Comparison of emissions of CO₂ and local pollutants and health impacts of mitigation transport scenarios in three Indian mega cities – Delhi, Mumbai and Bangalore

Outline
• Framework for evaluation
  • Focus on CO₂ emissions and Health impacts due to PM₂.₅ concentration
  • Construction of policy packages for the case cities
• Scenarios for Delhi, Mumbai and Bangalore
• Comparison of CO₂ emissions for the 3 case cities
• Comparison of PM₂.₅ emissions for the 3 case cities
• Mortalities due to PM₂.₅ concentrations for the 3 case cities
• Electric mobility scenarios under different energy mixes assumptions
• CO₂ emissions and health impacts with electric mobility scenarios
• Conclusions

Framework for evaluation (1)

Benefits
• Mitigation CO₂ emissions
• Reduction of local pollutants
• Health effects
• PM₂.₅
• Other local pollutants
• Changes in travel pattern due to a policy package
• Increase in traffic congestion
• Time savings and losers
• Increased health effect due to waiting and stop
• Potential reductions in traffic injuries and fatalities
• Improvement in case cities livability
• Energy security: Reductions in fossil fuel consumption

PM2.5 emissions with BAU and “Best” Policy packages

4 scenarios for electric mobility under different energy mixes
• Four different scenarios are based on different projections of the electric energy production in the horizon years:
  • Scenario 1: New Policies Scenario (IEA, 2015)–Non-renewable sources and 
    Electricity (75% - 24%)
  • Scenario 2: Electricity from non-renewable sources (52%)
  • Scenario 3: Partial electricity from renewable and another 50% of non-renewable sources (50%)
  • Scenario 4: Electricity purely from renewable sources (100%)
• The type of energy mix used has substantial impact on CO₂ emissions

Focus on CO₂ and PM2.5 emissions

In this presentation we focus on:
• CO₂ emissions
• Health effects (mainly mortalities due to PM2.5 using WHO model)
PM2.5 is the most important pollutant for health effects

Policy Packages adopted in the 3 case cities

Policy Packages in 2030 and 2050 for case cities, in nr. of deaths pr year

In Delhi the estimated reductions compared to the BAU in 2030 is 58% through implementation of the best policy package and uptake of electric mobility. In 2050 the reductions are estimated to be as much as 82% in Delhi.

In Mumbai the CO₂ emissions can be lowered by 21% through implementing the best policy package combined with electric mobility, and in 2050 the emissions can be 65% lower.

In Bangalore CO₂ emissions can almost be eliminated with the best policy package and electric mobility, with only 0.3 million tonnes of CO₂ in 2030, which is a 99% reduction compared to the BAU. In 2050 the reductions can also be as high as 99%.

4 Energy source scenarios
• Scenario 1: New Policies Scenario (IEA, 2015) – Non-renewable sources and electricity (75% - 24%)
• Scenario 2: Electricity from non-renewable sources (52%)
• Scenario 3: Partial electricity from renewable and another 50% of non-renewable sources (50%)
• Scenario 4: Electricity purely from renewable sources (100%)

Effects of a 100% clean electric energy source (Energy scenario 4)

• In Delhi the estimated reductions compared to the BAU in 2030 is 58% through implementation of the best policy package and uptake of electric mobility. In 2050 the reductions are estimated to be as much as 82% in Delhi.
• In 2030 in Mumbai the CO₂ emissions can be lowered by 21% through implementing the best policy package combined with electric mobility, and in 2050 the emissions can be 65% lower.
• In Bangalore CO₂ emissions can almost be eliminated with the best policy package and electric mobility, with only 0.3 million tonnes of CO₂ in 2030, which is a 99% reduction compared to the BAU. In 2050 the reductions can also be as high as 99%.

Conclusions
• We have presented the evaluation results of mitigation policies in the passenger transport sector in three Indian cities – Delhi, Mumbai and Bangalore – with focus CO₂ emissions and PM₂.₅ emissions as well as health impacts estimated in terms of mortalities related to PM₂.₅ concentration.
• The different policy packages have varying, however mainly positive, impacts on the different types of emissions compared to that of the BAU in the case cities.
• For both Delhi and Mumbai, a larger scale conversion of the vehicle stock into electric vehicles will by far have the greatest impact on CO₂ emissions for both horizon years, compared to that of the BAU, given a renewable source of electricity production.
• In particular, this is the case when EVs are combined with the ‘best’ performance policy package, i.e. policy package 3 for Delhi and policy package 2 for Mumbai.
• For Bangalore, the differences of some of the policy scenarios vs. the BAU scenario are small. When incorporating electric mobility in policy package 4, the results are much more pronounced, also for Bangalore.
• The positive impacts of electric mobility are highly dependent on the energy source for the electricity production, whether it is from renewable or non-renewable sources.
• In some cases, utilizing electricity from non-renewable (fossil-based) power sources can have little positive impact terms of CO₂ and other emissions, and sometimes do more bad than good.
• Notwithstanding, the energy source scenarios show just a modest introduction of renewable power sources can have profound positive effects.
• The emission of local pollutants, including PM₂.₅ emissions, in all the case cities under electric mobility scenarios will be outside the city boundaries, with positive impact on the case cities air quality.
• The mortalities due to PM₂.₅ concentration can also be reduced in all the case cities by implementing the best policy packages.
• However, since the electric power production in most cases happens outside the city boundaries, local pollutants (PM₂.₅) will not be affected by the type of energy source.

PM2.5 emissions with BAU and “Best” Policy packages

Mortalities due to PM2.5 emissions reductions with BAU and “Best” Policy packages (IEA, 2015 scenario)