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Modelling flexibilities & modelling impacts in urban environments

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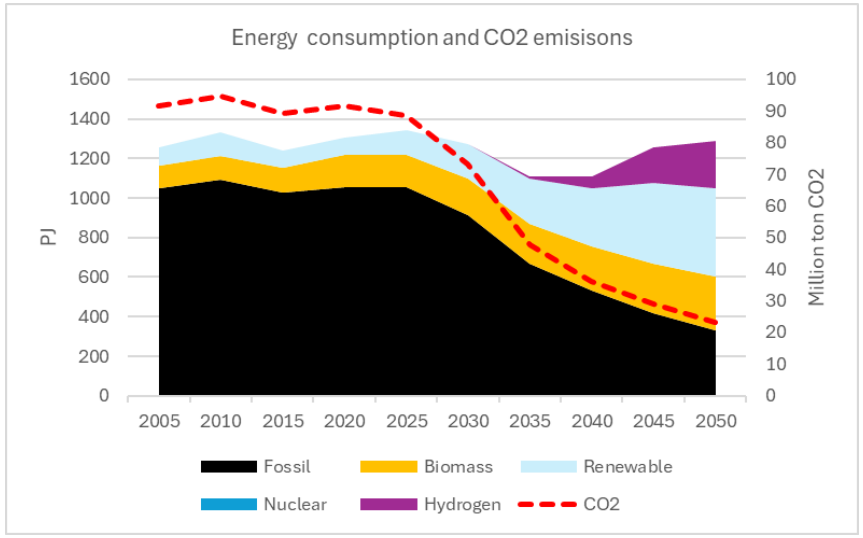
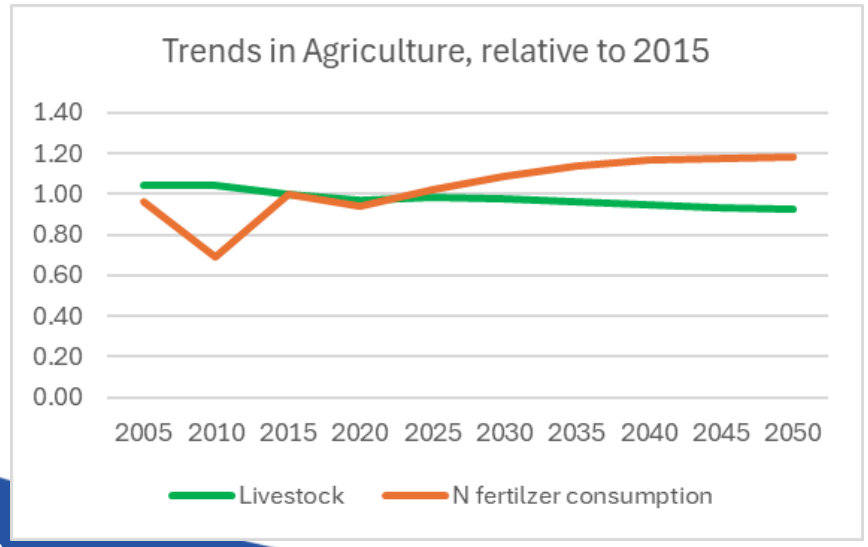
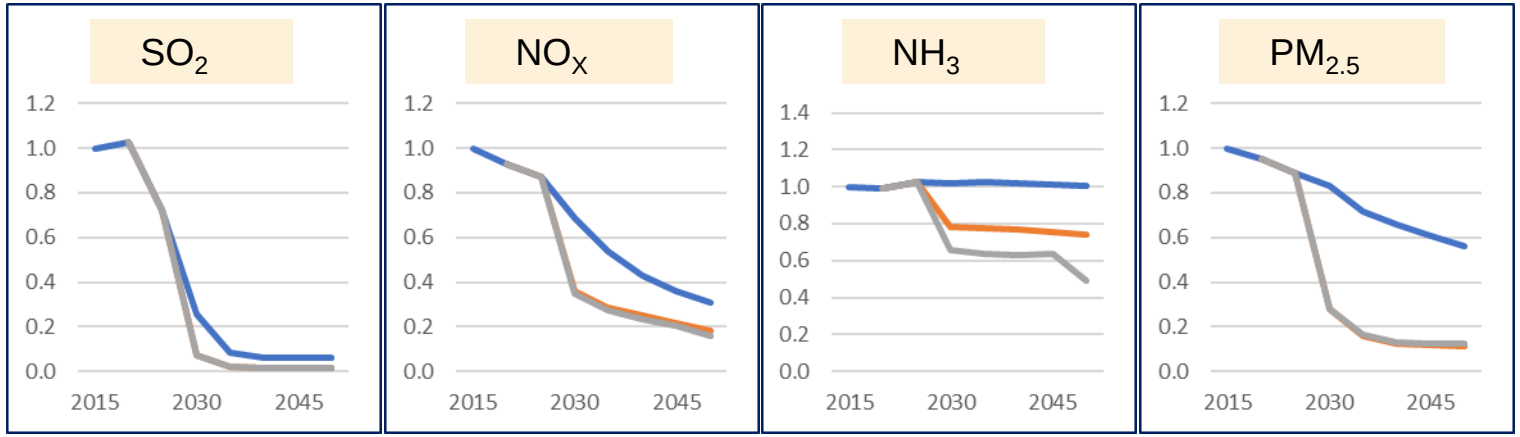
Analysing flexibility options - staged approach

- Staged approach, e.g., prescribed mitigation in specific sectors or a group of them, creates a ‘preferred’ solution for a given region
- Such a ‘preferred’ solution for any given region can be used in search of cost-effective solutions (for all other regions) to achieve the community-wide targets
- The defined variant(s) are compared and analysed against the cost-optimal solutions for the whole domain
- Similar type of analysis can be done for ‘phased’ approaches where targets for certain regions are achieved at different time

West Balkan – Key activity and emissions

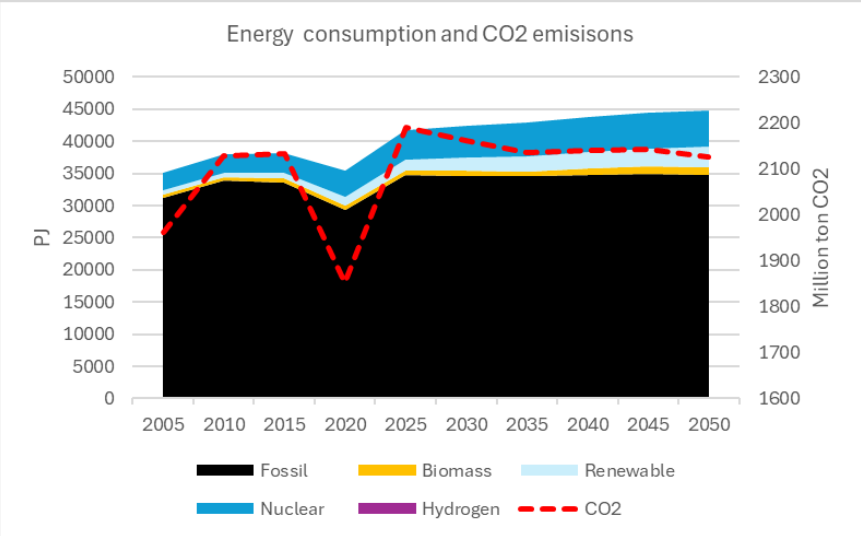


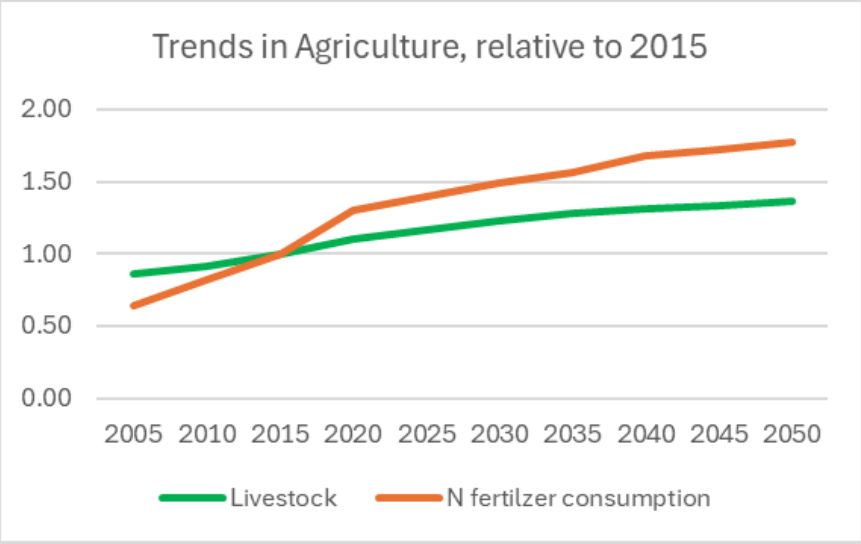


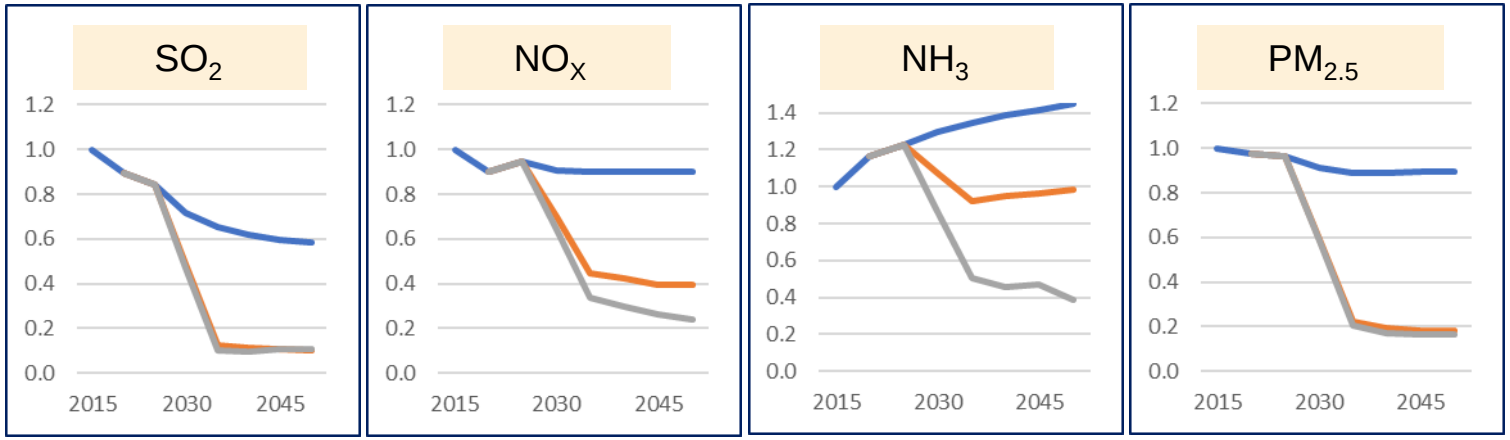


- Baseline includes an ambitious energy transformations resulting in over 70% reduction of CO_2 emissions
- Jointly with announced air quality legislation, baseline emissions show strong decline, except ammonia
- Apart from importance of enforcement of existing legislation, further emission mitigation potential exists

EECCA+Türkiye – Key activity and emissions





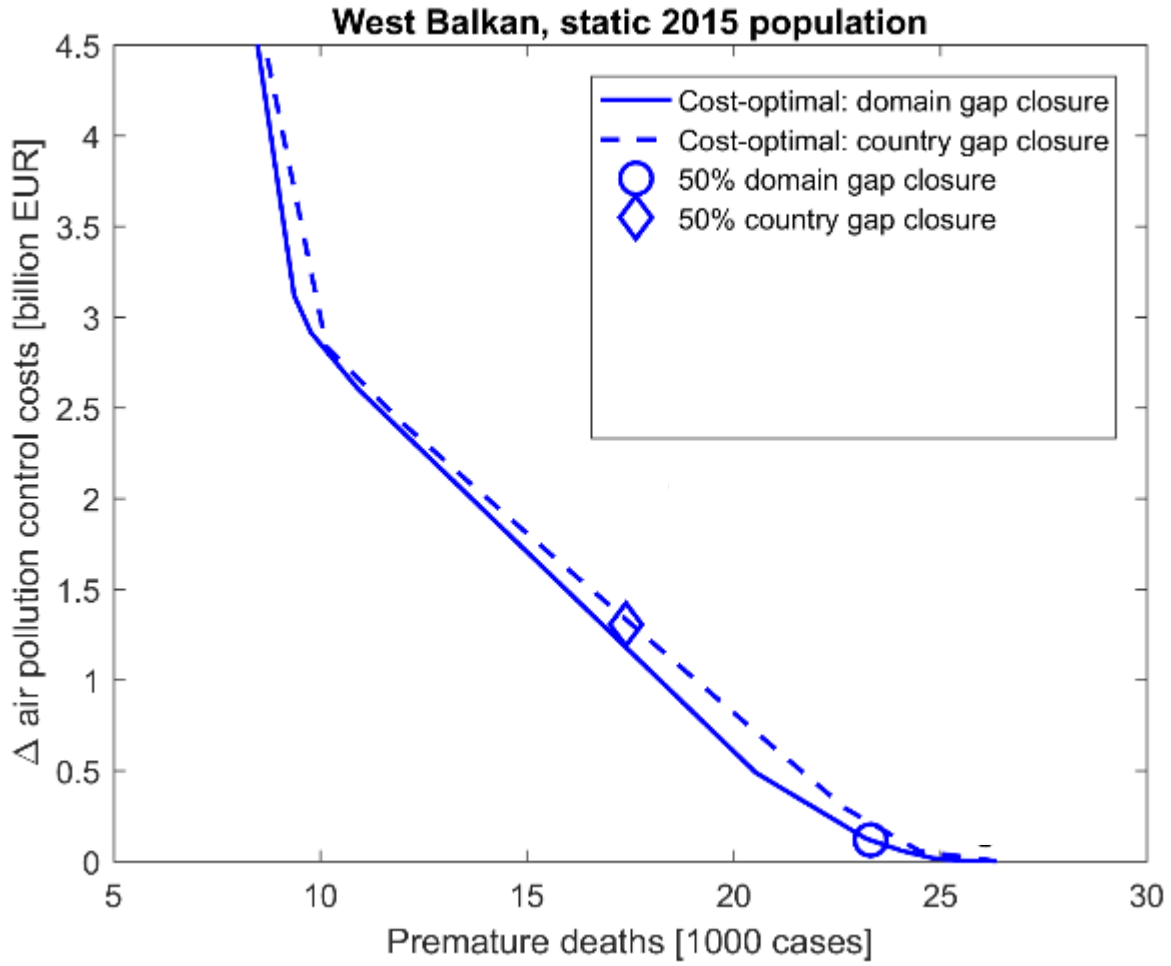


- Baseline does not include significant energy and agriculture transformations and CO_2 is not expected to decline
- Announced air quality legislation results in some decline or stabilization of emissions, except ammonia
- Apart from importance of enforcement of existing legislation, significant further emission mitigation potential exists

Designing preliminary staged/phased approaches in GAINS
Sector intervention scenarios

- 4 sectors with specific intervention scenarios as variants of the baseline scenario
- For these sectors we assume that EU standards for emission controls will be implemented after 2030 to comply with the EU policies
  - PP: Power & Heating Plants
  - IND: Industrial combustion and processes
  - TRA: Road and off-road transport
  - DOM: Residential combustion
- All other sectors remain as in the Baseline

Comparing domain wide optimization vs staged approach - West Balkan



- Large difference in benefits between the 50% domain-wide (UNECE-Europe!) vs country gap closure

STAGED APPROACH

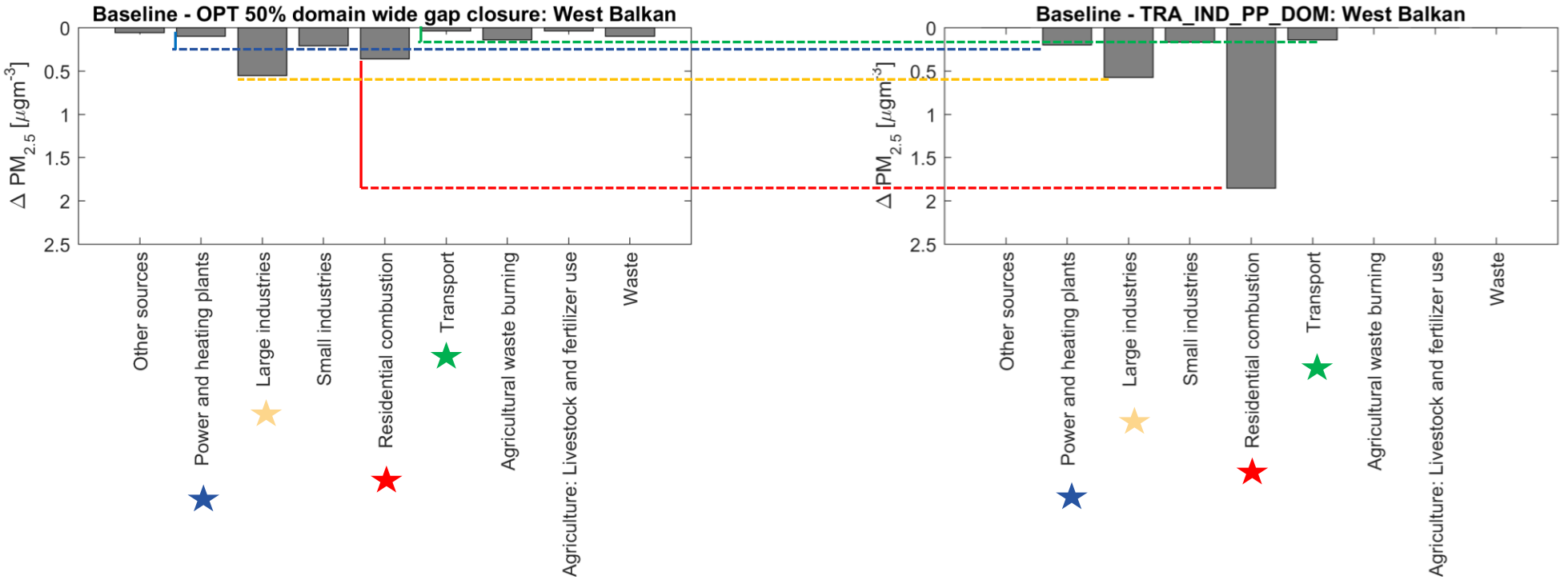
- Only small improvement and much larger costs for achieved benefits in the preliminary staged approach case (including all four sectors)

- Costs for residential heating dominate the total costs in the staged approach

Comparing domain wide optimization vs staged approach - West Balkan

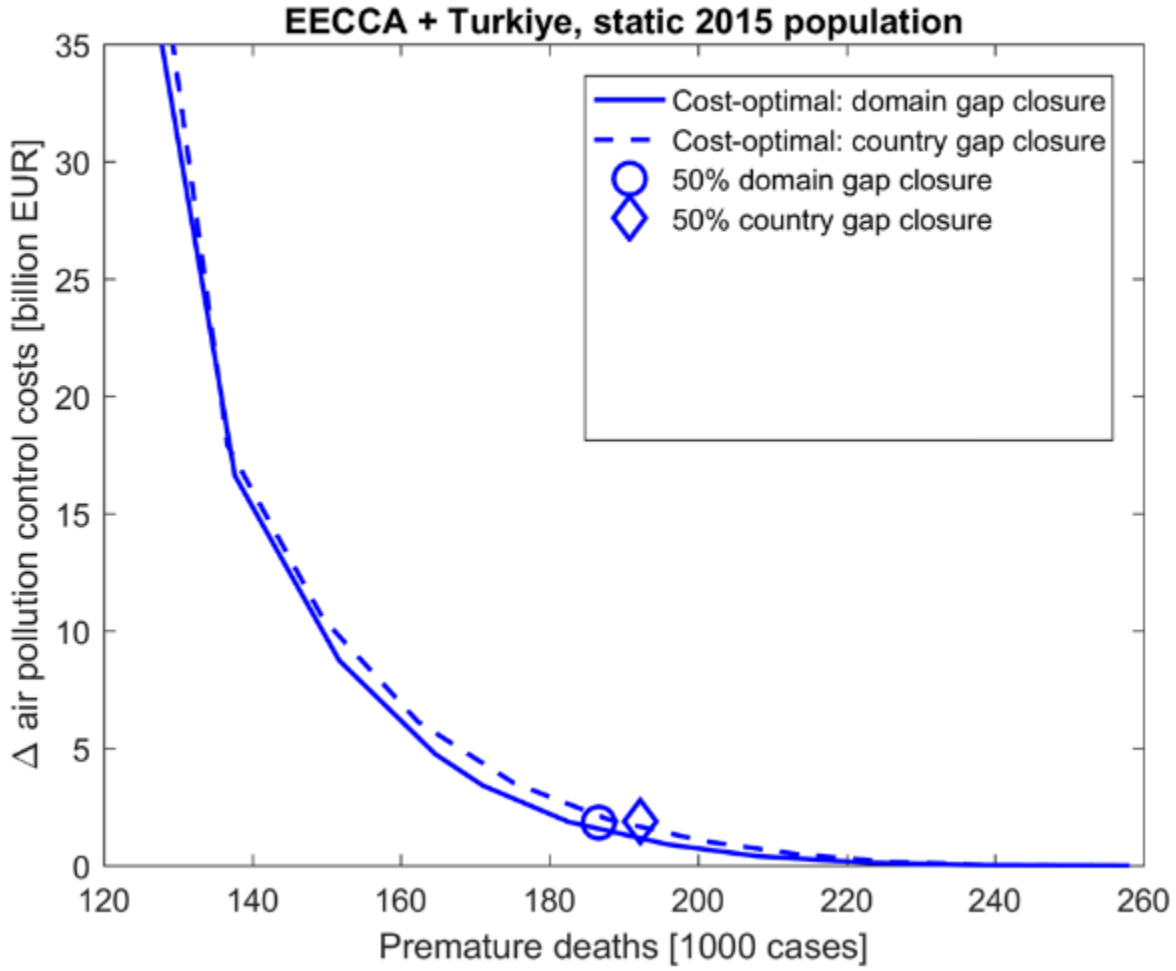
Least-cost approach (domain wide)

Draft *staged approach* case:
enforcing EU legislation for power, industry, residential combustion, and transport



- Staged approach has similar reductions for several selected sectors as in the domain wide solution

Comparing domain wide optimization vs staged approach - EECCA + Türkiye

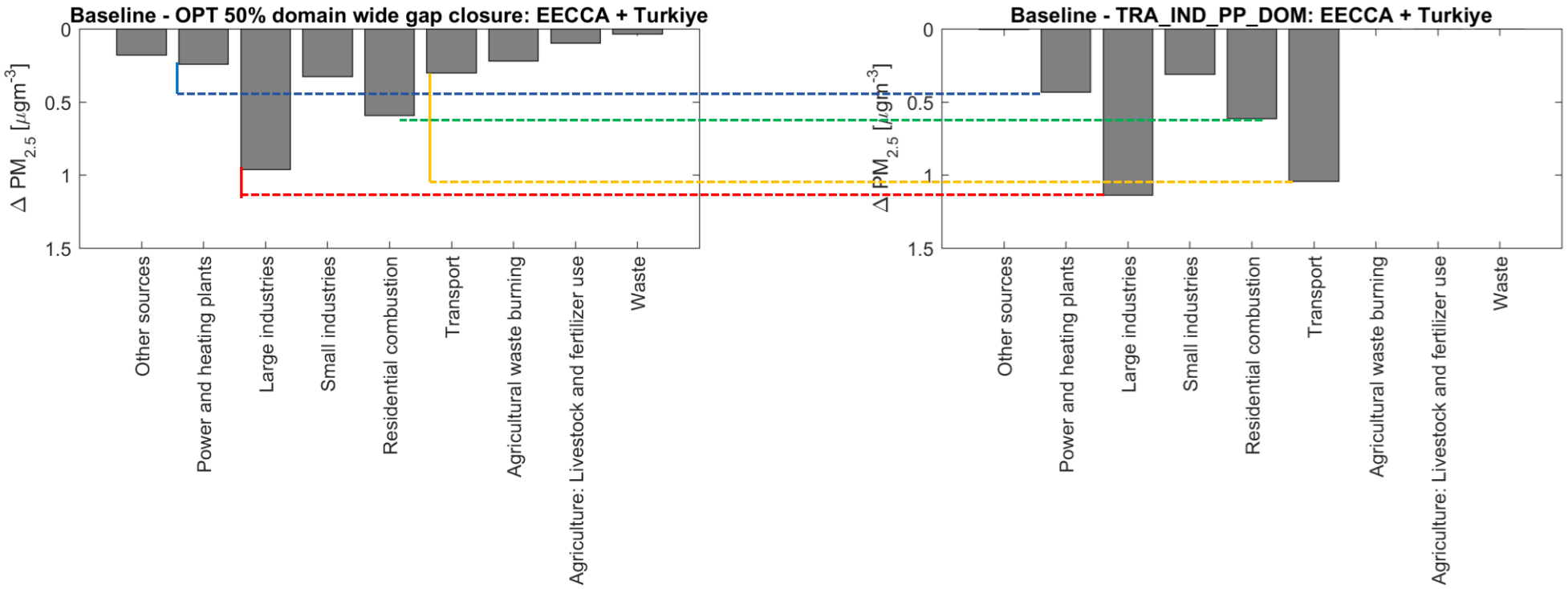


- 50% gap closure solutions are similar, here UNECE-Europe wide gap closure forces stronger reductions
- While a sizable health improvement is estimated for the staged approach, the costs are much larger for achieved benefits in the preliminary staged approach case (all four sectors included)
- Some of the mitigation potential mobilized in the staged case is beyond the cost-effective portfolio of solutions to reach domain wide goals [see next slide]

Comparing domain wide optimization vs staged approach - EECCA + Türkiye

Least-cost approach

Draft *staged approach* case:
enforcing EU legislation for power, industry, residential combustion, and transport



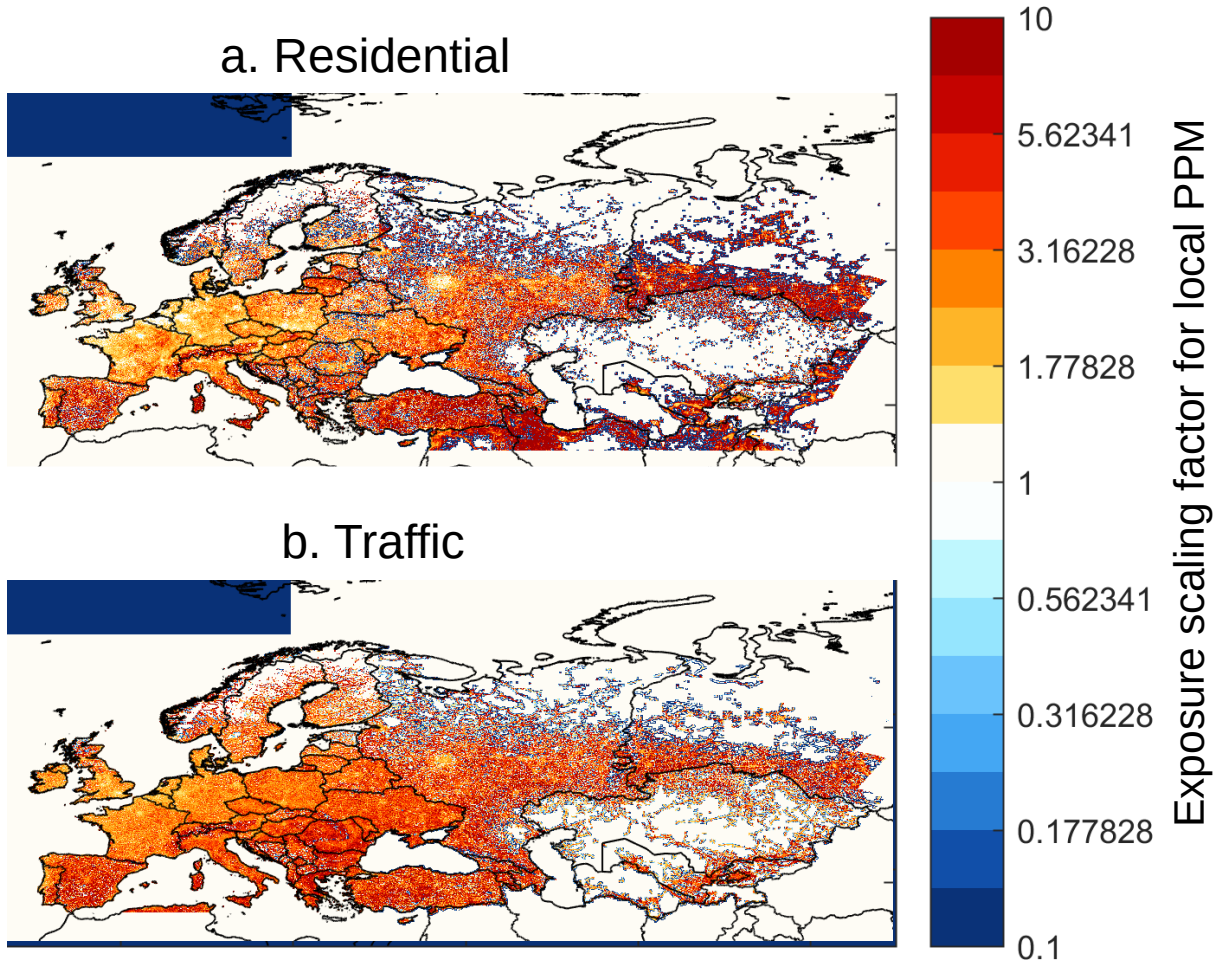
- Staged approach mobilizes additional mitigation potential for most addressed sectors, compared to the cost-effective solution

Preliminary conclusions and further work

- Staged approach can provide important improvements, but not in all regions and possibly at relatively high cost, compared to the cost-effective solutions
- Coordinated early action on agriculture could offer another case, e.g., implementation of EU IED for Agriculture
- The staged approach implementation is a draft and will be further fine-tuned to better represent country-specific aspects
- Phased approaches: not yet considered. Could do sequential optimization with tightening targets over time?
- *Need advice on how to proceed, especially for phased approach*

Impacts on urban environments

Downscaling for $PM_{2.5}$ based on uEMEP



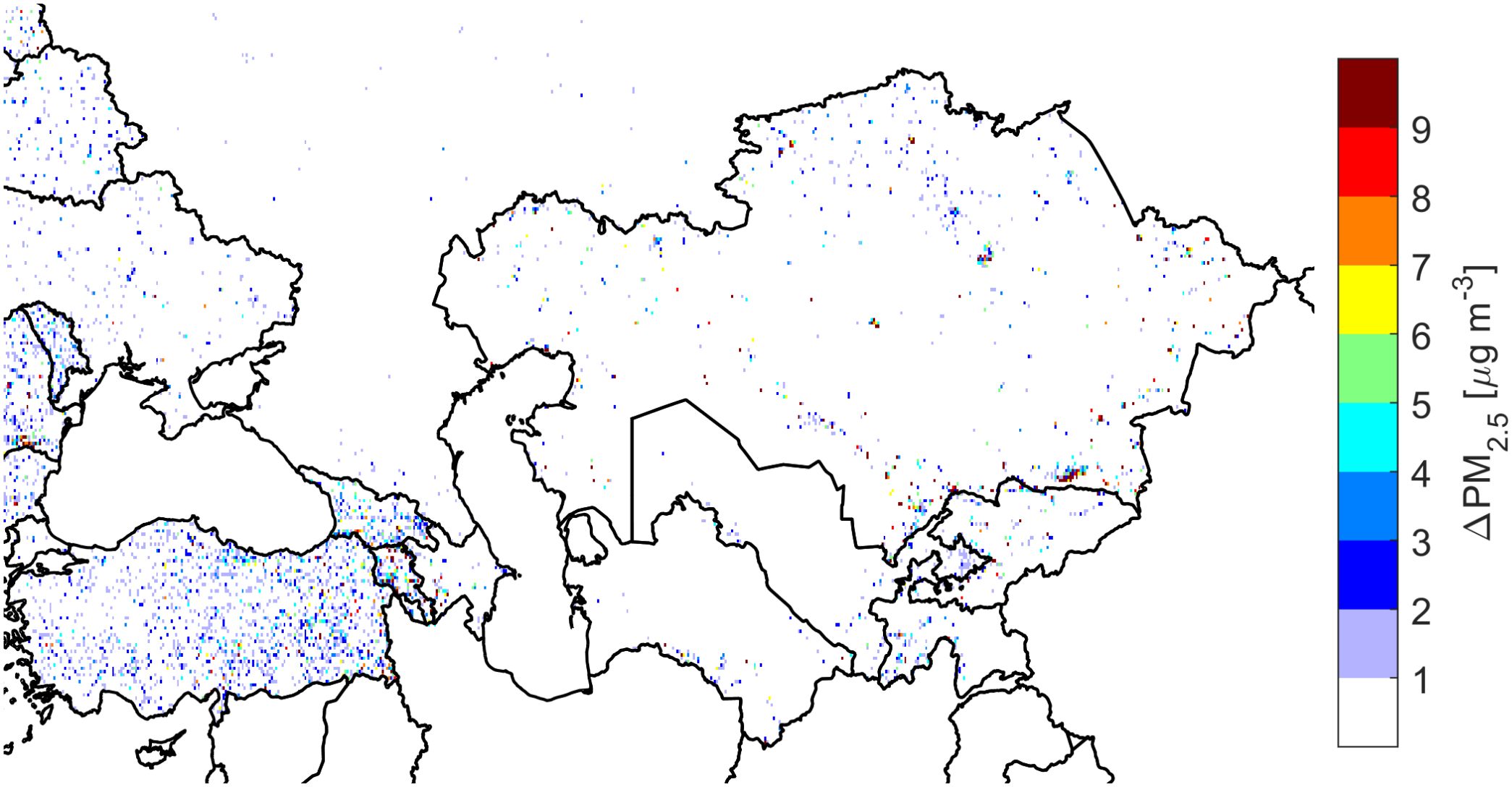
Downscaling increment for PPM based on uEMEP model simulations has been implemented for the whole UNECE-Europe domain.

Formulation: see Denby et al. (2024)

Exposure increment coefficients for local PPM for low-level sectors allow GAINS at 0.1° resolution to reproduce $PM_{2.5}$ exposure calculated with 250m resolution. Particularly relevant for Balkans & EECCA.

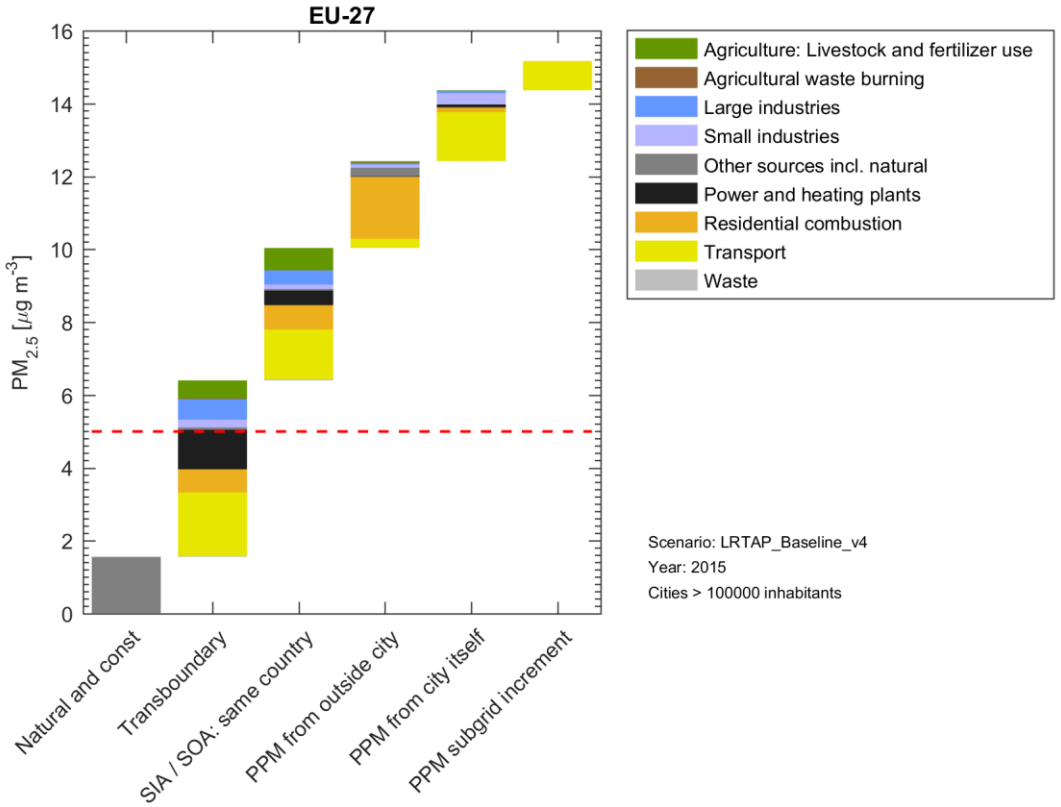
Will feed into the next generation of optimized scenarios (those on CIAM website only include it to 40°E).

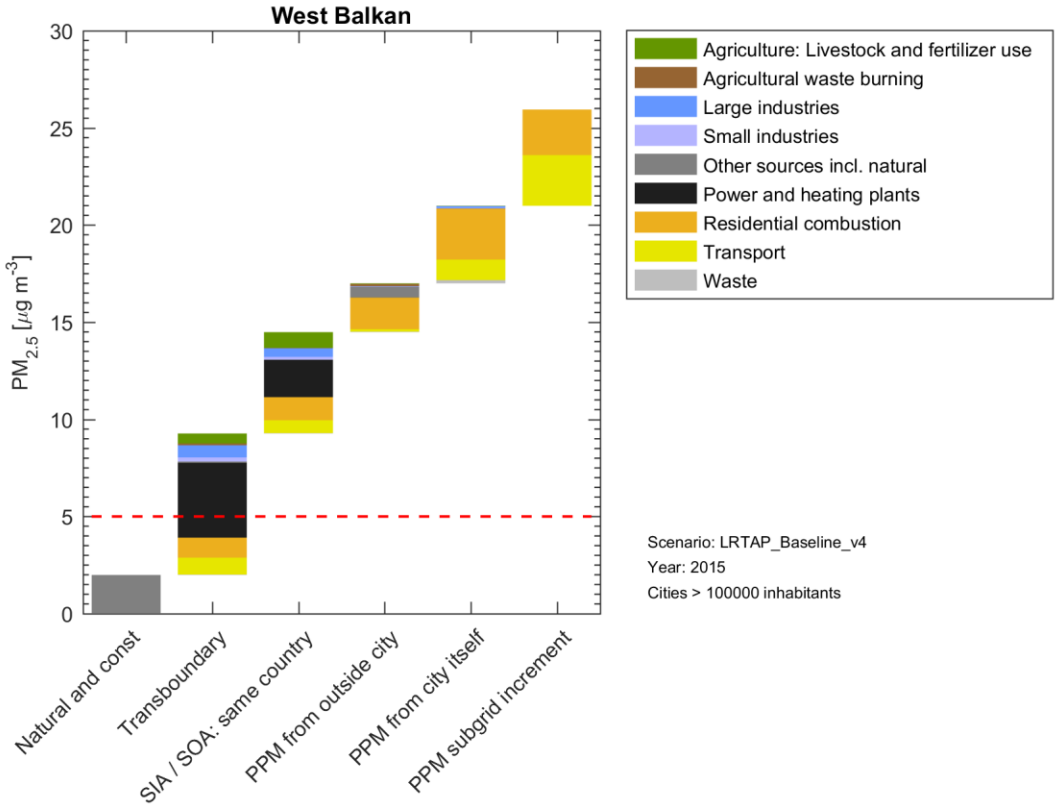
$PM_{2.5}$ concentration increment



Source contributions to $PM_{2.5}$ in cities (2015)

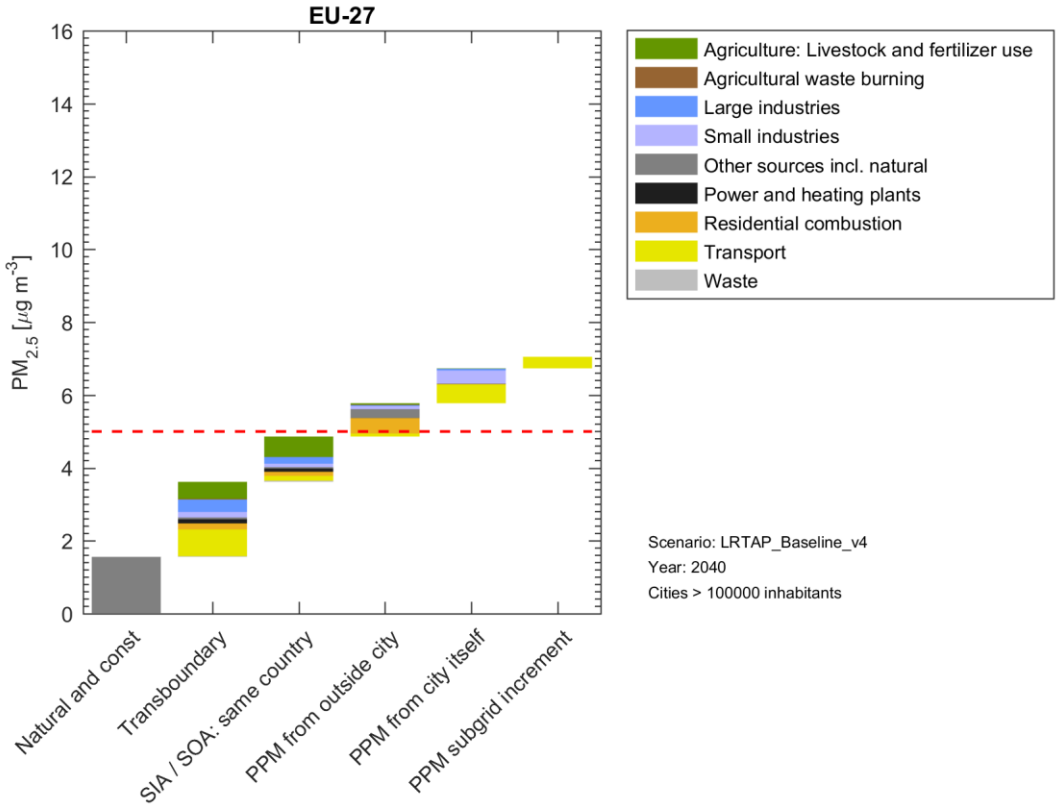
Population-weighted mean $PM_{2.5}$ in all cities >100,000 inhabitants in the region

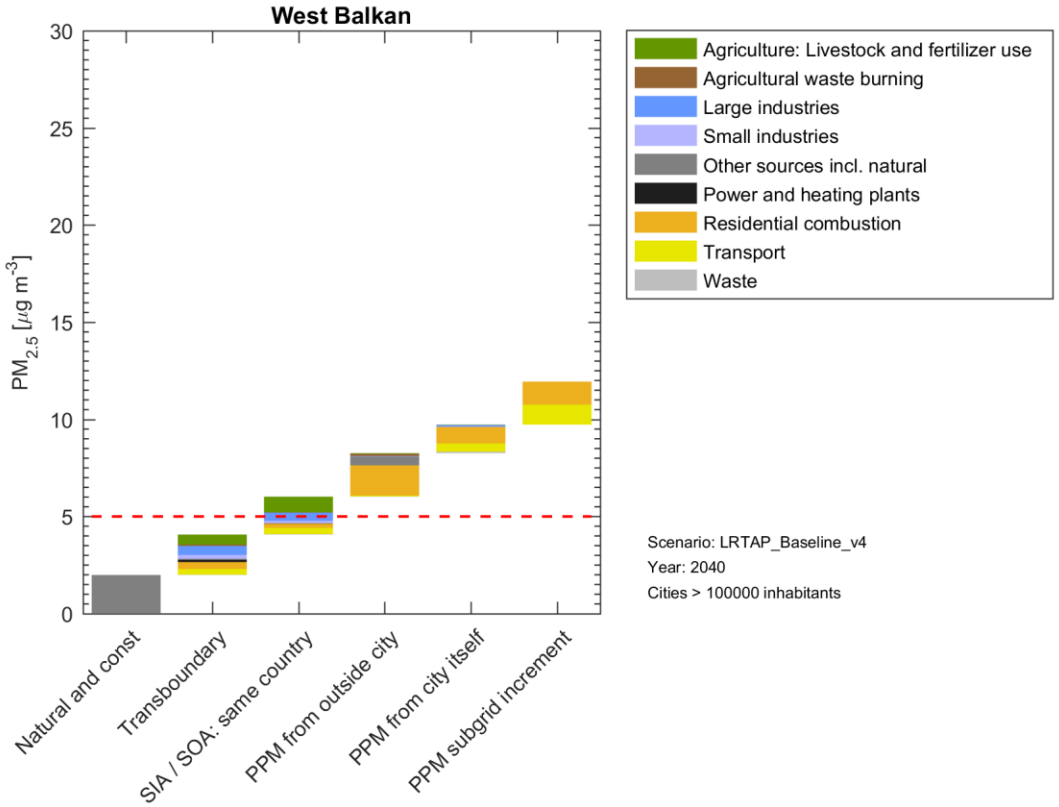




Source contributions to $PM_{2.5}$ in cities (2040 CLE)

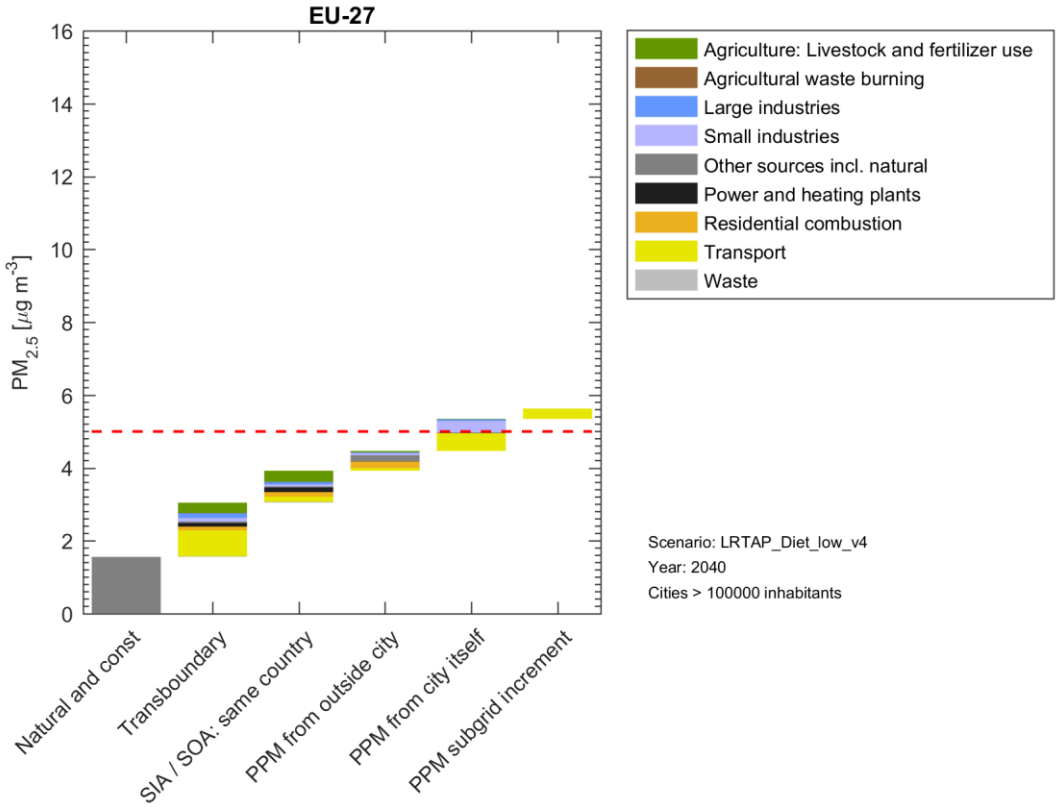
Population-weighted mean $PM_{2.5}$ in all cities >100,000 inhabitants in the region

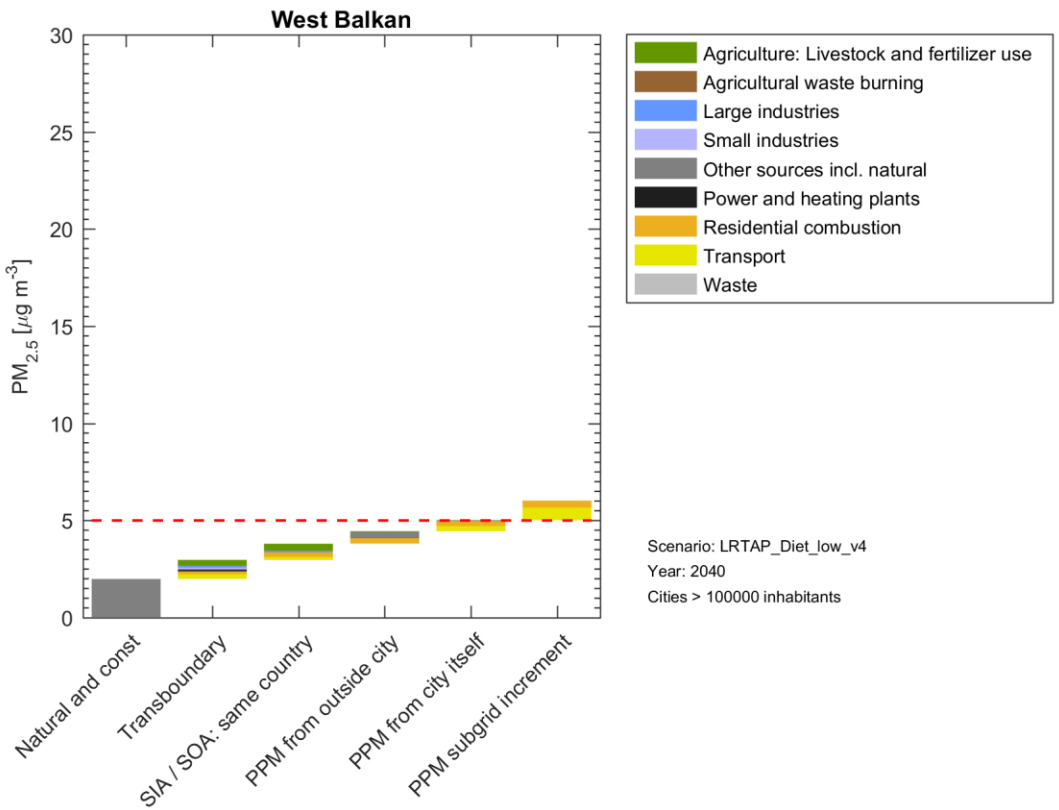




Source contributions to $PM_{2.5}$ in cities (2040 LOW)

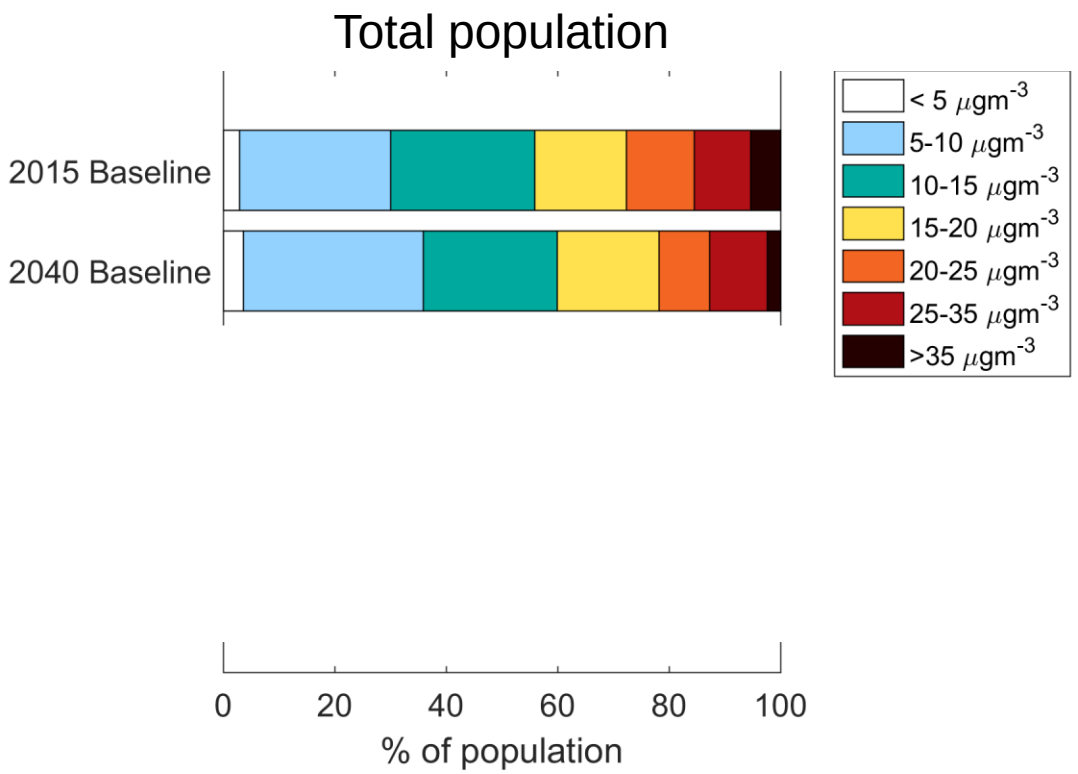
Population-weighted mean $PM_{2.5}$ in all cities >100,000 inhabitants in the region

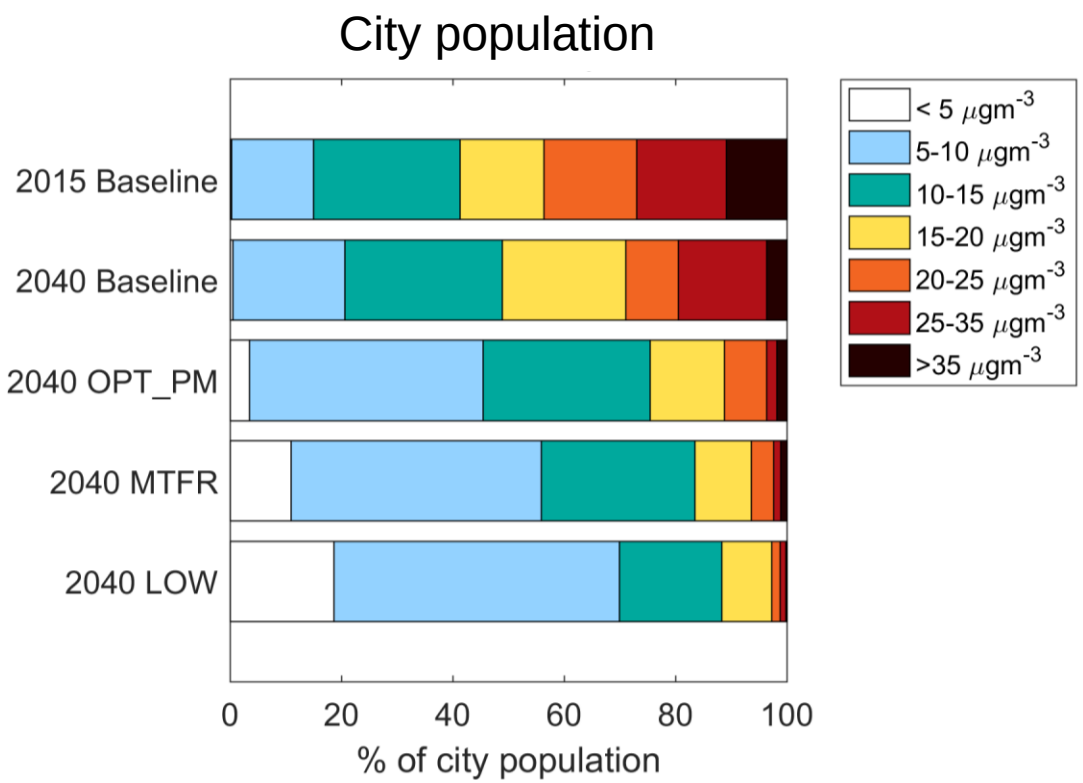




$PM_{2.5}$ exposure distribution: EECCA + Turkiye

Total $PM_{2.5}$ incl. natural dust

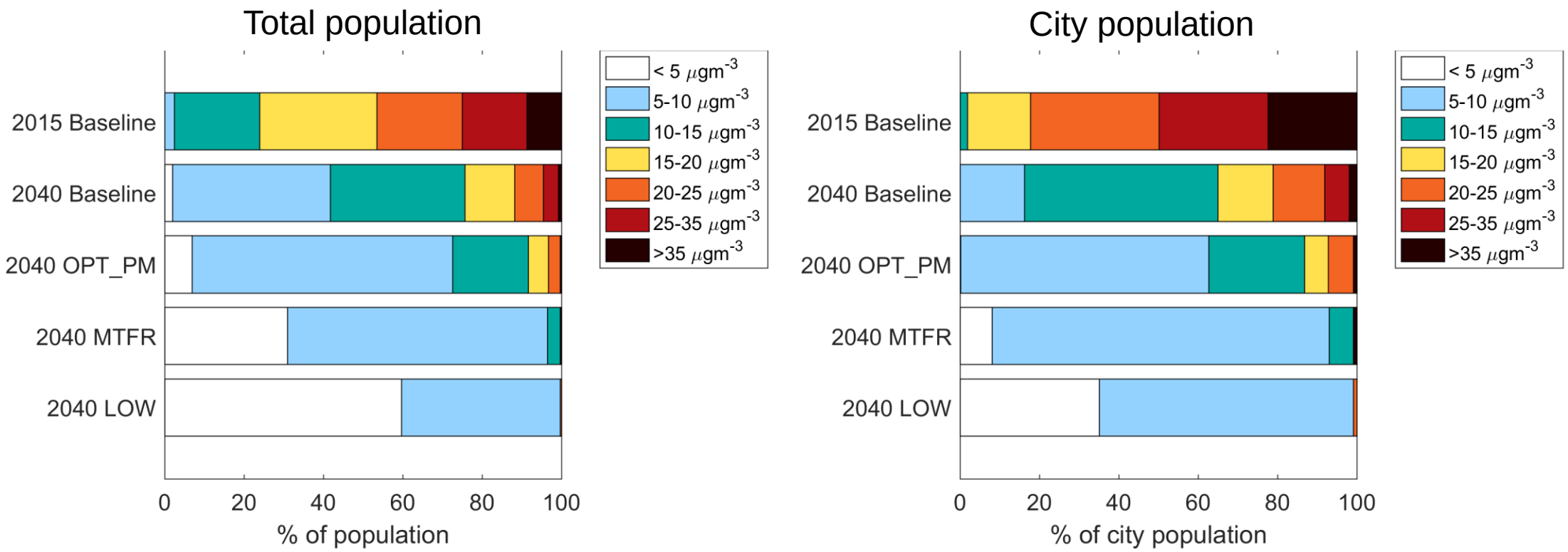




Population: JRC GHSL 250m (R2019), projection according to UN WUP 2018.
City definition: JRC UCDB urban core polygons

$PM_{2.5}$ exposure distribution: West Balkan

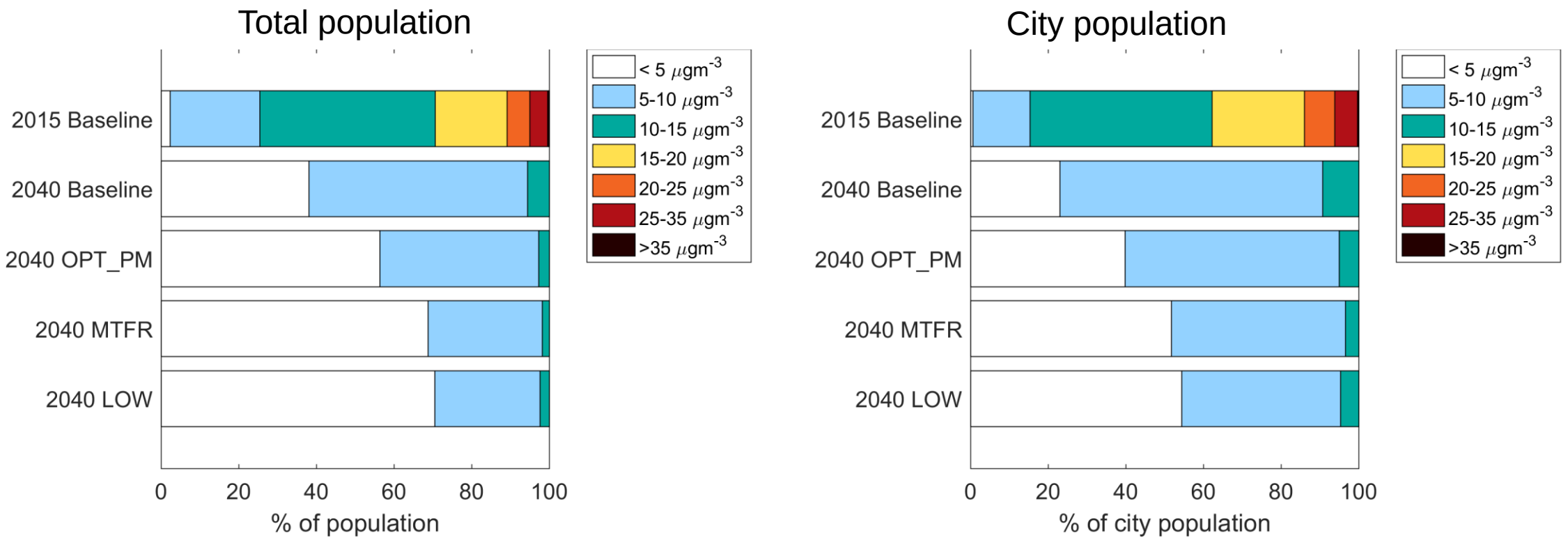
Total $PM_{2.5}$ incl. natural dust



Population: JRC GHSL 250m (R2019), projection according to UN WUP 2018.
City definition: JRC UCDB urban core polygons

$PM_{2.5}$ exposure distribution: EU

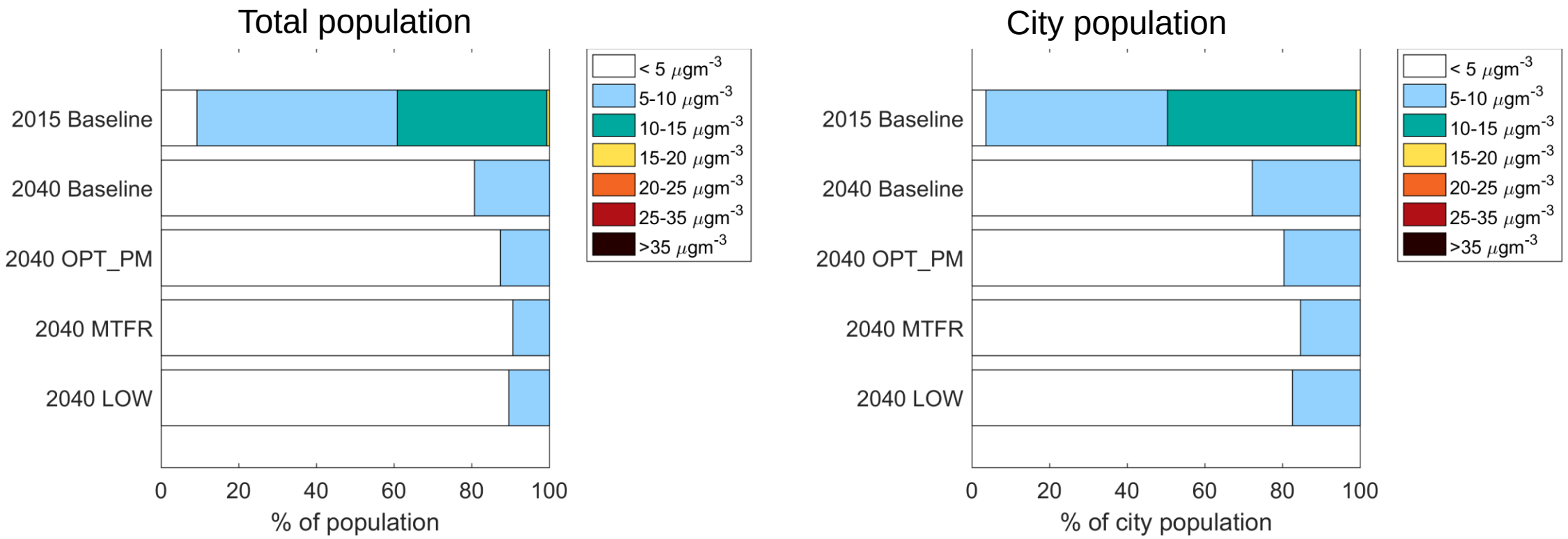
Total $PM_{2.5}$ incl. natural dust



Population: JRC GHSL 250m (R2019), projection according to UN WUP 2018.
City definition: JRC UCDB urban core polygons

$PM_{2.5}$ exposure distribution: EFTA+UK

Total $PM_{2.5}$ incl. natural dust



Population: JRC GHSL 250m (R2019), projection according to UN WUP 2018.
City definition: JRC UCDB urban core polygons

Initial conclusion on urban population exposure

West Balkan, EECCA, and Turkiye

- Confirmed interest in seeing ex post analysis for urban population
- Not surprisingly, currently, urban populations are exposed to higher concentrations, especially in West Balkan
- While current policies are expected to reduce exposure by 2040, disparity remains
- Optimized scenarios for community-wide health targets provide more equitable distribution of exposure, effectively 'shaving' peaks

EU, EFTA, and UK

- Less pronounced difference in exposure of total and urban population to high concentrations
- However, larger difference remains in exposure to levels above WHO AQG