# Oil Sands GHG Mitigation Roadmap Study



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# Project drivers, Scope, Deliverables



**Drivers:**

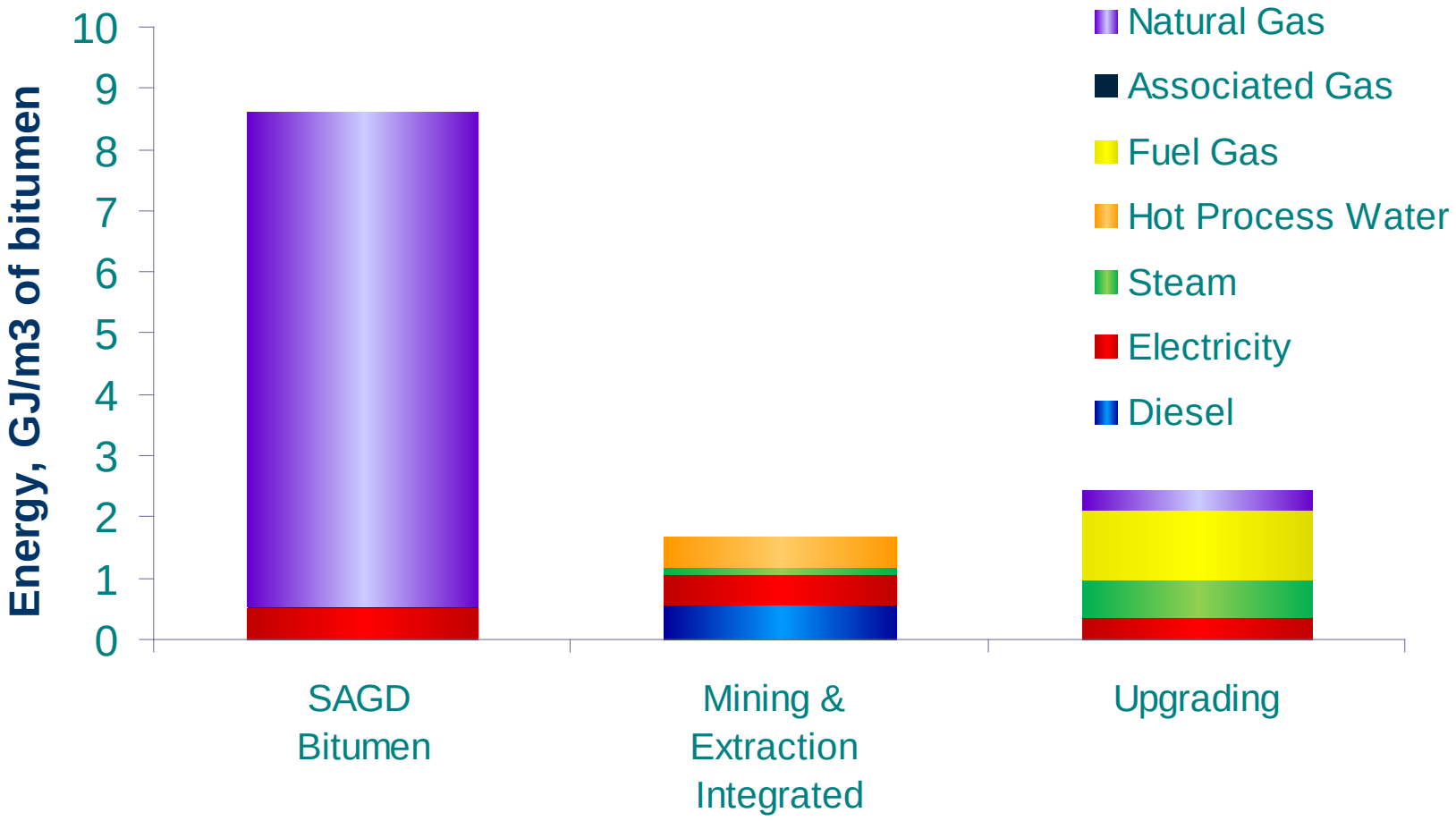
- Assessment of practical actions for achieving GHG reductions
- Use Lifecycle analysis (LCA) tools to better understand and manage GHG intensity of oil sands-derived fuels
- Positioning of oil sands resource as economically & environmentally competitive

**Scope and Deliverables:**

- Identify and quantify energy efficiency and GHG abatement opportunities for three oil sands process facility types: **In Situ, Mining/Extraction, Upgrading**
- Identify major technology opportunities
- Develop metrics for benchmarking
- Update lifecycle analysis (LCA) of oil sands-derived crudes
- Roadmaps and recommendations

# Energy use by process type





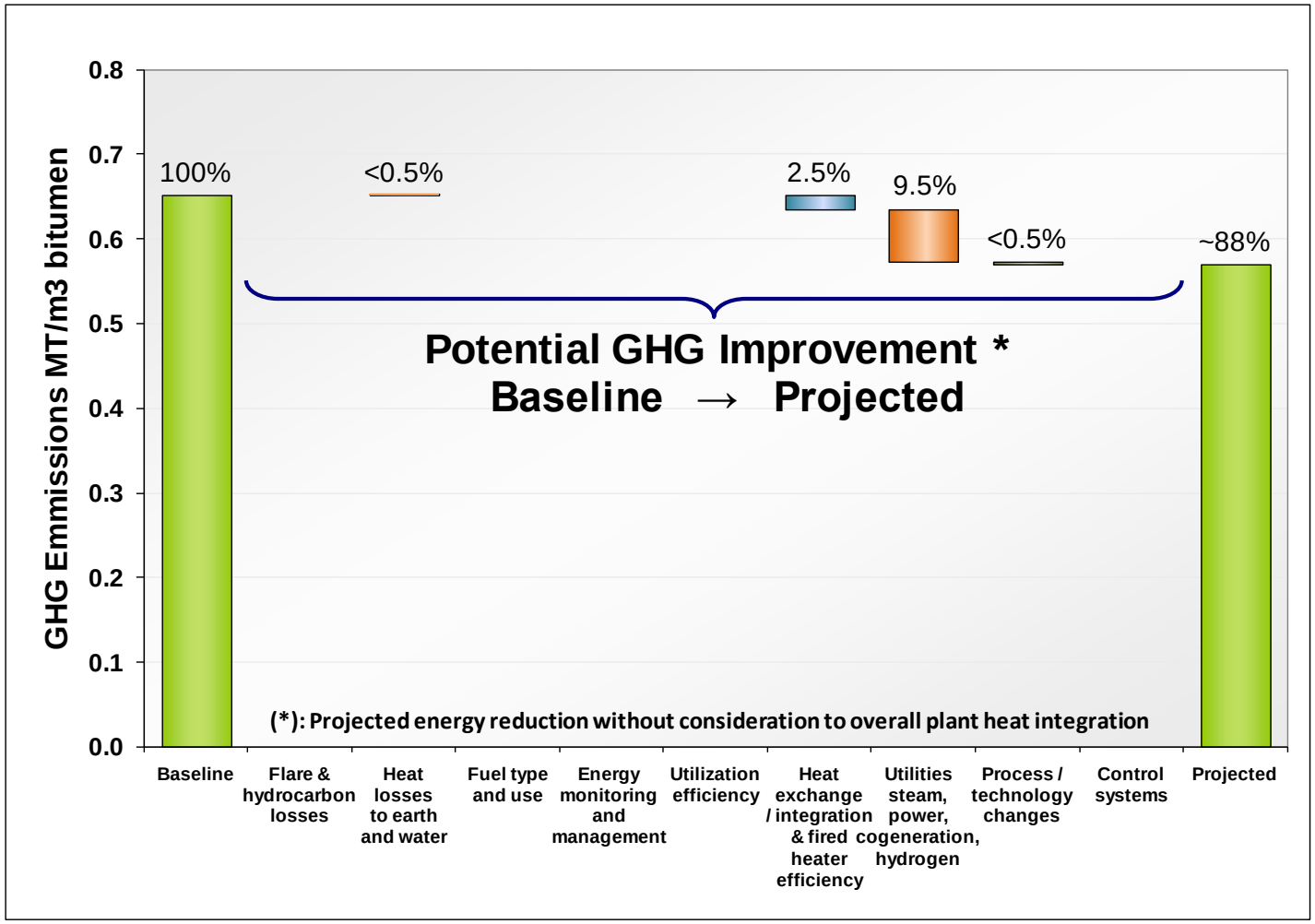
# Energy efficiency assessment approach



- Estimate energy efficiency and GHG reduction potential
  - Nine improvement areas evaluated (economics, magnitude, timing):
    - Flare & hydrocarbon losses
    - Fuel type and use
    - Utilization efficiency
    - Utilities: steam, power, cogen, H2
    - Control systems
    - Heat losses to earth and water
    - Energy monitoring and management
    - Heat integration & fired heater efficiency
    - Process / technology changes
- Project opportunities
  - Operations/capital improvements that could reduce GHG emissions
- Technology opportunities
  - Incremental Technologies to improve existing facilities
  - New technologies to re-configure new facilities
- Economic criteria for energy improvements
  - Economically achievable (<5 year simple payback)
  - Non – Economic (> 5 year simple payback)

# In Situ energy efficiency results






- Energy efficiency improvement
  - 8% reduction in energy intensity
  - 12% reduction in GHG emissions
- 1,210 tpd GHG reduction in a 100,000 bpd facility
- In-situ should be primary focus for energy efficiency technology improvements

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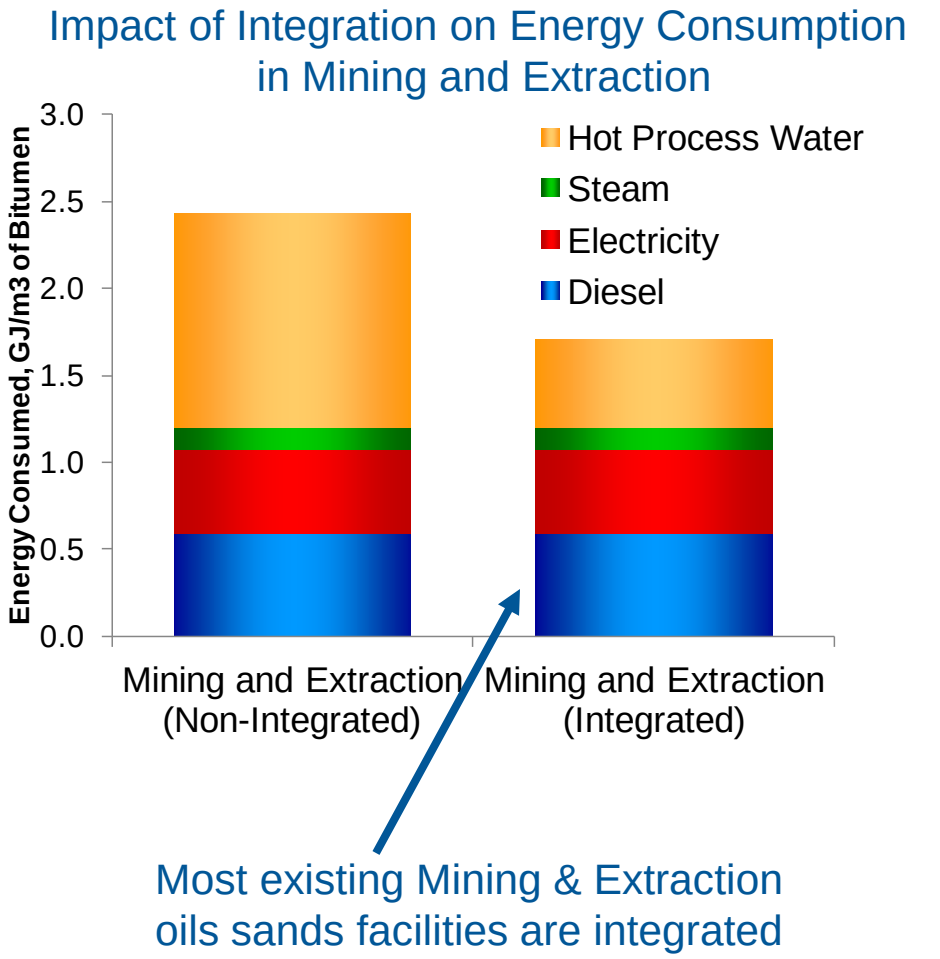
# Impact of integration



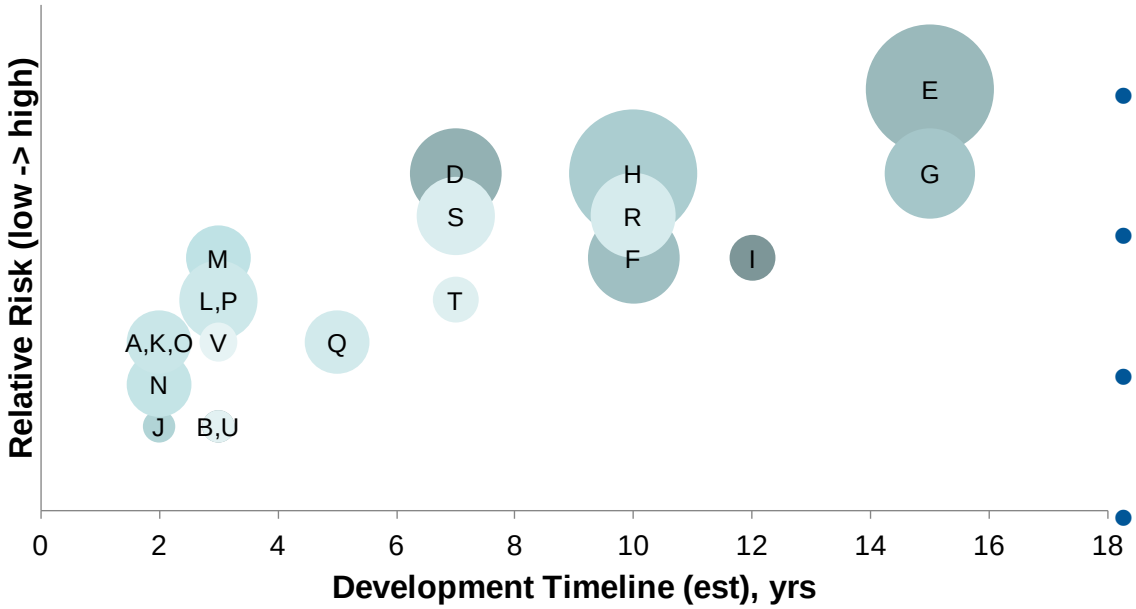
- Integration uses waste heat from one process as the energy input for another
  - Co-generation of electricity and steam, and waste heat recovery for bitumen extraction are commonly used in oil sands operations
- Co-generation can reduce the LCA well to tank GHG intensity by up to 5%
  - Applicable to in situ, upgrading, and stand-alone extraction facilities
- Maximizing integration of extraction facilities with Upgrader waste heat can reduce GHG emissions 30-50%
  - Requires co-location of extraction plant with an upgrader or refinery



# Results: Evaluation of new technologies



## Opportunity Radar – In Situ Technologies




Top ideas: reduce steam consumption by injecting solvents or polymers, or by modifying bitumen viscosity in other ways

- Evaluated potential impact of new technologies for reducing GHG emissions over 10-15+ years
- Opportunity radars developed for each area
- Identified potential magnitude, risk and timing of each opportunity
- 22 separate technologies identified and evaluated
- Significant potential estimated for each area
  - In-situ – 20%,
  - Mining and extraction 30%
  - Upgrading 10%

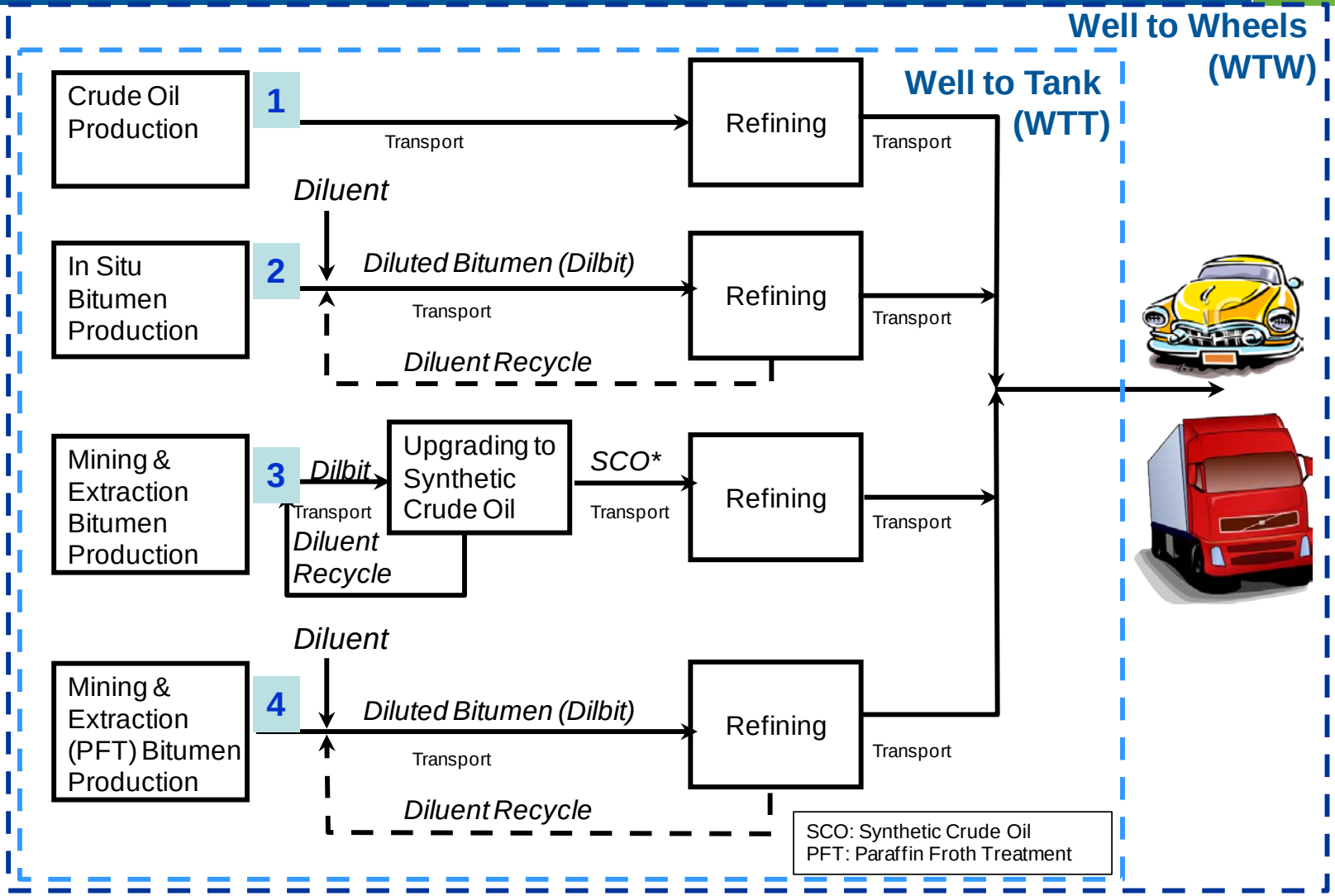
# Results: Metrics for Benchmarking



- A series of energy/GHG intensity metrics were identified and calculated for each facility type
  - Separate impact ofresource quality from the facility design/operation
  - Validated with one year of Suncor operating data
- Strong basis for further discussions on benchmarking with industry/regulators
  - Better data for comparison of industry performance, identifying improvement opportunities
  - Need input from other facility operators and others before possible use

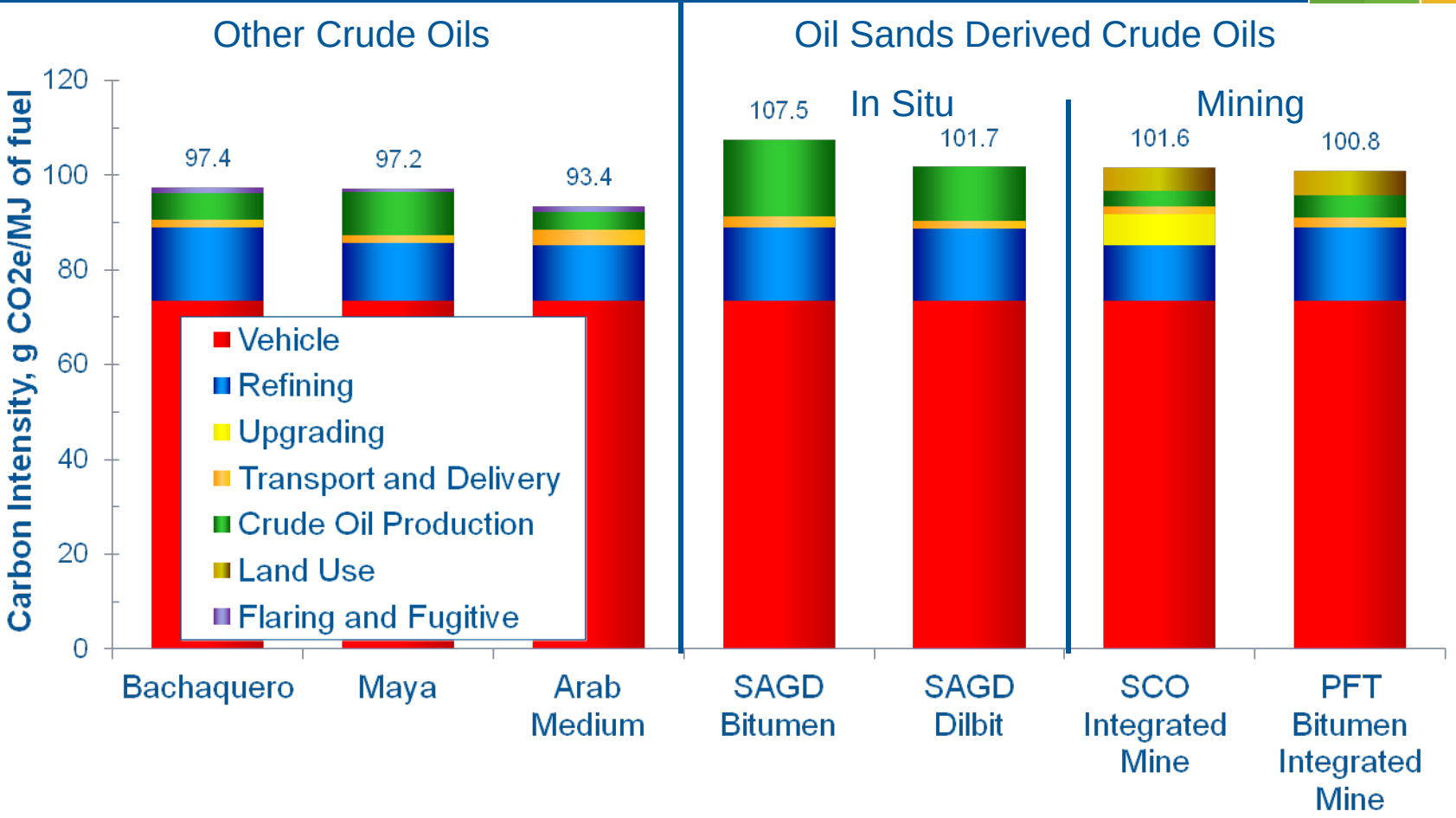
# LCA of bitumen to products





# LCA baseline summary for gasoline

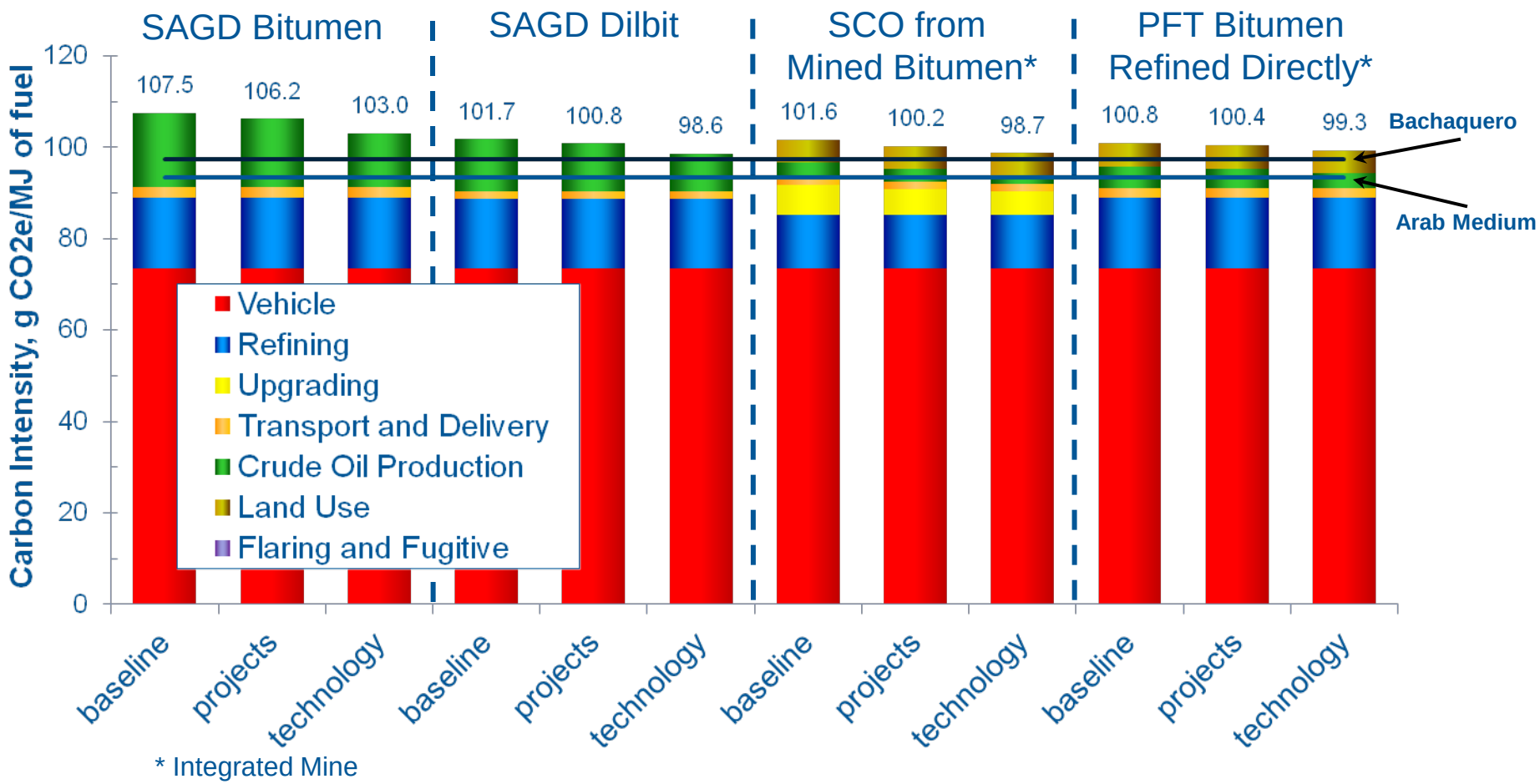





LCA – gasoline production from crude oil

# Impact of improvement opportunities






* Integrated Mine

LCA – gasoline production from crude oil

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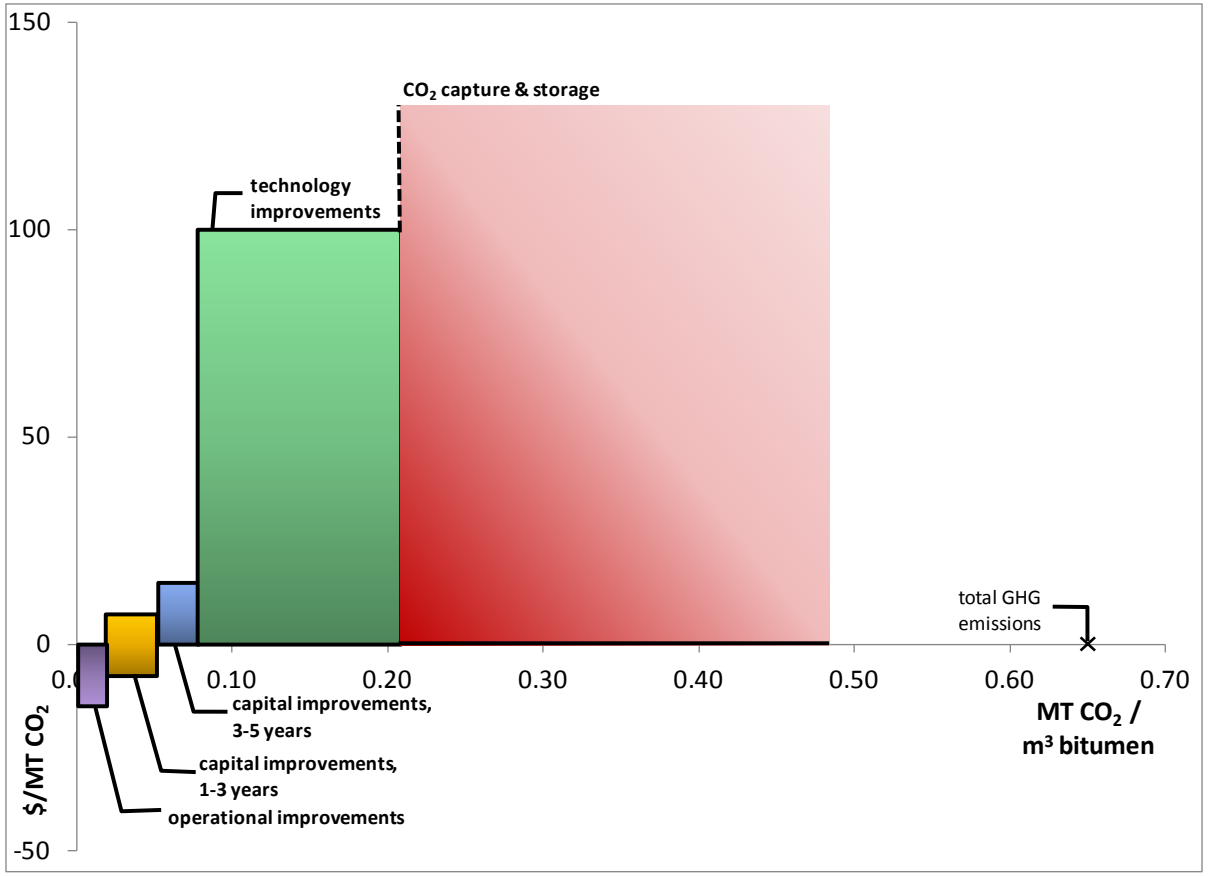
# Results: GHG reduction roadmaps



## In Situ - GHG Reduction Roadmap




- GHG reduction roadmap developed for each area
- Incorporates cost, magnitude of each GHG reduction opportunity
- Includes operational and capital energy efficiency opportunities, new technologies and CCS

In situ GHG emissions can be reduced ~80% from baseline

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# Summary of major findings



- Significant potential for energy and GHG emission reduction
- New technologies offer potential for significant improvements over 10+ years

| Improvement type | In Situ | Mining and Extraction | Upgrading | Timing - Uncertainty |
|---|---|---|---|---|
| **Operational (near-term)** | 3% | 2% | 2% | -Near term (1-3 yr)<br>-low risk |
| **Project (mid-term)** | 9% | 5% | 6% | -Mid term (3-5 yr)<br>-moderate risk |
| **Technology (long-term)** | 20% | 30% | 10% | -Long term (10+ yr)<br>-higher risk |

- Integration can have large impact on GHG emissions
  - Integrating in-situ and extraction with co-gen can reduce GHG intensity by up to 5%.
  - Integrating extraction with upgrading can reduce extraction GHG intensity by 30-50%.
- Energy efficiency benchmarking metrics developed and validated with Suncor data
  - Needs further input collaboration with industry, government
- Lifecycle analysis (LCA) for oil sands-derived fuels updated in the study
  - Useful tool to compare improvement opportunities and optimize design of new facilities
  - Further work needed to reduce uncertainties

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