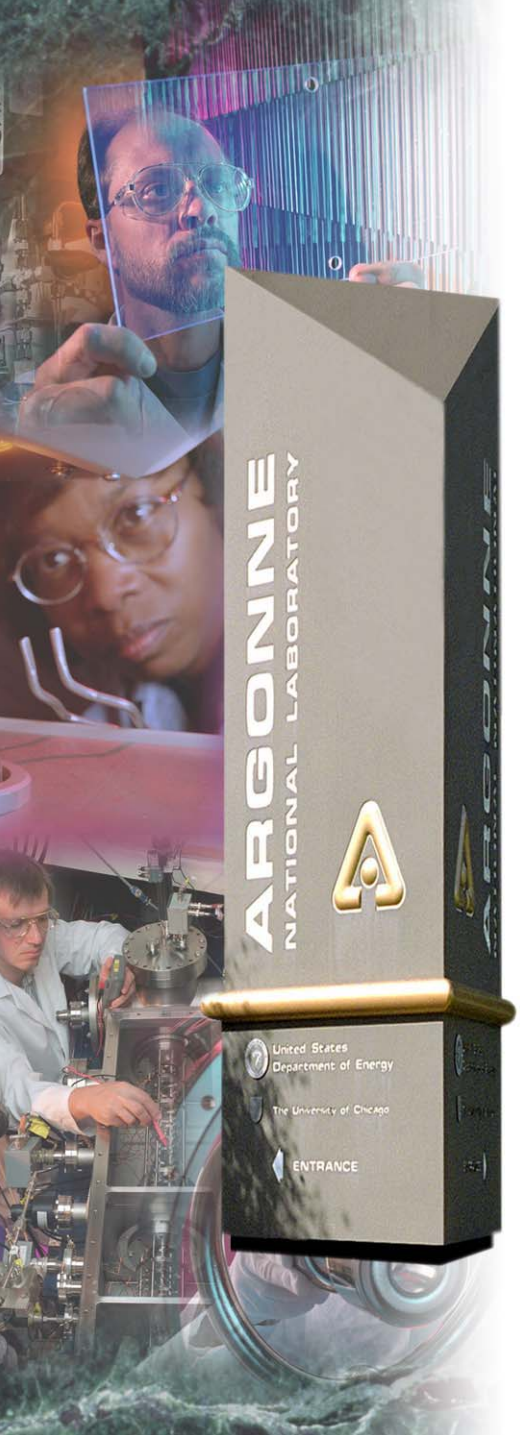

Assessment of Well-to-Wheels Energy Use and Greenhouse Gas Emissions of Selected Fischer-Tropsch Diesel Plants

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Alternative Diesel Fuels Symposium
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Argonne National Laboratory

Office of Science
U.S. Department of Energy

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Acknowledgments

- This work was conducted for U.S. DOE EPACT Fuels Petition. It generically characterizes only moderate size plants proposed by Mossgass, Rentech, and Syntroleum.

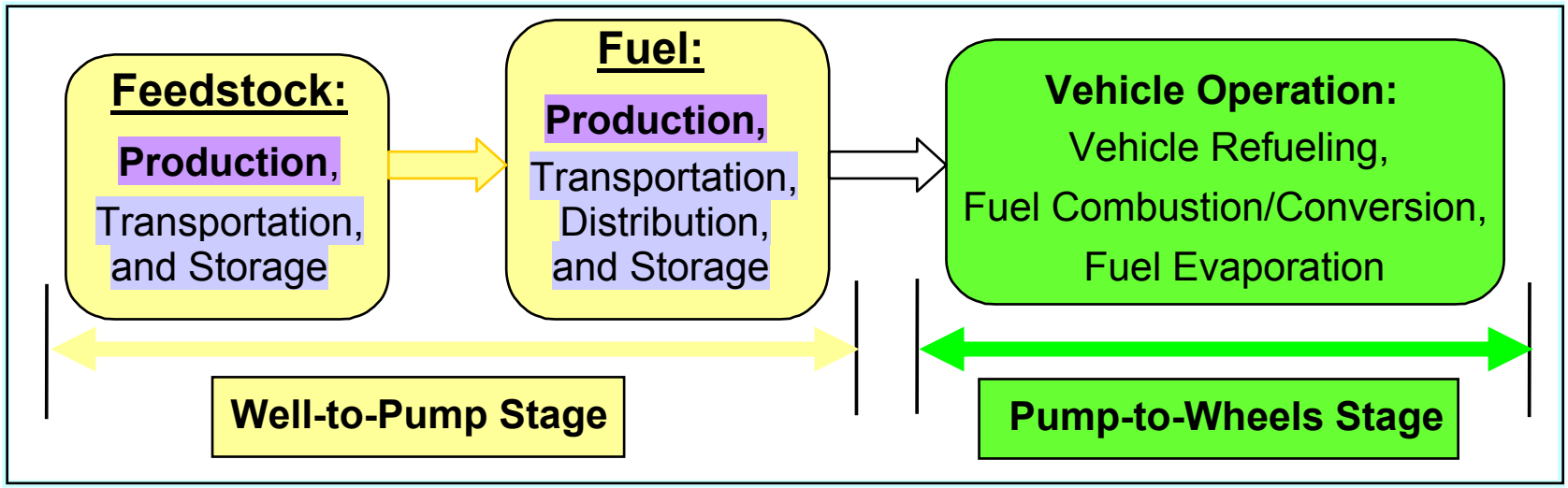
- We are grateful to Linda Bluestein, our DOE project manager

- The report for this presentation and FTD petition materials are available at http://www.ott.doe.gov/epact/fuel_pet.shtml

Acronyms

- WTW = well to wheels
- WTP = well to pump
- PTW = pump to wheels
- NG = natural gas
- NA = North American
- FTD = Fischer-Tropsch diesel fuel (from natural gas in this study)
- DOE = Department of Energy
- EPACT = Energy Policy Act
- GHG = Greenhouse gases (CO_2, CH_4 and N_2O included)
- ppm = parts per million
- mmBtu = million British thermal units (i.e. Btu = British thermal unit)
- kWh = kilowatt-hour
- kBtu = kilo (thousands) of British thermal units
- CD = conventional diesel
- ULSD = ultra-low sulfur diesel
- S = sulfur
- SA = stand alone

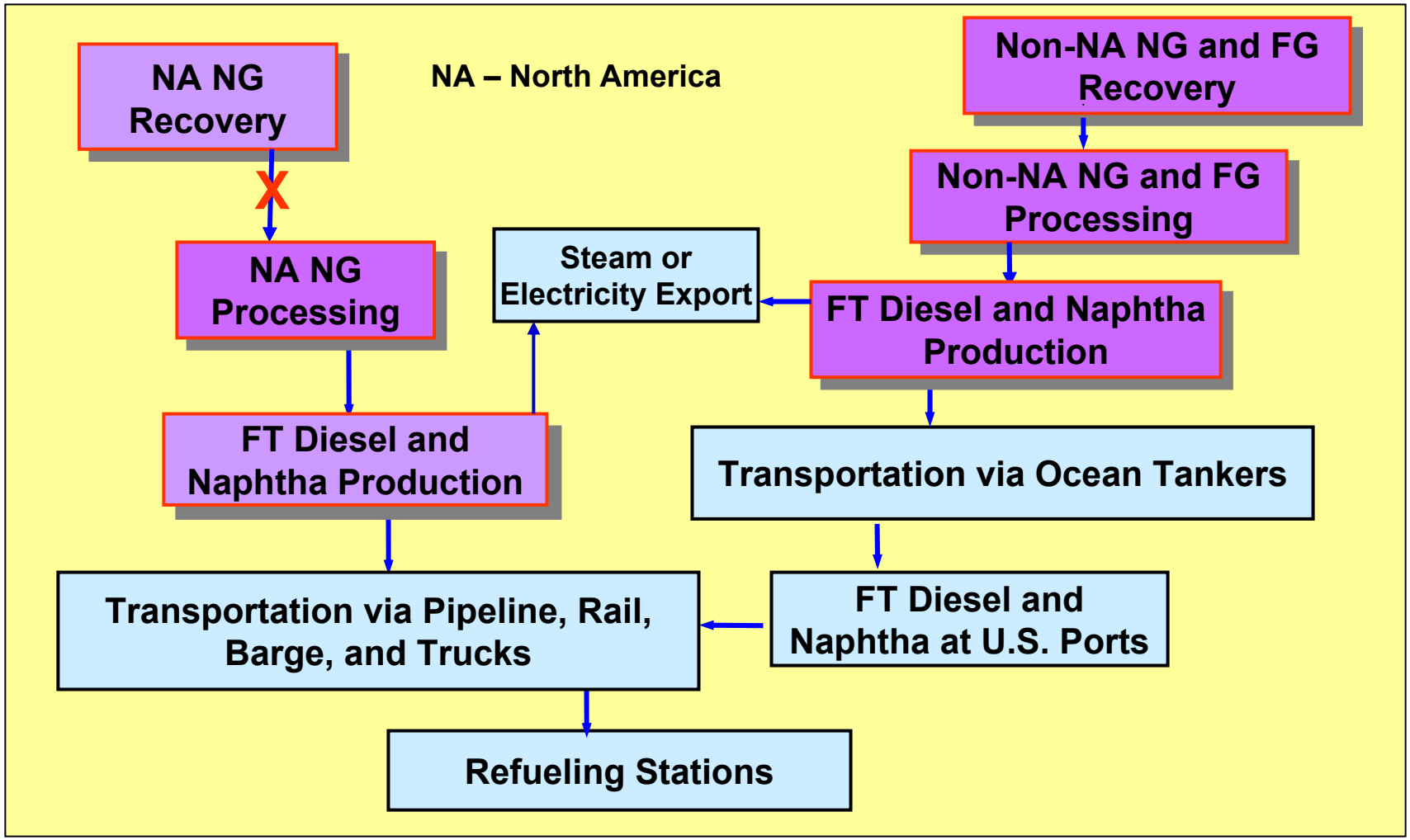
Fuel Cycle Stages for Vehicle/Fuel Systems



Argonne developed the GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) model for WTW analyses

- The GREET model and Its documents are available at **http://greet.anl.gov**
- There are about 900 GREET users worldwide including governmental agencies, industries, universities, and research institutions
- FTD WTW energy use and GHG emissions are in the present GREET model

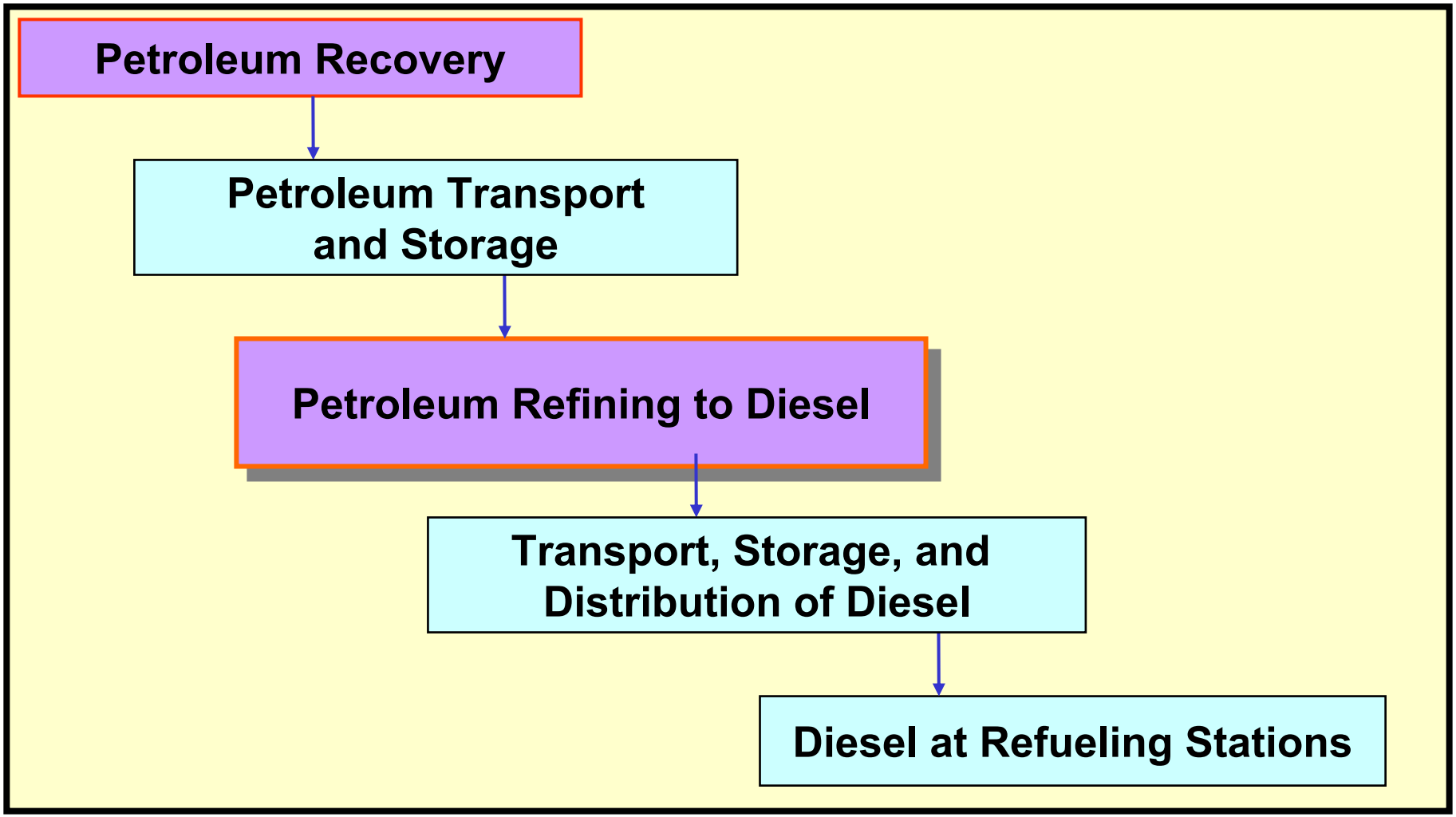
WTP Stages of Fischer-Tropsch Diesel



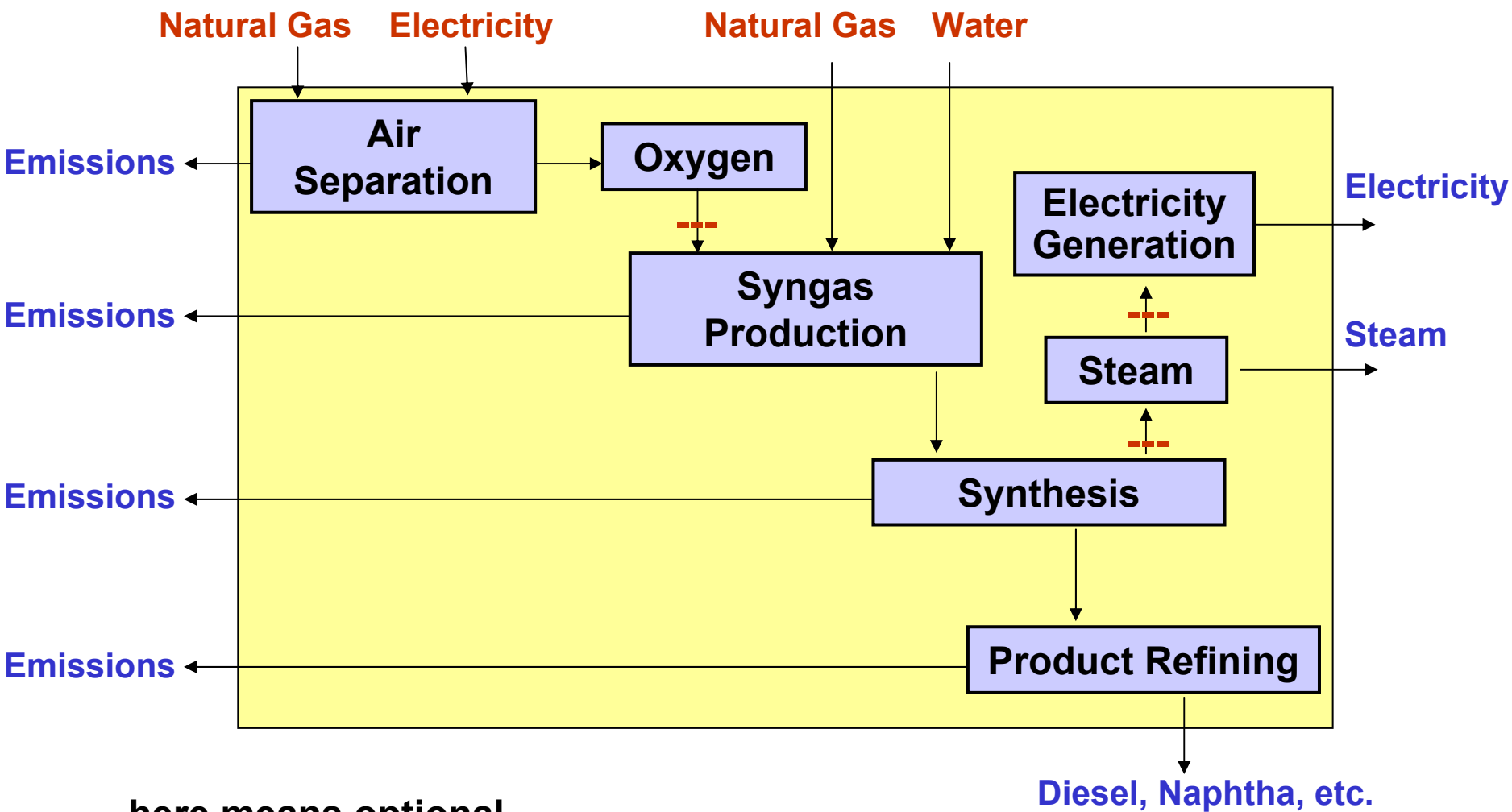
Key Issues for Estimating FTD WTW Energy Use and GHG Emissions

- **Energy and carbon efficiencies of FTD plants (efficiencies are defined as output energy divided by input energy)**
- **FTD plant general designs**
  - Standalone to produce FTD, naphtha, and other products
  - Co-generation of steam and/or electricity for export
- **Post-synthesis refining choices**
  - Affect product slate and product quality
  - Ultimately affect WTW energy efficiencies and GHG emissions
- **Natural gas feeds**
  - North American gas
  - **Non-North American gas (results included here)**
  - Non-North American flared gas
- **Combustion efficiencies of FTD vehicles**

WTP Stages of Petroleum Diesel Fuel Cycle



Boundary of FTD Plants for WTP Assessment

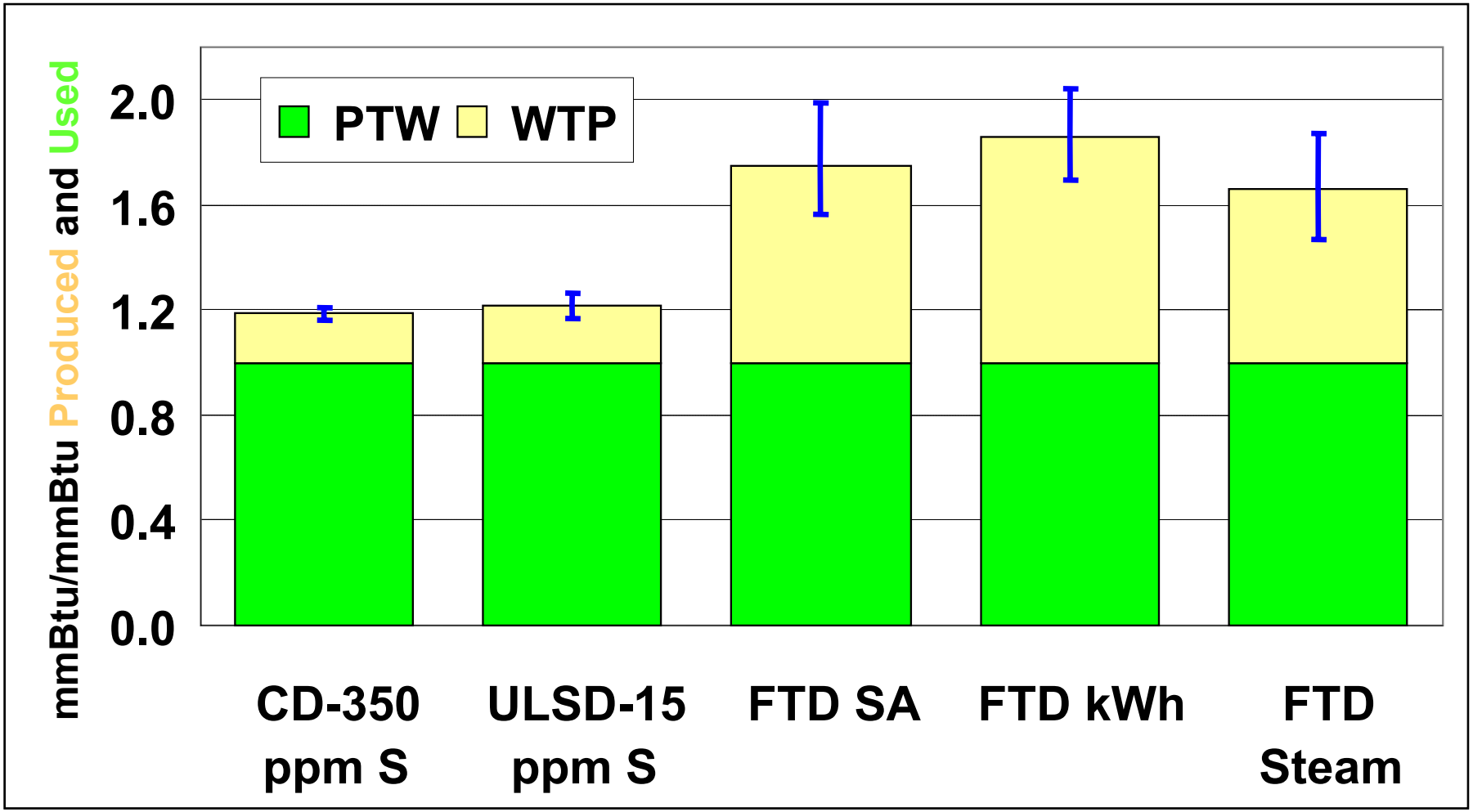


--- here means optional

Key Parametric Assumptions in This Study

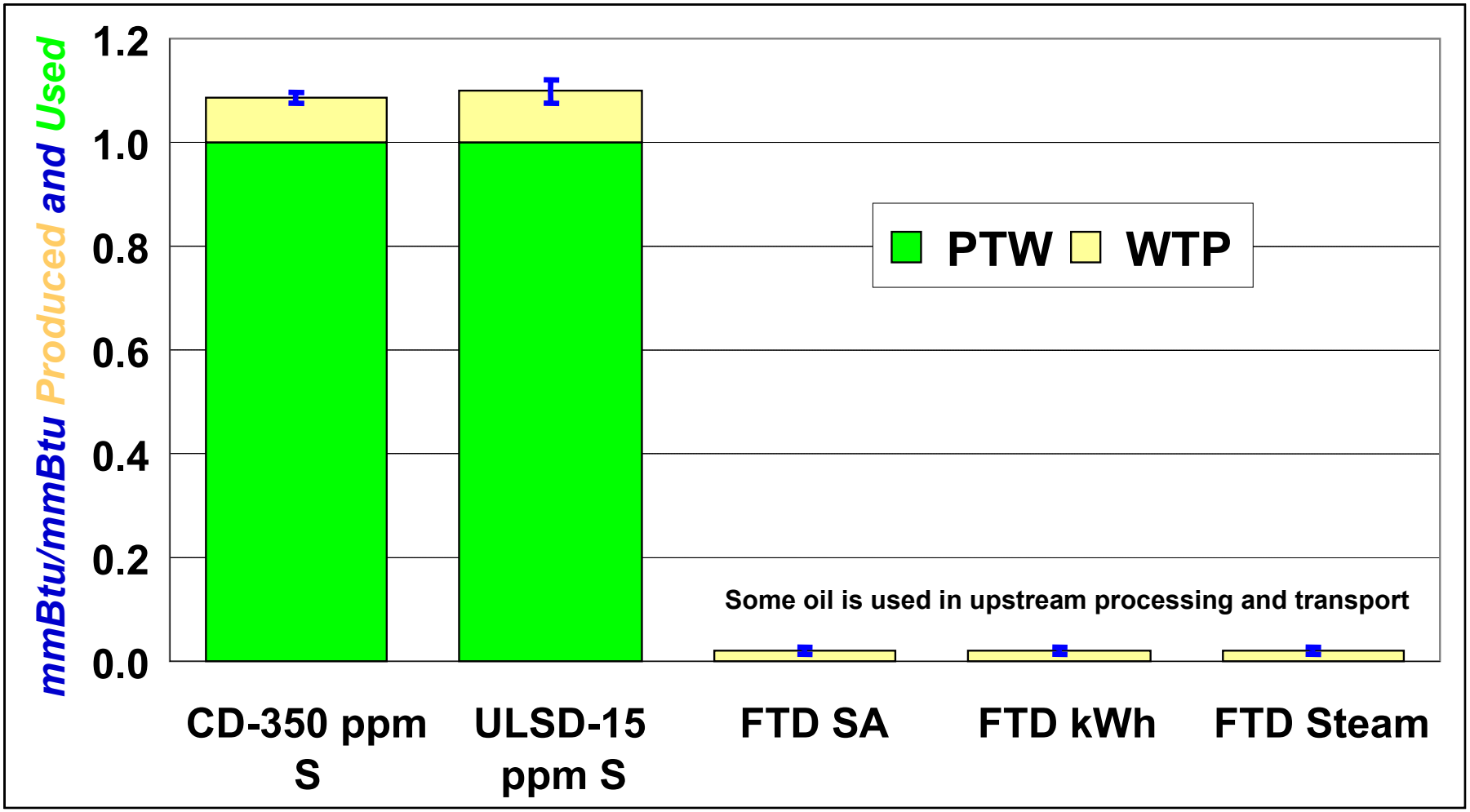
	Min	Mean	Max
Petroleum recovery efficiency (%)	96.0	98.0	99.0
Diesel refining efficiency (%): 350 ppm S	88.0	89.0	90.0
Diesel refining efficiency (%): 15 ppm S	85.0	87.0	89.0
NG recovery efficiency (%)	96.0	97.5	99.0
NG processing efficiency (%)	96.0	97.5	99.0
Standalone FTD plant efficiency (%)	54.0	61.0	68.0
Electric co-gen. FTD plant: efficiency (%)	49.0	53.0	57.0
Electric credit: kWh/mmBtu produced	16.6	23.6	30.5
Steam co-gen. FTD plant: efficiency (%)	49.0	53.0	57.0
Steam credit: kBtu/mmBtu produced	189	268	347
FTD plant carbon efficiency (%)	62.5	71.3	80.0

WTW Total (Virtually Fossil) Energy Use by FTD is Considerably Greater than for Petroleum Diesel

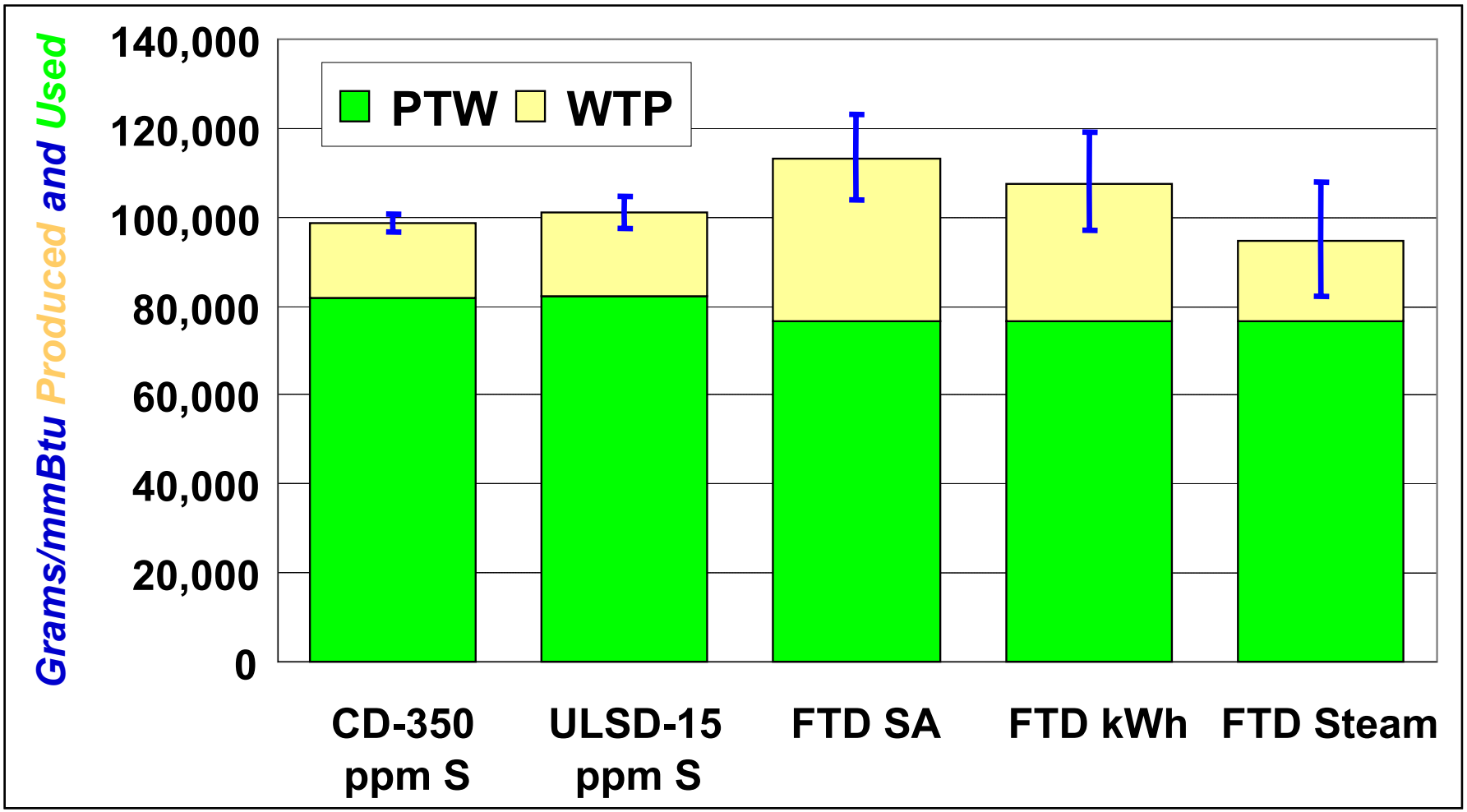


Flared gas results are not presented here.

WTW Petroleum Use of FTD is Nearly Zero



Despite High Energy Differences, Lower Carbon Content Can Make FTD GHGs Like Petro-Diesel's



Conclusions

- For each unit of FTD available for use in vehicles, its production consumes more total energy and fossil energy than production of petroleum diesel
- However, use of FTD almost eliminates petroleum use
- For facility types examined, use of a unit of FTD may cause somewhat higher GHG emissions than use of petroleum diesel does. But there are considerable overlaps in the probability-based estimates between FTD and petroleum diesel

Use of otherwise flared gas (unlikely for most West Coast sources of natural gas) results in large energy and GHG emission reduction benefits. See study report.