

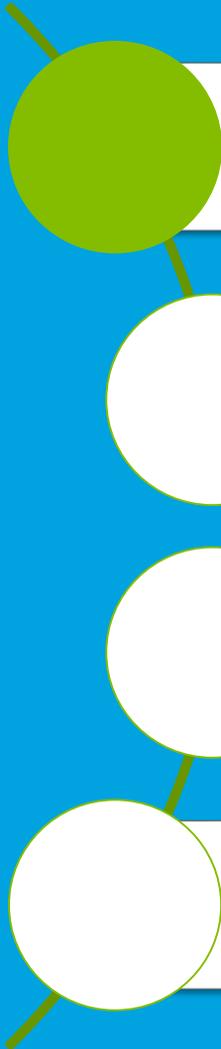
# Policies to Reduce Carbon Emissions in The Transportation Sector

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# Presentation Outline



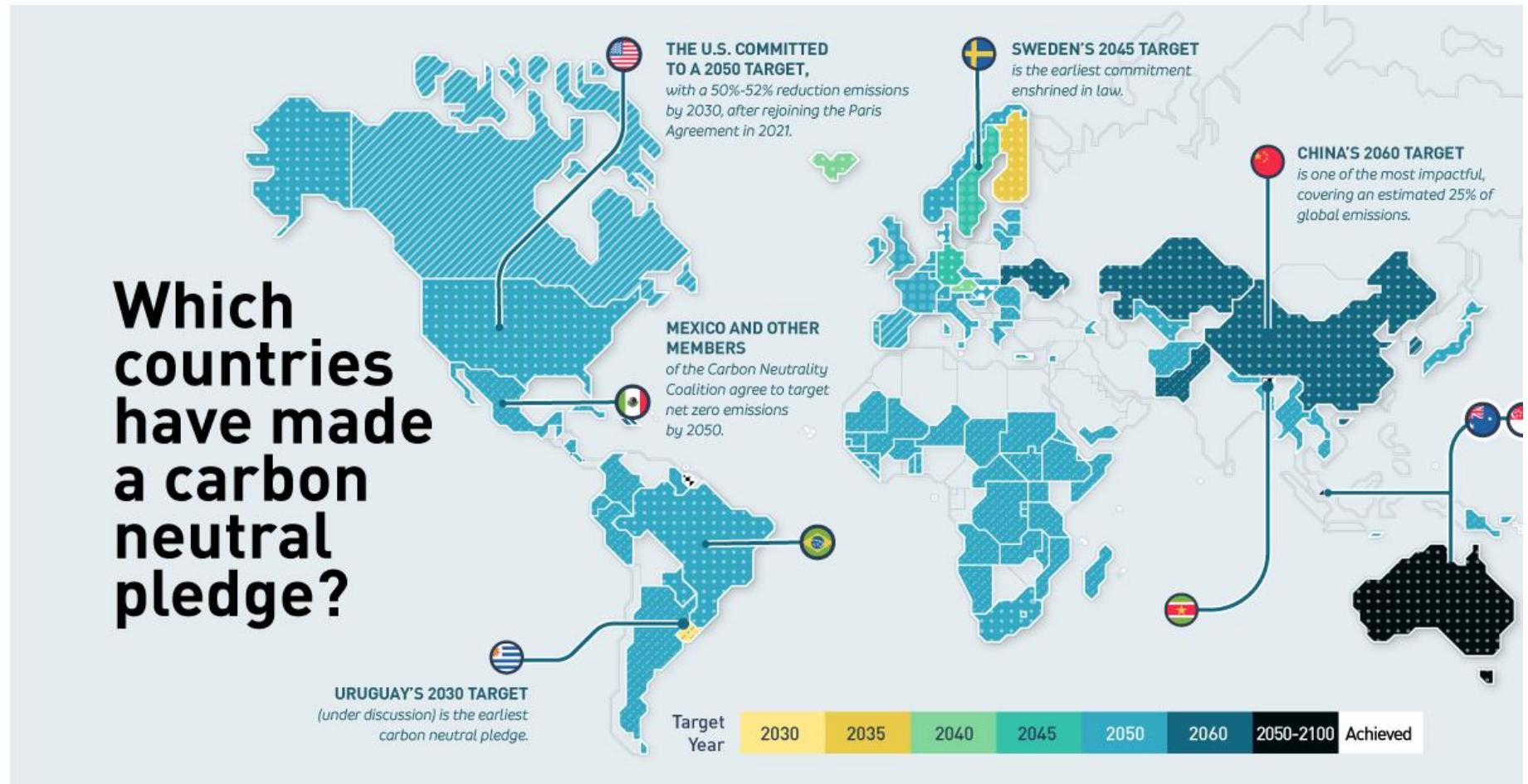
Background

Transport Policies

GHG Consequences of the China Dual Credit Policy

Summary and Final Thoughts

# Countries Committed to Carbon Neutrality



→ A global trend of achieving carbon neutrality to save the planet.

Source: <https://www.visualcapitalist.com/wp-content/uploads/2021/06/Race-to-Net-Zero-Carbon-Neutral-Goals-by-Country-Full-Size.html>



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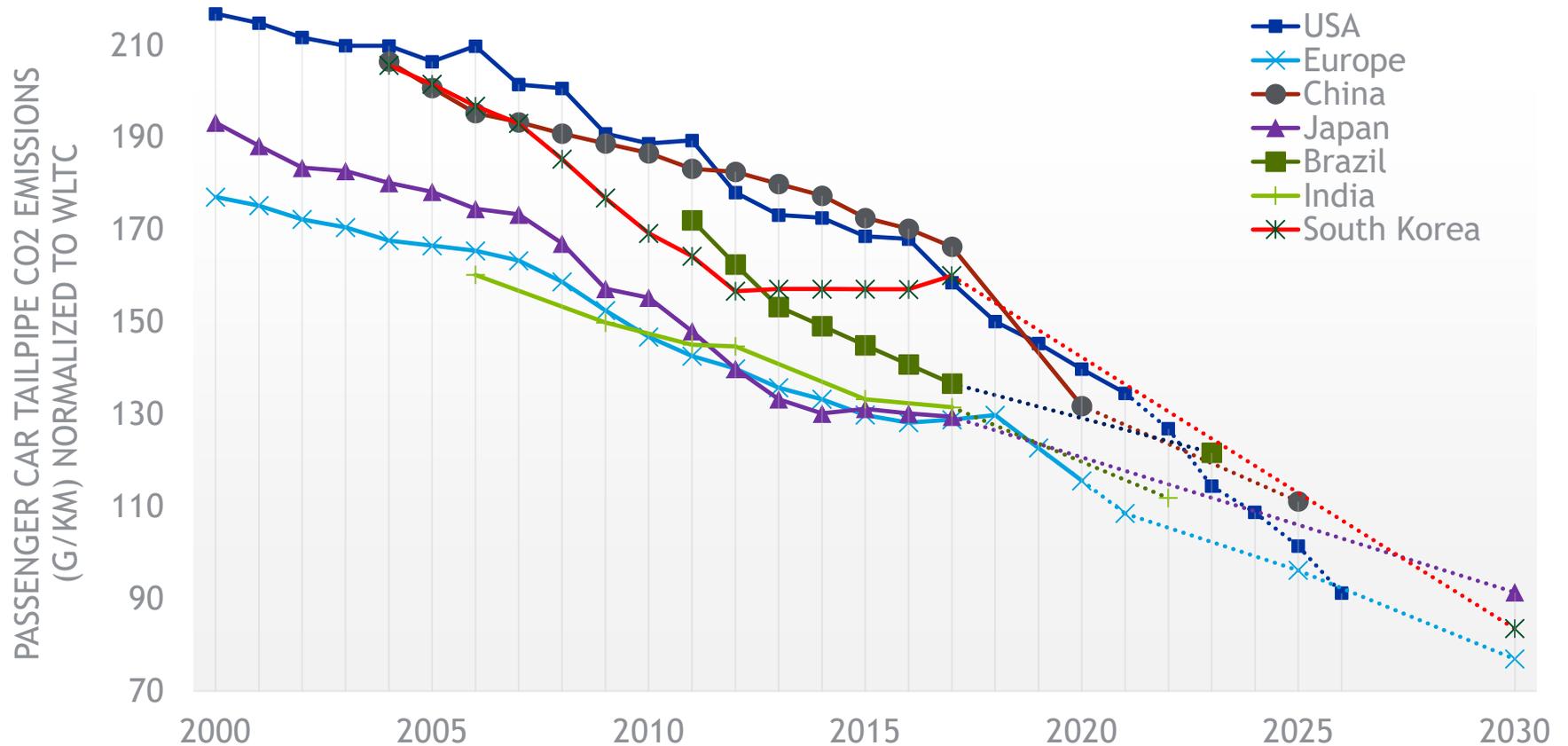
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# Fuel Efficiency Standards



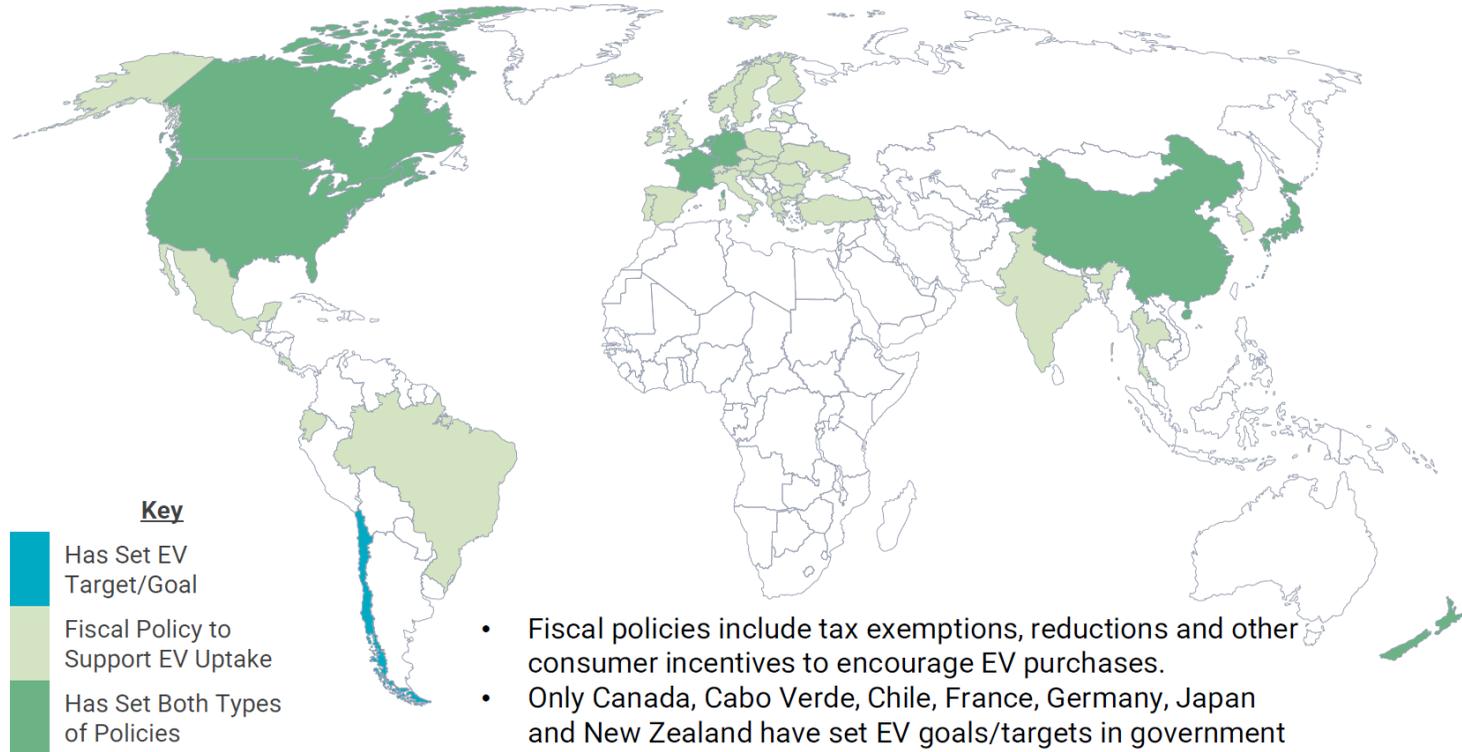
Source: Compiled by Aramco STAT,

based on [https://theicct.org/wp-content/uploads/2021/06/Japan\\_2030\\_fuel\\_standard\\_update\\_20191007.pdf](https://theicct.org/wp-content/uploads/2021/06/Japan_2030_fuel_standard_update_20191007.pdf)

→ Fuel efficiency standards drive tailpipe GHG emissions down.

# Electric Vehicle Policies

*Typical policies include goals/targets (but not mandates) and fiscal policies to support EV uptake*



*Not pictured: Cabo Verde, which has an EV target in place*

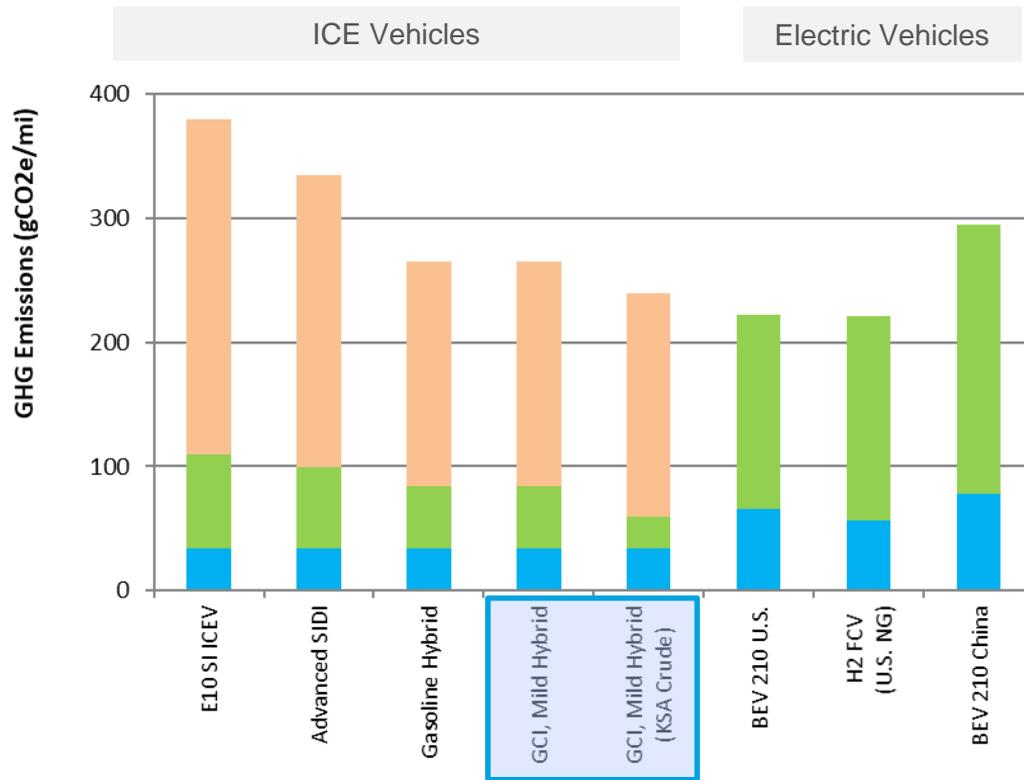
*Source: Compiled by Transport Energy Strategies, April 2021*

- Fiscal policies include tax exemptions, reductions and other consumer incentives to encourage EV purchases.
- Only Canada, Cabo Verde, Chile, France, Germany, Japan and New Zealand have set EV goals/targets in government programs.
- Only China has an actual mandate in place through its New Energy Vehicle program.
- Most policy focuses on the light-duty fleet.



**Source: Compiled by Transport Energy Strategies citing Global Fuel Economy Initiative, April 2021**

# Life Cycle Analysis



- Vehicle Operation\*
- Fuel/Electricity Production
- Vehicle Cycle

### Assumptions:

- Mixed vehicle technologies
- Calculations adapted from 2019 GREET Model (US and Aramco-China versions)
- Gasoline Compression Ignition results based on joint study by Argonne and Aramco



\*Biogenic CO2 in the fuel has been deducted, where relevant

→ The GHG emissions of BEVs are not zero and could be higher than ICEVs.

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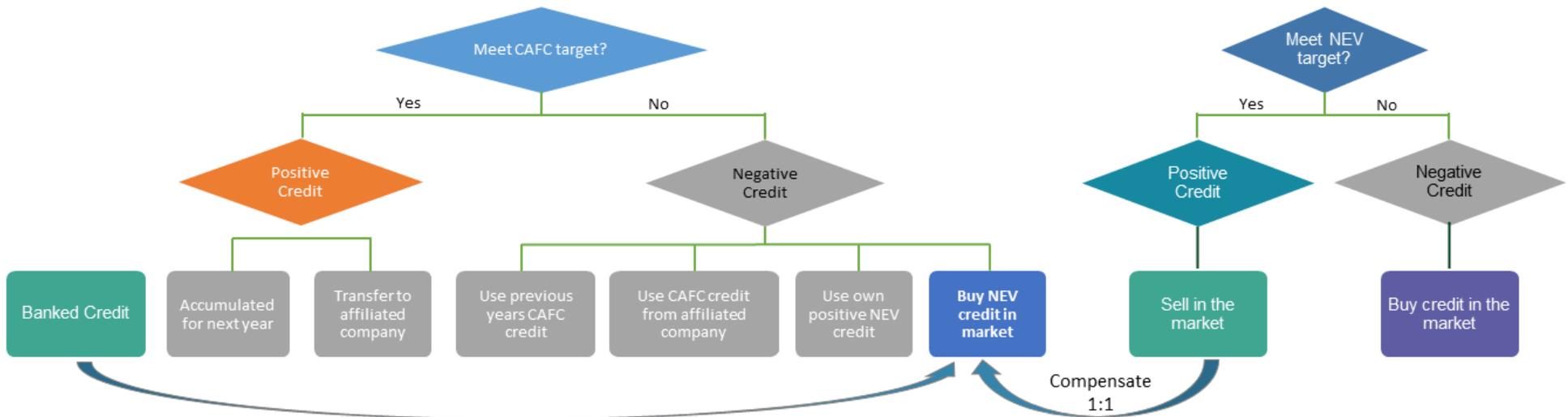
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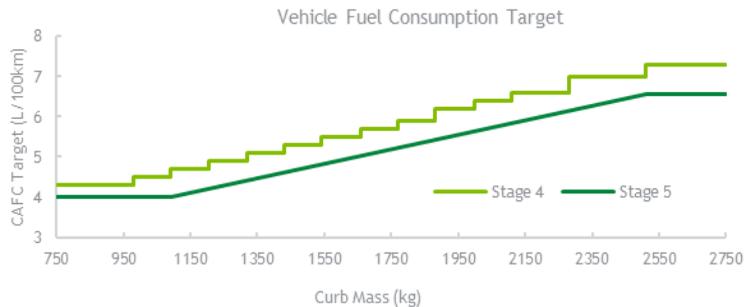
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# China -- Dual Credit Policy



$$\text{CAFC Credit} = (\text{CAFC}_{\text{Stage}} \times \text{Factor}_{\text{Year}} - \text{CAFC}_{\text{Actual}}) \times \text{Sales}$$

$$\text{NEV Credits} = (\sum_{i=1}^N \text{Credit}_{\text{Base}_i} \times W_{\text{NEV}_i} \times \text{Sales}_{\text{NEV}_i}) - (\sum_{i=1}^N \text{Sales}_{\text{ICEV}_i} * W_{\text{ICEV}_i}) \times \text{NEV Quota}$$



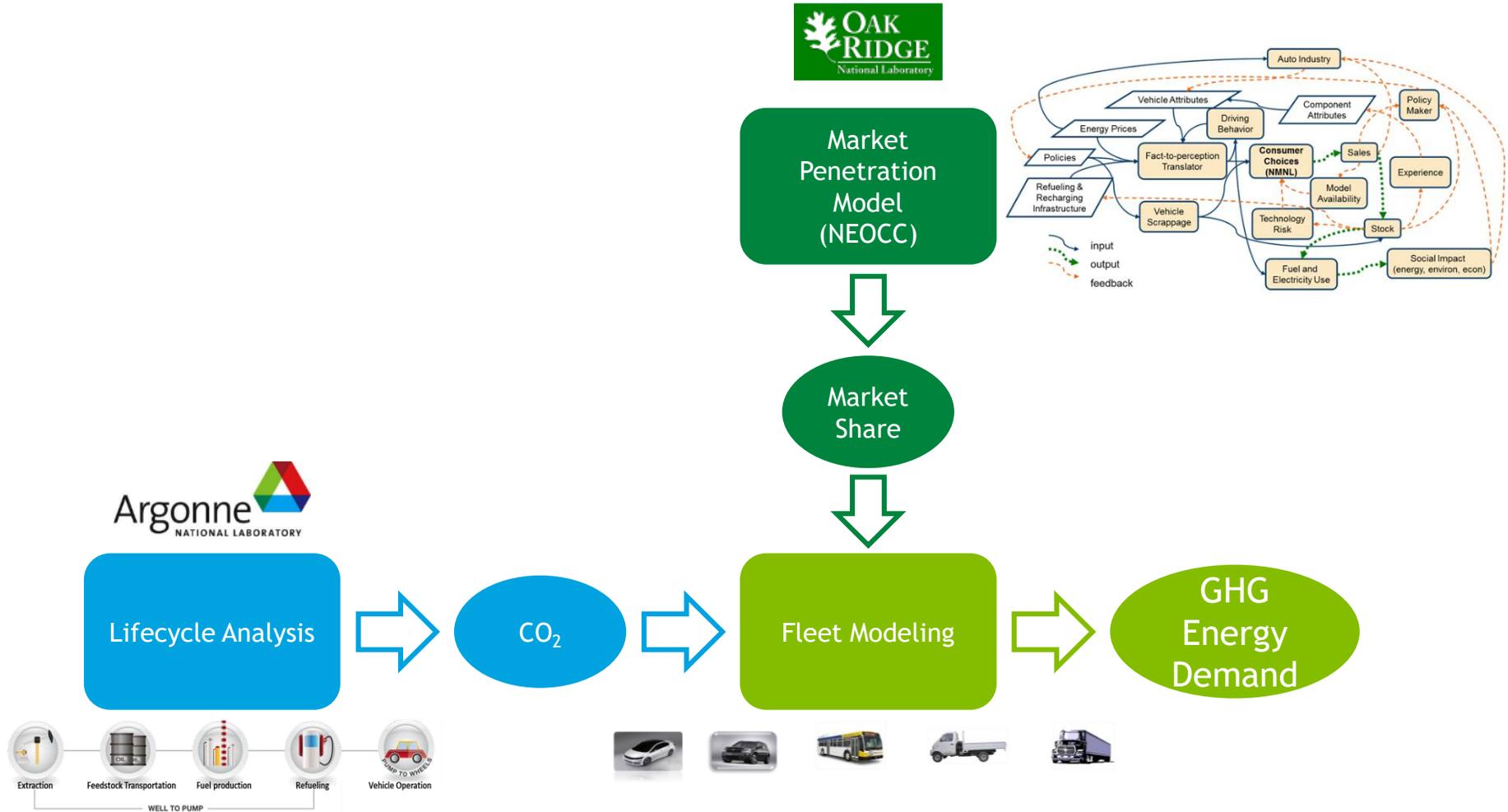
2021-2023		
Vehicle Type	EV Range (km)	Base Credit / vehicle
BEV	R < 150	1
	R ≥ 150	Min (0.006 × R + 0.4, 3.4)
PHEV	R ≥ 50	1.6
FCV		Min (0.08 × P, 6)

NEV Quota	
2019	10%
2020	12%
2021	14%
2022	16%
2023	18%

→ A tail-pipe based policy focusing on improving vehicle efficiency and mandating a minimum share of NEVs.

Source: Compiled by Aramco STAT Team, April 2022

# Life-Cycle Analysis, Market Penetration, and Fleet Modeling



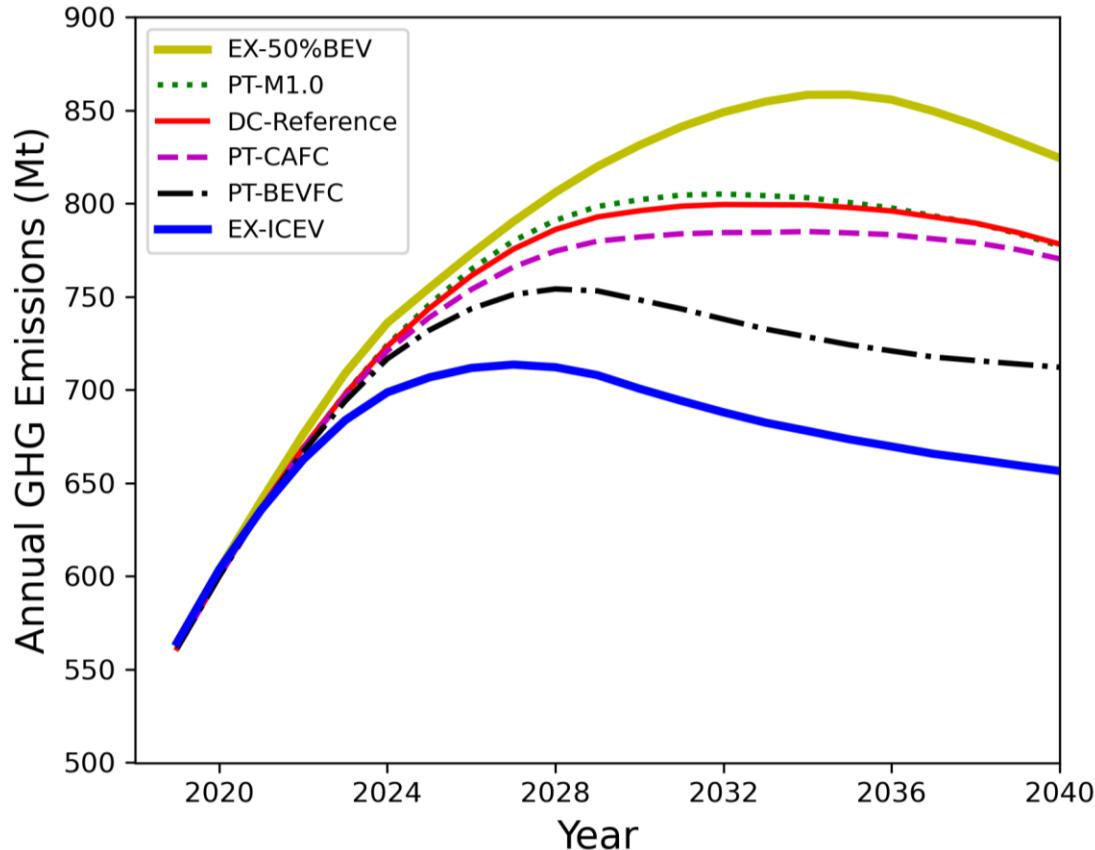
→ Aramco is working closely with reputable organizations to better understand the Chinese market.

# Scenarios

Scenario Category	Acronym	Scenarios
Dual Credit Policy - Reference	DC-Reference	Dual Credit policy - Reference scenario
Extreme Market Penetration Scenario (CAFC Policy Only)	EX-ICEV	Aggressively improving ICEV efficiency
	EX-50%BEV	Fast BEV penetration: 50% of vehicle sales by 2030
Policy Tweak (PT)	PT-CAFC	Remove NEV credit requirements in the Dual Credit policy
	PT-BEVFC	Set non-zero FC for NEVs in the CAFC standards
	PT-M1.0	Set fuel-efficient ICEV multiplier = 1.0 in the Dual Credit policy

→ Scenarios created to explore the policy impact on GHG emissions

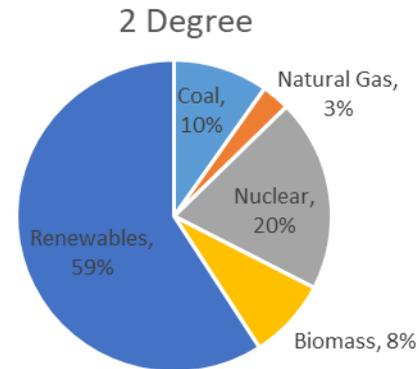
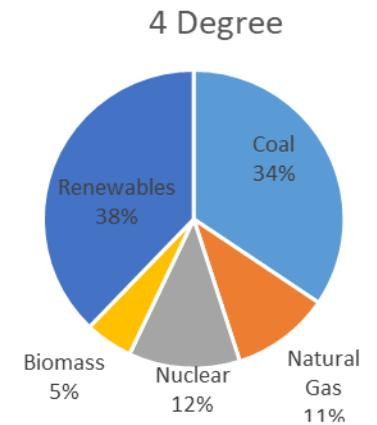
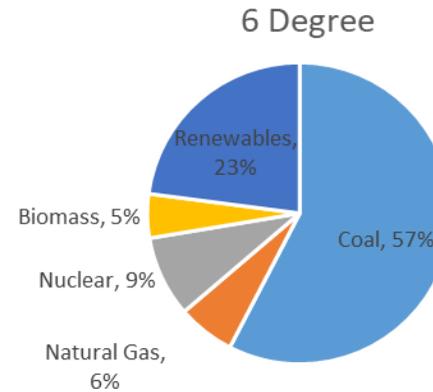
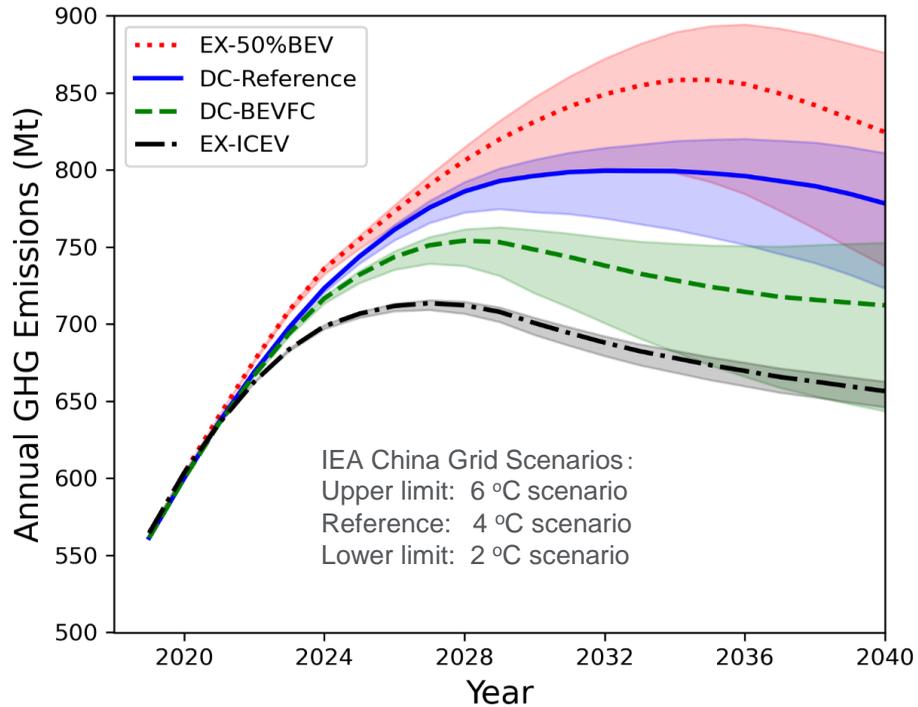
# GHG Emissions - Policy Impact



- The dual-credit policy is a tail-pipe based policy. The higher the BEV market share, the higher the total GHG emissions from the life cycle perspective.
- Removing NEV mandates from the Dual Credit policy achieved lower GHG emissions.
- Accounting for electricity consumption of BEVs in the CAFC standards encourages auto manufacturers to achieve better fuel economy for ICEVs, which is the primary reason for the reduction in the GHG emissions.

Source: <https://www.nature.com/articles/s41467-020-19036-w>

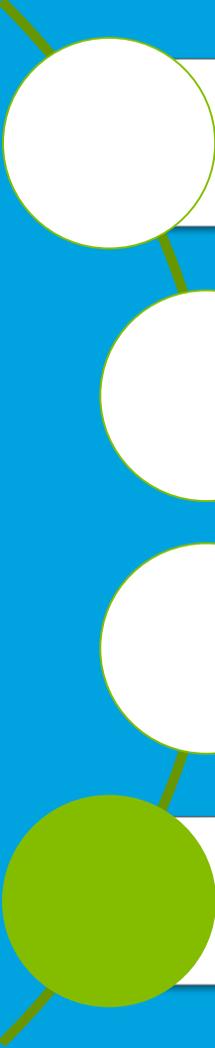
# Uncertainties Due to the GHG Intensity of Power Generation



- The uncertainties increase over time due to the higher NEV market share and the increasing differences in electricity GHG intensities between the three electric grid scenarios.
- Under the 2 °C electricity scenario, the annual GHG emissions of the DC-BEVFC scenario could be lower than the EX-ICEV scenario after 2038.

Source: <https://www.nature.com/articles/s41467-020-19036-w>

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# Final Thoughts



- Transitioning directly to a net-zero fuel is difficult - building a pathway to them is more practical
- Conventional technologies have significant potential to reduce GHG emissions in the near- and mid-term
- Collaboration between the automotive and energy industries along with government will lead to better transport solutions.
- Moreover, tools such as LCA can cultivate an even playing field and should be utilized when creating transport policies.

# Acknowledgements

- Aramco: Jessey Bouchard, Mohamed Ali Saafi
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- China Automotive Technology and Research Center: Rujie Yu

# Thank You for Your Attention!



## enabling sustainable mobility solutions

As a dependable partner we are committed to creating mutual value through long lasting relationships with our partners, customers and communities

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