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ENHANCING OPPORTUNITIES FOR INNOVATORS

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# Fuels & Infrastructure for a Carbon-Neutral Economy

July 15, 2020



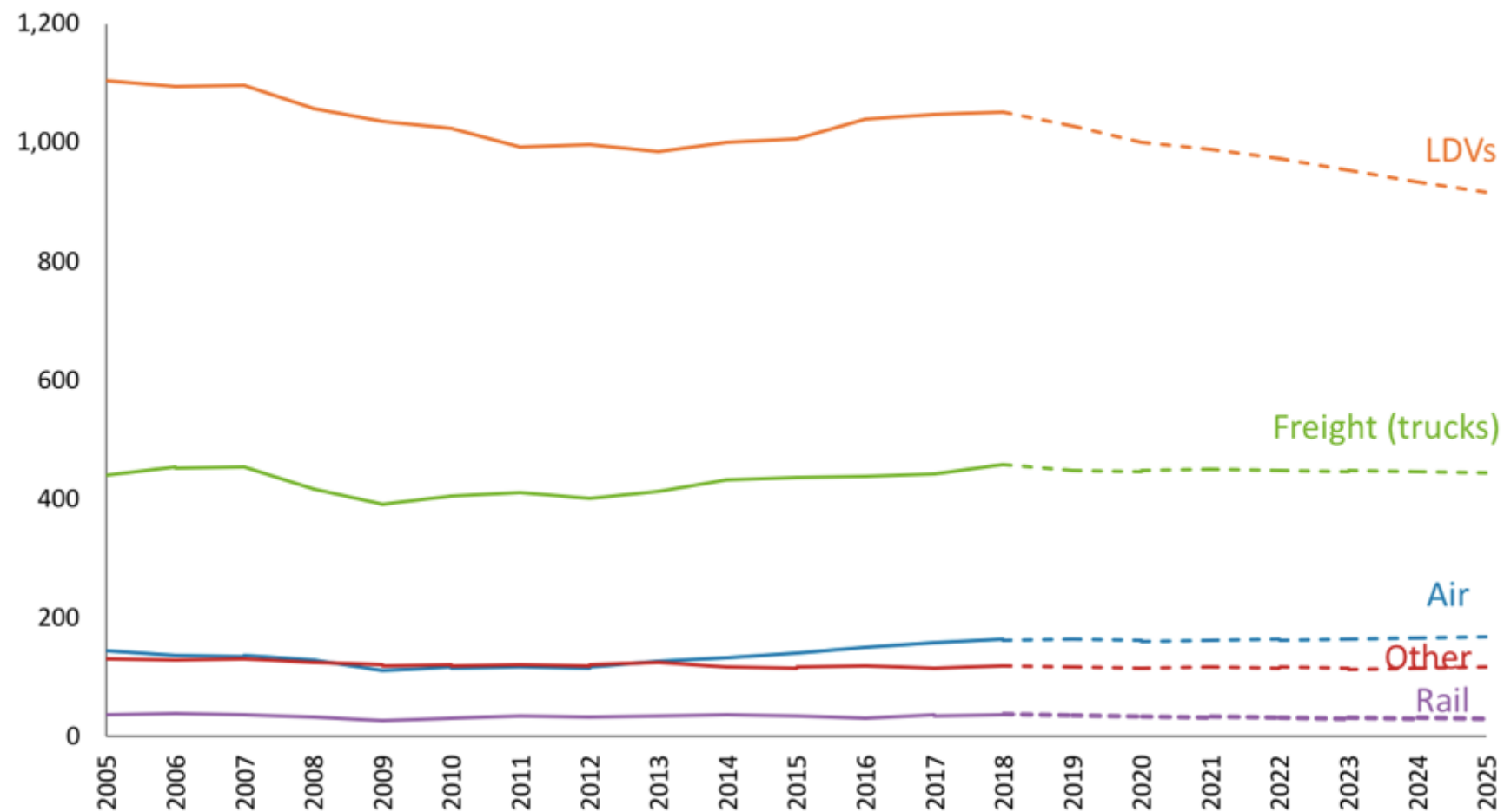
# HARD-TO-ELECTRIFY SECTORS

- Aviation
- Long-haul trucking / shipping
- Rural
- Industrial



# U.S. transport emissions by mode

Million metric tons CO<sub>2</sub>e

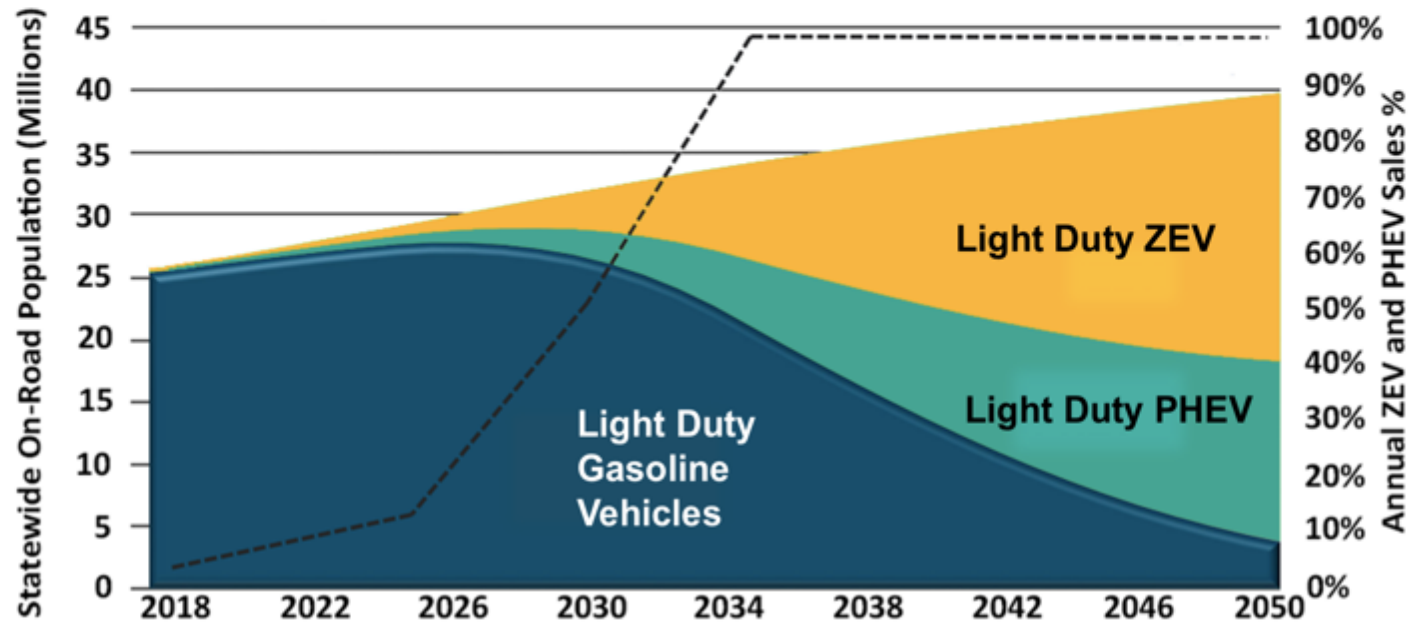


Source: Rhodium Climate Service



# LIGHT-DUTY CHALLENGES

## TRANSITIONING TO ZERO-EMISSION VEHICLES (ZEV)



Source: Richard Corey, CARB



# POTENTIAL SOLUTION: AVIATION

- Sustainable Aviation Fuel
  - ❑ Fully fungible fuel made from renewable feedstocks
- Headwinds:
  - ❑ LCFS provides important but limited value to SAF
  - ❑ Hard to capture the premium value & justify the long-term investment.
  - ❑ Global book-and-claim unavailable



# SOLUTIONS: LONG-HAUL / SHIPPING

- Renewable Diesel
  - ❑ Offered by several companies already; interest from oil majors
- Direct Air Capture to Fuel
  - ❑ What will be the demand for pure underground sequestration, and how will that be paid?
  - ❑ What are the policies driving DAC?
- Ammonia & Hydrogen
  - ❑ Especially suitable for marine & rail
- Headwinds:
  - ❑ Infrastructure
  - ❑ Up-front expense



# POTENTIAL SOLUTION: RURAL

- Low-carbon compatible vehicles
  - For any combustion engine sold in CA, require that the engine be low-carbon fuel compatible
    - E.g., FFVs + PHEV
- Would offer decarbonization benefits before fleet fully turns over
- Headwind:
  - Infrastructure



# POTENTIAL SOLUTION: INDUSTRIAL

Refineries may continue to operate in California past 2050, just focused on exports.

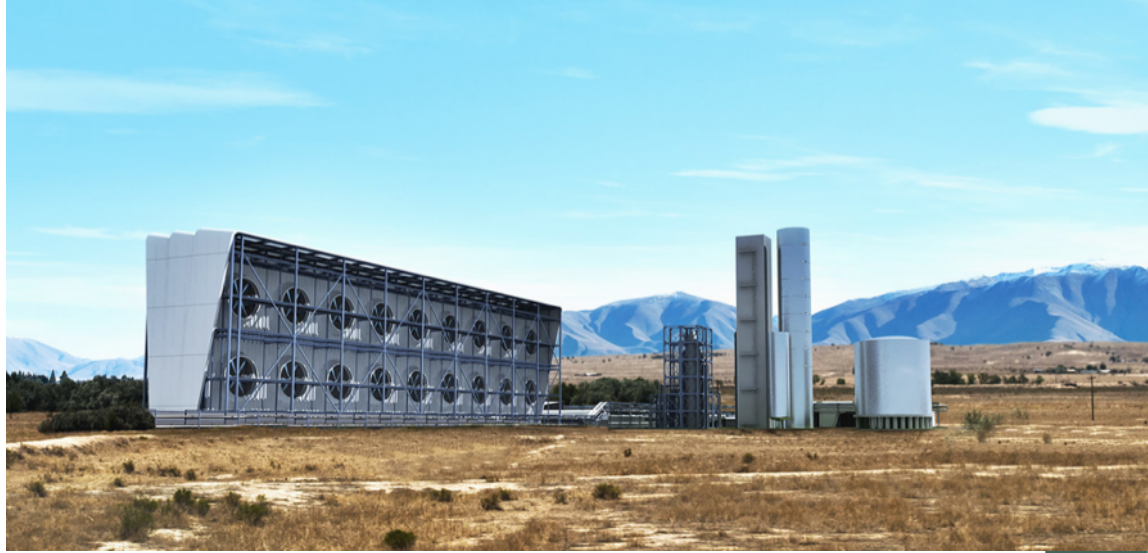
- Renewable natural gas to green hydrogen
- Solar steam
- CCS for process heating, paired with upstream methane abatement
- Ammonia
  
- Headwinds:
  - ❑ No LCFS value for exports
  - ❑ NGO advocacy against RNG





## CASE STUDY: WORLD ENERGY

- Paramount, CA facility
  - ❑ Producing sustainable aviation fuel, renewable diesel, naphtha
  - ❑ Scaling facility to meet 10% of California's diesel demand
  - ❑ Approved CIs range from 43 to recently approved score of 24
  - ❑ Potential for carbon neutrality through pathway development



## CASE STUDY: CARBON ENGINEERING

- Direct Air Capture
  - ❑ TX partnership with Occidental Petroleum
  - ❑ Commercial-scale demonstration
  - ❑ Infinitely scalable; range of uses
- Research into supersonic jet fuel with Aerion



# INVESTMENT BARRIERS

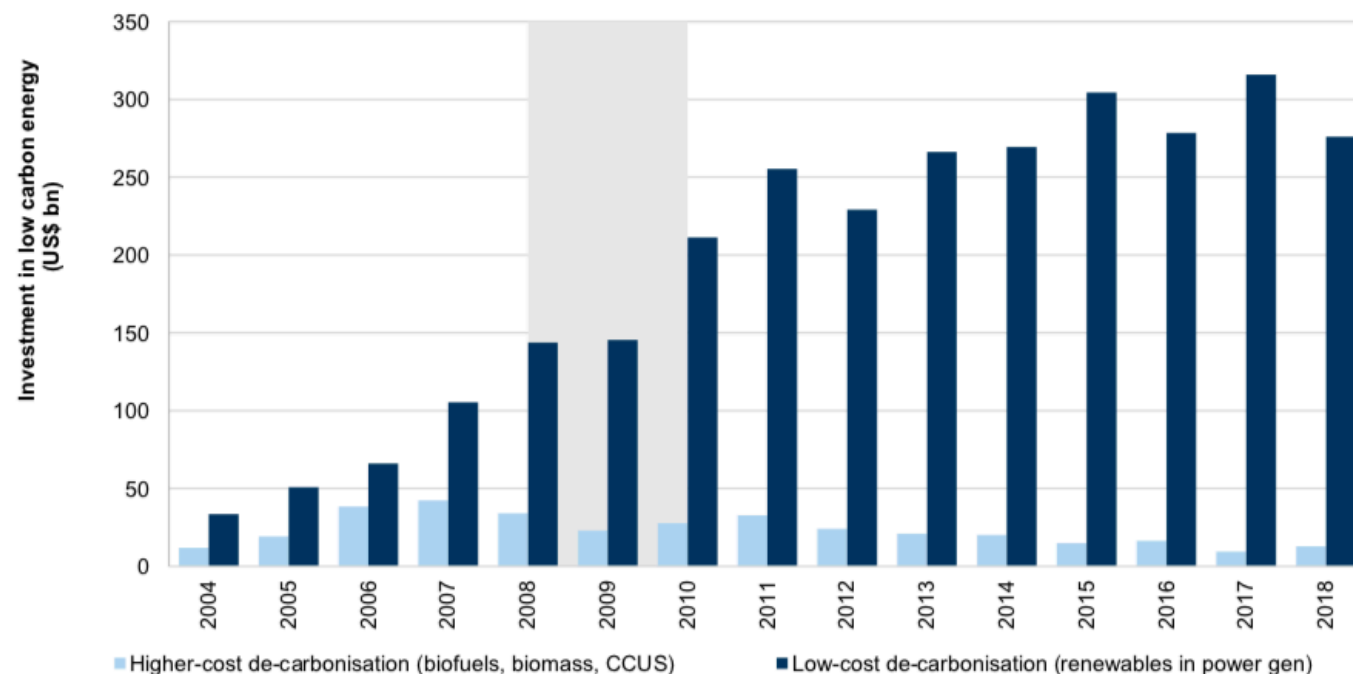
- Scale of future market
- Market access
- Feedstock diversification
- Price uncertainty = investor uncertainty
- Government and regulatory policy



# INVESTMENT CONSIDERATIONS

**Exhibit 31: The biggest impact of the financial downturn was experienced by higher-cost technologies such as biofuels and CCUS, as opposed to the lower-cost renewables**

Total global investment in low-carbon energy (US\$bn)



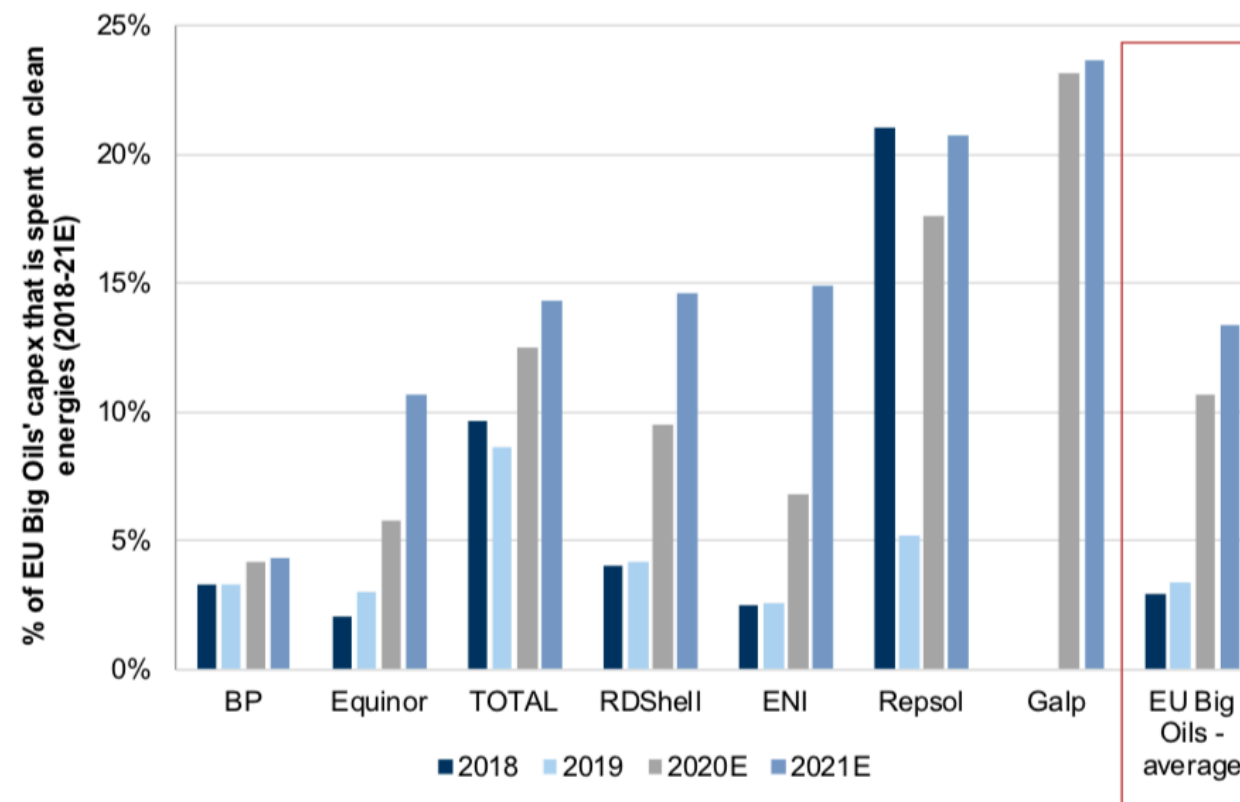
Source: FS-UNEP Collaboration Centre, IEA, Goldman Sachs Global Investment Research



# INVESTMENT CONSIDERATIONS

**Exhibit 48: EU Big Oils are spending c.10-15% of their total capex on low-carbon energy, as capex in the traditional oil & gas business falls by c.20% for the group in 2020-21E and low-carbon initiatives remain intact**

Share of renewables as a % of total capex for EU Big Oils



Source: Company data, Goldman Sachs Global Investment Research



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# THANK YOU.

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