B. Notter, F. Weber

Greenhouse gas mitigation potentials in the transport sector in Kenya

Summary of assumptions and results

System boundaries – National vs. global perspective

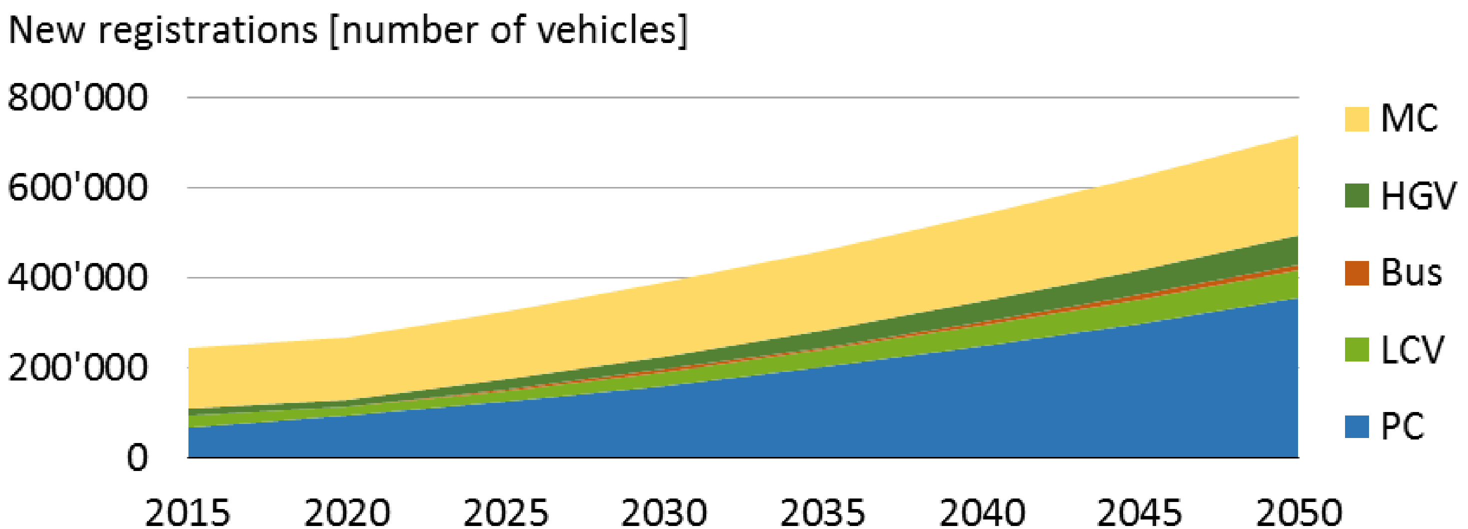
National perspective: emissions within national borders of Kenya (no upstream emissions of fossil fuels since produced outside Kenya, but with upstream emissions of electricity, since produced within Kenya). Same assessment boundary as the national GHG inventory reporting based on IPCC.

Global perspective: total well-to-wheel (WTW) emissions

à The analyses generally reflect a national perspective (in line with UNFCCC inventory reporting).

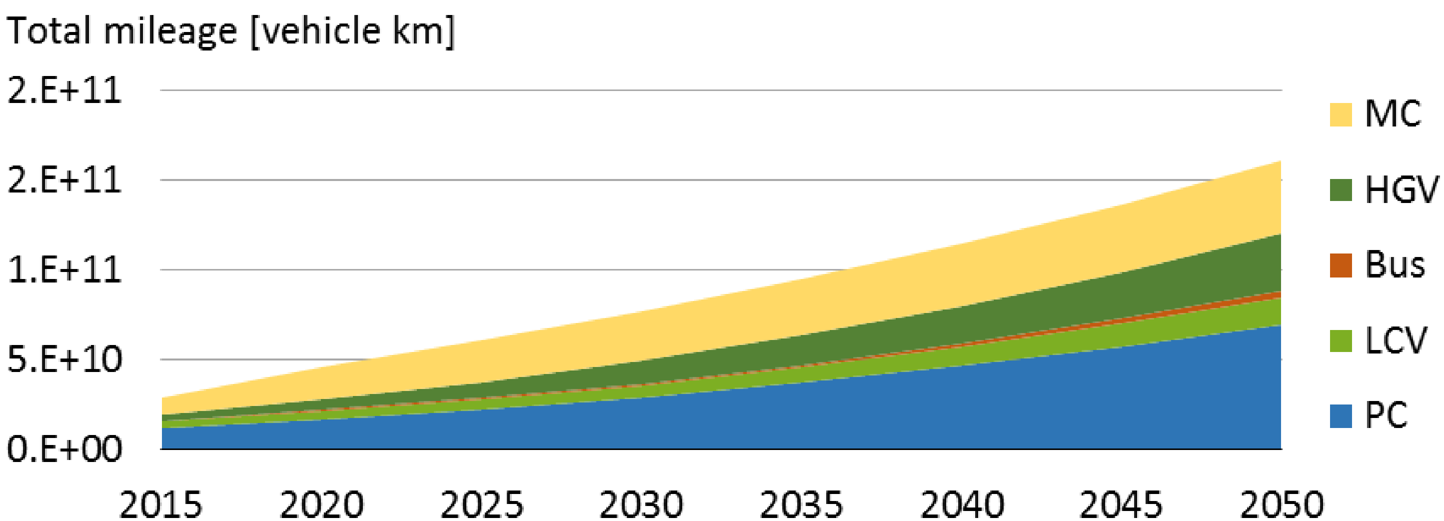
Baseline – new registrations

- 2050: Increase of new registrations by 200% compared to 2015
- Dominated by motorcycles and passenger cars
- Highest increase in new passenger cars



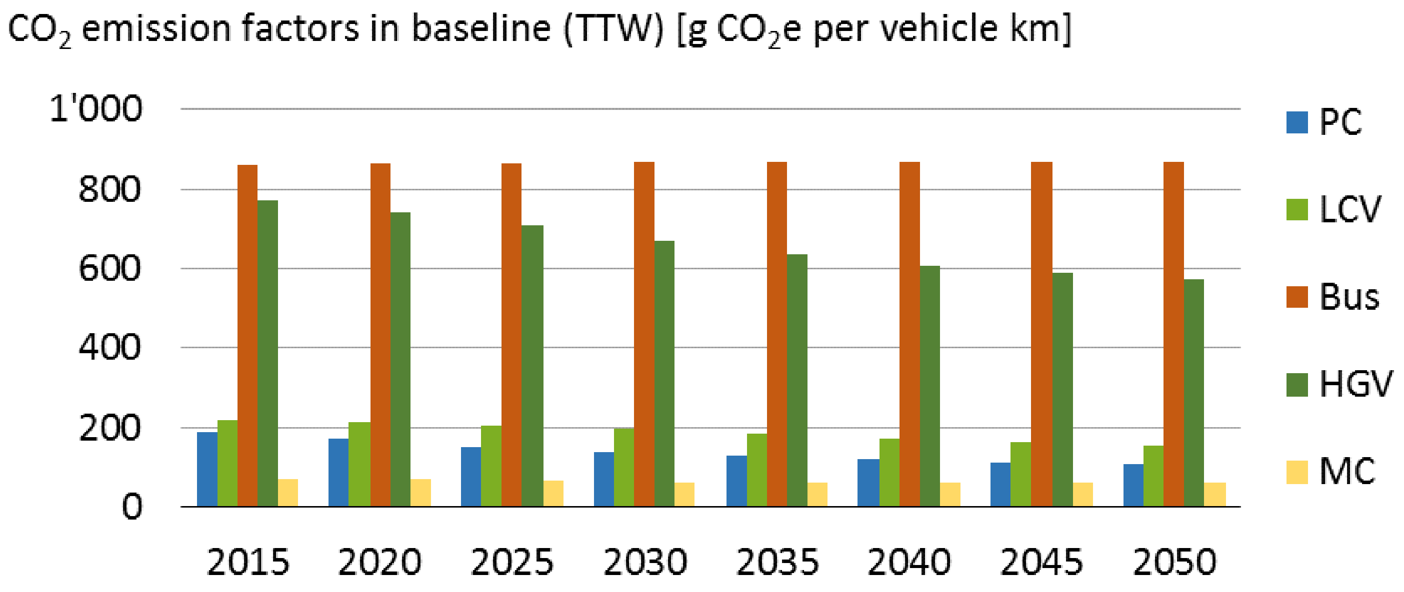
Baseline – total mileage

- 2050: Increase of total mileage by 450% compared to 2015
- High shares for passenger cars, motorcycles and heavy goods vehicles
- Highest increase of mileage from HGV (+750%)
- Assumed that there are no electric vehicles



Baseline – tank to wheel (TTW) emission factors

- Light duty vehicles (PC and LCV): 1.2% reduction/a, based on optimization potentials of of ICE engines and hybridization
- HGV: 0.4 to 1.2% reduction/a of fuel consumption
- Buses and motorcycles (MC): no reduction



Baseline – well to tank (WTT) emission factors

- Fossil fuels: WTT calculated according to the EN 16258 standard by using the ratio given between TTW and WTT emission factors by fuel type. Petrol: 19% WTT per TTW; diesel: 21% WTT per TTW.
- Electricity: Grid emission factors used for WTT emissions of electric vehicles (i.e., BEV, PHEV, eScooters and electric powered trains). Two different versions of grid emission factors were applied in order to show how different assumptions regarding grid emission factors influence the mitigation potentials:
  - Grid emission factor “Basic” (from Kenya’s Second National Communication) à used as standard
  - Grid emission factor “Alternative” (from the LCPDP Vision scenario) à used for comparison (only in scenarios “shift from road to rail” and “electrification”)

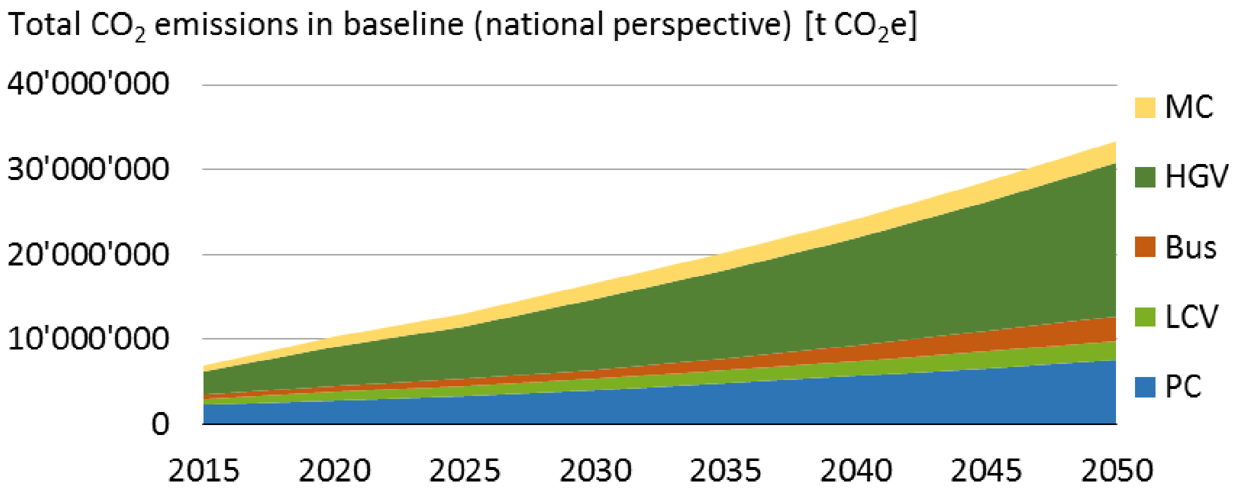
Baseline – Grid emission factors (electricity)

- "Basic": diversification of electricity sources, potentially increasing coal, reduce recent trend of oil thermal comprising the largest portion of new capacity
- "Alternative": complete and prompt phase out of oil in the year 2020. The electricity gap occurring from that would be covered by imports, which would not lead to emissions (because WTT emissions occurring abroad are not included in the national perspective and TTW emissions of electricity are assumed to be zero).

in gCO_2e/MJ	2015	2020	2025	2030	2035	2040	2045	2050
"Basic": Grid EF from Kenya's Second National Communication (Government of Kenya 2015)	33.4	96.1	104.6	103.2	90.3	89.3	88.6	87.9
"Alternative": Grid EF from Least Cost Power Development Plan (LCPDP) Vision scenario (ERC 2018)	22.0	5.3	9.3	38.2	39.6	41.4	41.4	41.4

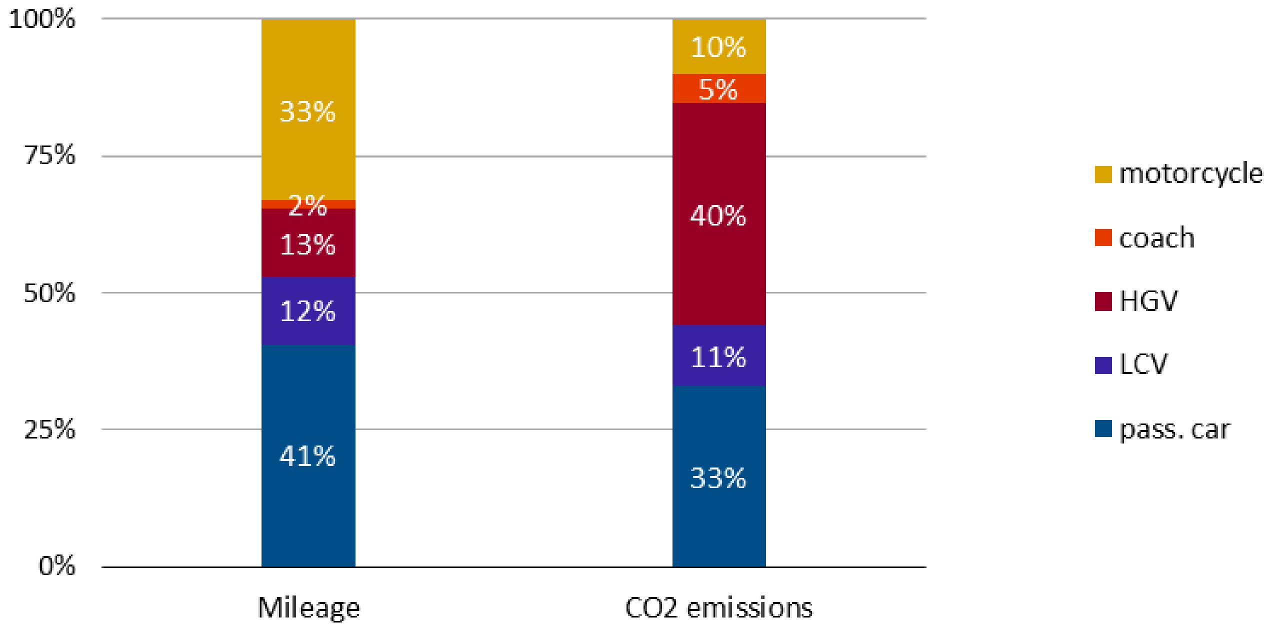
Baseline – emissions

- 2050: Increase of total road transport emissions by 380% compared to 2015
- Dominated by heavy goods vehicles (share of emissions: 41% in 2015, 55% in 2050)
- Upstream emissions (production and transport of fossil fuels) not included in this figure. The analyses use the same assessment boundary ("national perspective") as the national GHG inventory reporting (based on IPCC). Only emissions occurring within Kenya are included.



Baseline - Mileages and CO_2e emissions of road transport in Kenya

- Total mileage of road transport vehicles is approx. 29'000 million vehicle kilometres in 2015
- The corresponding CO_2e emissions are about 6.9 Mt
- Passenger cars dominate regarding mileage but trucks cause most emissions:



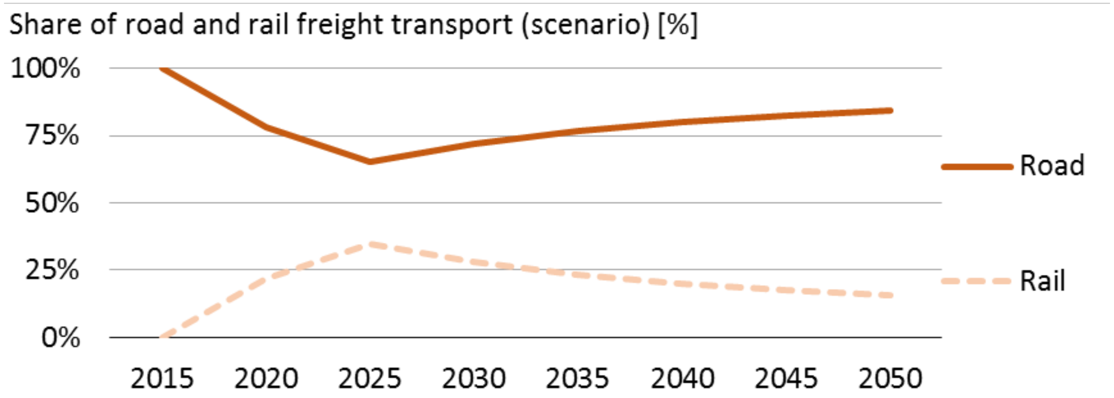
Baseline - Modelled fuel consumption vs. sales statistics

2015 [tonnes]	Fuel sales („Retail pump outlets and road transport“)	Modelled consumption (road transport)	Relative Difference
Petrol	1'133'169	905'595	-20%
Diesel	1'749'524	1'251'538	-28%
TOTAL	2'882'693	2'157'133	-25%

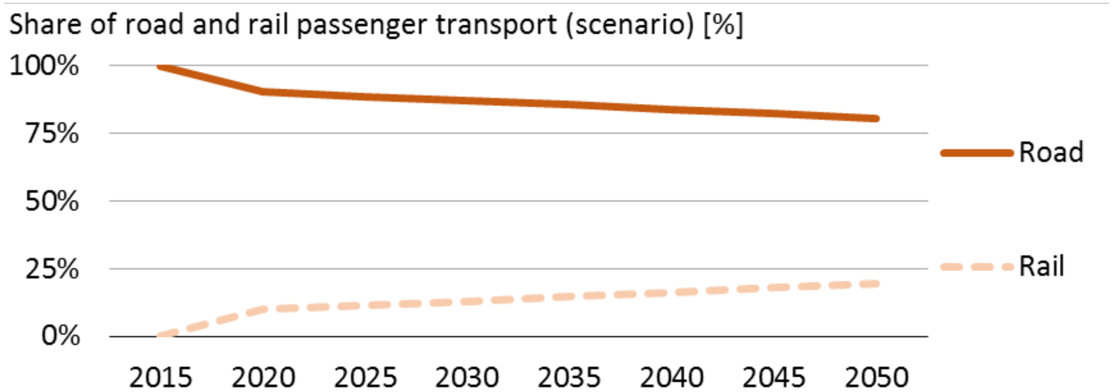
- For 2015, modelled fuel consumption lies 25% below fuel sales from sales statistics
- Discrepancy can (at least partly) be explained by non-road fuel consumption, e.g. construction

Shift from road to rail – main assumptions

- Capacity of freight rail (max. of 22‘000 kt or 10‘135 Mio. tkm reached in 2025):
  Note that the reduction of the rail share after 2025 only means that rail capacity is constant (max. capacity reached) whilst total freight is increasing. It does not imply a reduction of rail freight transport.

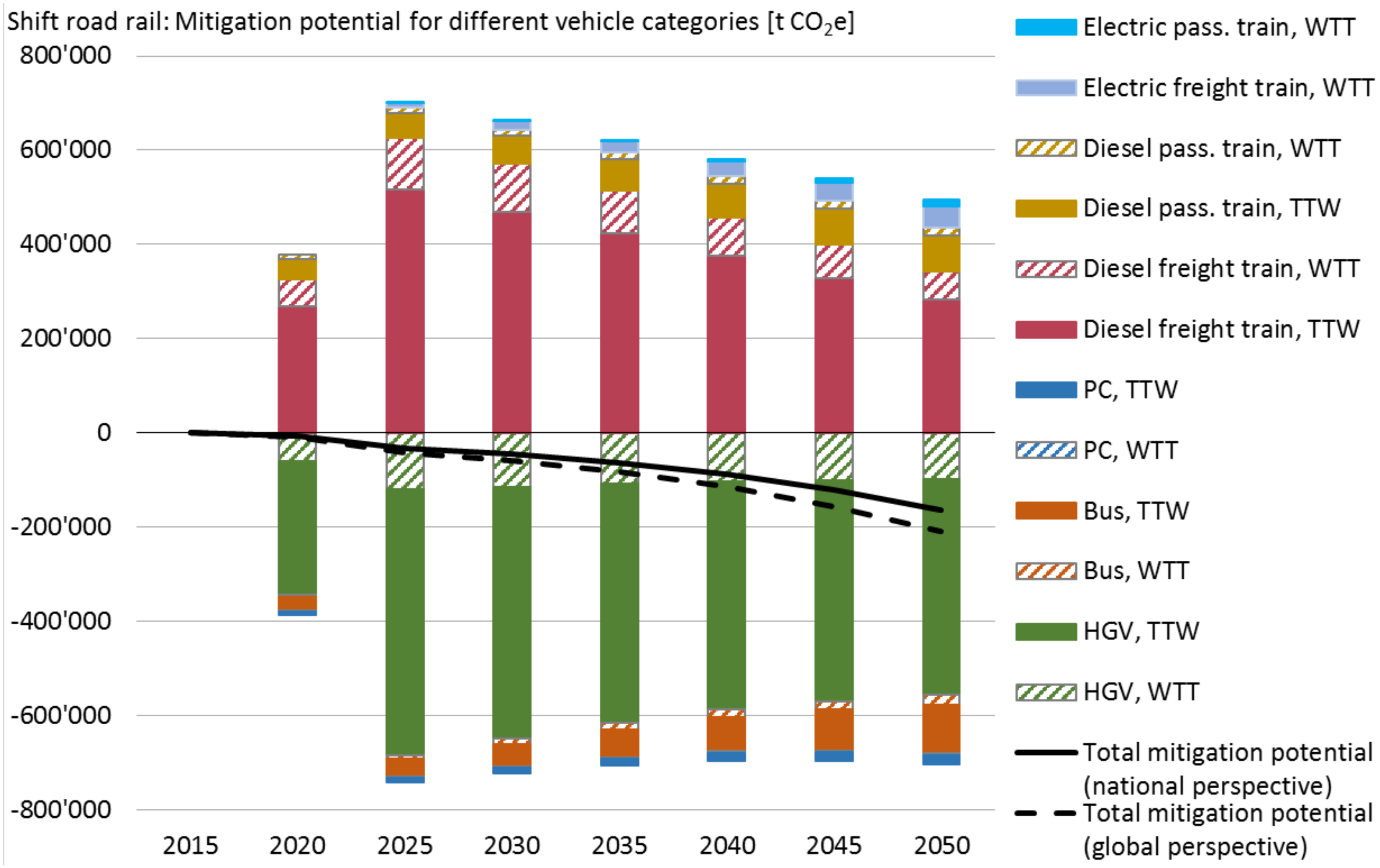


- Capacity of passenger rail (max. of 7.7 Mio. p. or 3’500 Mio. pkm reached in 2050):



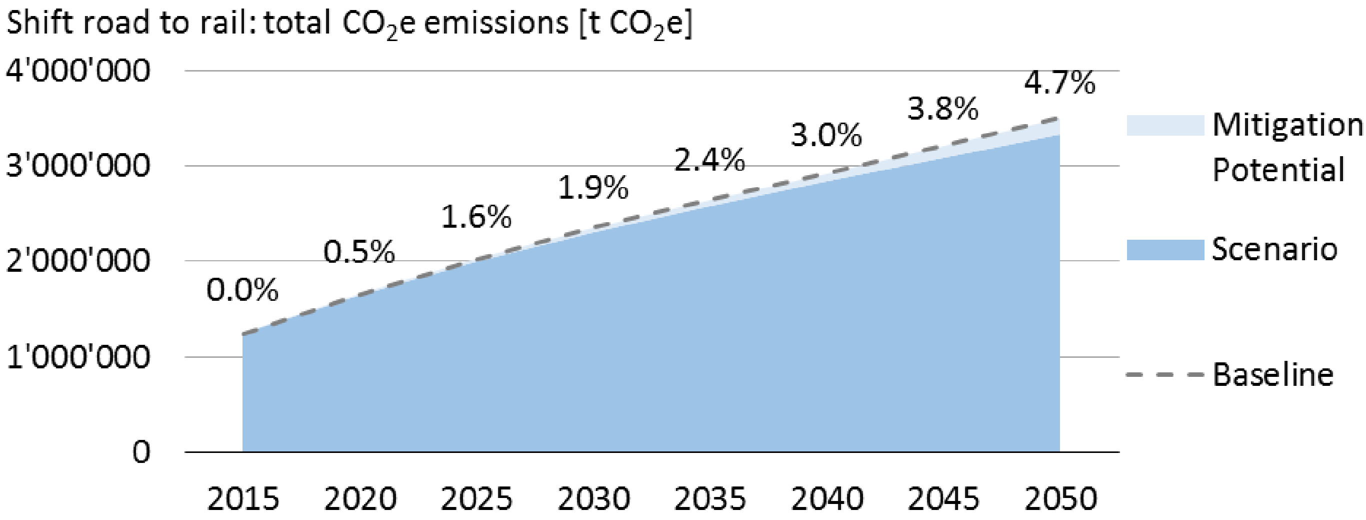
Shift from road to rail – mitigation potential

§ Yearly reduction: approx. 160 kt CO_2e by 2050 (national perspective)



Shift from road to rail – mitigation potential

- Yearly reduction: approx. 160 kt CO_2e by 2050 (national perspective)
- This is a reduction of about 4.7% of emissions on the corridor Mombasa – Nairobi – Uganda
- Compared to total road transportation emissions in Kenya, the cumulated potential for the years 2015-2050 amounts to 0.3%
- With grid emission factor „Alternative“: cumulated potential for the years 2015-2050 amounts to 0.4%



Shift from road to rail – interpretation

The mitigation potential of a shift from road to rail is limited:

§ High emission factor per pkm of diesel rail (shift from bus to diesel train increases emissions; bus: 32-33 g/pkm TTW vs. diesel train: 44 g/pkm TTW)

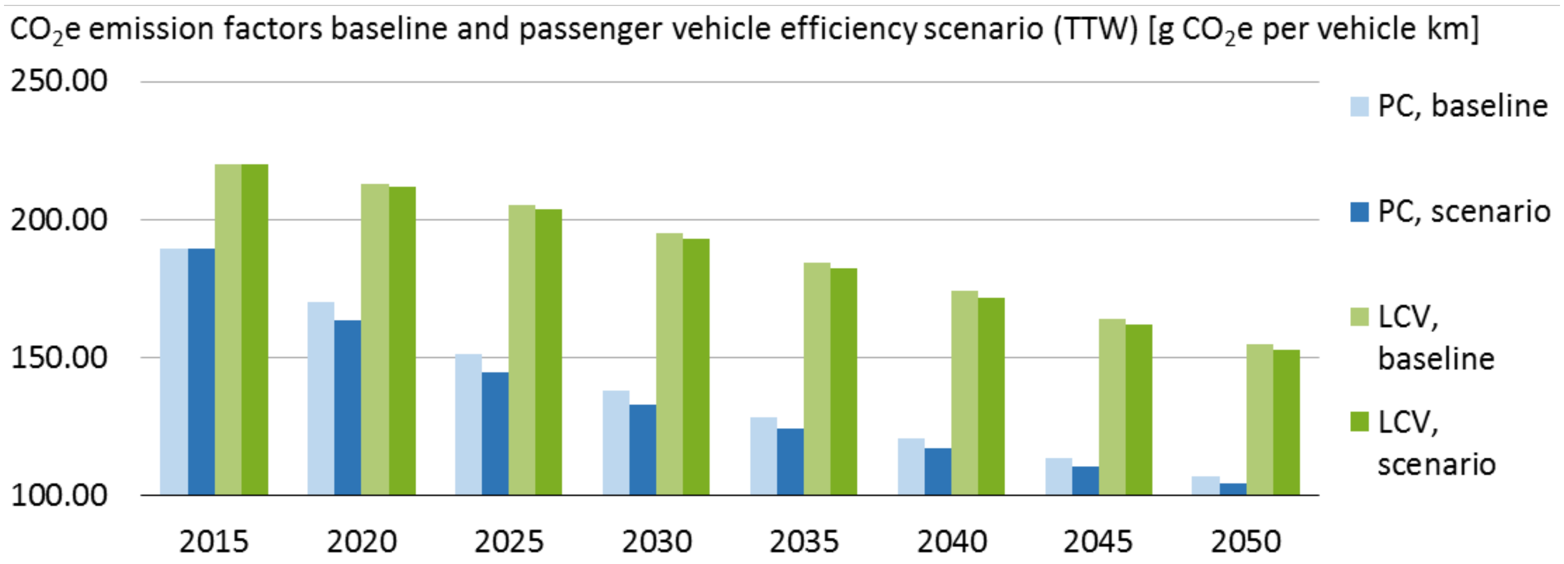
§ Only one train line in the whole country (apart from BRT/LRT mitigation potential)

§ Very little information available on the planned capacity of the SGR; potential in terms of capacity may be higher than assumed

Potential is a little higher when grid emission factor “Alternative” is applied.

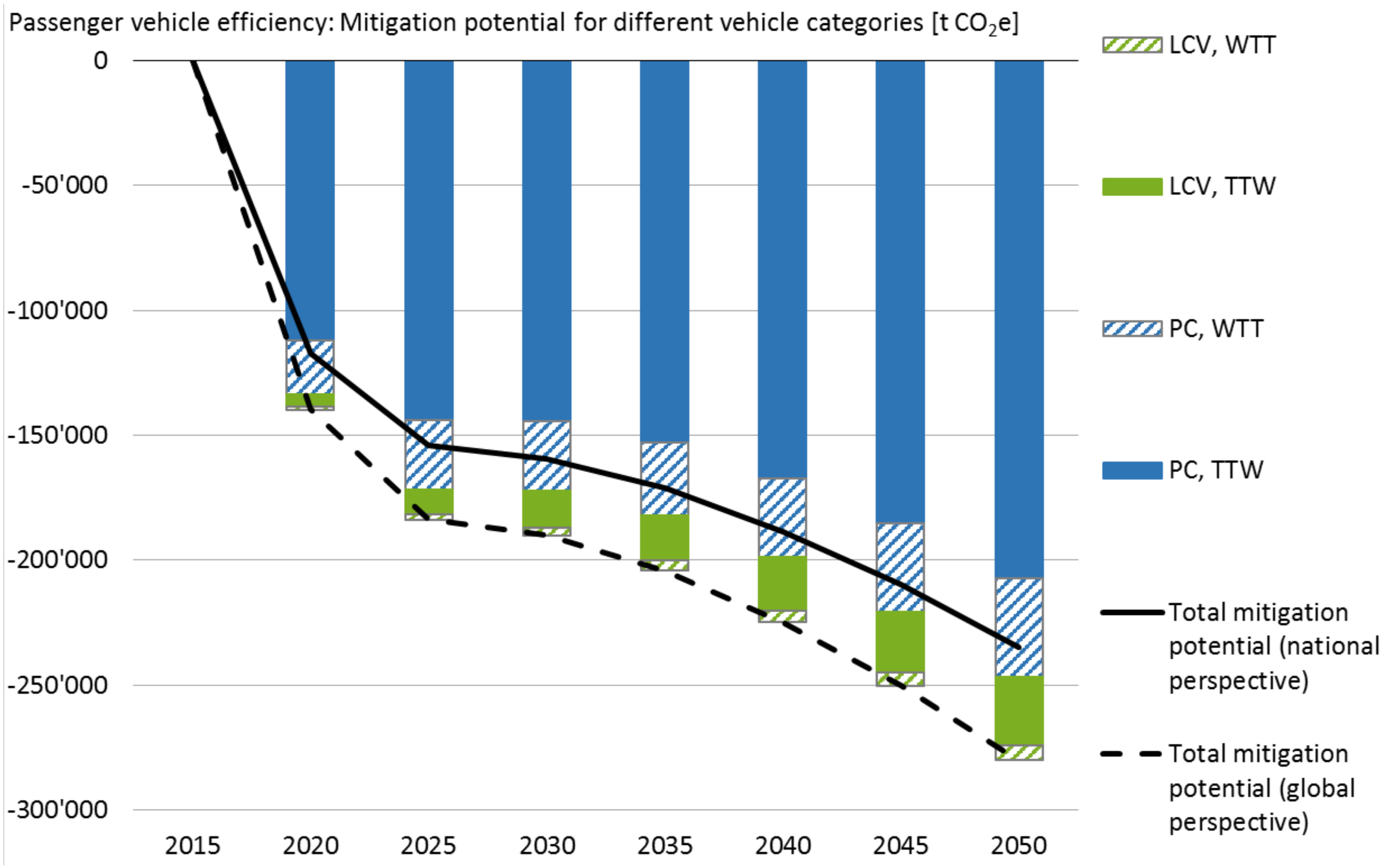
Passenger vehicle efficiency – main assumptions

- Maximum import age of all new registrations is lowered to 5 years (baseline: 8 years)



Pass. vehicle efficiency – mitigation potential

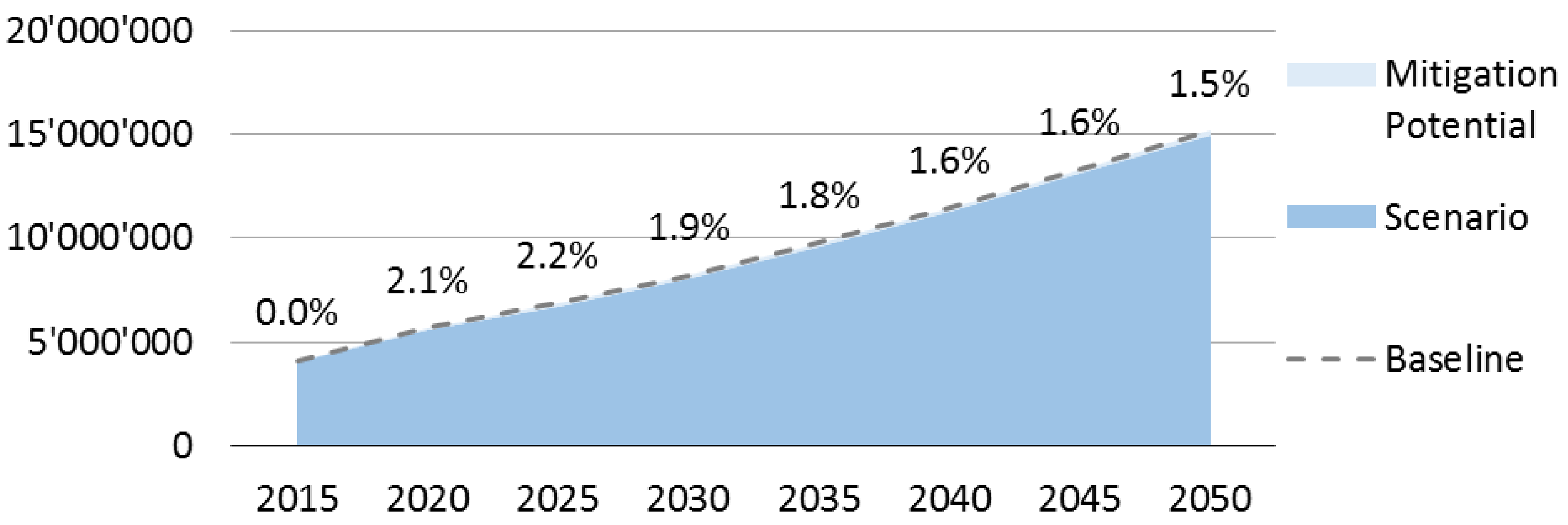
§ Yearly reduction: approx. 235 kt CO_2e by 2050 (national perspective)



Pass. vehicle efficiency – mitigation potential

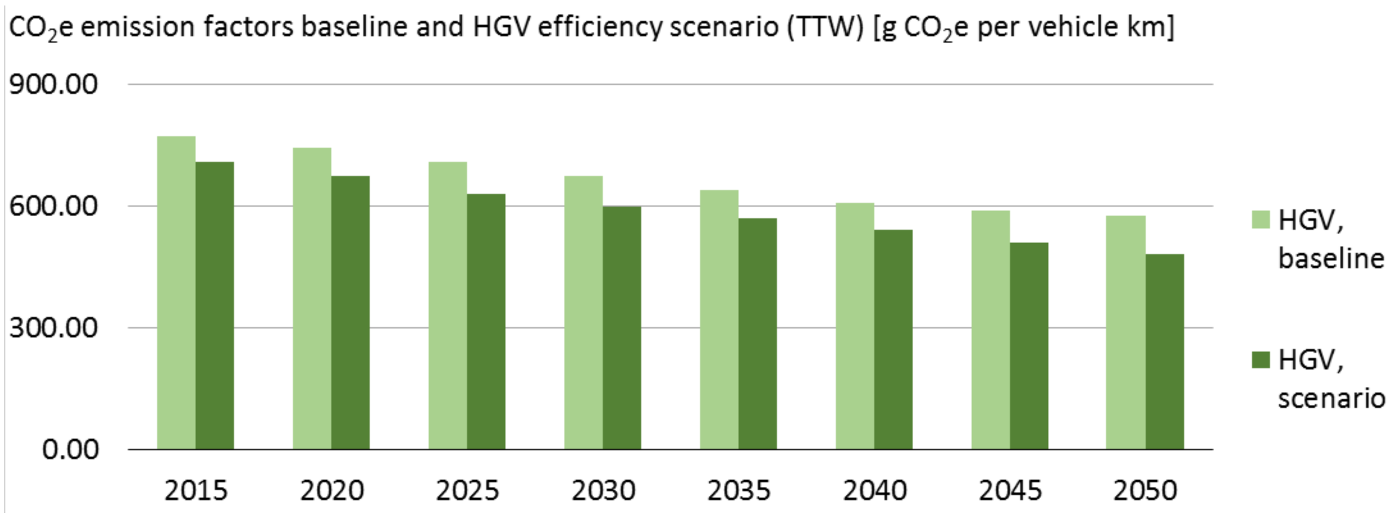
- Yearly reduction: approx. 235 kt CO_2e by 2050 (national perspective)
- Compared to the pass. vehicle efficiency baseline, this is a reduction of about 1.5%
- Compared to total road transportation emissions in Kenya, the cumulated potential for the years 2015-2050 amounts 0.8%

Passenger vehicle efficiency: total CO_2e emissions [t CO_2e]



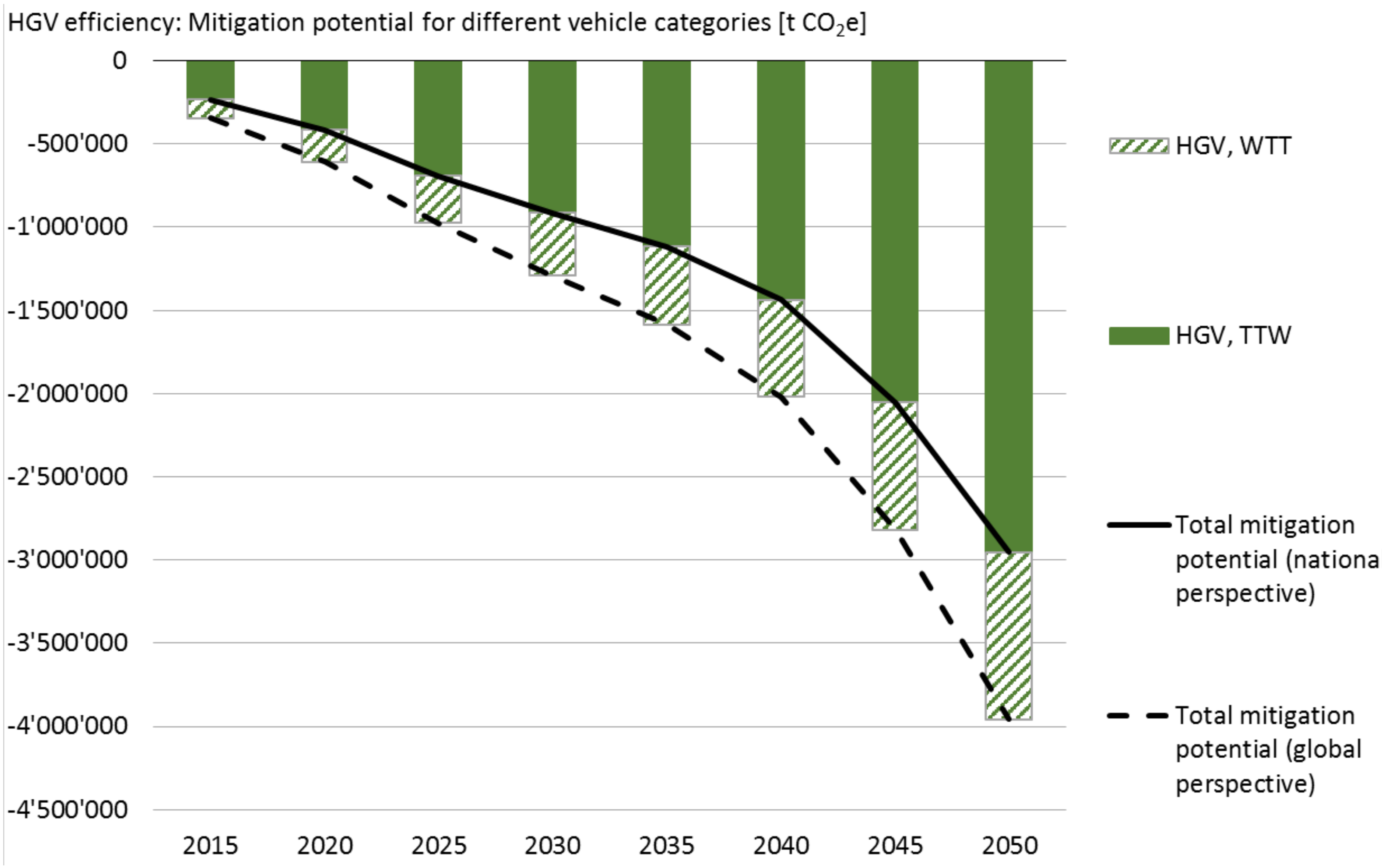
HGV efficiency – main assumptions

- Maximum import age of all new registrations is lowered to 5 years (baseline: 8 years; similar to passenger vehicle efficiency)
- Improved road condition (road surface roughness index IRI)
- Improved tyres and superstructures
- Improved driving behaviour through eco-drive education



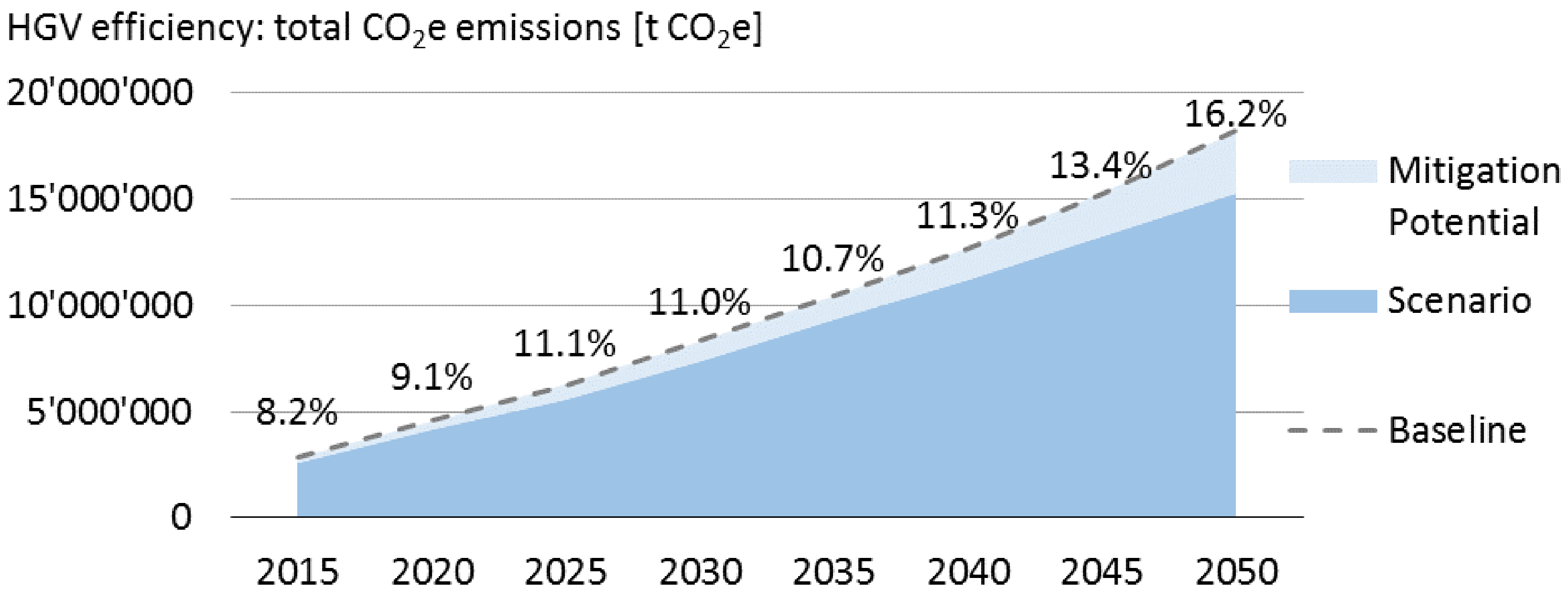
HGV efficiency – mitigation potential

§ Yearly reduction: approx. 2‘950 kt CO_2e by 2050 (national perspective)



HGV efficiency – mitigation potential

- Yearly reduction: approx. 2'950 kt CO_2e by 2050 (national perspective)
- Compared to shift road rail baseline, this is a reduction of about 16.2%
- Compared to total road transportation emissions in Kenya, the cumulated potential for the years 2015-2050 amounts 6.2%

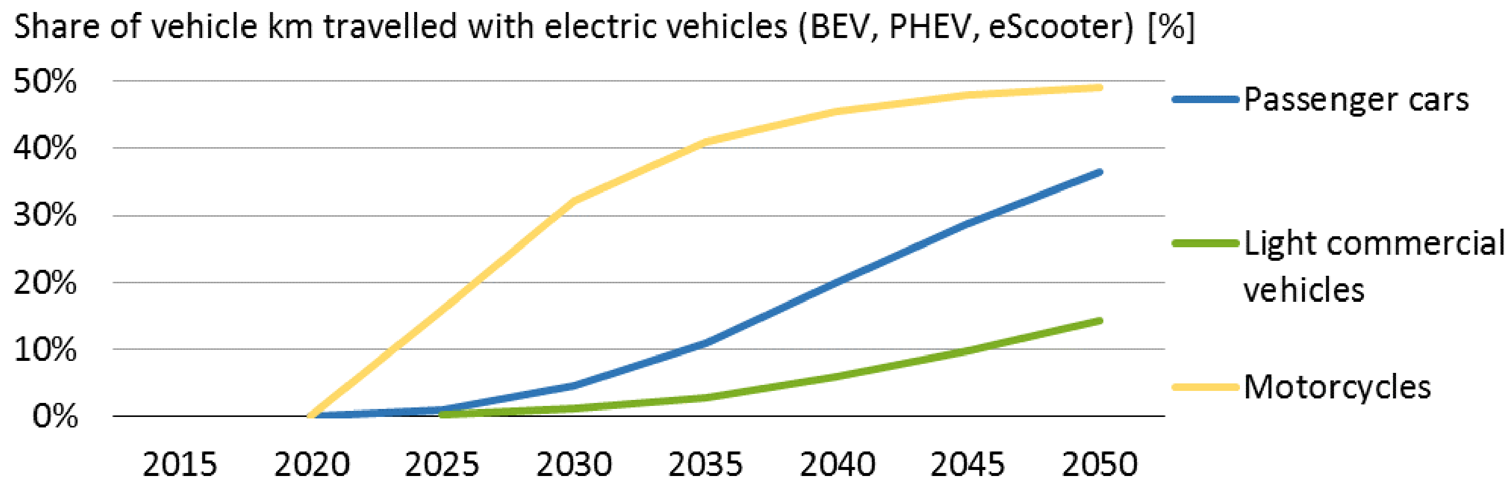


HGV efficiency – interpretation

- High relevance of freight transport in Kenya (2015: 41%, 2050: 55%)
- Several measures not linked to engine (i.e. not linked to efficiency improvements from countries of origin):
  - road conditions
  - tyres, superstructures
  - eco-driving
- Therefore, the impact of these mitigation actions can be major, and the HGV efficiency scenario bears the highest potential of the four mitigation actions analysed.

Electrification – main assumptions

- PC: First electric vehicles in 2024, about 23.6% shares (BEV and PHEV) in new registrations by 2050.
- LCV: First electric vehicles in 2024, about 20% share in new registrations by 2050 (no PHEVs)
- MC: Within 2015-2021, the share of e-Scooters in new registrations rises from 0% to 50%, then remains at the 50% level up to 2050.

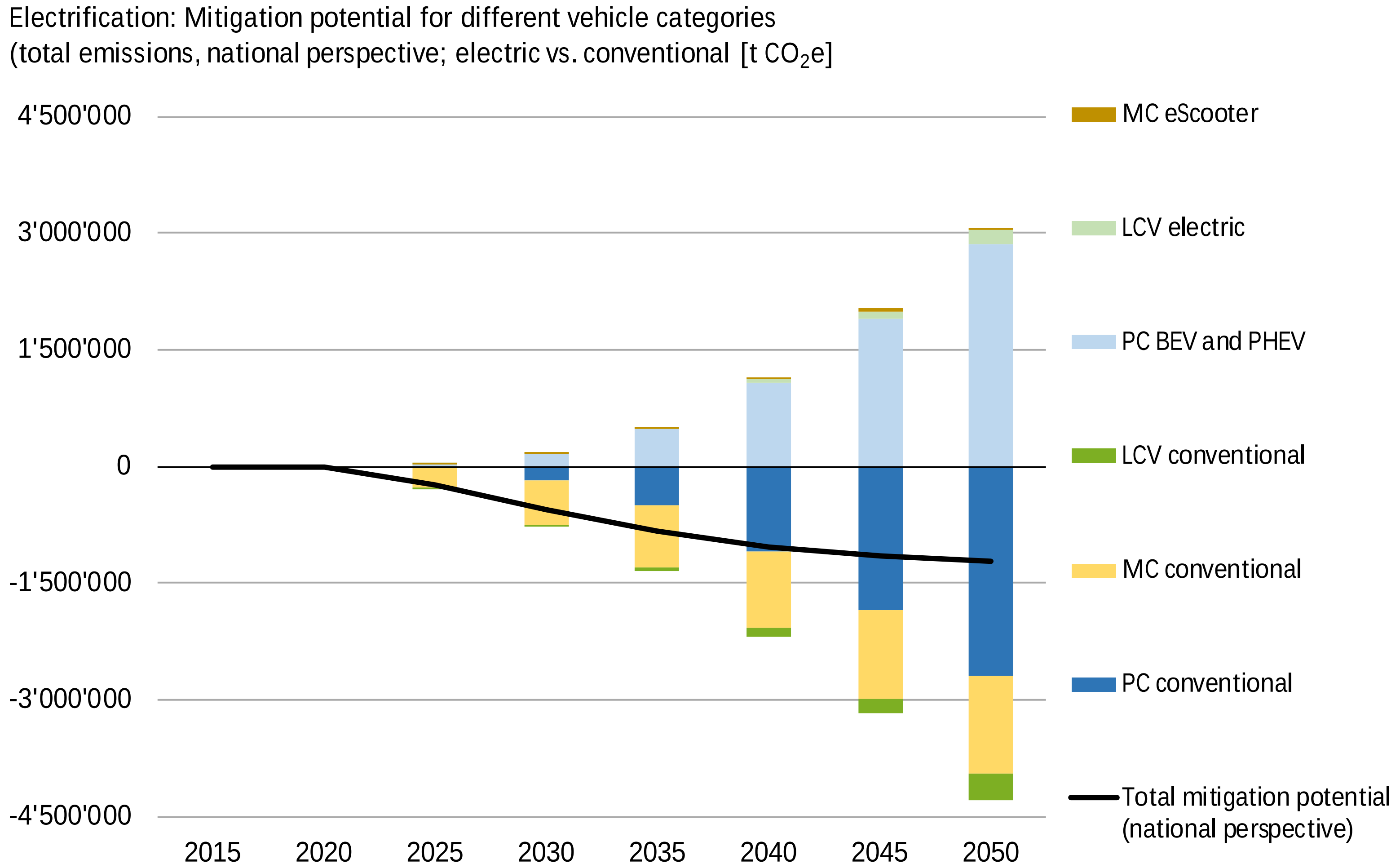


Electrification – mitigation potential

- Grid emission factor „Basic“:
  - National perspective: emission reduction through electrification between 2015-2040.
  - Global perspective: higher emission reductions than with the national perspective, since the reduction of upstream emissions for producing and transporting fossil fuels is included
- Grid emission factor „Alternative“: Due to the lower grid emission factor, the electrification scenario leads to reductions compared to baseline emissions over the whole time series (for both, the national and the global perspective).

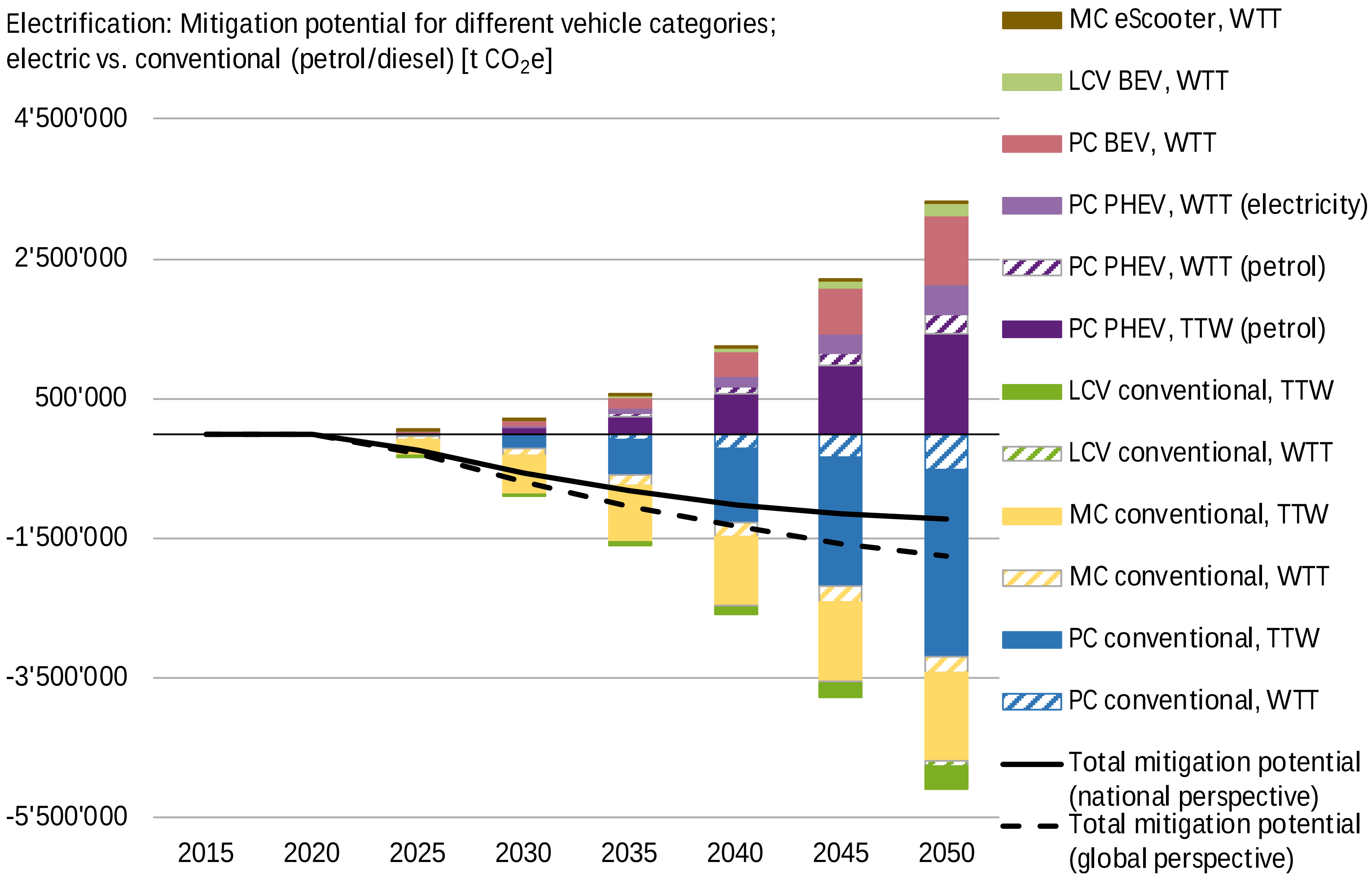
Electrification – mitigation potential

§ Grid EF „Basic“, total national emissions per vehicle category



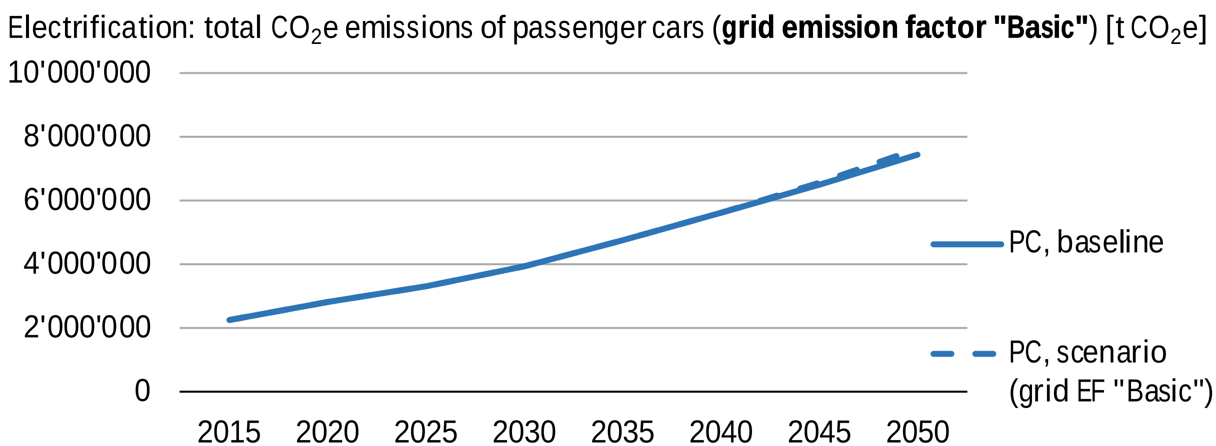
Electrification – mitigation potential

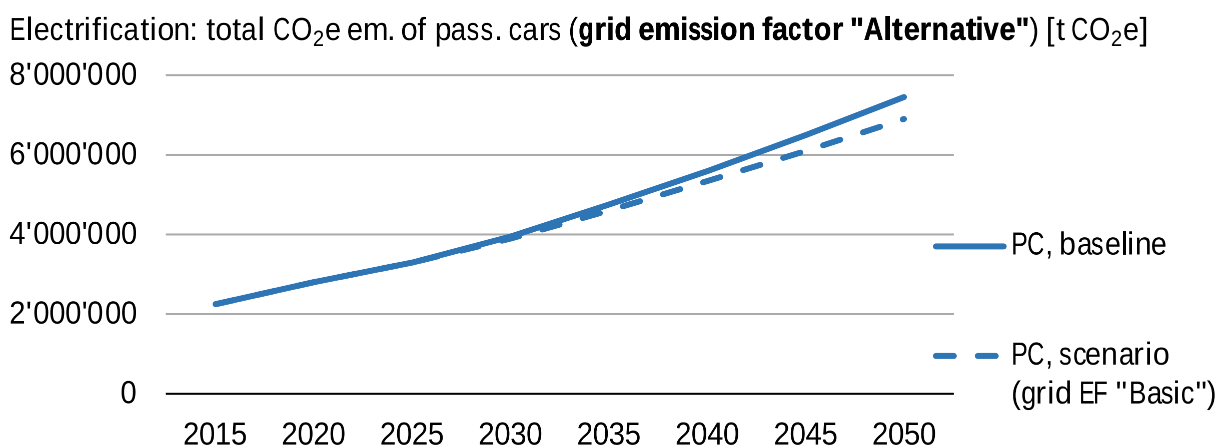
§ Grid EF „Basic“, differentiation between TTW and WTT emissions



Electrification – mitigation potential

- Especially for passenger cars, the choice of grid emission factors has a high impact on scenario emissions:

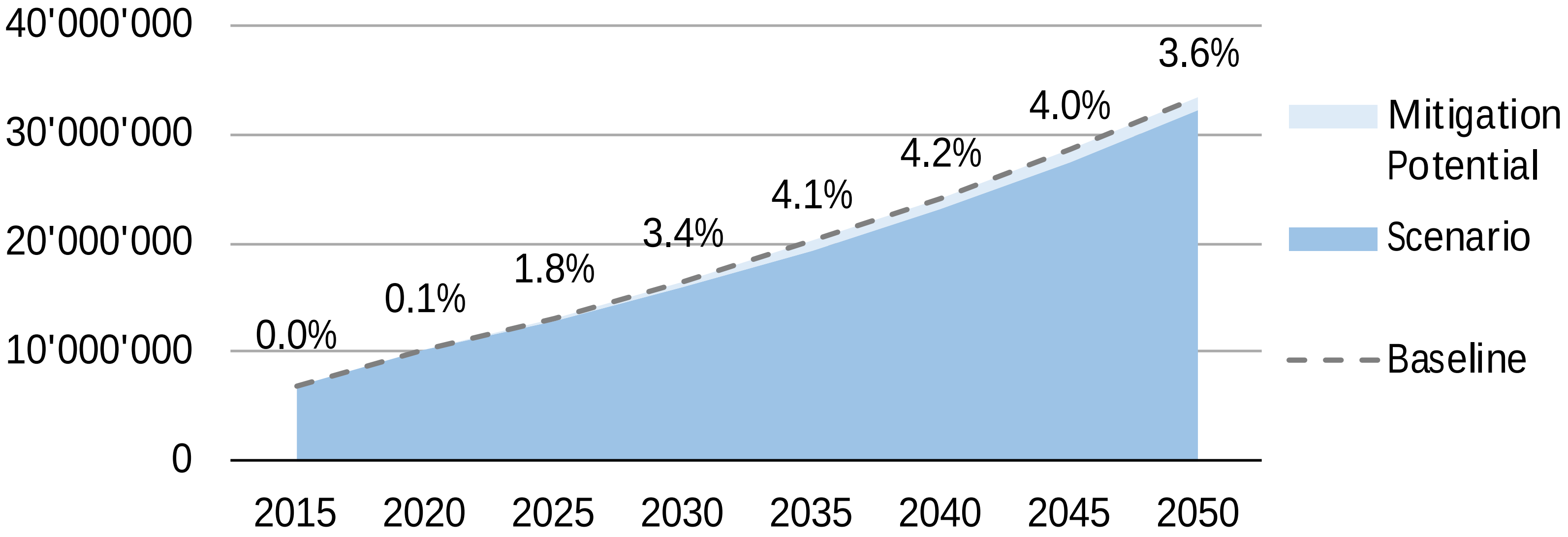




Electrification – mitigation potential Grid emission factor „Basic“

- Compared to total road transportation emissions in Kenya, the cumulated potential for the years 2015-2050 amounts 3.3% with the grid EF „Basic“

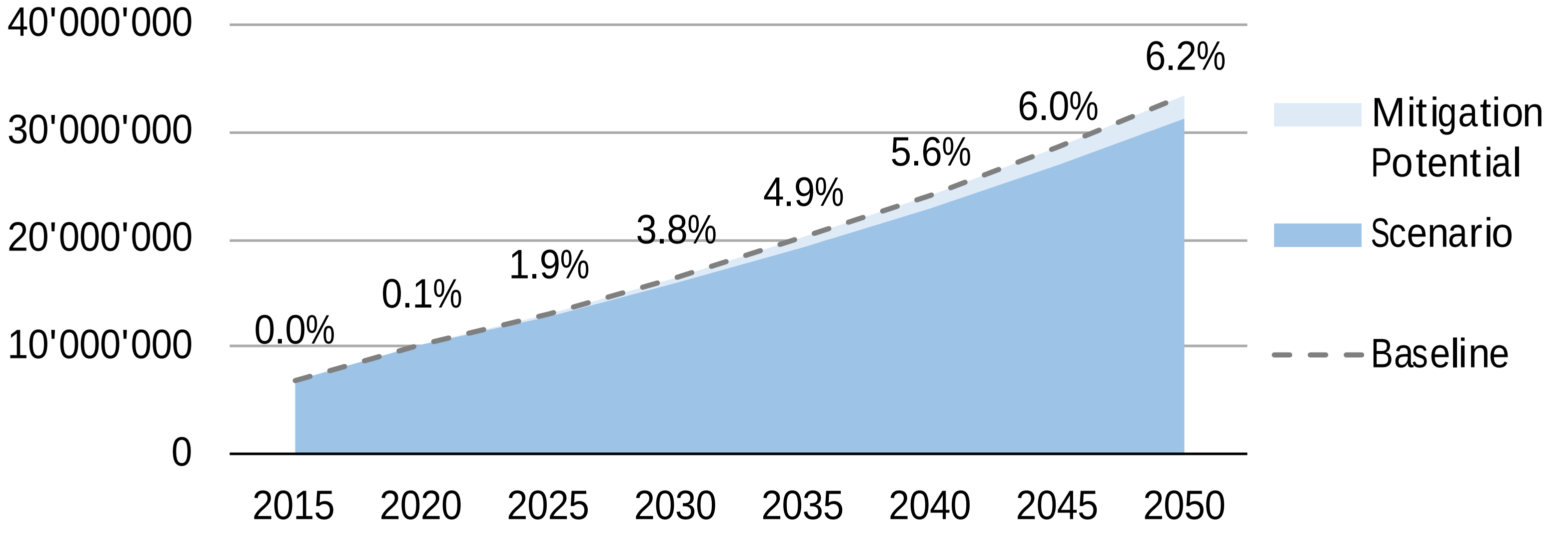
Electrification: total CO_2e emissions (**grid emission factor "Basic"**) [t CO_2e]



Electrification – mitigation potential Grid emission factor „Alternative“

- Second highest mtigation potential with alternative power scenario
- Compared to total road transportation emissions in Kenya, the cumulated potential for the years 2015-2050 amounts 4.5% with the grid EF „Alternative“

Electrification: total CO_2e emissions (**grid emission factor "Alternative"**) [t CO_2e]



Electrification – interpretation

§ Depends a lot on the share of renewables in the electricity mix

à Higher potential when grid emission factor „Alternative“ is applied

§ National perspective does not include all upstream emissions, which is why the potential is higher when the scenario is analysed from the global perspective

Overview of results (national perspective)

Scenario (national perspective)		unit	2015	2020	2025	**2030**	2035	2040	2045	**2050**	**Total (2015-2050)**	**% of total BL**
Shift road rail (grid EF "Basic")	Pot.	kt CO_2e	-	-8	-33	-45	-64	-87	-122	-163	-2'197	-0.3%
	BL	kt CO_2e	1'245	1'658	2'026	2'351	2'643	2'919	3'207	3'498	85'875	
Shift road rail (grid EF "Alternative")	Pot.	kt CO_2e	-	-8	-42	-58	-79	-107	-147	-194	-2'686	-0.4%
	BL	kt CO_2e	1'245	1'658	2'026	2'351	2'643	2'919	3'207	3'498	85'875	
Passenger vehicle efficiency	Pot.	kt CO_2e	-	-117	-154	-159	-171	-188	-210	-235	-5'589	-0.8%
	BL	kt CO_2e	4'080	5'694	6'874	8'225	9'773	11'476	13'295	15'197	324'884	
HGV efficiency	Pot.	kt CO_2e	-233	-417	-691	-914	-1'117	-1'436	-2'054	-2'952	-41'106	-6.2%
	BL	kt CO_2e	2'821	4'561	6'228	8'310	10'433	12'658	15'271	18'214	339'891	
Electrification (grid EF "Basic")	Pot.	kt CO_2e	-	-6	-236	-560	-832	-1'025	-1'149	-1'214	-22'078	-3.3%
	BL	kt CO_2e	6'901	10'255	13'102	16'535	20'206	24'134	28'566	33'411	664'775	
Electrification (grid EF "Alternative")	Pot.	kt CO_2e	-	-6	-255	-629	-982	-1'344	-1'711	-2'072	-29'813	-4.5%
	BL	kt CO_2e	6'901	10'255	13'102	16'535	20'206	24'134	28'566	33'411	664'775	
Total Kenya Road Transportation	BL	kt CO_2e	6'901	10'255	13'102	16'535	20'206	24'134	28'566	33'411	664'775	

Overview of results (global perspective)

Scenario (global perspective)		**unit**	2015	2020	2025	**2030**	2035	2040	2045	**2050**	**Total (2015-2050)**	**% of total BL**
Shift road rail (grid EF "Basic")	Pot.	kt CO_2e	-	-9	-42	-58	-83	-113	-157	-210	-2'838	-0.4%
	BL	kt CO_2e	1'509	2'010	2'456	2'850	3'204	3'540	3'890	4'242	104'125	
Shift road rail (grid EF "Alternative")	Pot.	kt CO_2e	-	-9	-51	-71	-98	-133	-182	-241	-3'327	-0.5%
	BL	kt CO_2e	1'509	2'010	2'456	2'850	3'204	3'540	3'890	4'242	104'125	
Passenger vehicle efficiency	Pot.	kt CO_2e	-	-140	-184	-190	-204	-225	-250	-280	-6'664	-1.0%
	BL	kt CO_2e	4'881	6'811	8'224	9'842	11'697	13'738	15'919	18'199	388'861	
HGV efficiency	Pot.	kt CO_2e	-346	-608	-975	-1'290	-1'585	-2'018	-2'817	-3'958	-57'227	-8.6%
	BL	kt CO_2e	3'423	5'534	7'557	10'084	12'660	15'359	18'530	22'102	412'432	
Electrification (grid EF "Basic")	Pot.	kt CO_2e	-	-7	-285	-687	-1'041	-1'335	-1'573	-1'761	-29'040	-4.4%
	BL	kt CO_2e	8'304	12'346	15'781	19'926	24'357	29'097	34'449	40'301	801'293	
Electrification (grid EF "Alternative")	Pot.	kt CO_2e	-	-7	-303	-756	-1'191	-1'654	-2'134	-2'618	-36'775	-5.5%
	BL	kt CO_2e	8'304	12'346	15'781	19'926	24'357	29'097	34'449	40'301	801'293	
Total Kenya Road Transportation	BL	kt CO_2e	8'304	12'346	15'781	19'926	24'357	29'097	34'449	40'301	801'293	

Conclusions

- Emissions from road transportation in Kenya are expected to strongly increase by 2050.
- Due to the improvement in fuel efficiency in the countries of origin of the imported vehicles, the additional mitigation potential within Kenya is limited if only the import age is reduced from 8 to 5 years.
- The highest potential lies in the efficiency of freight transportation. Second highest in electrification under the alternative grid scenarios with higher shares of renewable energy.
- Mitigation actions need to be considerably strengthened and de-carbonisation of national grid is a requirement to achieve significant emissions reductions through electrification.
- The potential of a mode shift (road to rail) is relatively small under current assumptions.
- Uncertainties in the calculations of the mitigation potentials are rather high.

Further information

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

The full technical report is available from GIZ‘s www.changing-transport.org:

Download the report here!

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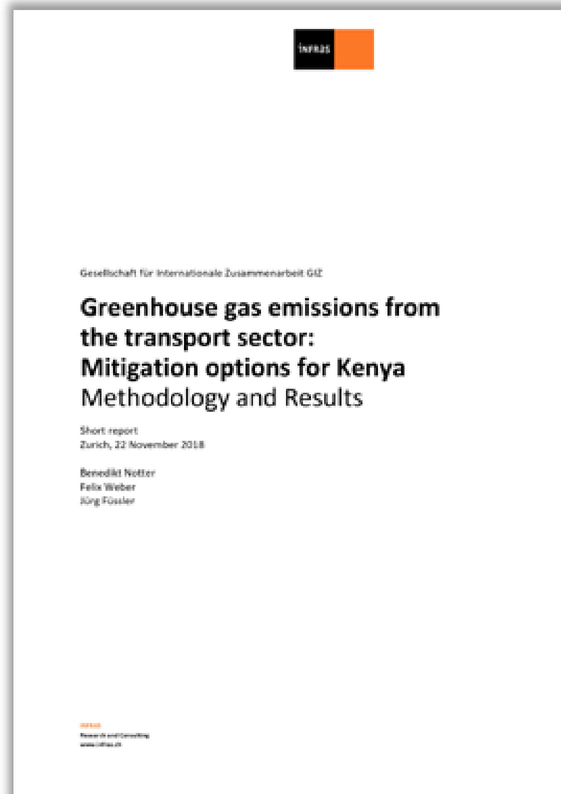
Facilitating climate actions in mobility


Gesellschaft für Internationale Zusammenarbeit GIZ

Greenhouse gas emissions from the transport sector: Mitigation options for Kenya
Methodology and Results

Short report
Zurich, 22 November 2018

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