KAPSARC
مركز الملك عبدالله للدراسات والبحوث البترولية
King Abdullah Petroleum Studies and Research Center

# Accelerating Just Energy Transition in Transport Systems

## Electrification of Vehicles (Infrastructure, Batteries & Minerals)

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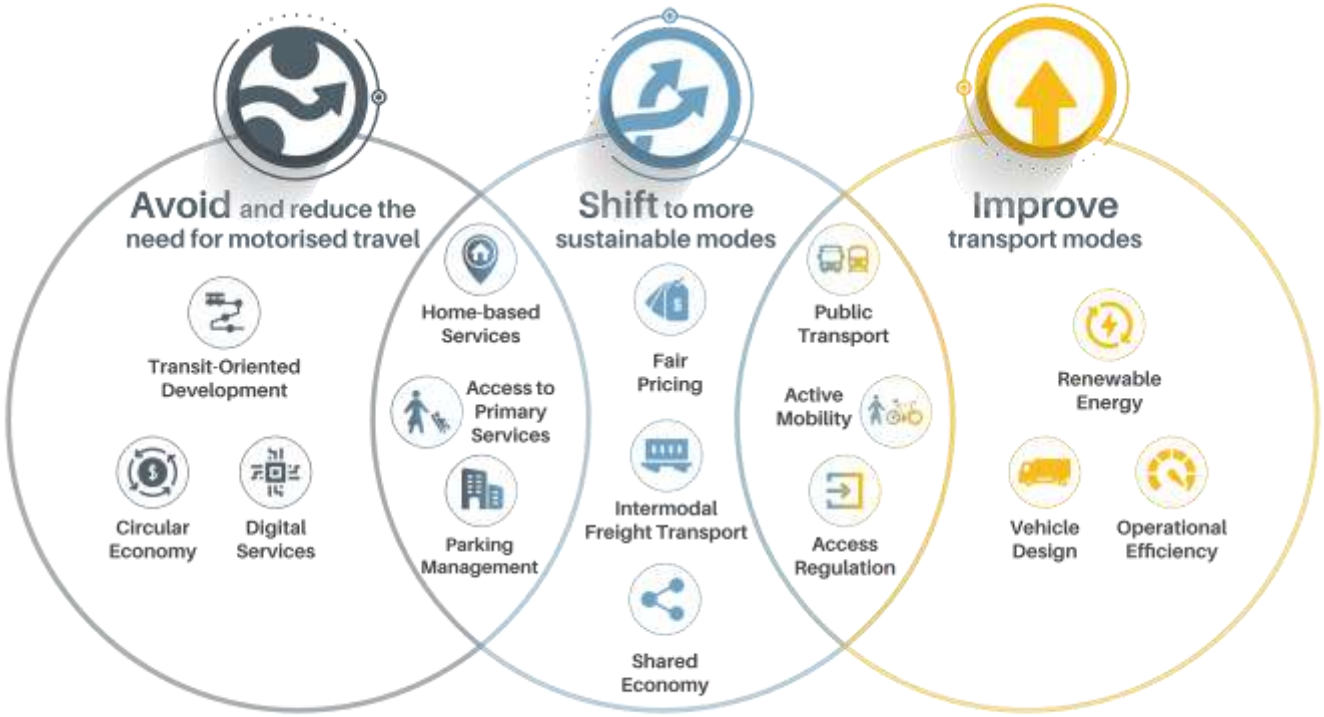
# Integrated approach in Avoid-Shift-Improve



**Research indicates that Avoid and Shift strategies can significantly reduce transport emissions at a lower cost than Improve strategies [1,2,3,4].**



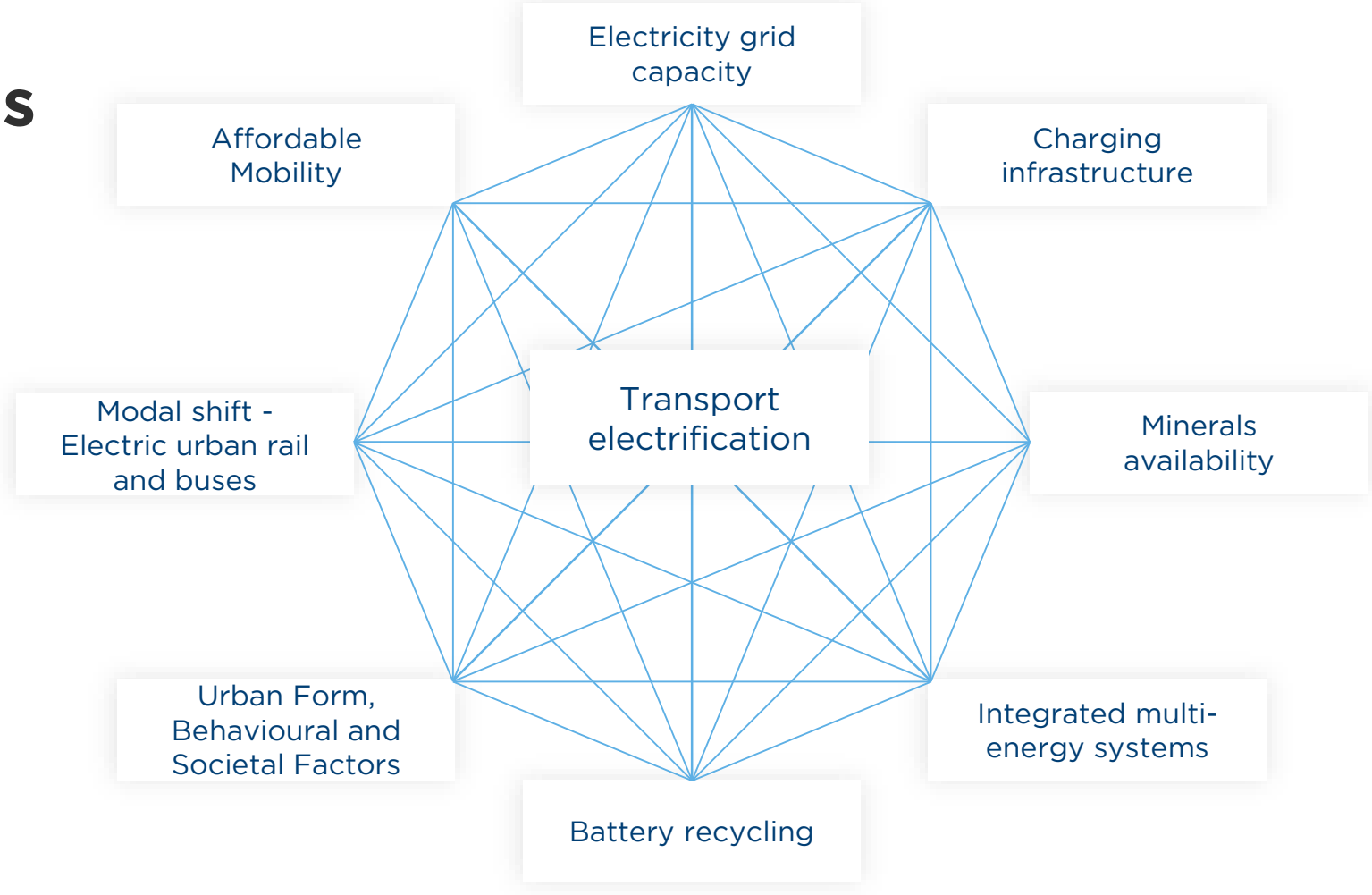

*The A-S-I diagramme presents a non-exhausive list of measures for illustrative purposes only. Source: [1]

Source(s): [1]: https://slocat.net/asi/; [2]: https://doi.org/10.1038/s41467-022-31354-9; [3]: https://www.vtpi.org/wwclimate.pdf ; [4]: IPCC Special Report on Global Warming of 1.5 °C

# Beyond technological innovation and tailpipe emissions



**The “improve” goal of electric vehicles should not conflict with the “avoid” and “shift” strategies, which are bigger game-changers [1,2,3,4].**



# A broader strategy needed

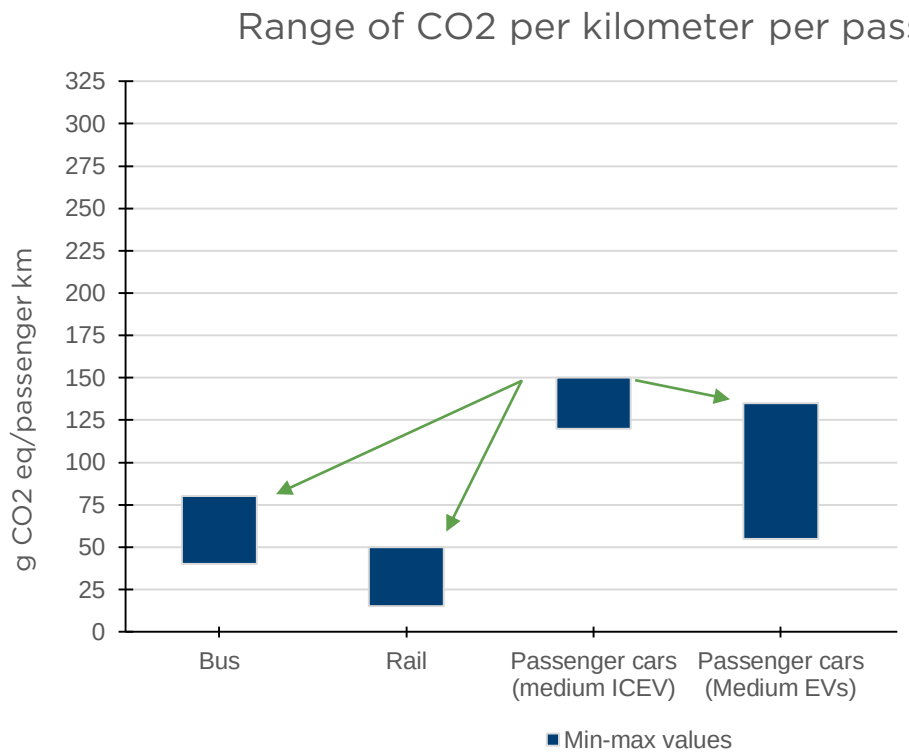


**A multidimensional, life-cycle and circular economy perspective is needed to develop integrated transportation decarbonization policies that look beyond tailpipe emissions alone. Vehicle technologies, including alternative fuels, should be part of a broader strategy.**

Current EV Policies

# CO2 per kilometer per passenger

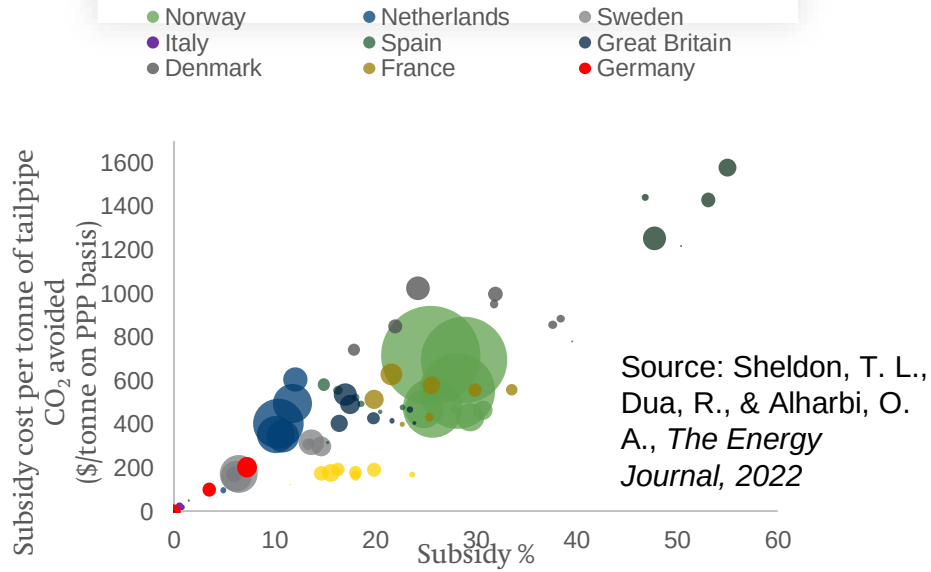
**Moving from ICE cars to ICE buses has better impact on CO2 than to EV cars.**




Source(s): Author's estimate based on literature

Note(s): note that these figures are approximate averages and can vary depending on several factors such as vehicle efficiency, load factor, distance travelled, and energy sources used.

| Transport sector | Electrification potential |
|---|---|
| Passenger cars, including 2&3 wheelers | Very High***** |
| Urban transit (rail, buses, and minibuses) | High**** |
| Light commercial vehicles | High**** |
| Medium & heavy-duty | Mid-Low** |




Source: Sheldon, T. L., Dua, R., & Alharbi, O. A., *The Energy Journal, 2022*

**And EV subsidy is an expensive way to decarbonize**

# Critical Minerals/Metals for Energy Transition



## Each 1MW wind turbine requires:

85-210t steel
2-12t Cu
1-2t Al
~200kg rare earths

## Each 1MW solar panel requires:

35-45t steel
4.5t Cu
3.5-8t $Al^3$

## Each electric vehicle requires:

900kg steel
80kg Cu
280kg Al
~40kg $Li_2CO_3$

Source:
Mark Davies, Rio Tinto, Bank of America SmartMine 4.0 2023 Presentation

# Critical Minerals for EV – more than the battery




Source:
The Role of the Chemical Sciences in Finding Alternatives to Critical Resources: A Workshop Summary

# Decarbonization pathways are context specific



General Motors and EVgo plan to add more than 2,700 fast chargers across the U.S. The charging stations will offer 100-350-kilowatt capabilities.

## An alternative blueprint for light-duty transportation decarbonization

COMMENTARY

An alternative blueprint for light-duty transportation decarbonization


### AN ALTERNATE LIGHT-DUTY BLUEPRINT

1. Evaluate on a state-by-state basis which vehicle powertrain option has the lowest GHG impact, determined by an LCA analysis over a range of assumptions. This can be done, for example, through a National Academies study such as the one proposed by Johnson and Senecal, *SAE Update*, 2022. An example for a Kia Niro small SUV/crossover vehicle is shown in the map on page 6.
2. Roll out incentives in each state based on the vehicle powertrain type that produces the lowest GHGs. Also consider incentives by vehicle size (encouraging smaller vehicles when/where it makes sense). By promoting a combination of hybrids and EVs, we will use battery resources much more efficiently than if we convert the entire fleet to electric vehicles. This is especially important as resource bottlenecks have been identified throughout the supply chain.
3. Ramp up charging infrastructure in the states where the study supports it.
4. Reduce the fossil fuel content in liquid fuels through policy measures such as the Next Generation Fuels Act. The need for low-carbon/sustainable fuels is unassailable given the vast existing fleet.
5. Determine federal funding for batteries, engines, and fuels in proportion to our nation's projected needs for each technology.
6. Revamp GHG regulations for cars and trucks based on the suggestions of Johnson and Senecal, *SAE Update*, 2022.
7. Repeat steps 1–6 periodically (e.g., every five years)

Country-specific LCA analysis

Incentivize powertrains with the lowest GHGs - today

Promote improvement efforts for low-carbon fuels and infrastructure

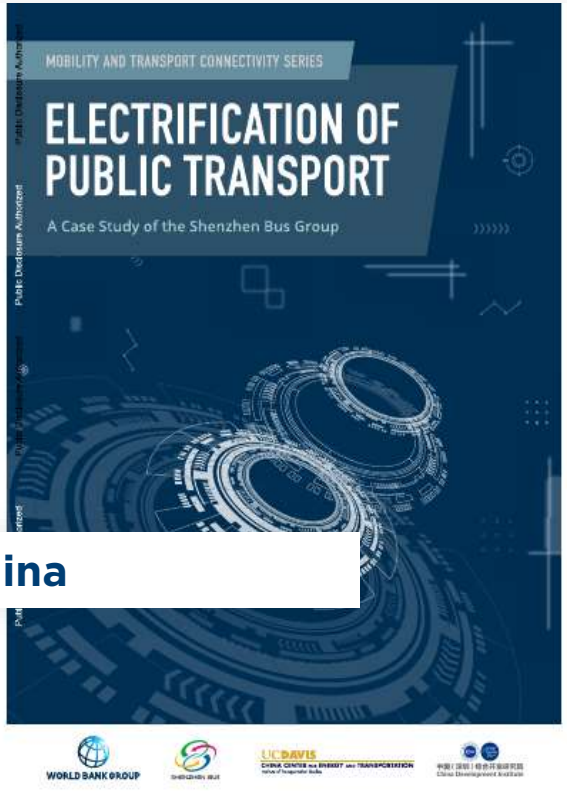
Reevaluate regularly to promote powertrains with the lowest GHG

Source(s):
https://www.nxtbook.com/smg/sae/23UPD03/index.php?startid=7#/p/Cov1

# Electrifying road transport beyond cars is a growing ambition



China




Indonesia


South Africa

# Electrification of transport – A Just Transition approach



1. **Life Cycle Analysis (LCA)** to establish low GHG reduction pathways for each country.

2. Look at the broader picture when **competing priorities** – is charging infrastructure translating to free parking at the cost of affordable housing in developing cities?

3. **Prioritize electrification of mass transit** – controlled load on the grid, easier to integrate renewables, controlled charging infrastructure.

4. **Electrification of shared mobility** - controlled load on the grid and easier to integrate renewables, controlled charging infrastructure


Source: : www.share-north.eu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Thank you!
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