

# The Impact of Stringent Fuel and Vehicle Standards on Premature Mortality and Emissions

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**ICCT Roadmap Webinar Series**  
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**icct**  
THE INTERNATIONAL COUNCIL  
ON CLEAN TRANSPORTATION

# Webinar Structure

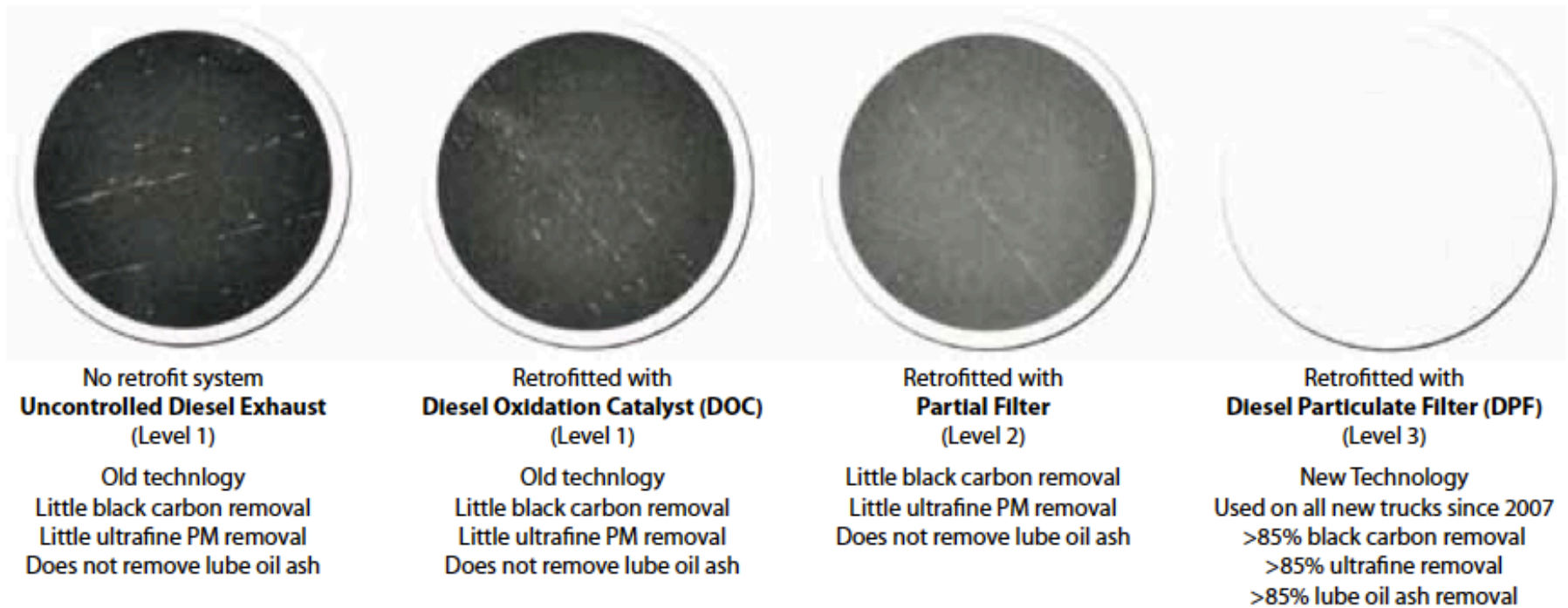
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- Introduction and report overview
  - 15 min, Cristiano Façanha
- Emissions methodology
  - 10 min, Josh Miller
- Health impact methodology
  - 20 min, Sarah Chambliss
- Q&A
  - 15 min

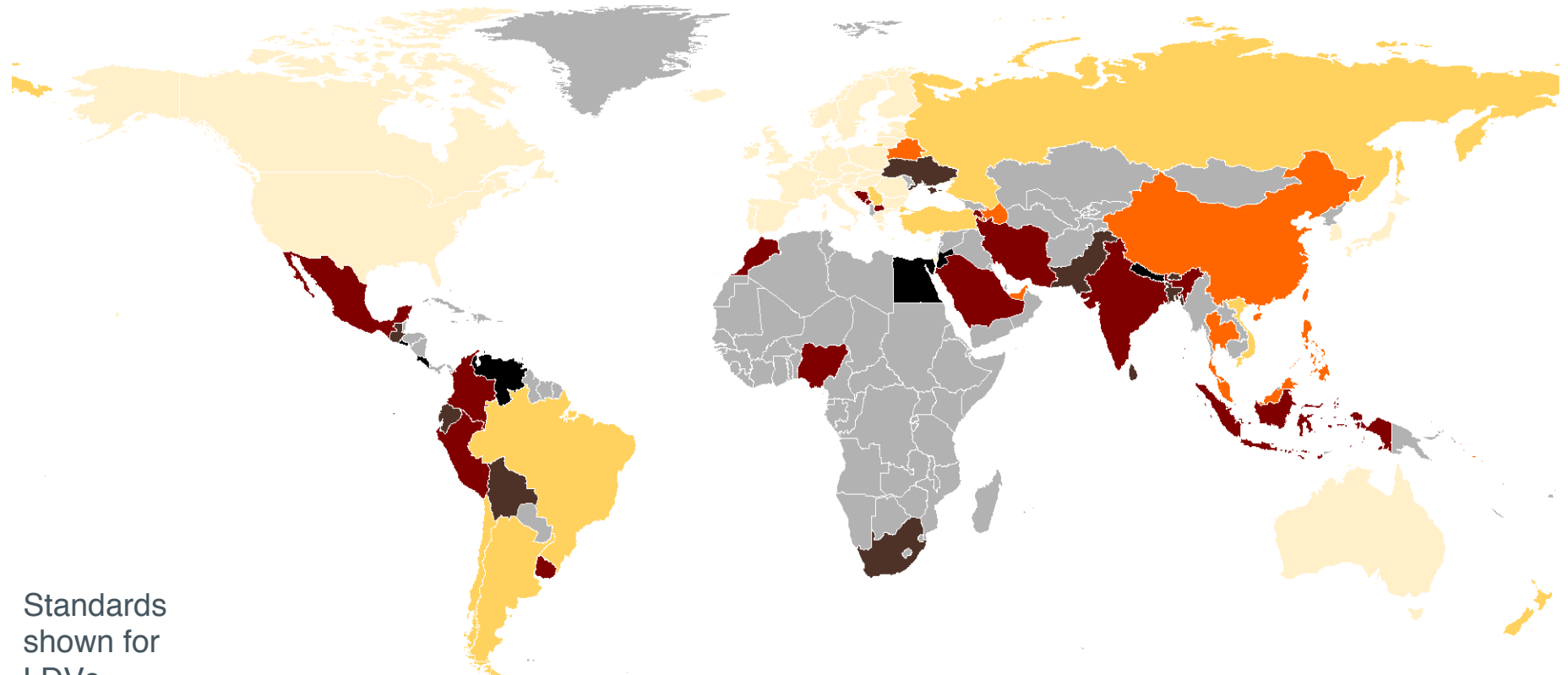


# Most advanced controls can reduce emissions by over 99%

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# There is wide discrepancy regarding the stringency of vehicle emission standards worldwide



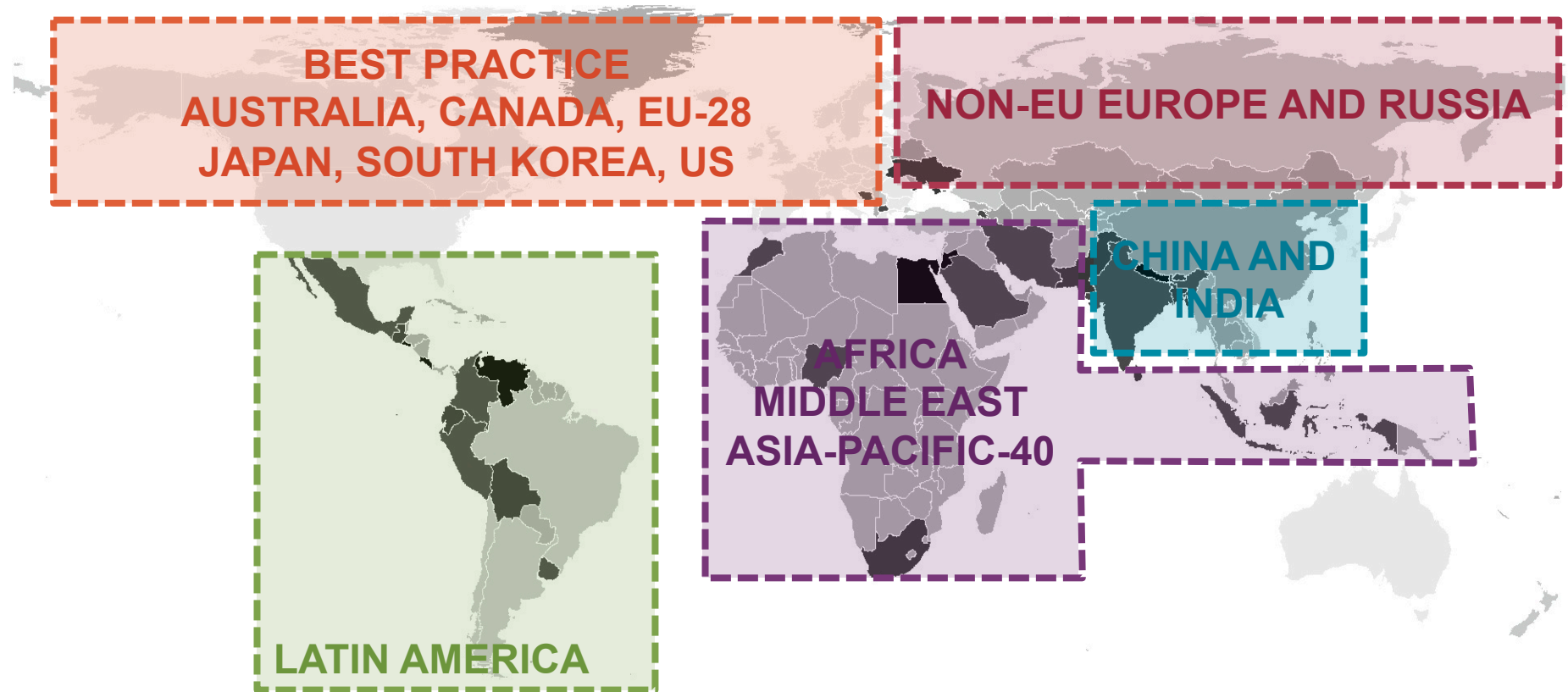
Standards shown for LDVs



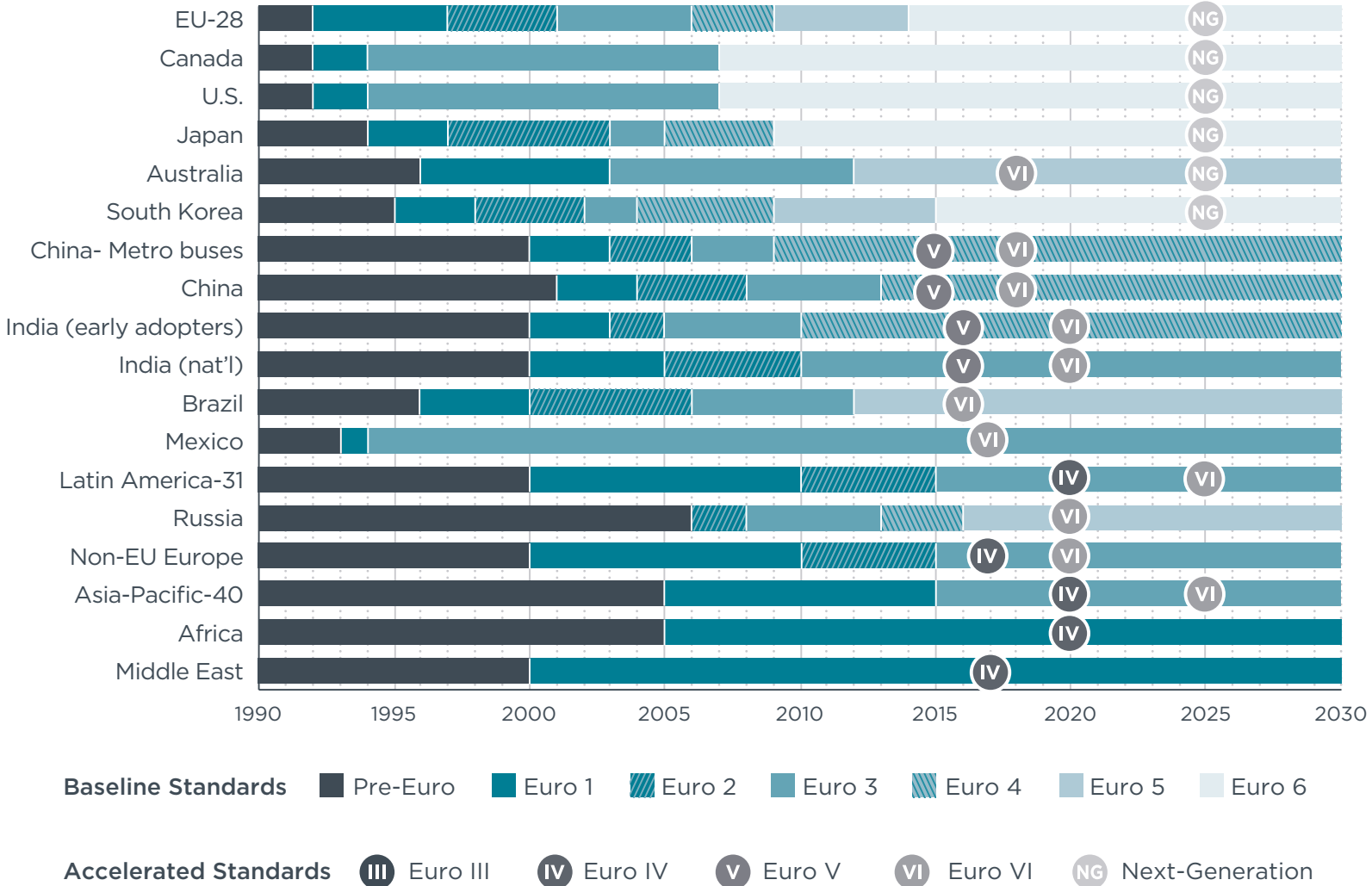
Grey: no standards/  
import standards or  
unknown.

# A global focus on health impacts from transportation is critical to provide policy insights

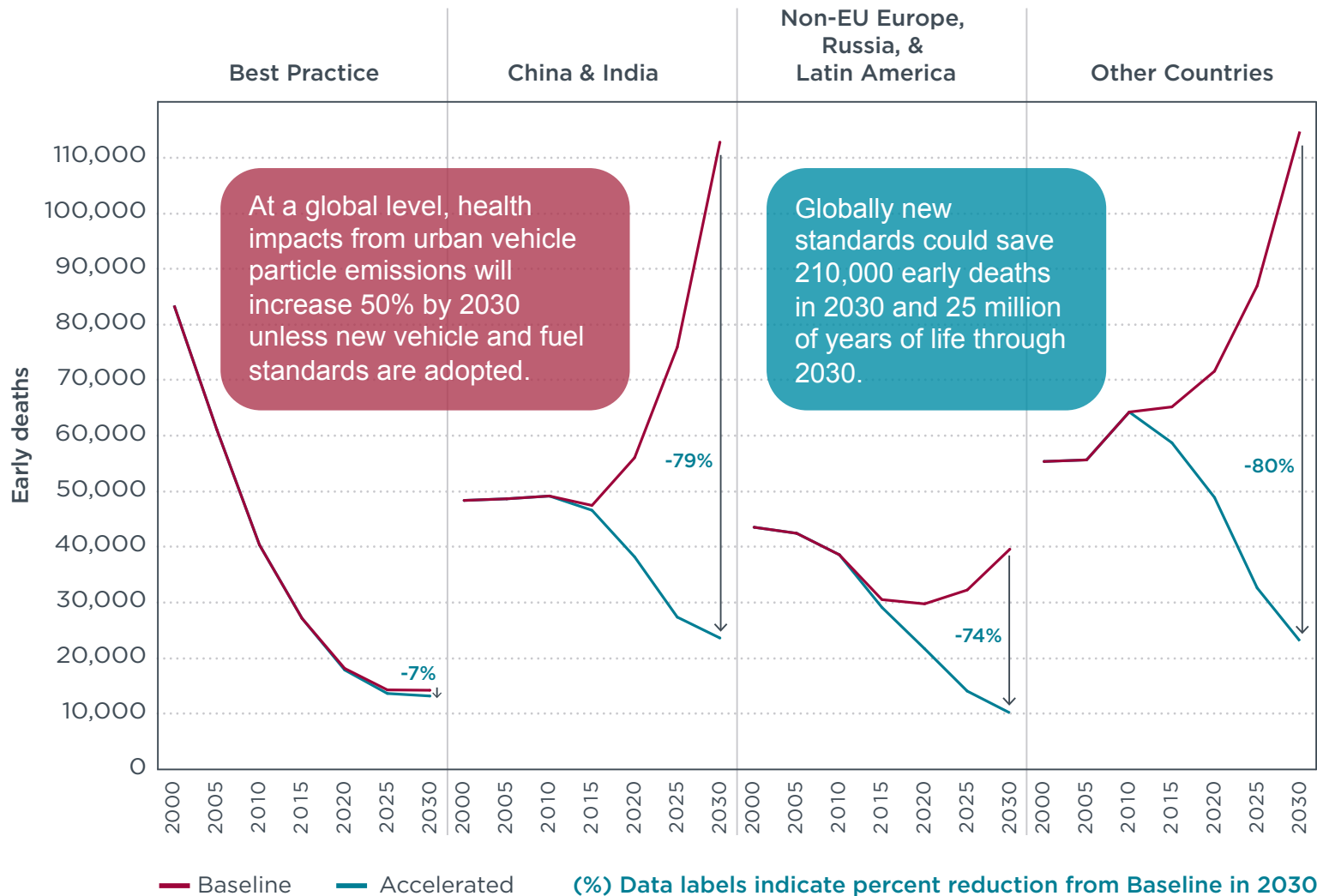
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# The study relies on a well-informed policy roadmap towards cleaner vehicles and fuels

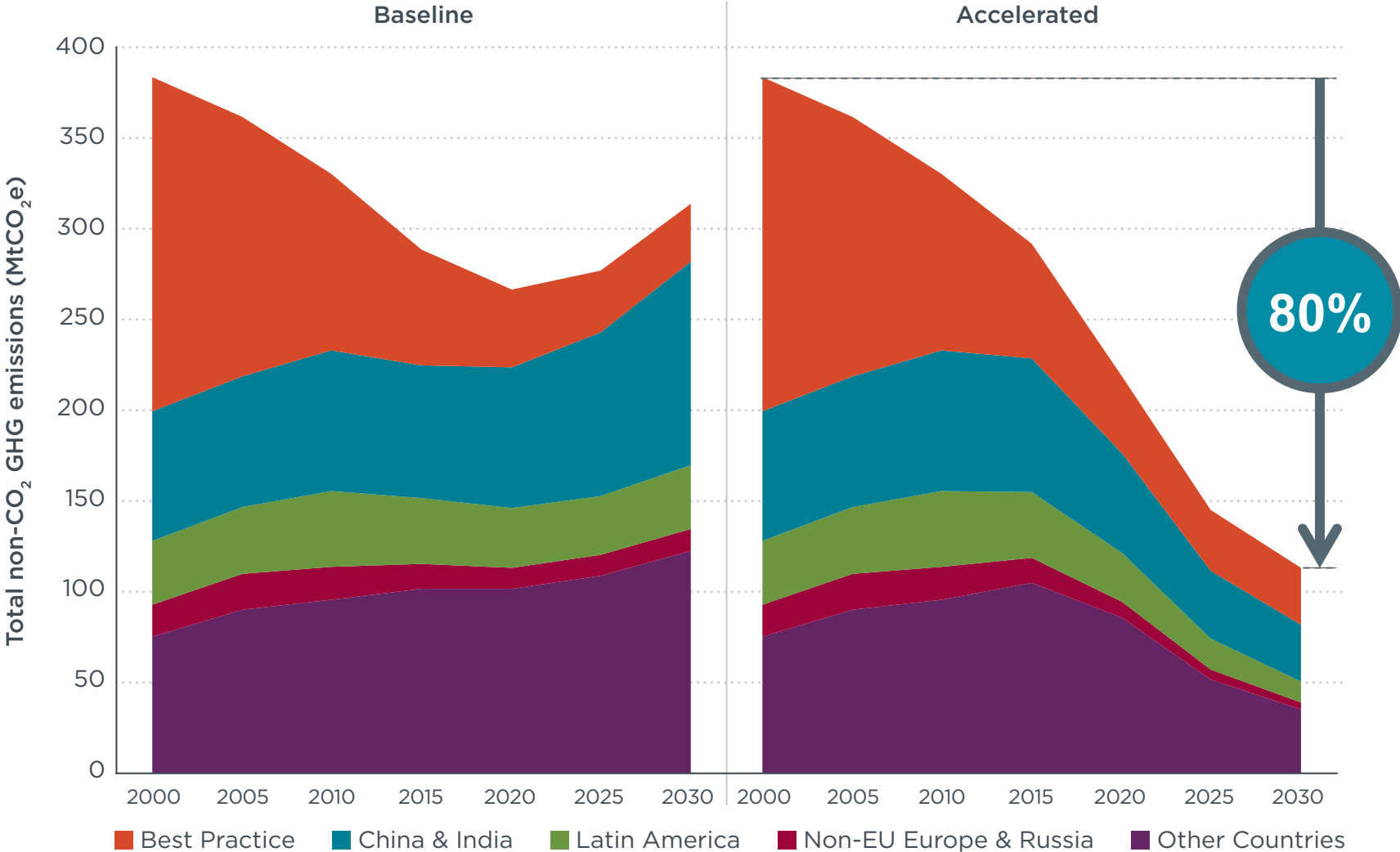


# Latest vehicle controls can reduce emissions and premature mortality worldwide by 75%

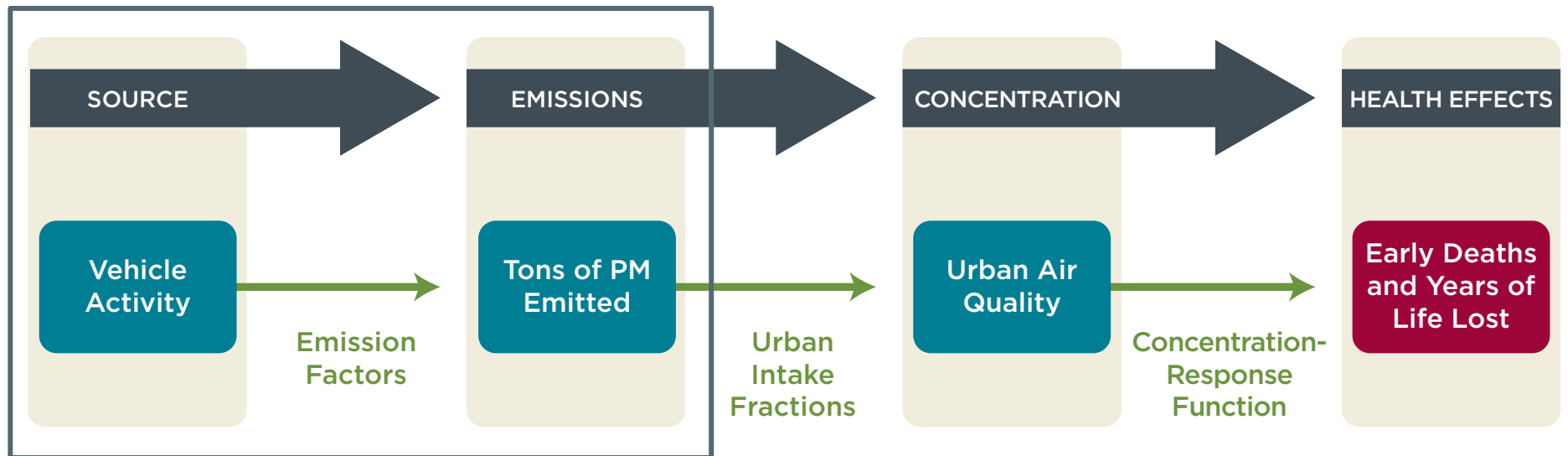




# And they can cut short-lived climate pollutants by over 80%



# Framework for evaluating the health impacts of transportation emissions



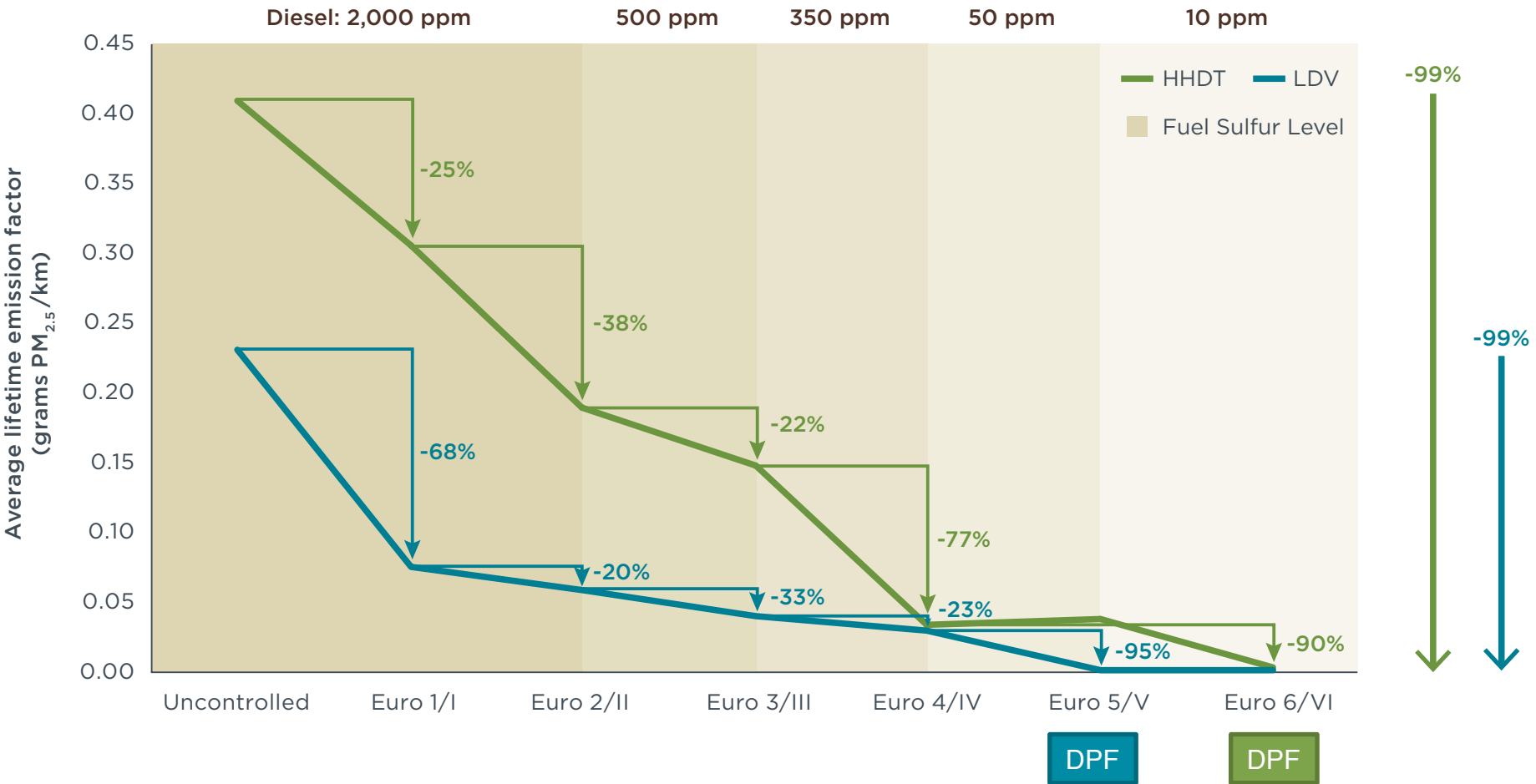
- Source: vehicle-km traveled by road vehicles in urban areas
  - Historical data from government agencies in major markets, IEA in other countries
  - Projected based on changes in population and PPP-GDP
- Emission factors: grams per vehicle-km
  - Consider vehicle fleet composition, fuel type, emission control technology
  - Influenced by emission standards and diesel sulfur content
- Emissions: metric tons, product of activity and emission factors

# Emission factors

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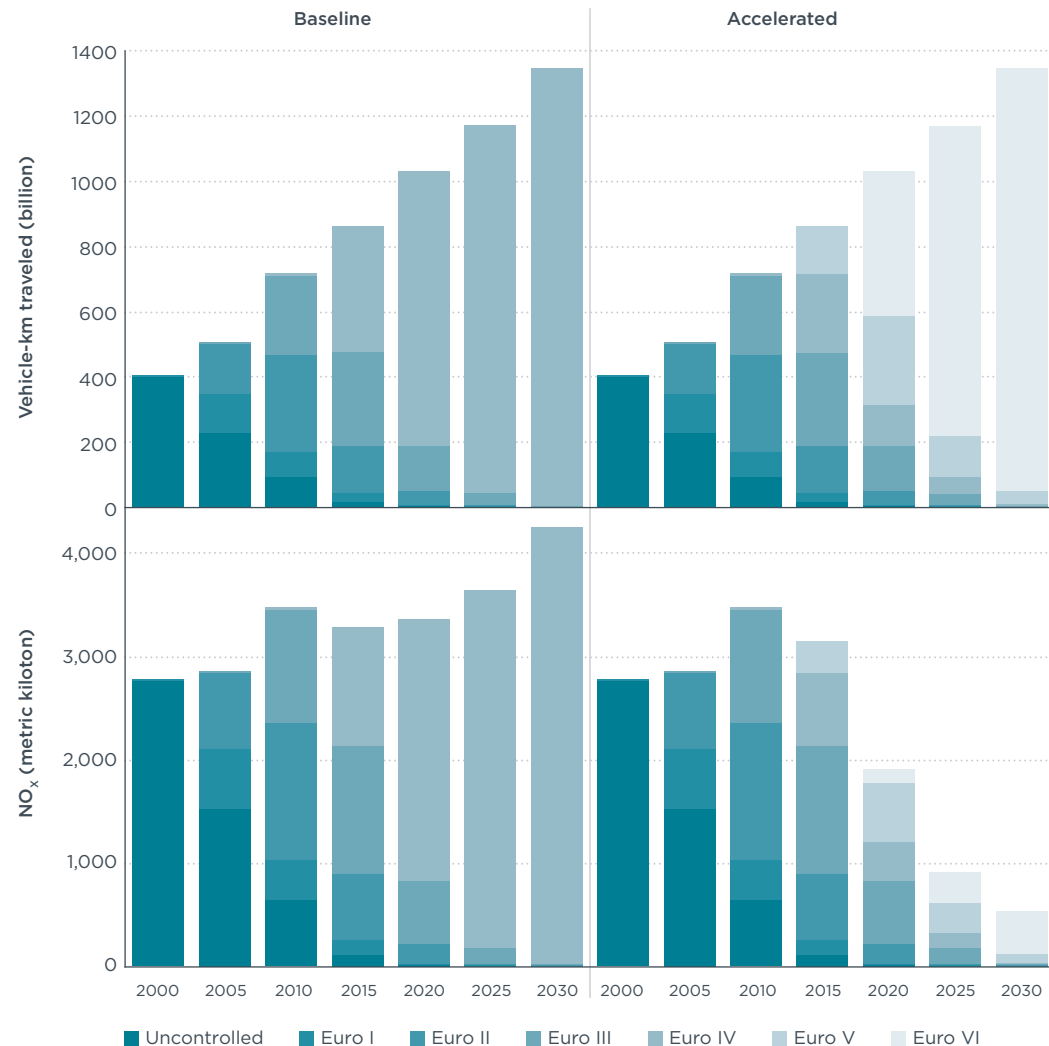
- Reasons for using emission factors
  - Reflect policy effects on real-world emissions
  - Lifetime average emission factors include deterioration
  - Depend on speed, temperature, road grade, vehicle types
- Reasons for applying COPERT factors across regions
  - Most countries follow European classification scheme for vehicle standards (Euro 1/I through Euro 6/VI)
  - Developed by strong research/academic team
  - Well-supported, up-to-date standards and technologies
  - Comprehensive, public documentation
  - Emission factors broadly in line with other models

# Vehicle emission limits and ultra-low sulfur diesel are key drivers of PM emission reduction

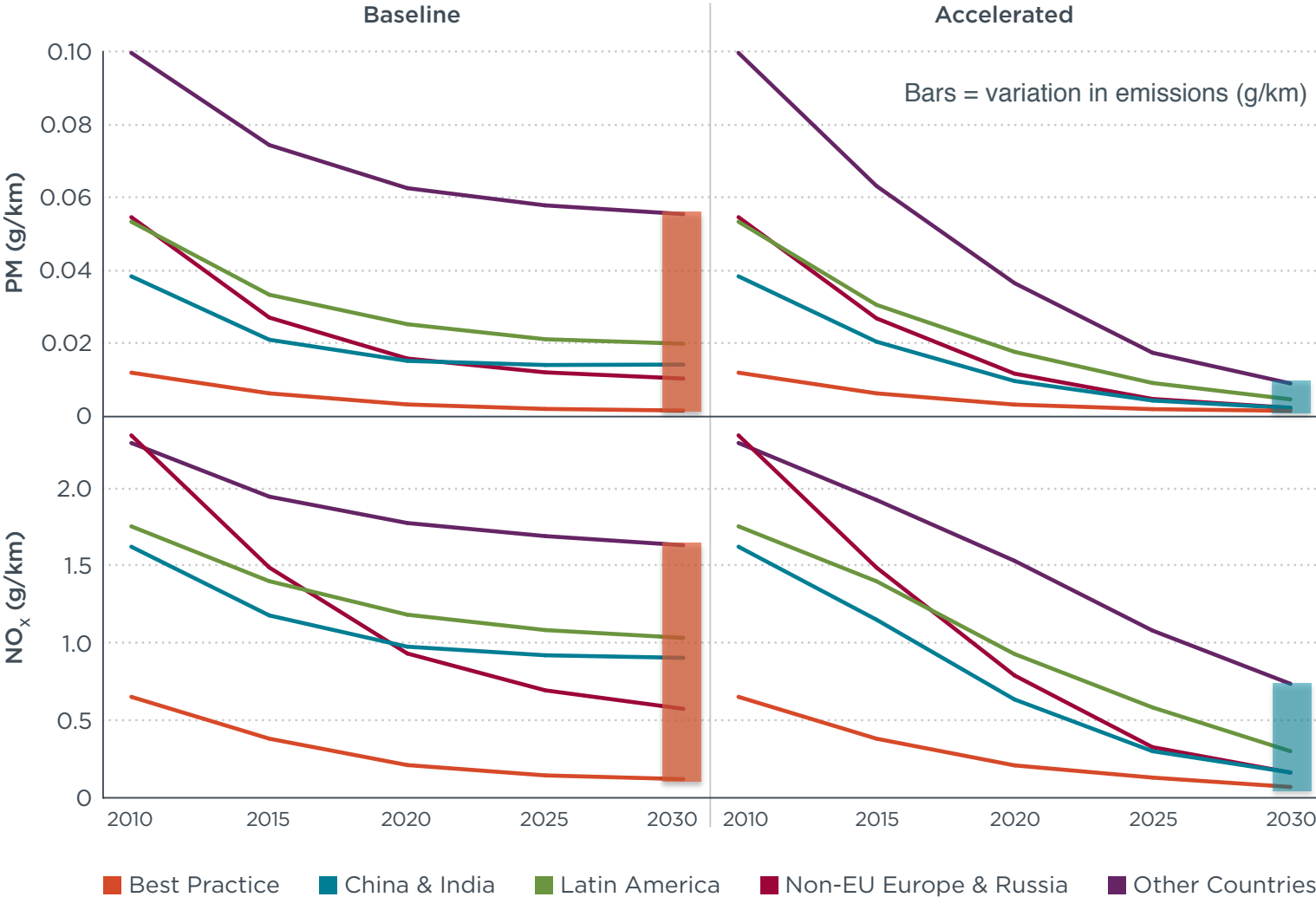


# Vehicle turnover translates standards into fleetwide emission reductions

- Figure: HDV activity and NOx emissions by control level in China
- Baseline: China IV yields initial reductions, outpaced by VKT growth
- Accelerated: China V and VI result in sustained NOx reductions

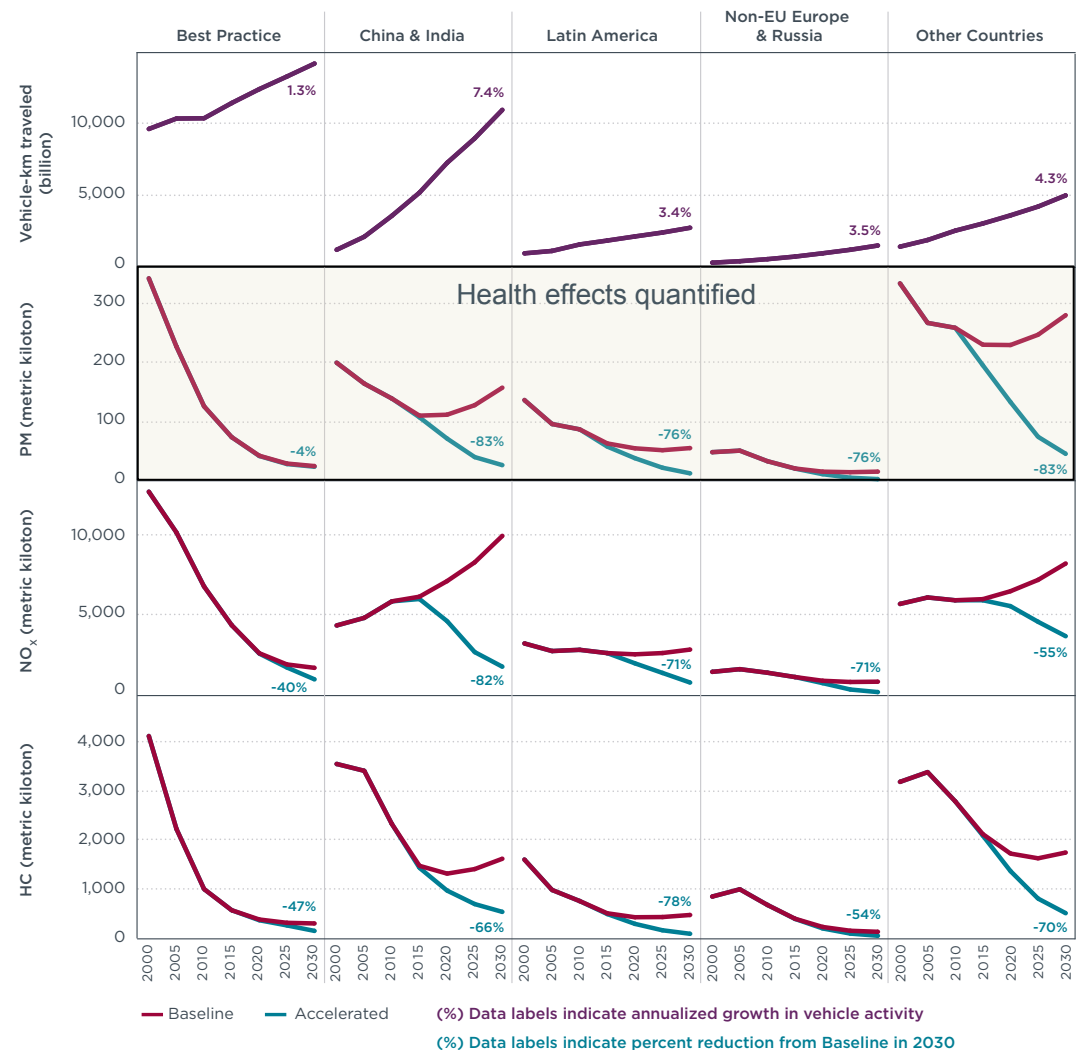


# Accelerated standards drive convergence in average emissions per vehicle-km

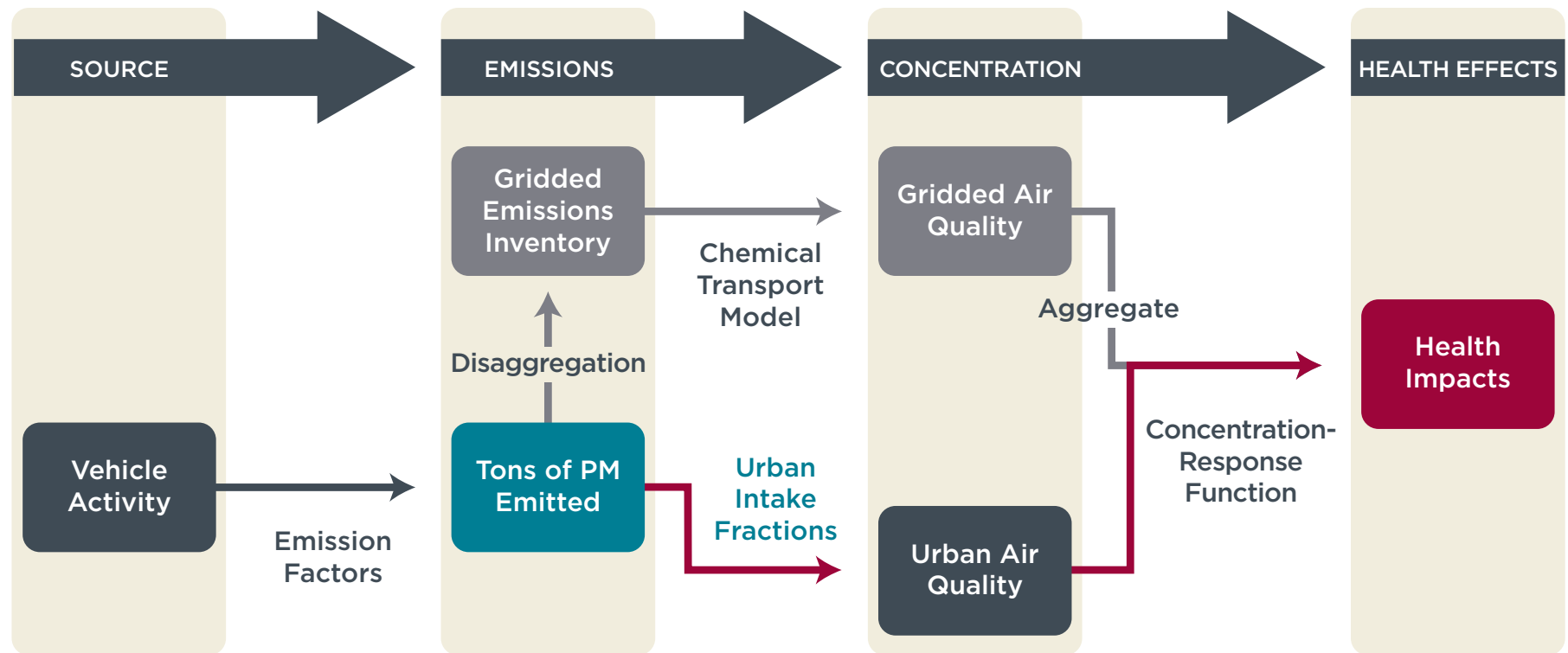


# Emissions projections

- Figure: (top row) vehicle-km, (below) PM, NO<sub>x</sub>, HC emissions
- Baseline: sustained decreases in Best Practice regions
- Accelerated policies reverse emission trends in many regions (2020-2030)
- By 2030, 80% reduction in PM compared to baseline in regions yet to adopt best practices



# Urban concentration with intake fractions





# Intake fraction

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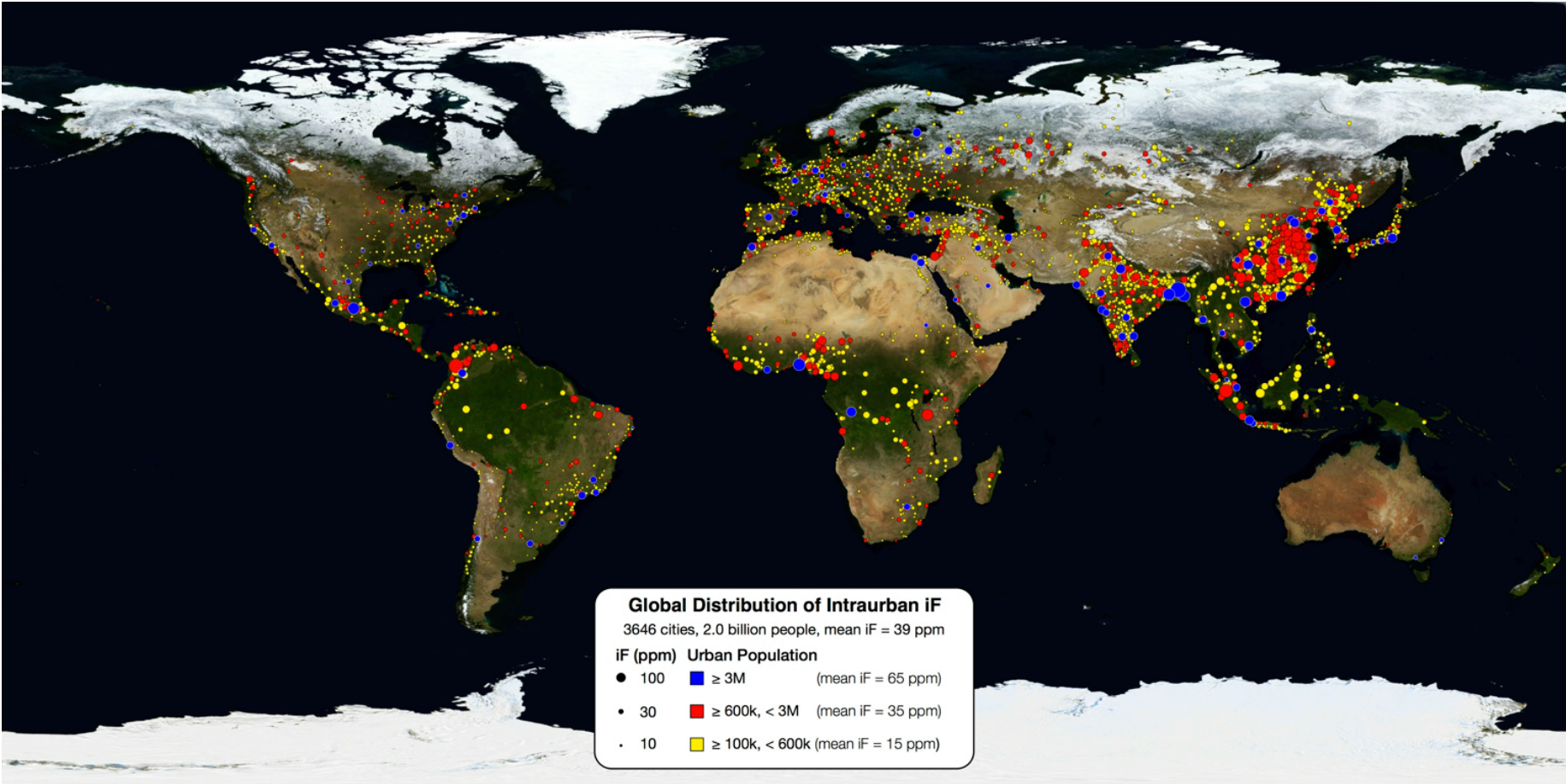
- Intake fraction is the ratio of the mass of pollutant inhaled to mass emitted

- $$iF = \frac{\text{Population intake}}{\text{Total emissions}} = \frac{P \times C \times Q}{E}$$

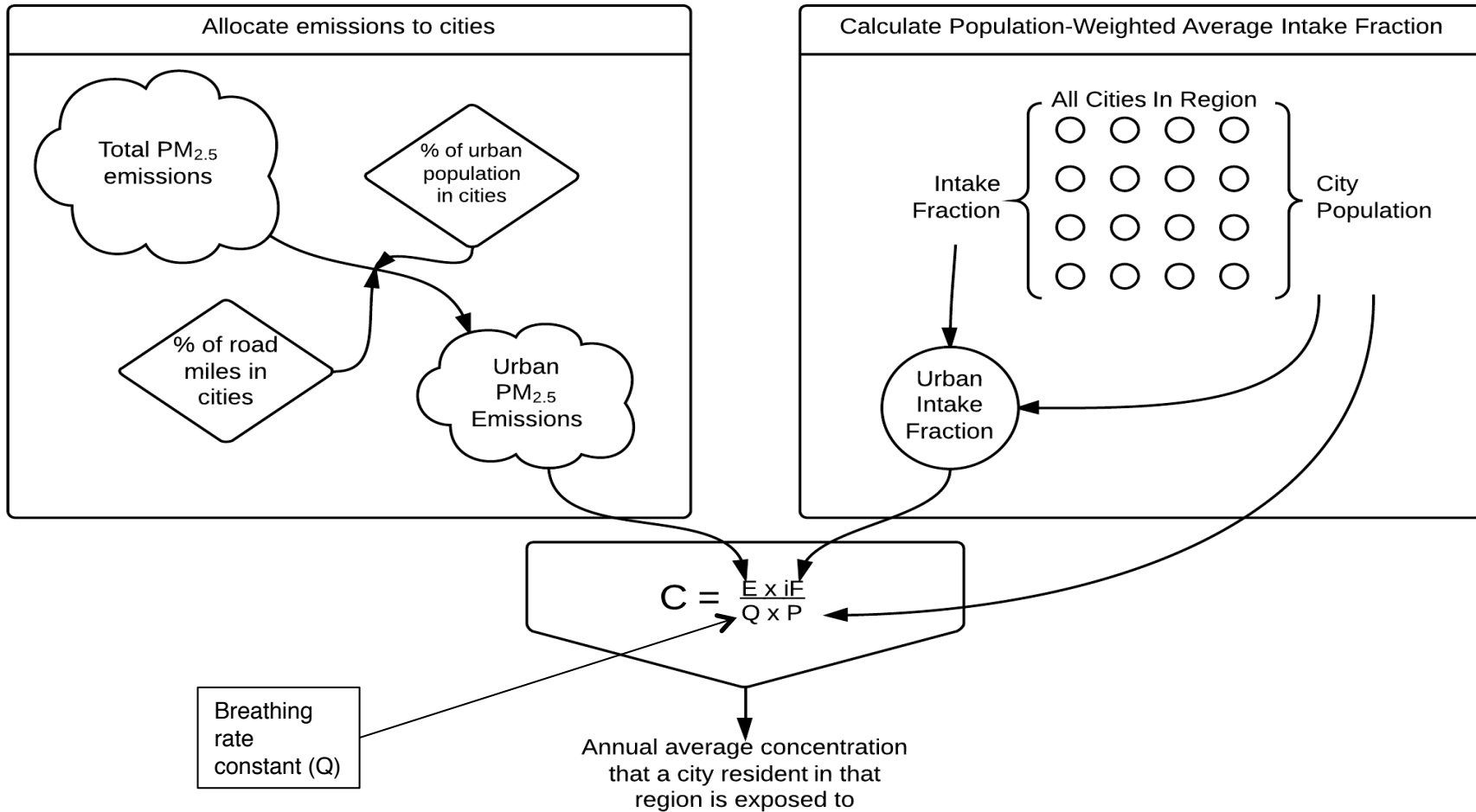
- $$C = \frac{iF \times E}{P \times Q}$$

- Intake fraction varies by source and setting
  - Size of exposed population
  - Proximity of emissions to population
  - Environmental persistence of pollutant

# Variation in intake fraction worldwide (Apte 2012)



# Calculating concentration from intake fraction

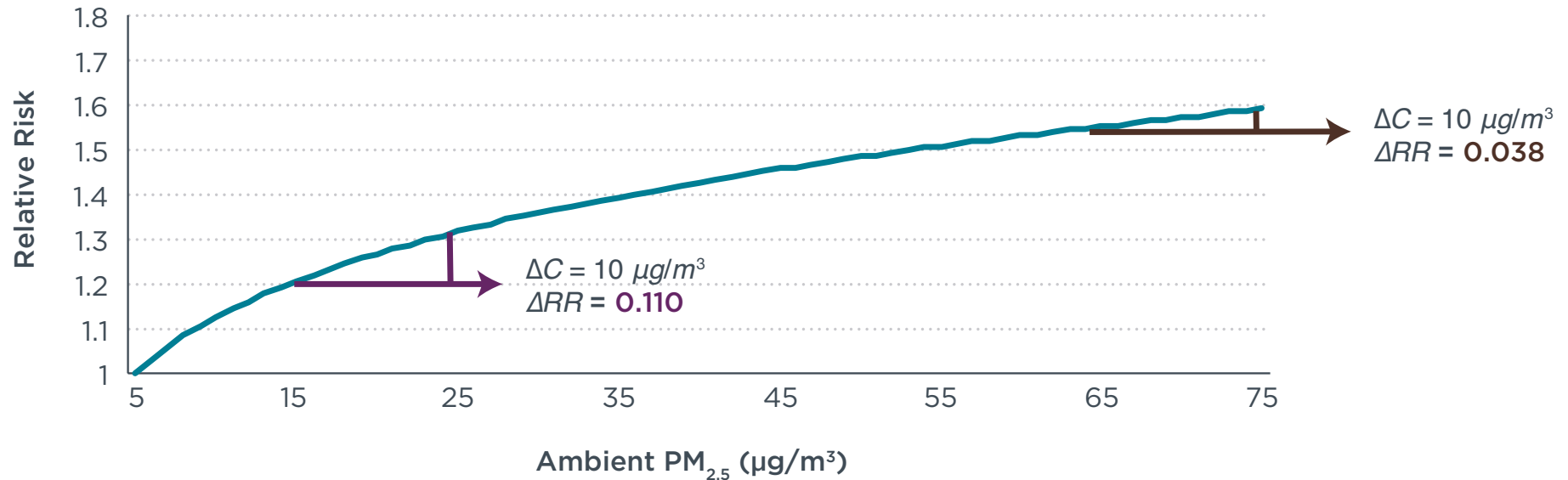


# Estimating impacts from exposure

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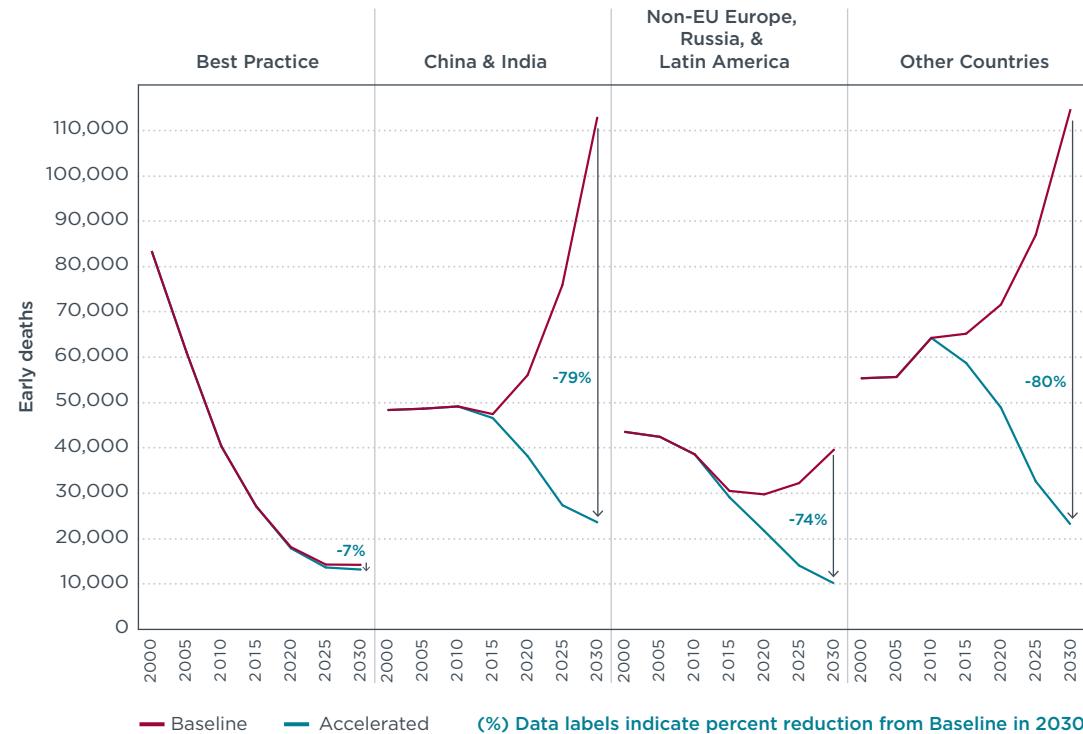
- The “relative risk” predicts how much more often deaths will occur at higher concentrations
- The size of the urban population and the baseline disease rate both influence the final estimate of total early deaths
- RRs are estimated for 3 disease categories that lead to premature mortality
  - Lung cancer, adults over 30
  - Cardiopulmonary disease, adults over 30
  - Acute respiratory infection (ARI), children under 5

# Estimating impacts: nuances of the concentration-response function



- Two forms of concentration-response functions, linear and log-linear (Ostro et al. 2005)
- The background concentration can influence the increase in relative risk
- We take the average of the change in risk near the counterfactual and at the background concentration

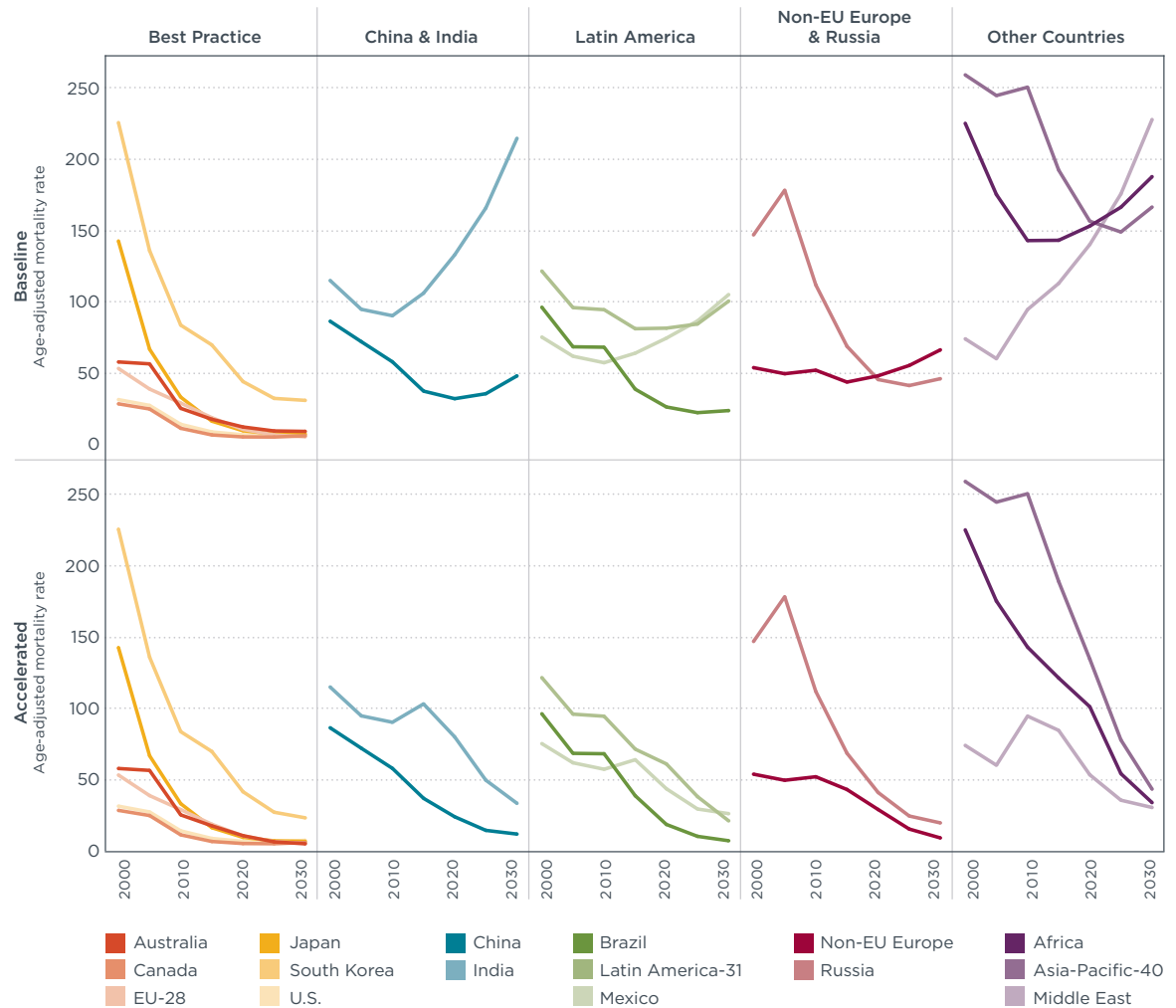
# Premature mortality from on-road urban PM<sub>2.5</sub> emissions



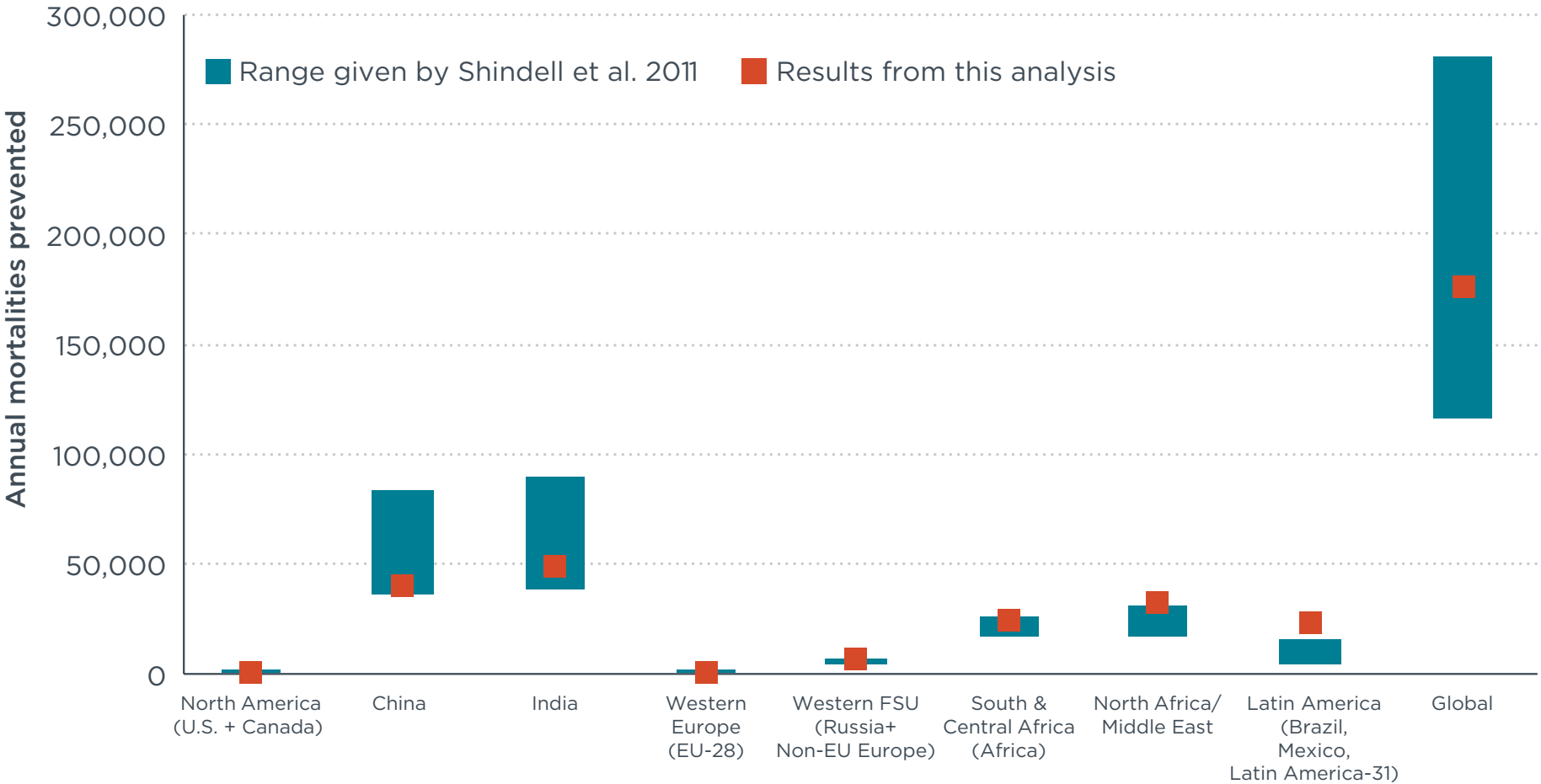
- Best Practice countries show decreased years of life lost under baseline conditions
- Urbanization and rising emissions cause increased baseline health impacts in China & India and Other Countries
- Accelerated policies reduce impacts across regions

# Comparing health impacts

- Rates control for population size and age
- Accelerated policies bring mortality rates to comparable low levels across regions



# Comparison of benefits estimates between this analysis and Shindell et al. (2011)





# Benefits beyond preventing early death

Study	Region (year)	Premature Mortalities	Hospitalizations (Respiratory and Cardiac Illness)	Emergency Room Visits	Restricted Activity Days
Kuschel et al. 2012	New Zealand (2006)	1,000	600	Not estimated	1.4 million
Guttkunda and Goel, 2013	Delhi (2010)	7,000-16,000	31,000	480,000	51.2 million
U.S. EPA 2011	United States (2010)	164,000	86,000*	86,000	84 million*
U.S. EPA 2011	United States (2020)	237,000	135,000*	120,000	110 million*

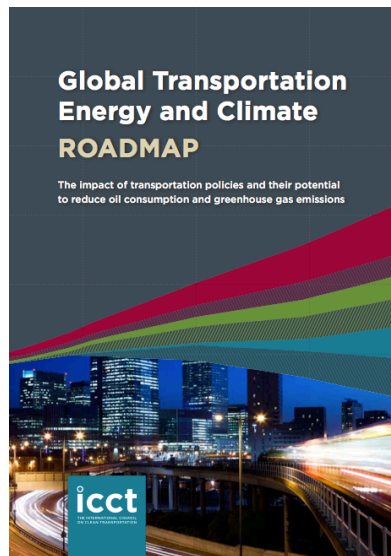
# Main Messages

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- Very clean vehicle and fuel technologies exist. These technologies are already cost effective, and costs will continue to decline.
- Despite progress in developed countries, current penetration in developing countries is insufficient to limit the worsening in health impacts.
- Standards have proved to be an effective policy to bring substantial health and climate co-benefits.
- The adoption of new standards would cause emission rates around the world to converge at much reduced levels, resulting in a drop in PM<sub>2.5</sub>, NO<sub>x</sub>, and HC emissions.
- By a conservative estimate, reducing PM<sub>2.5</sub> emissions through new standards will prevent over 210,000 early deaths in the year 2030 in urban areas.
- The full health benefits of new policies increase when considering nonfatal health impacts, impacts in rural areas, and impacts of ozone.

# Thank you! For more information:

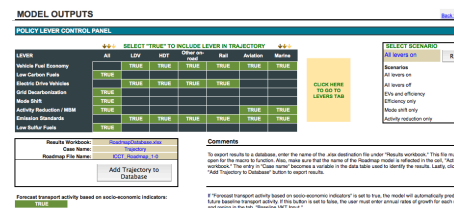
## ICCT'S Global Transportation Health and Climate Roadmap Series



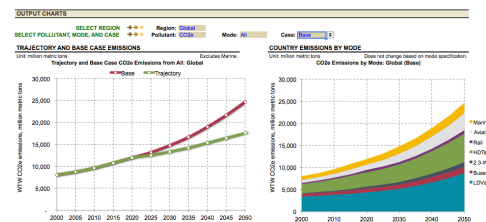
**Global Transportation Energy and Climate Roadmap**  
<http://www.theicct.org/global-transportation-energy-and-climate-roadmap>



**The Impact of Vehicle and Fuel Standards on Premature Mortality and Emissions**  
<http://www.theicct.org/global-health-roadmap>



**Roadmap Model**  
<http://www.theicct.org/global-transportation-roadmap-model>



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