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LCA of Current & Future GHG Emissions from Petroleum Jet Fuel

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Background

- Globally, aviation is projected to grow by ~5% per year [Mahabashde et al, 2011]
- IEA forecasts petroleum to remain a significant primary energy source out to 2040 [IEA WEO, 2015]
- Understanding petroleum's complete environmental impact is important
  - Well-to-pump emissions constitute ~20% of petroleum jet fuel lifecycle emissions
  - LCA of conventional fuels in needed to compare alternative fuels

LCA Model – Emissions Sources

1. Extraction

- **Drilling**
  - Prime movers
- **Artificial Lift**
  - Rod pumps
  - Gas lift
- **Surface Processing**
  - Heater/treater
  - Crude stabilizer
  - Wastewater treatment
  - Water re-injection
  - Flaring, venting, fugitive
- **Enhanced Oil Recovery**
  - CO_2 flooding
  - Steam injection
  - Gas injection
- **Unconventional Oils**
  - Canadian oil sands
  - Tight oil
- **Land-Use Change**
  - Vegetation
  - Soil carbon

2. Crude Movement

- **Fuel Consumption**
  - Tankers
  - Pipeline
  - Rail
  - Trucks
  - Barge
- **VOC Emission**
  - Loading
  - Transit
  - Ballasting

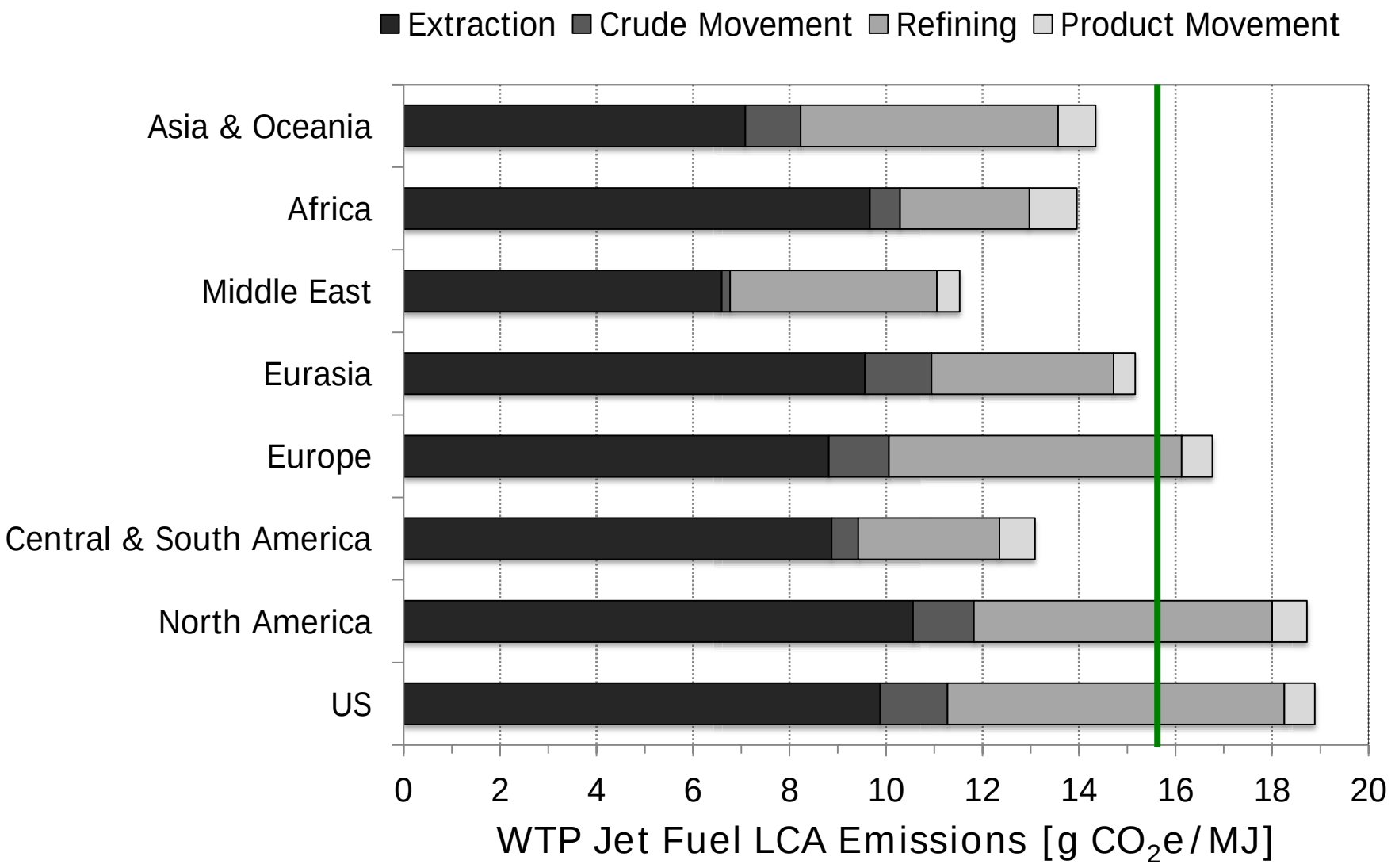
3. Refining

- **Distillation**
  - Atmospheric
  - Vacuum
- **Reforming**
- **Hydrotreating**
  - Naphtha
  - Gasoline
  - Diesel
  - Kerosene
  - Gas oil
- **Catalytic Cracking**
  - FCC
  - Hydrocracking
- **Thermal Cracking**
  - Vis breaking
  - Coking
- **Alkylation**
- **Isomerization**
- **Cogeneration**
- **Flaring & Fugitive**

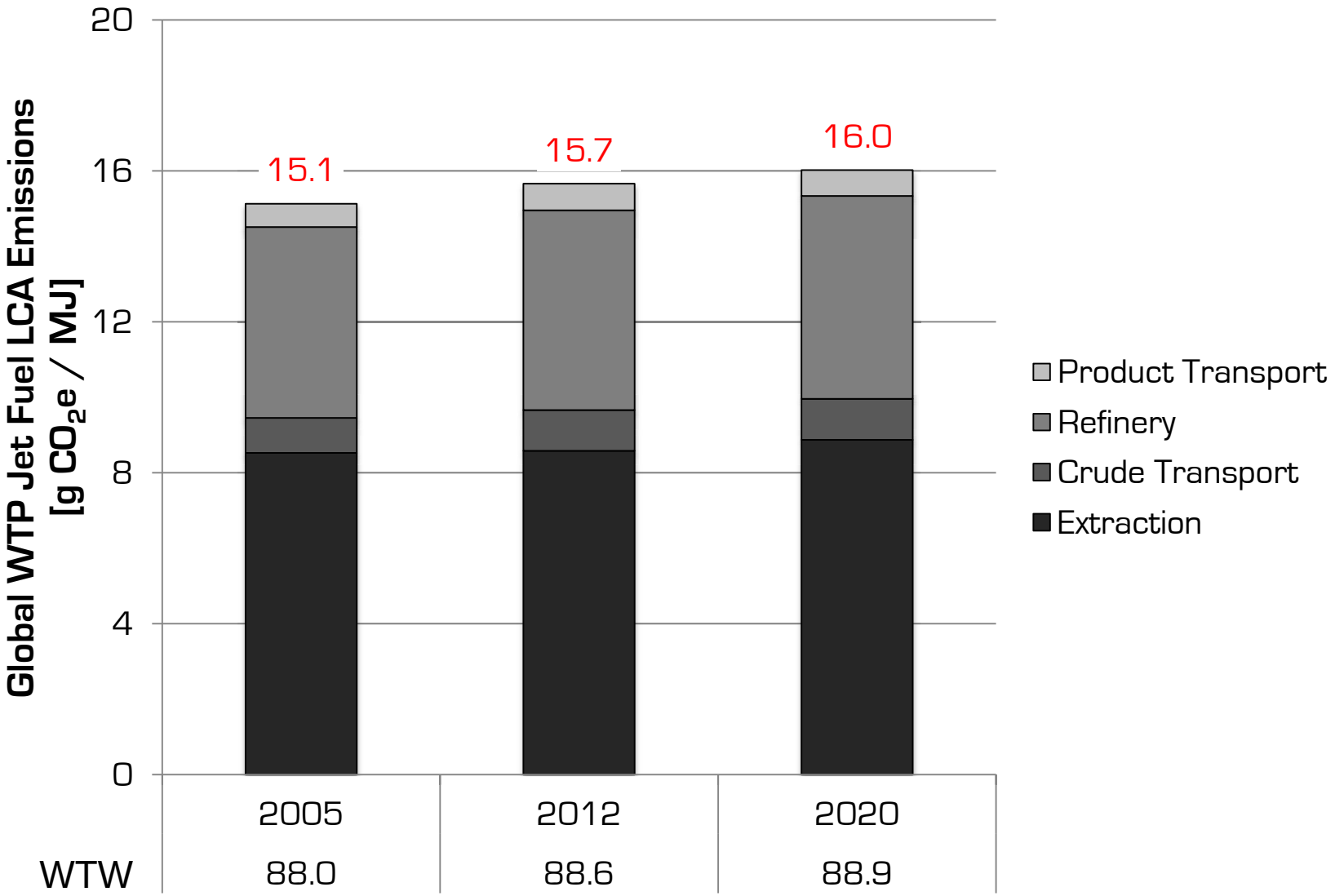
4. Product Movement

- **Fuel Consumption**
  - Tankers
  - Pipeline
  - Rail
  - Trucks
  - Barge
- **VOC Emission**
  - Loading
  - Transit
  - Ballasting

Regional Variation of WTP Emissions



Past and Near Future



2050 Approach

Identify key drivers of emissions over petroleum lifecycle

Survey literature for projections on how these factors may change by 2050

Create scenarios to represent different coherent futures using various factors

Calculate emissions using LCA Model

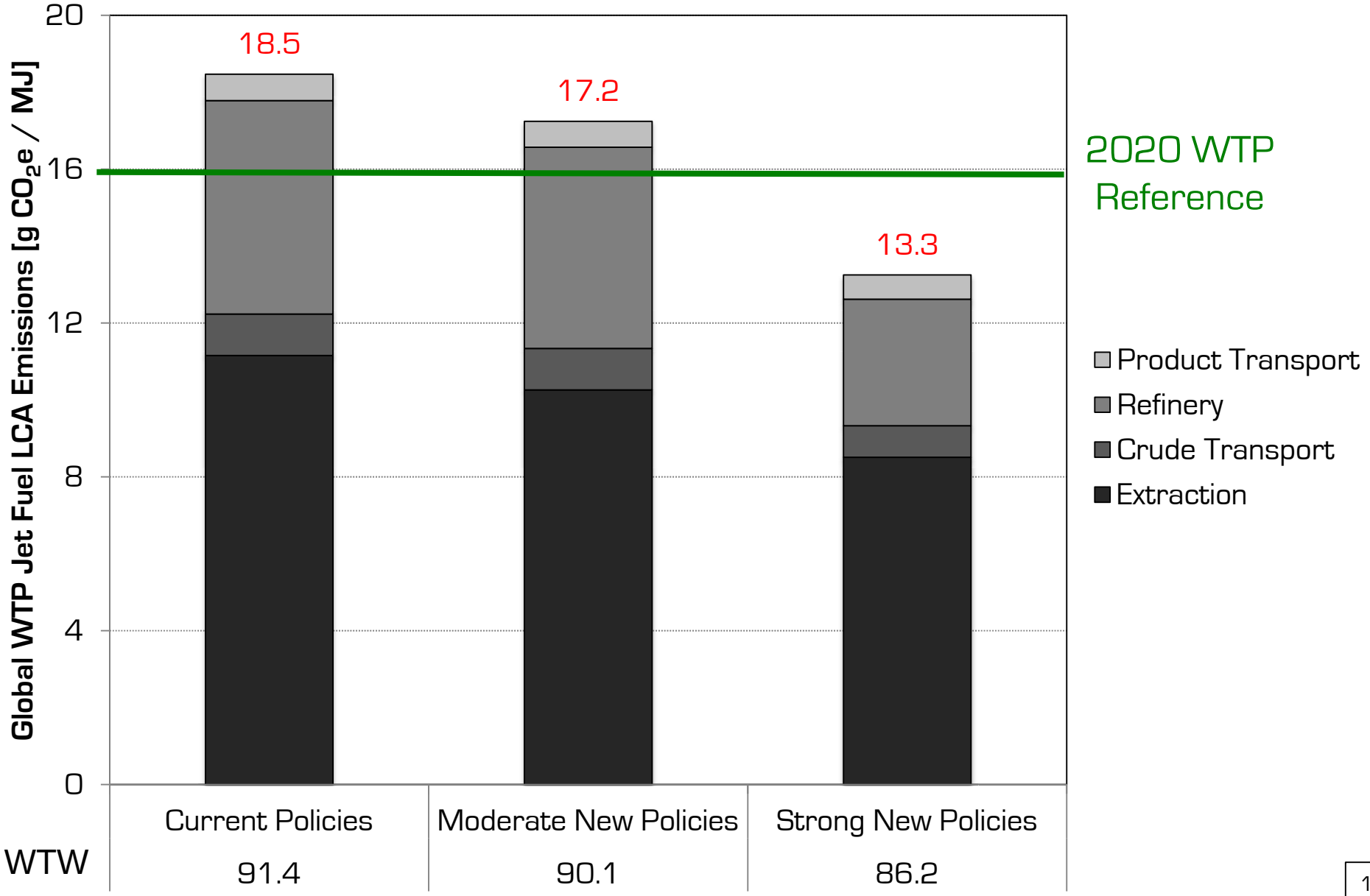
Iterate

Scenario Descriptions

- Different futures are conceptualized, with policies used to reflect the approach taken towards environmental issues

Current Policies	Moderate New Policies	Strong New Policies
• Use of unconventional resources unrestricted	• Use of unconventional resources moderately restricted	• Use of unconventional resources strongly restricted and emissions reduced
• Electricity & hydrogen production remain carbonized	• Electricity & hydrogen production moderately decarbonized	• Electricity & hydrogen production heavily decarbonized
• Demand for petroleum products unabated	• Diesel demand is reduced at a faster pace than jet fuel	• Demand for all petroleum products strongly reduced

Results: 2050 Scenarios



Conclusions

- WTP emissions contribute ~20% of WTW emissions for petroleum-derived jet fuel
- This work informed ICAO CAEP in its adoption of the reference value for international jet fuel (89 g CO_2/MJ)
- Long-term future emissions are largely dependent on policies (within and beyond petroleum industry)
  - With current polices, operations are on track to increase WTP emissions by 2.5 g CO_2e/MJ above 2012 levels
  - Adoption of de-carbonization measures may help to reduce 2050 WTP emission by 2.4 g CO_2e/MJ below 2012 levels

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