEC demonstrates significant green house gas reductions and improved life cycle costing when recycling processes utilised
- **Next phase** – Can demonstrated CO_2 reductions be utilised as carbon off-set credits ***or*** traded?