Will electric vehicles deliver the transition to a low carbon future?

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SUMMARY

To create a better understanding of whether and how transport electrification would contribution to climate change mitigation, this research aims to develop **an integrated modeling methodology to couple transport model, economic model, and climate model**, which can depict the interaction between the transport, energy, macroeconomy, and climate change. Scenarios are created to simulate the potential for different transport, energy, and climate policy interventions. This project attempts to develop **an interdisciplinary framework that integrates transport planning and climate change studies**, with the objective of helping shape the policy agenda for electrified transport.

INTRODUCTION

● Background

The transport sector accounts for approximately a quarter of global greenhouse gas emissions. Road transport is by far the biggest emitter accounting for more than half of all transport-related emissions. Switching to electrified road transport permits an optimistic outlook to meet the stringent climate targets. **Electric vehicles (EVs) are often considered as an attractive solution towards a green future.**

● Objectives

Are EVs as green as they are supposed to be?

To understand the role of transport electrification in achieving climate change targets, this study is intended to (1) reveal the **interactive mechanism between transport electrification, energy, and climate change**, and (2) provide a better policy simulation tool for the electrification of road transportation towards a green future.

METHODOLOGY

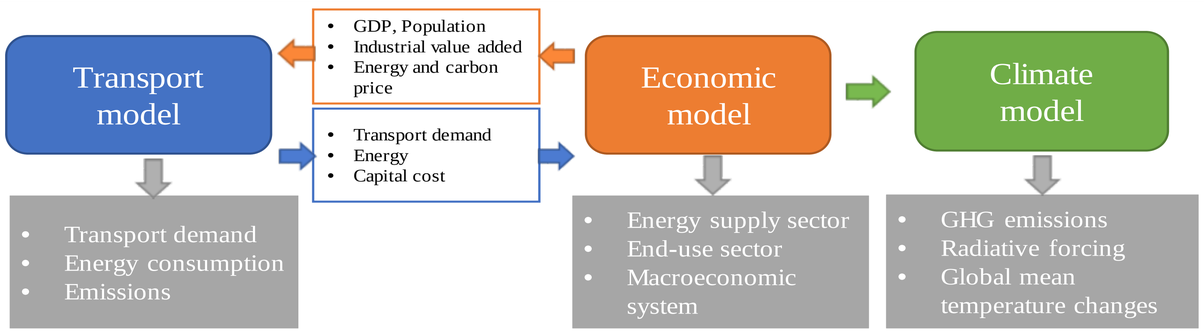

Figure 1. Model framework

■ The transport model

The transport model offers spatially flexible and temporally dynamic simulations of transport demand, energy use, and emissions. To understand how transport electrification might affect the anticipated low carbon transition, the transport model considers more technological details and behavioral factors on EVs.

■ Coupling of transport model, economic model, and climate model

Computable General Equilibrium (CGE) model and simplified climate model MAGICC are employed to couple with the transport model. **An iterative algorithm is used to obtain the convergence of coupled transport-economic-climate model.**

The CGE model passes the macroeconomic variables to transport model for transport demand projection. The transport demand, transport-related energy consumption, and capital cost for transport device feedback from transport model is passed to economic model. This loop continues until the energy consumptions computed in economic model and transport model are equal.

● Scenario definition

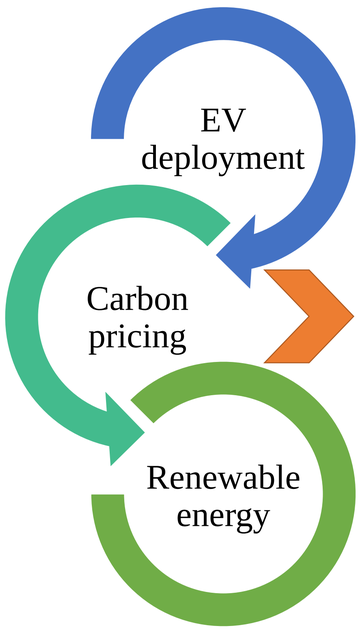

Table 1. Scenarios framework

SCENARIOS	DESCRIPTION
LoEV_BaU	Moderate preference on EVs with no climate efforts
LoEV_2D	Moderate preference on EVs with no carbon pricing for 2 degree target
LoEV_Renew	Moderate preference on EVs with high preference on renewable energy
HiEV_BaU	100% of EV market share by 2050 with no climate efforts
HiEV_2D	100% of EV market share by 2050 with carbon pricing for 2 degree target
HiEV_Renew	100% of EV market share by 2050 with high preference on renewable energy

RESULTS

● Emission from transport

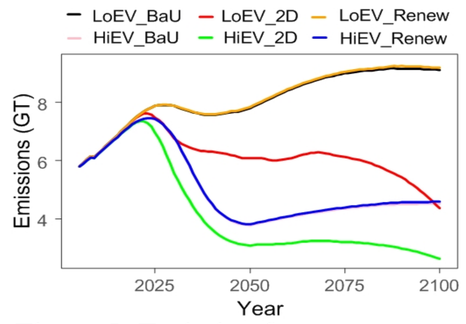

Figure 2. Emission from transport

- For transport sector, the deployment of EVs is more effective to reduce the emissions than carbon pricing.
- Electrified road transport together with carbon pricing have the highest mitigation potential.
- Renewable energy policy does not have direct positive effects on emission reduction in transport sector.

● Emission by sectors

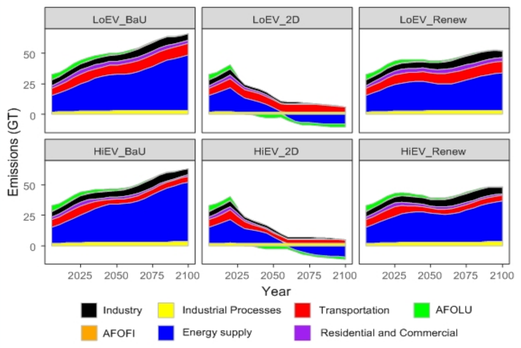

Figure 3. Emission by sectors

- Although transport electrification has more powerful and effective impacts on emission reduction for transport sector, it requires high emissions in energy supply sector if the transport is not powered by decarbonized electricity generation.
- Compared with the high preference on renewable energy, carbon pricing has the most effective effects on emission reduction.

● Emission from power sector

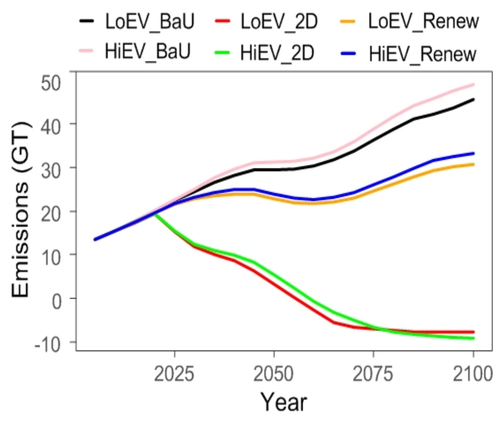

Figure 4. Emission from power sector

- Transport electrification slightly produces more emissions from energy supply, because the deployment of EVs requires more electricity.
- Carbon pricing has the most powerful effect on emission reduction in power sector, followed by high preference on renewable energy.
- Transport electrification needs to be implemented together with decarbonization of power sector, otherwise the emissions from power sector still keep growing.

● Biofuel

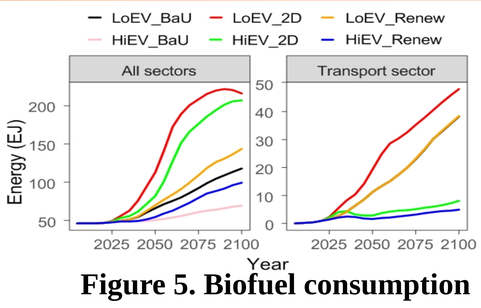

Figure 5. Biofuel consumption

- EV policy produces lower consumption of biomass compared with scenarios without the deployment of EV.
- Carbon pricing tends to increase the consumption of biomass in all sectors including transport sector.

DISCUSSION & IMPLICATIONS

- Transport electrification is bound to shift the emissions from transport sector to power sector.
- EV policy fails to contribute to the emission reduction when the power sector is not decarbonized, though the transport-related emissions can be reduced significantly.
- Transport electrification might help to ease the pressure of biofuel consumption on agricultural production and food security.
- Single transport electrification does not mean the successful emission reduction. Instead, the linkage between sectors deserve attention to meet the stringent climate target.
- Renewable energy policy and carbon price need to be taken into consideration to match up with the transport electrification policy.