A Holistic Approach to Sustainable Transportation

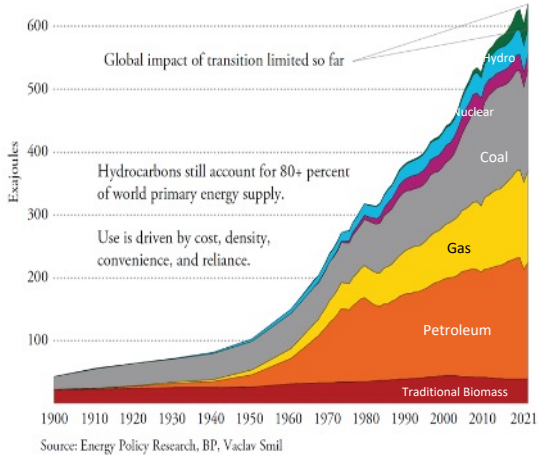
Dr. David Cleary

Research Center Leader

Aramco Research Center - Detroit

Today's Dual Challenge

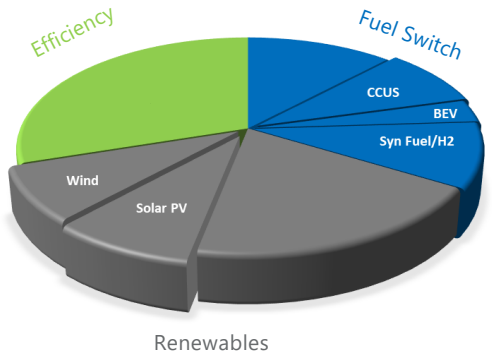
Meeting the World's Growing Energy Needs



Reliable and Affordable Energy Required

Ensuring a Sustainable Environment

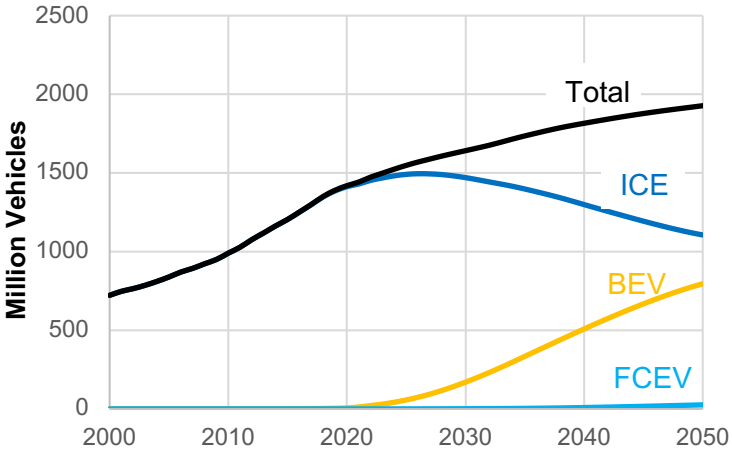
Efficiency, Renewables, Fuel Switch and CCUS



Multiple Solutions Needed

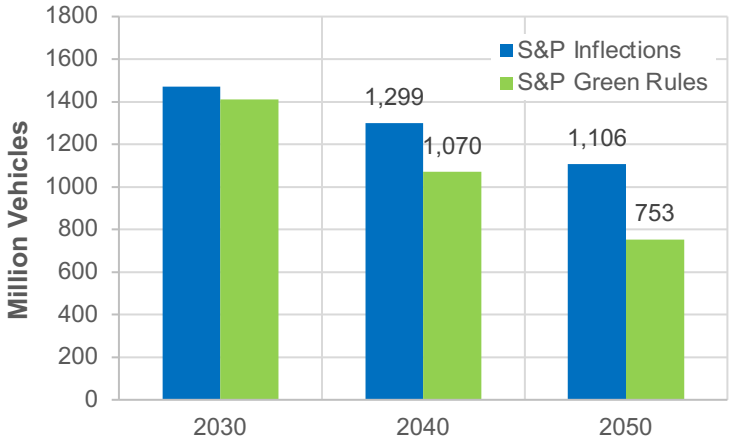
Global Passenger Car Parc Projections

Passenger Car Parc (S&P Inflections)



57% ICE in 2050

ICE Passenger Car Parc



0.753 - 1.1 billion ICE Vehicles on the road in 2050

Holistic (Cradle-to Grave) Greenhouse Gas Emissions

A cradle-to-grave lifecycle approach is needed to accurately account for GHG emissions

- Synthetic fuels requires lifecycle regulations
- California Low Carbon Fuel Standard (LCFS)
- DOE updates the Petroleum Equivalency Factor (PEF) annually
- European regulators are developing a common lifecycle methodology

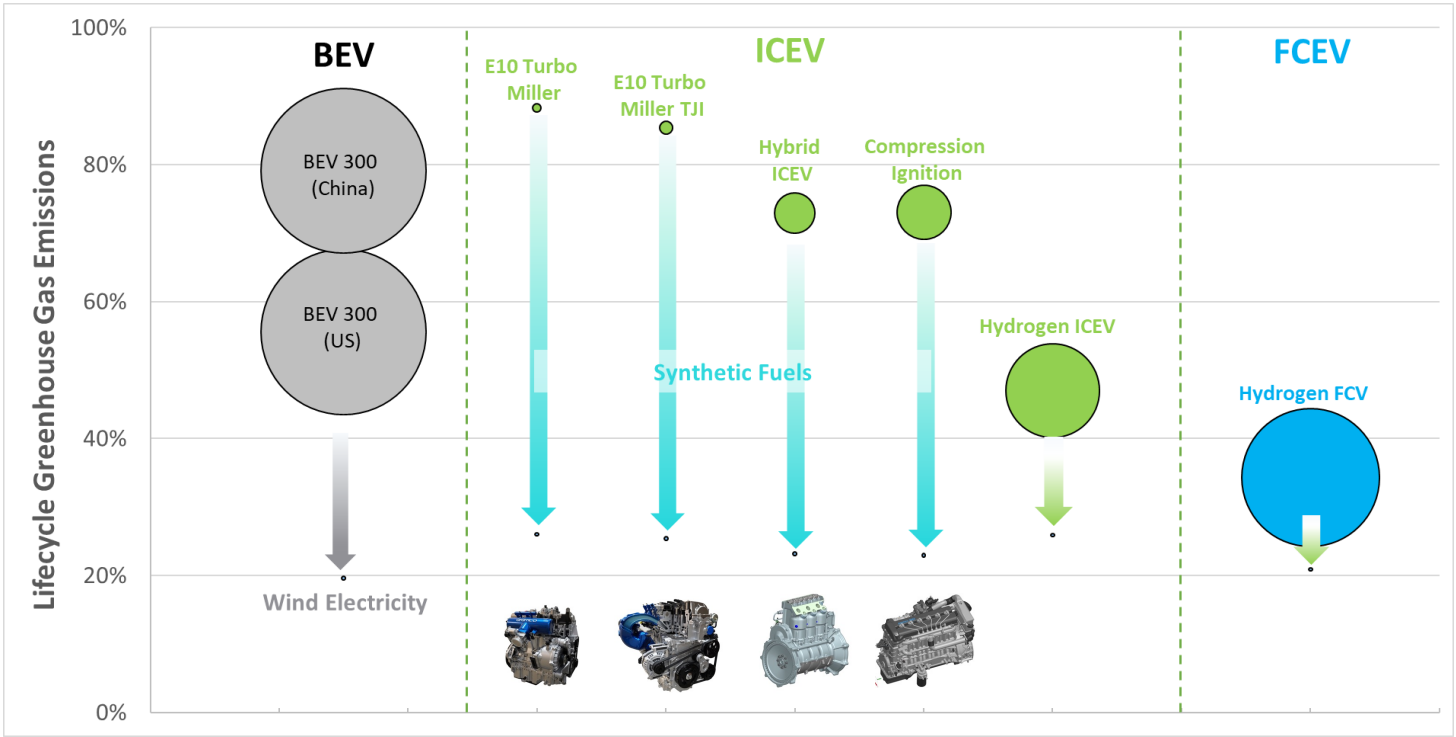
Vehicle Production Emissions

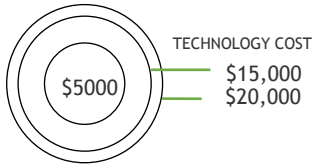
Oil Production Emissions

Refinery or Power Generation Emissions

Tailpipe Emissions

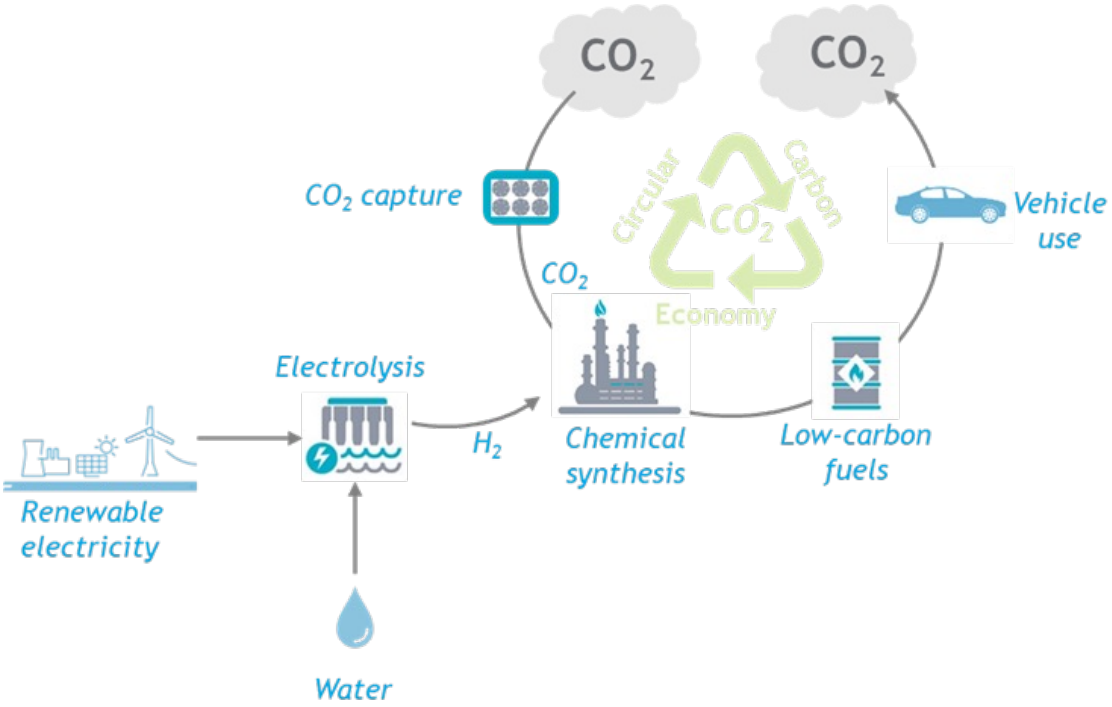
Lifecycle Greenhouse Gas Emissions (SUV)





* Cost data from “Powertrain Market and Technology Study” FEV Consulting
** Lifecycle greenhouse gas emissions data from Argonne National Lab’s GREET Model

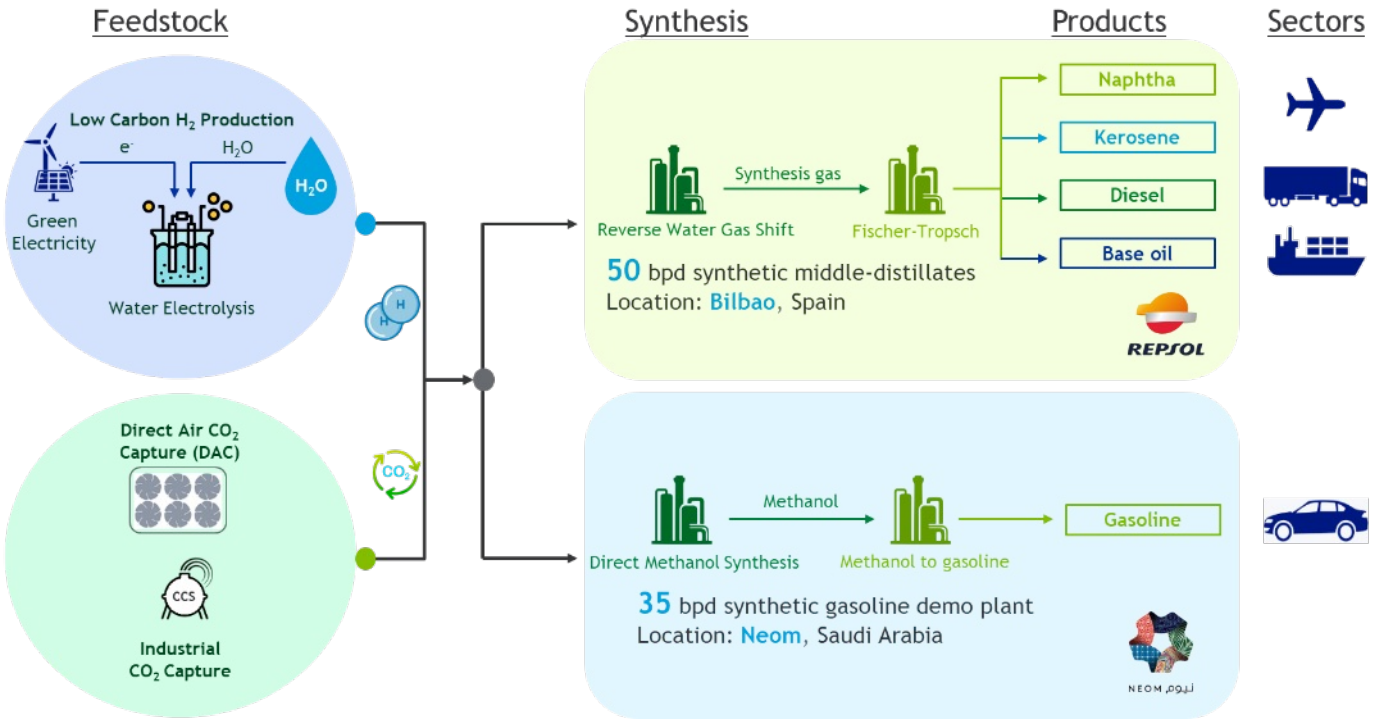
Closing the Loop in the CO_2 Cycle



80%
GHG reduction **Target** relative to conventional fuels

>90%
GHG reduction **Potential** by 2050 relative to conventional fuels

Exploring Sustainable Fuels Production



Thank you

aramco
research & innovation

Dr. David Cleary
Aramco Americas, Novi, MI
248 896 3870
david.cleary@aramcoamericas.com