



## Sustainable Transportation Energy Pathways (STEPS)

### Natural Gas as a Pathway to Alternative Low Carbon Fuels: Infrastructure Issues and Barriers

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# Stylized Facts

## State of the Natural Gas Market

- Shale Revolution has led to plentiful, cheap natural gas (NG)
- Relative to diesel fuel, NG is an inexpensive energy source
- Relative to diesel fuel, NG tailpipe emissions are lower, implying potential GHG benefits.

These conditions make natural gas appealing as an emerging alternative fuel source for transportation.

# Infrastructure Issues and Barriers

## Barriers

- Refueling infrastructure requirements are costly
- With cheap nat gas comes cheap oil
- Emission advantages of NG over diesel may be misunderstood
- Renewable Natural Gas (RNG) has limited commercial potential at current relative prices

# Refueling infrastructure requirements are costly

Natural gas as an emerging long-distance fuel is competing against established incumbent diesel and gasoline distribution system

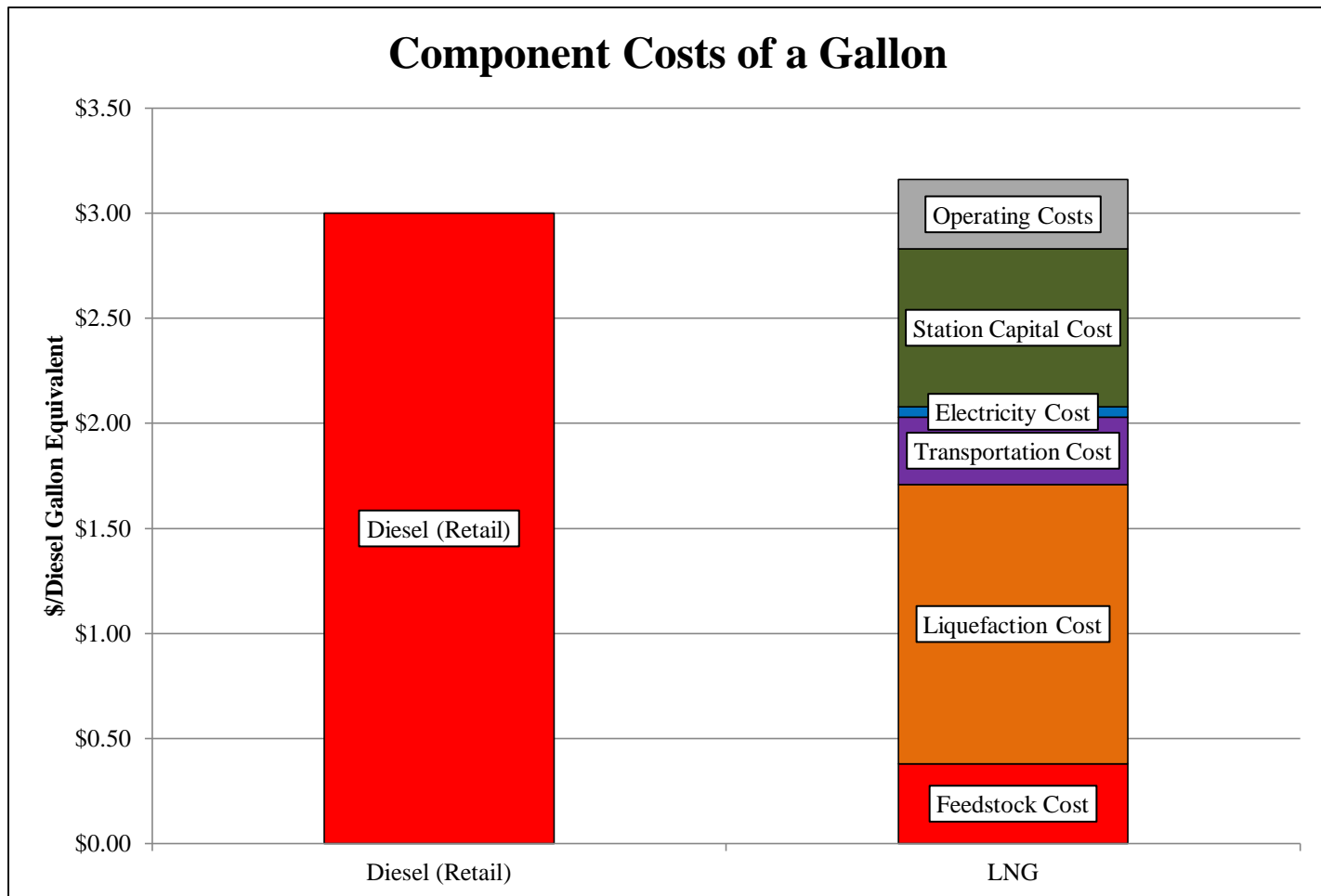
NG Requires:

- Large-scale liquefaction or compression plant
  - New pipeline construction to plant
  - Delivery by truck to retail location
  - Construction of new distribution equipment and storage tanks at refueling station
- or
- New pipeline construction to Refueling station
  - Small-scale compression or liquefaction equipment on-site
  - Construction of new distribution equipment and storage tanks at refueling station

Infrastructure costs are sizeable and require high-volume sales before NG is profitable given the margin between NG and diesel.

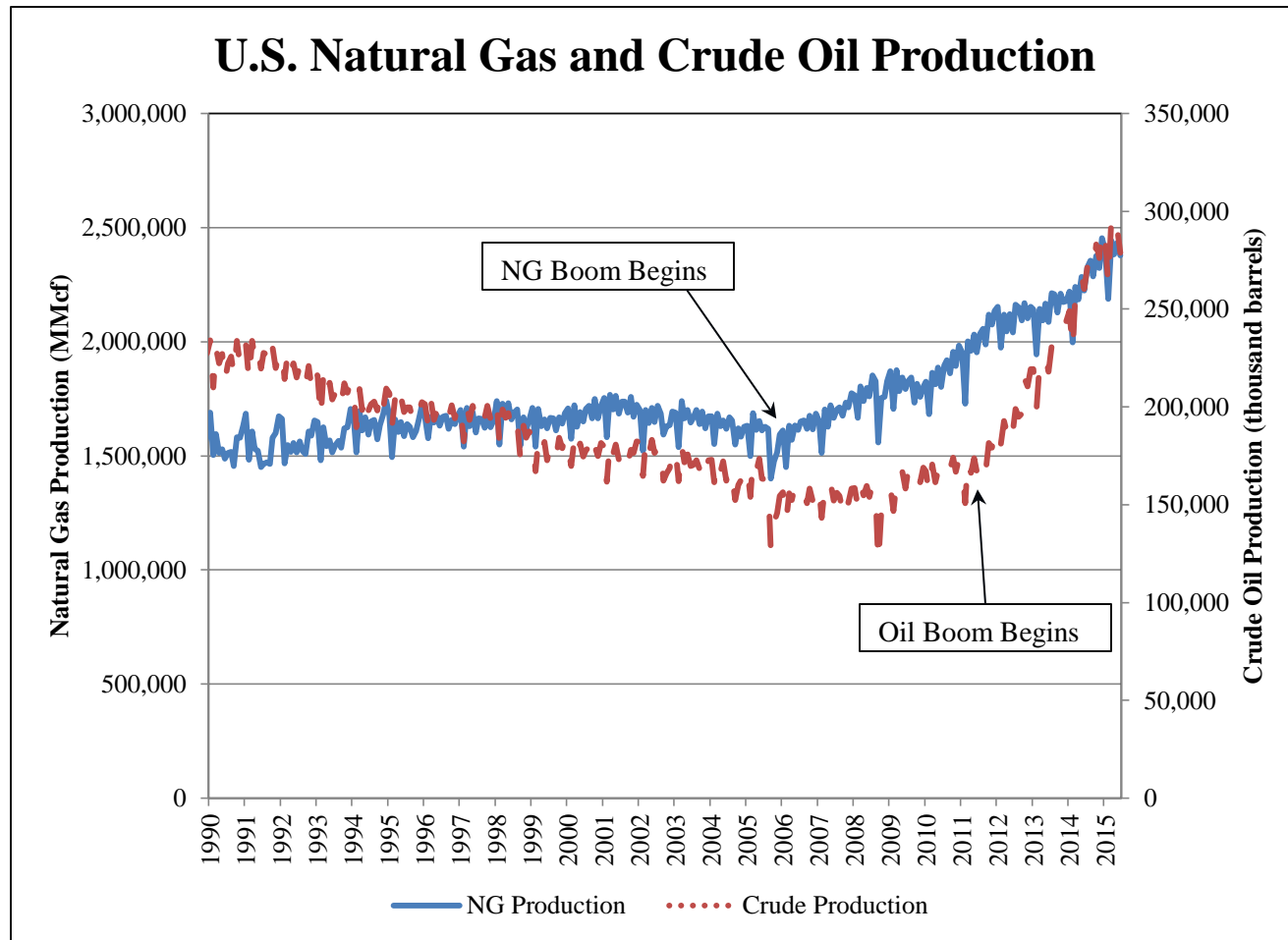
# Infrastructure requirements are costly

Infrastructure costs can exceed margins between natural gas feedstock price and diesel retail price. Sufficient margin is required in every location to construct a natural gas network.



# With cheap gas comes cheap oil

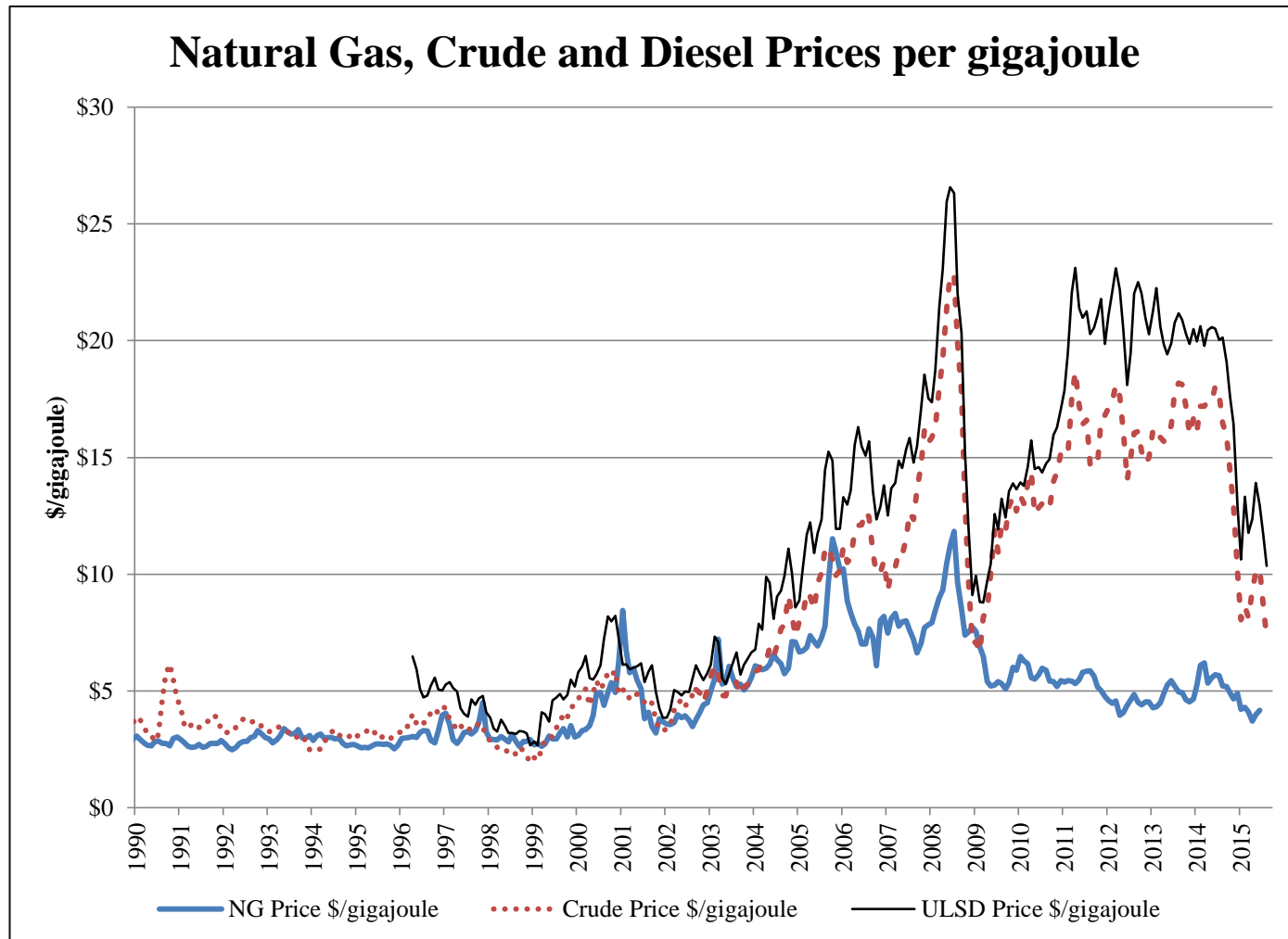
Production boom of crude oil lagged behind natural gas boom by five years



Source: U.S. Energy Information Administration

# With cheap gas comes cheap oil

Previously large margins between NG and diesel are disappearing



Source: U.S. Energy Information Administration

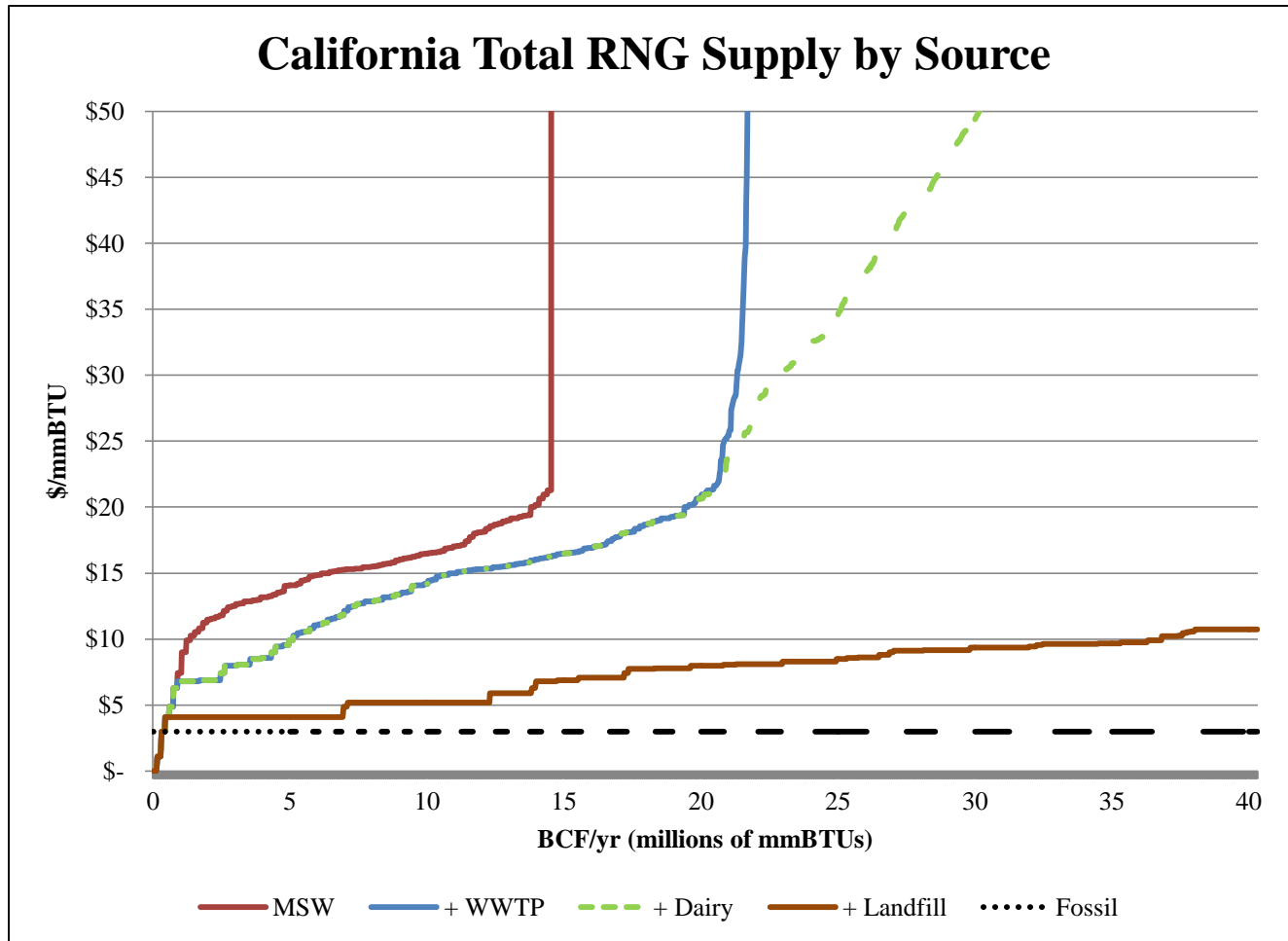
## Emissions Advantage?

- Natural gas is promoted as being the cleanest burning alternative fuel with commercial viability.
- Tailpipe emissions are, in some cases, lower than diesel emissions.
- Upstream leakage in pipeline and production coupled with lower NG engine efficiencies potentially eliminate any GHG advantage of NG as a fuel.



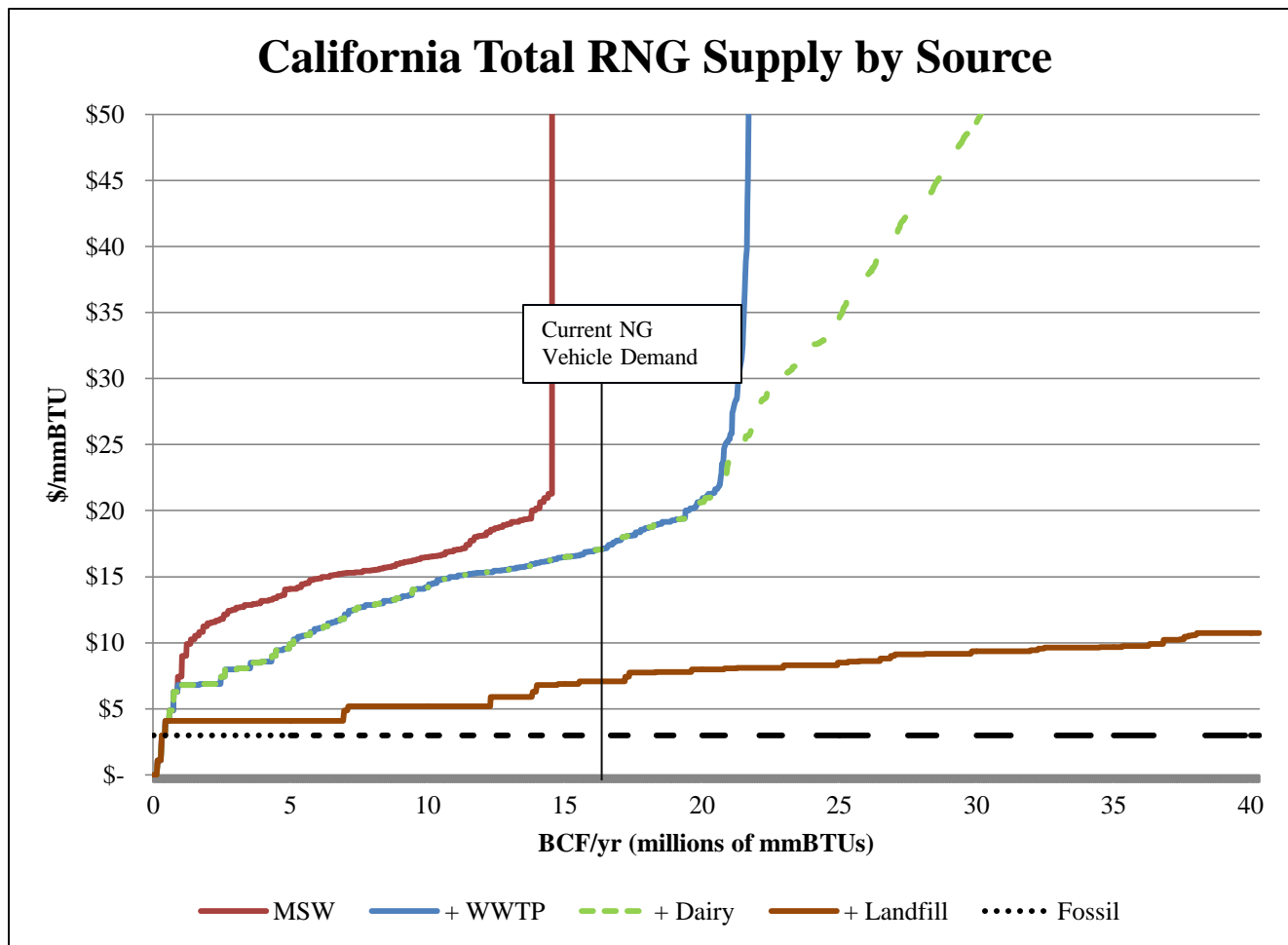
# Emissions Advantage?

Is renewable natural gas the solution? Not at current prices.



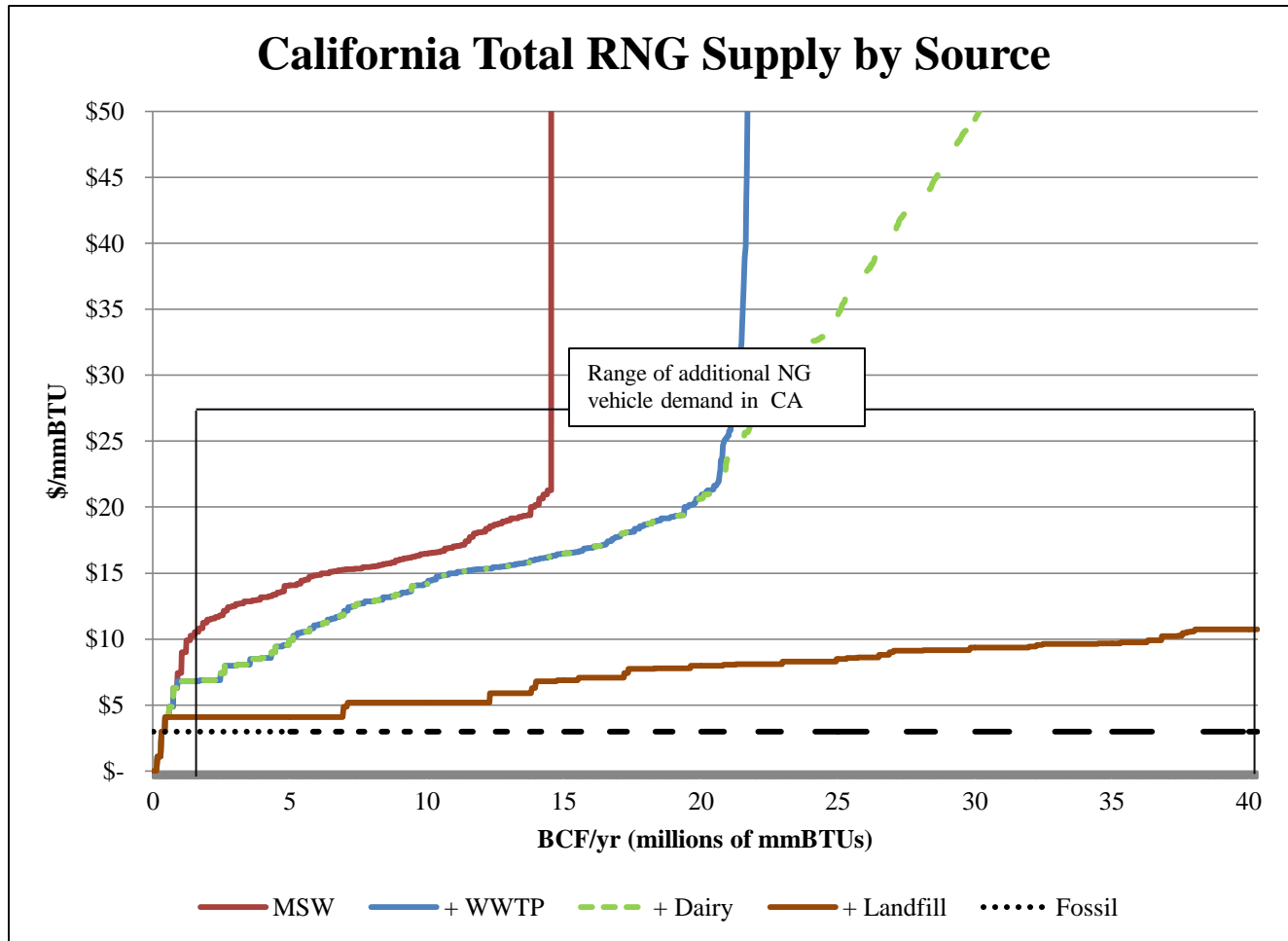
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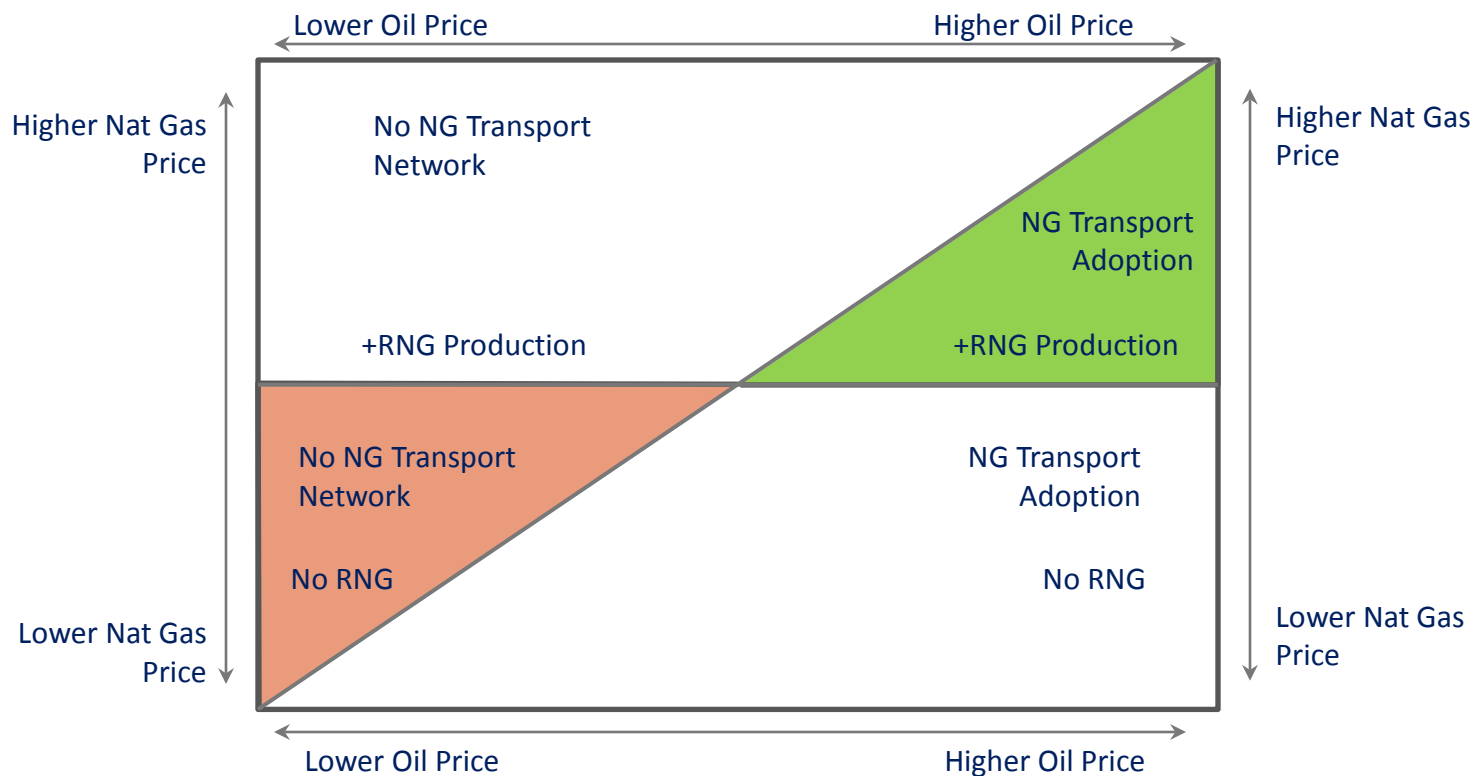
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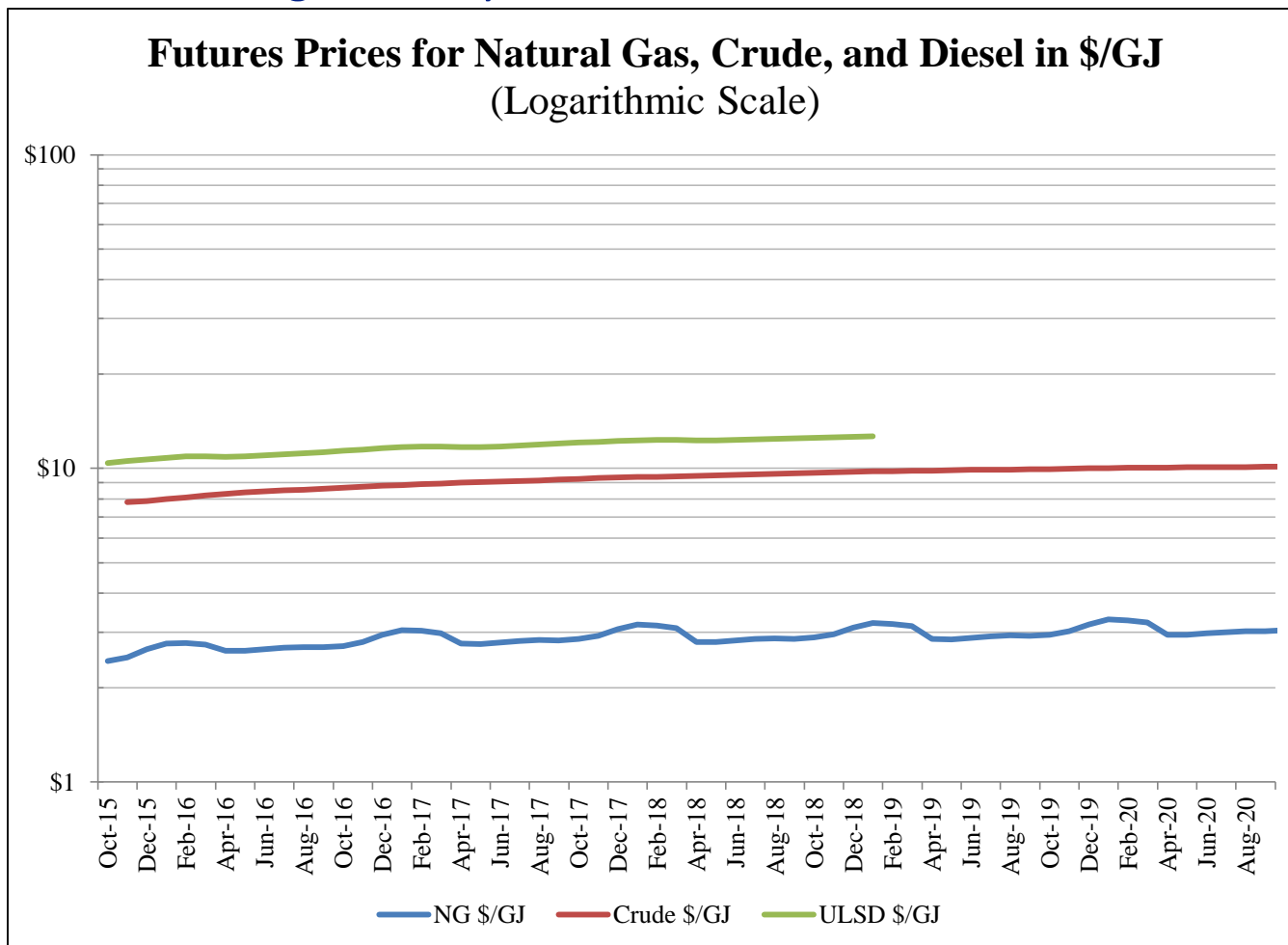
# Emissions Advantage?

Conditions that promote wide natural gas adoption in the transportation sector not the same as conditions that promote a cleaner NG supply from renewable sources.



# Emissions Advantage?

Futures prices indicate: margins expected to remain constant and prices unlikely to increase significantly



Source: CME Group