Modelling urban transports in a city energy system model – Applying TIMES on Malmö

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A climate policy framework &
a climate and clean air strategy for Sweden

1. **A long-term climate goal:** By 2045 - at the latest – Sweden will have no net emissions of greenhouse gases.
2. **Intermediate targets** only for emissions outside the EU Emissions Trading System (known as the non-trading sector/NETS).
   - **NETS** targets for year 2030 and 2040.
   - **Transport sector** targets for year 2030 (70% reduction).
3. **A clean air strategy** with a focus on reducing air pollutants (NOX, SO2, VOC, NH4 and particles) and thereby improved air quality.

SURECITY

Modelling Sustainable and Resource Efficient Cities

AIM: Support smart city level integration of policies and measures towards a low carbon energy system including mobility services

Part delivery: A generic TIMES-City model

- EU ERA-NET project, 2016-2018
- Partners in Austria, Portugal and Sweden

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ivl

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

3DRIVERS

ENERGIEAGENTUR Steiermark

CENSE center for environmental and sustainability research

PhD PROJECT

TIMES-Sweden

AIM: To improve transport sector representation within and around TIMES

- Identifying how the Swedish transport sector could be sufficiently described in an energy system optimisation model with the overall aim to improve the analysis of the transition to a Net-Zero GHG in Sweden.
- Consider both recourse, technical, economic, environmental and behavioural (e.g. choice of transport mode) factors
- NOT necessary include everything in TIMES, i.e. consider developing complementary methods/models

Modelling urban transports in a city energy system model – Applying TIMES on Malmö

- What is the system CHARACTERISTICS?
- What can we LEARN from Transport models?
- Which DEMAND should DRIVE the model?
- An illustrative results

Ongoing Study

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SYSTEM CHARACTERISTICS & MANAGEMENT

- Urban transport characteristics:
  - High frequency of movements
  - Low average speeds
  - Short distances
- Urban built environment creates lock-in patterns; affects energy-use for decades

- Mobility is key to the functioning of all cities
- Needs of local policy-makers:
  - Explore and analyse different long-term targets and policies, to…
  - …identify cost-efficient actions for improving overall system efficiency

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SYSTEM CHARACTERISTICS & GOALS

Cities account for

- 2/3 of global final energy use
- 75% of **GHG emissions**

+ **Air pollution** are a pressing problem in many cities; affects health, natural and built environments

Urban transportation is a major source of local and global emissions

- > 20-40% of urban GHGs
- Leading local contributor to e.g. NO_X, PM, CO

EU level initiatives targeting city-level

- Urban Mobility Package, SUMP
- Covenant of Mayors, SECAP
- Air Quality Directive (2008/50/EC)

Complex policy landscape

- Mobility of people and goods
- Energy system management
- Health and environment

AIM & APPROACH

Aim: Investigate the impact on cost-efficient low-carbon options for urban transportation when also considering ambitious air quality targets

Philosophy: Mathematical models powerful tools for ’mental experiments’ on complex systems development over longer time perspectives

- ✓ Based on the TIMES framework
- ✓ Differ between activities ‘in control’ by the municipality and activities not in control by the municipality.
- ✓ **Transportation, Residential & Commercial buildings,** Industry, Agriculture, Electricity & DH and Energy supply.

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TRANSPORTS – ENERGY

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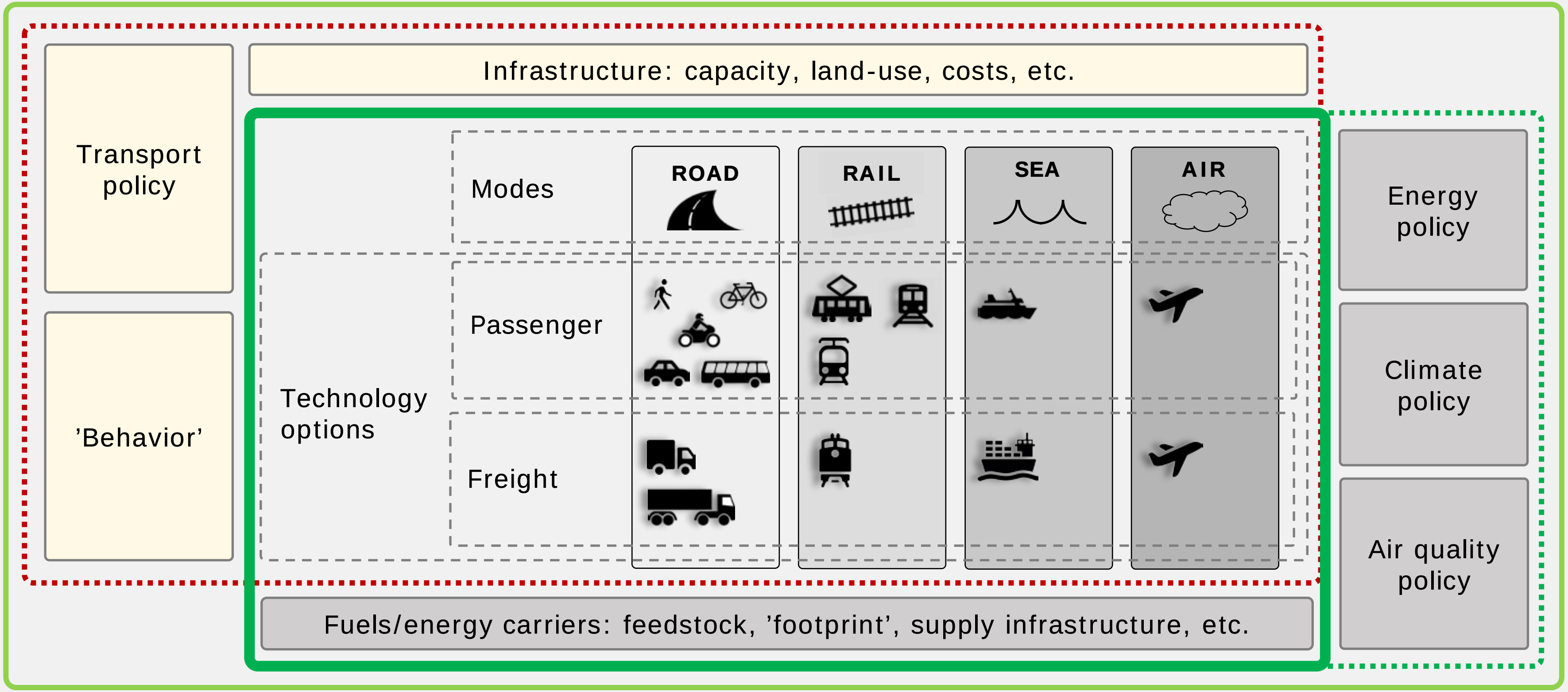
What is the Transport System?



WHAT CAN WE LEARN FROM OTHER MODELS

TRANSPORT MODELS

Modal split important determining factor for both energy-use and emissions

→ **Trip purposes** and **commodity group characteristics** important factors for frequency and mode choice of transportation

Typical base-year calibration:

- Travel surveys → passenger transportation disaggregated by trip purpose
- Goods flow surveys → freight transportation disaggregated by commodity groups

ESOM

Disaggregating transport demand input to ESOMs can improve

– Representation of different choices/ behaviour
– Understanding of mode shift potentials
– The ability to test effects of specific mode shift measures (targeting e.g. all commuting car-trips)

Drawbacks?

Further data and under-standing of the transportation system is needed

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→ TRANSPORT SECTOR IN TIMES-CITY

- Passenger & Freight
- All conventional modes and technologies, with addition of:
  - ’No physical travel’ (e-meetings etc)
  - Walking
  - Bicycle (conventional + electric)
  - Light electric vehicles (pass, freight)
  - Taxi
  - Car-pools
  - Public transport city ferry
- Conventional and emerging drivetrain and fuel options

Demand disaggregated by:

1) Mode
2) City organisation/Other
3) Intra-city/Long-distance

Mode shares exogenously determined, but… Input demands derived from ’scenario generator’ using **trip purpose** and **commodity groups**
→ indirect representation of behaviour/choices

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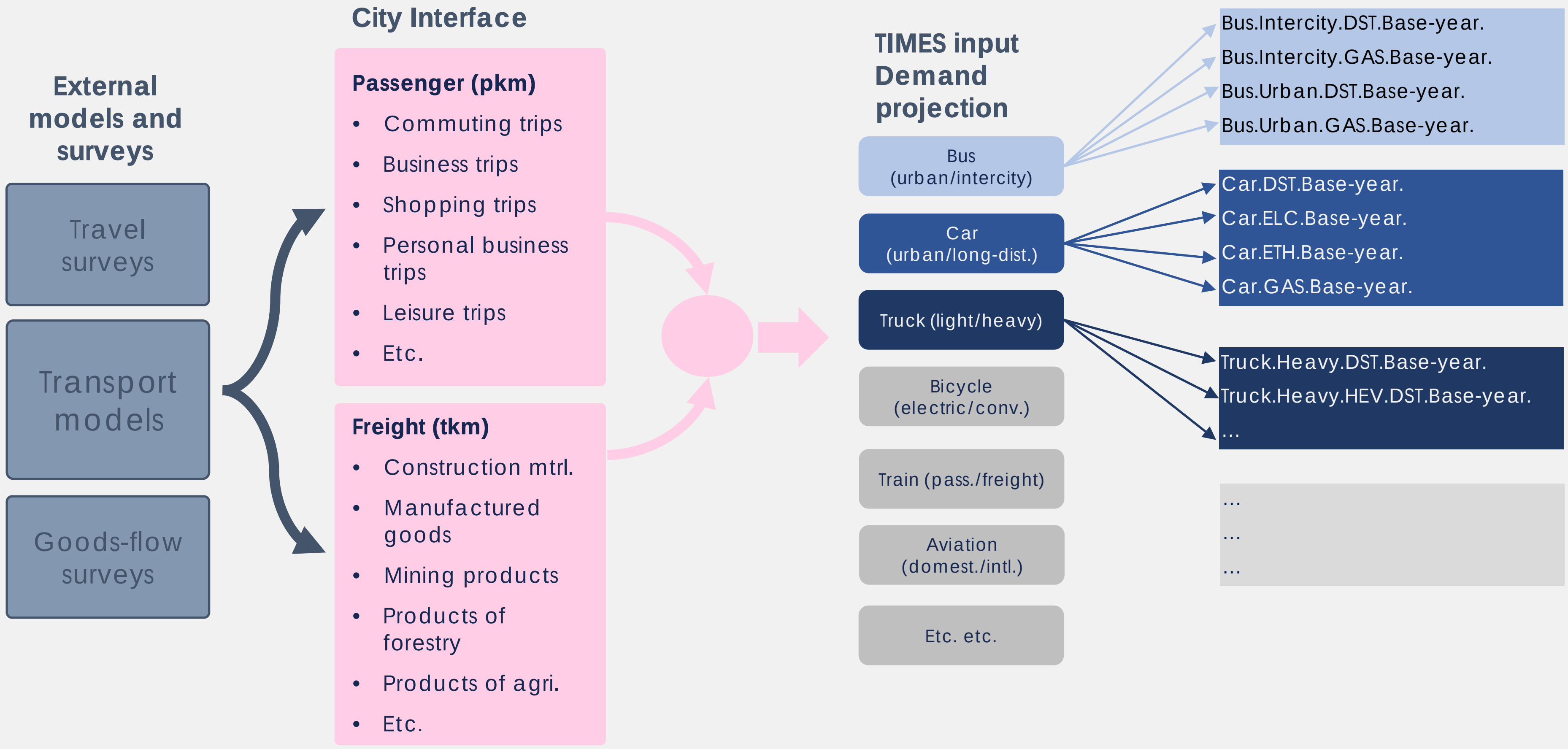
Generating Data Input



Transport demand

Passenger

- Official statistics on vehicles:
  - Driving range
- Base-year demand derived from travel survey (2014)
  - All trips by city residents within and to/from Malmö
  - Work, education, business, shopping, personal business, leisure, other
  - By mode and distance
- Future demand driven by population growth (SCB)

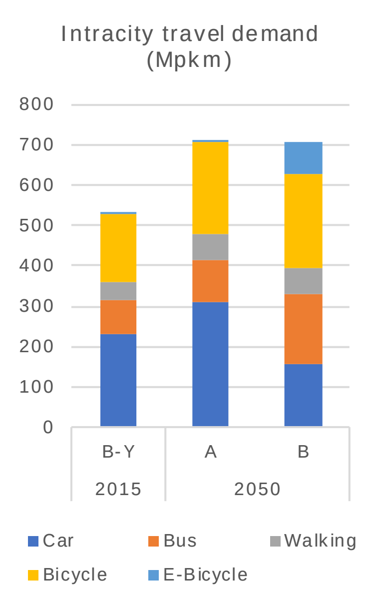
Freight

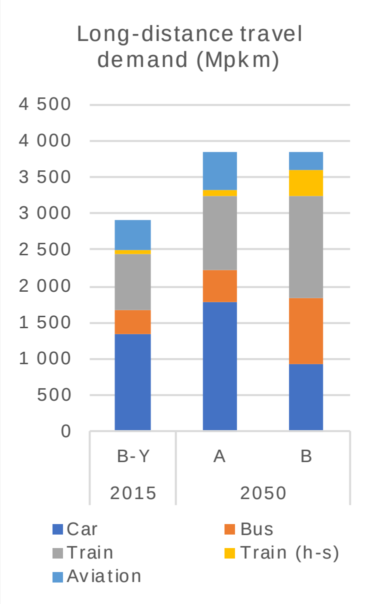
- Official statistics on vehicles:
  - Driving range
- No quantifiable base-year data → Alternative approach:
  - National 'Material footprint' approach determine freight demand (ton of goods per capita and GDP) * Malmö population
  - Intra-city freight: 100% by road
  - Long-distance freight: mode shares, distance by commodity groups based on national statistics
- Future demand driven by population growth (SCB) and GDP/capita (OECD)

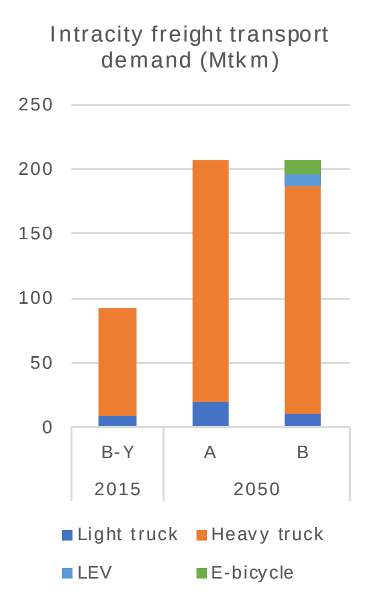
Mode share assumption
→ Generate Demand projections

Sub-sector	Technology	Base-year	REF_A: 2050	REF_B: 2050
Passenger – IntraCity	Walking	9%	9%	9%
	Bicycle	32%	32%	33%
	Bicycle (electric)	<0.5%	<0.5%	11%
	Bus	15%	15%	24%
	Car	44%	44%	22%
Passenger – LongDistance	Bus	12%	12%	24%
	Car	46%	46%	24%
	Train	26%	26%	36%
	Train (high-speed)	2%	2%	9%
	Aviation	14%	14%	7%
Freight – IntraCity	Bicycle (electric)	0%	0%	5%
	Light electric vehicle (LEV)	0%	0%	5%
	Truck, light	10%	10%	5%
	Truck, heavy	90%	90%	85%
Freight – LongDistance	Truck, light	0%	0%	0%
	Truck, heavy	63%	63%	63%
	Train	26%	26%	26%
	Navigation	11%	11%	11%

Mode share assumption
→ Demand projections







MODELLING LOW-EMISSION SCENARIOS

CO2

- Explore cost-efficient low-carbon pathways
- Mitigation targets based on Swedish national policy:
  - -70% CO_2 in 2030
  - -95% CO_2 in 2050
- Model generated CO_2 emission level for 2015 used as baseline

Air quality

- Explore cost-efficient low-pollution pathways (NO_X, PM, CO)
- Mitigation targets based on own assumptions:
- Model generated emission levels for 2015 used as baseline

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ILLUSTRATING SCENARIOS

No Target	Climate Target
Air quality Target	Climate & Air quality Target

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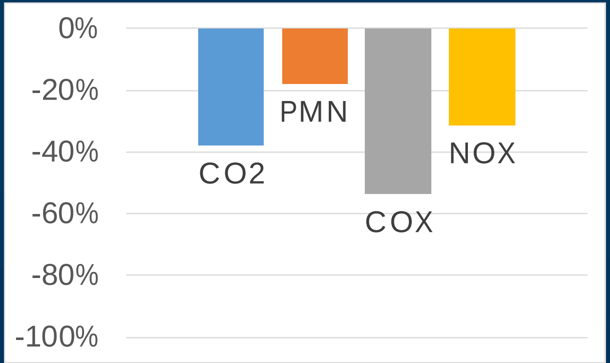
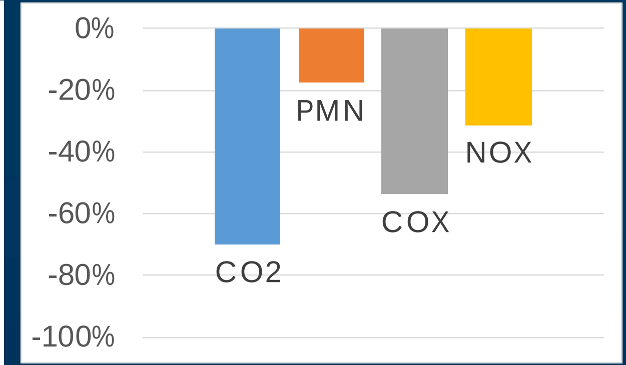
ILLUSTRATING RESULTS

No Target





Climate Target

Air quality Target

Climate & Air quality Target

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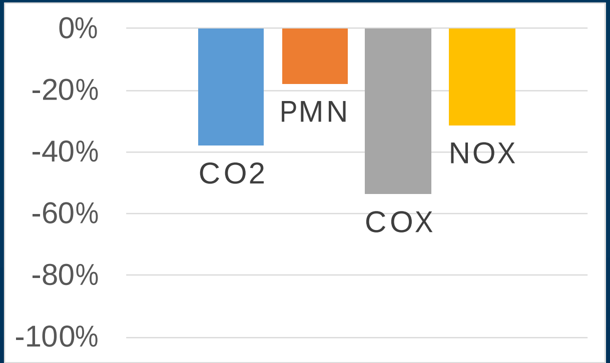
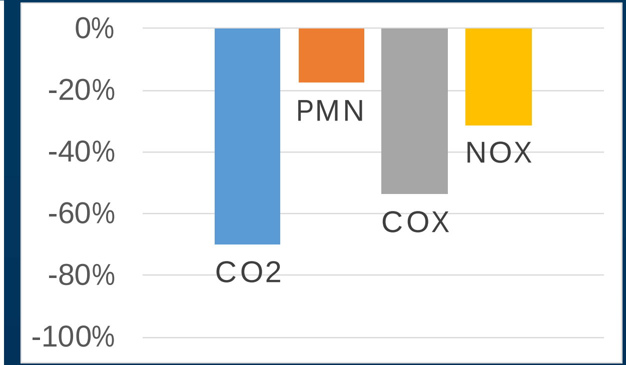
ILLUSTRATING RESULTS

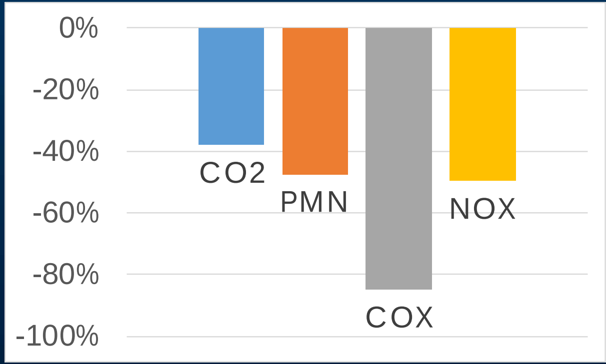
No Target



Climate Target



Air quality Target (NOX)



Climate & Air quality Target

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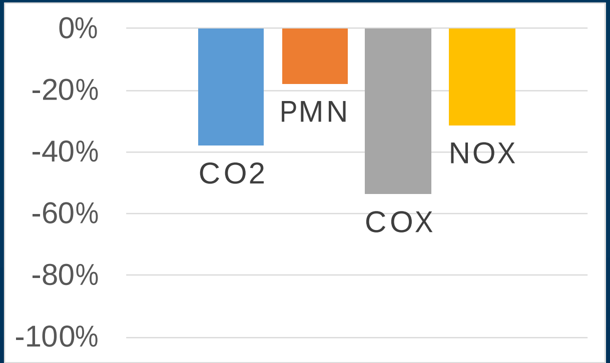
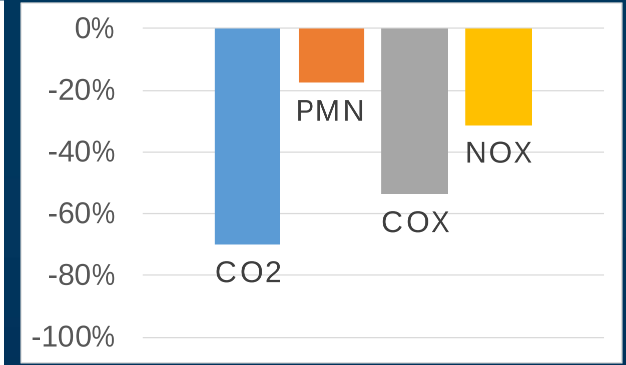
ILLUSTRATING RESULTS

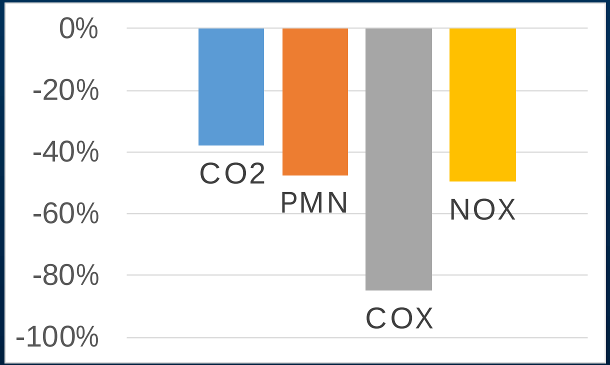
No
Target



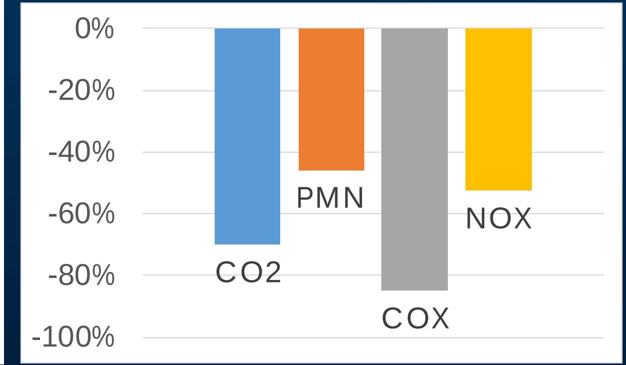
Climate
Target



Air quality
Target
(NOX)



Climate &
NOX
Target



FINAL REMARKS

When developing a city model: Important to consider what the municipality can impact directly, indirect or not at all.

By adding a City-interface (generates the demand inputs)

→ The underlying assumptions behind becomes 'visible', and

→ easier communicated with the city/municipality

There are not necessary co-benefits between CO_2 and Air quality target → important to also optimize for both!

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