The TOSCA Project

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UNIVERSITY OF CAMBRIDGE

TOSCA

COOPERATION

TOSCA Project

- Aims to identify promising **technology and fuel combinations** to reduce the climate impact of EU transport to 2050
- 18-month EU FP7-funded project
- Each component of the project subject to stakeholder review via workshops and questionnaires

http://www.toscaproject.org

UNIVERSITY OF CAMBRIDGE

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

PAUL SCHERRER INSTITUT
PSI

ECORYS Research and Consulting
80 YEARS

KTH VETENSKAP OCH KONST

DBFZ

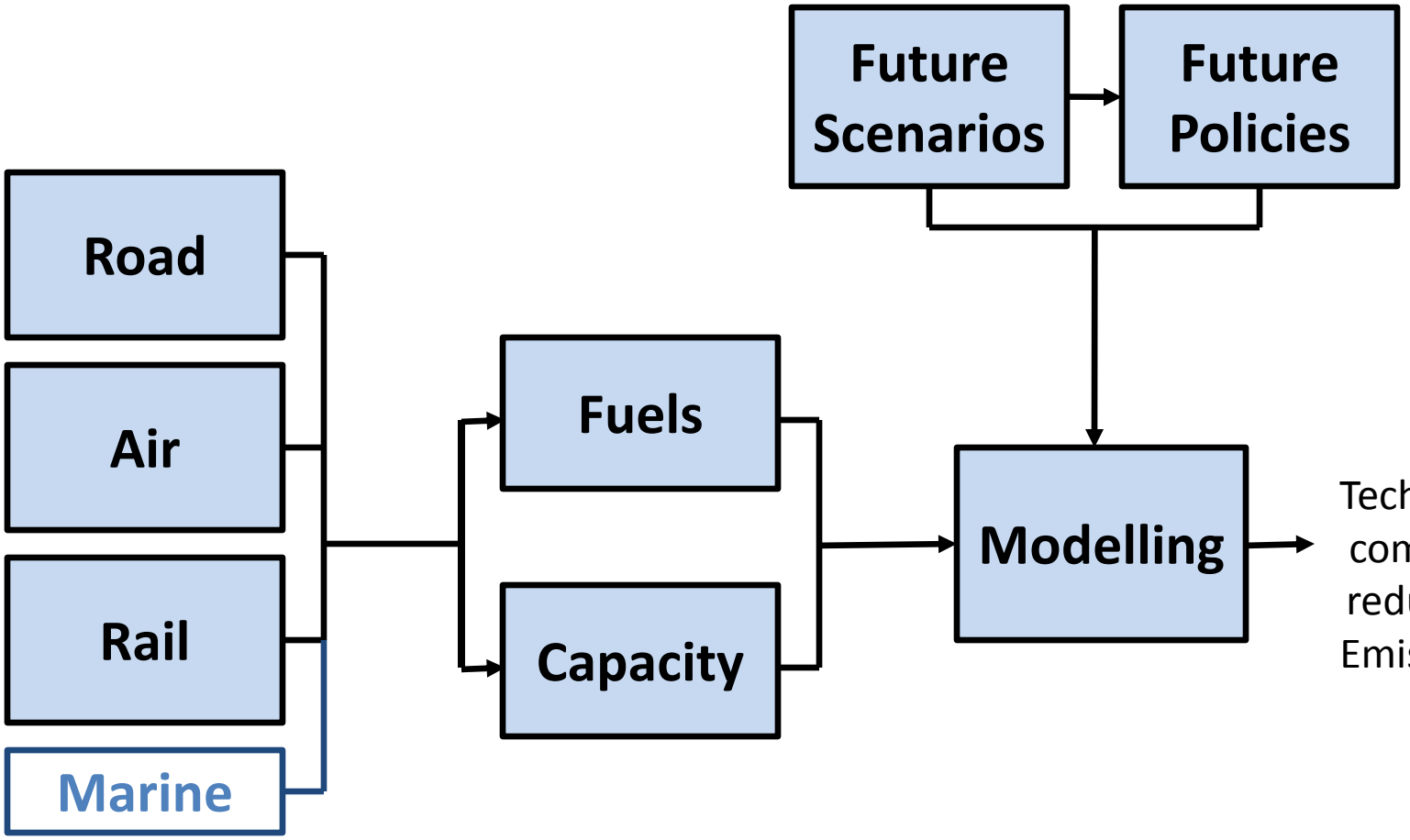
TOSCA

COOPERATION

TOSCA Project

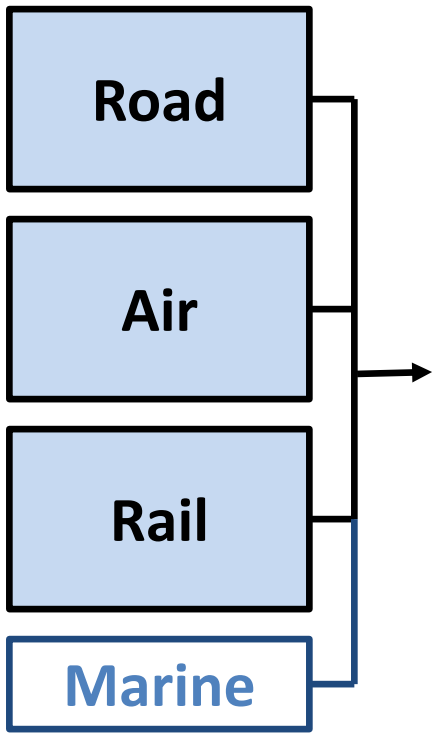
- Two main phases:
  - Estimate current and future technology characteristics to 2050
    - Energy use and emissions
    - Costs
    - Practical constraints (user acceptability, scalability, ...)
  - Model how/whether these technologies would enter future EU vehicle fleet
    - Affected by future scenarios and policies
    - May impact on demand or cause modal shift
    - Result is total transport CO_2 emissions by scenario/policy

TOSCA: Structure



Phase 1

- Estimate characteristics of new technologies by mode to 2050
  - Fuel use, emissions, costs, year of technology readiness, R&D requirements, impact on acceptability metrics (e.g. noise, job creation)
- Experts disagree on exact values
  - Include uncertainty in TOSCA estimates
  - WPs estimate 95% uncertainty ranges
  - Explore distribution using expert questionnaires
  - Propagate through modelling process



Key Technologies

Rail Freight
Low drag
Low mass
Energy recovery
Heavy freight
Eco-driving

Rail Passenger
Low drag
Low mass
Energy recovery
Space efficiency
Eco-driving

Road Passenger
Hybrid EV
Plug-in hybrid EV
Battery EV
Fuel cell hybrid EV

Road Freight
Hybrid electric LDT
Fuel cell hybrid electric LDT
Resistance reduction HDT
Idling reduction HDT

Capacity
AHS (Road passenger)
CVO (Road Freight)
SESAR (Air)
ERTMS/ETCS Level 3 (Rail)
Heavier/faster freight trains

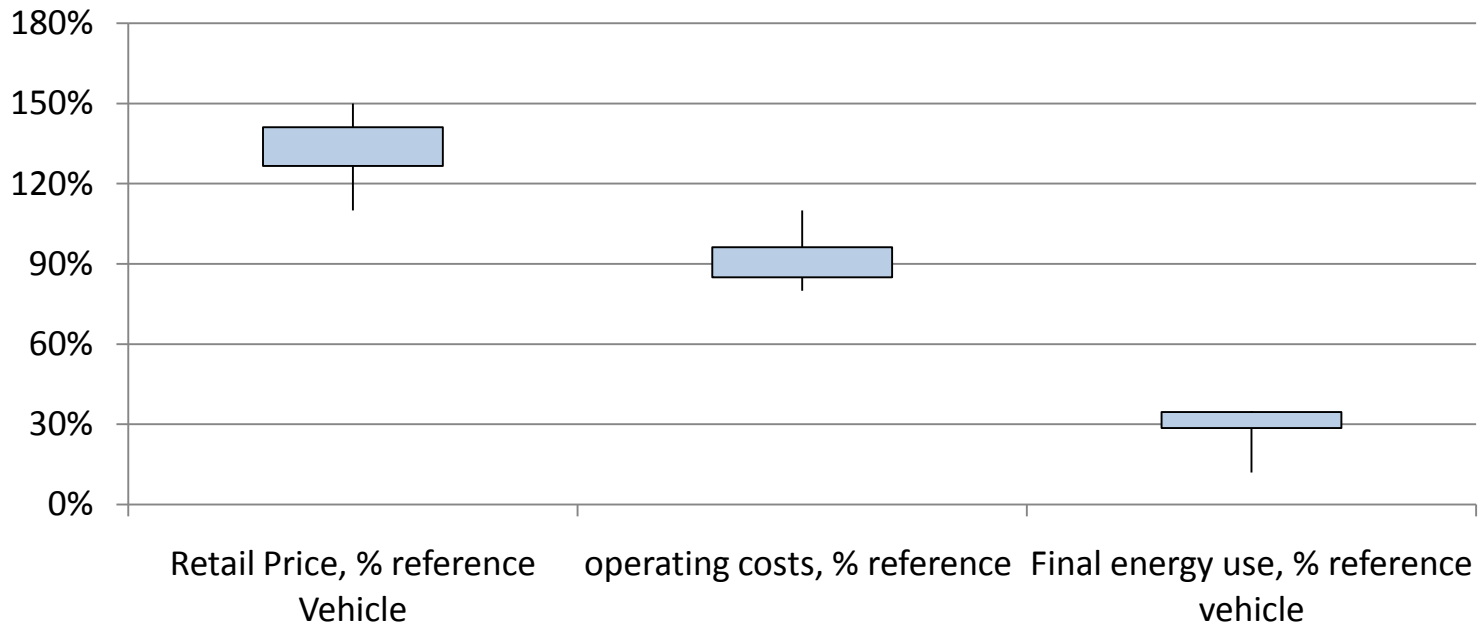
Fuels
Bioethanol (wood)
BTL (wood)
CNG
HVO
Hydrogen (NG, wood)

Air Passenger/Freight
Composite narrowbody
Fast open rotor
Reduced-speed open rotor
Turboprop replacement

Marine Freight
Air Cavity System
Engine Energy recovery
Propeller design optimization

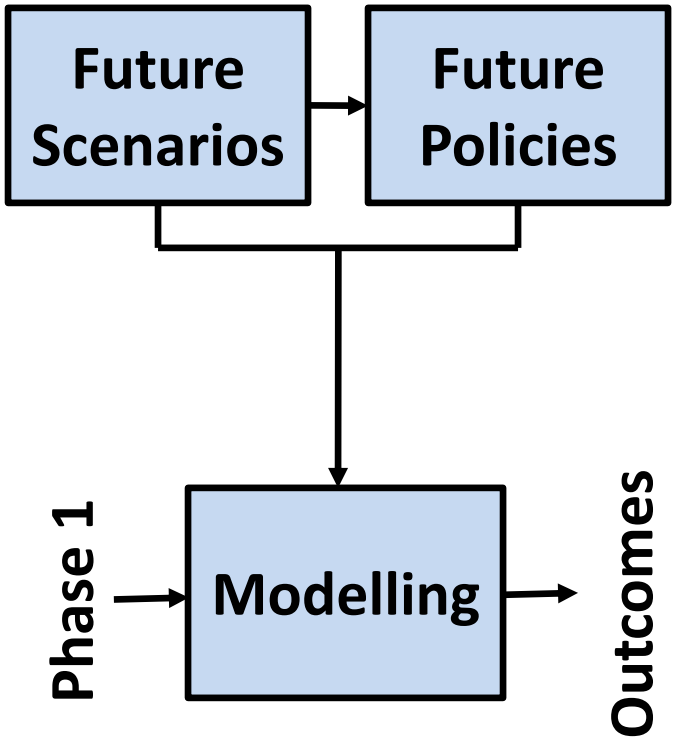
Sample Results – Expert Questionnaires

- Expert opinions on costs, energy, emissions, externalities etc. were collected for all new technologies studied in all modes
- E.g. Battery electric characteristics in 2020 compared to reference passenger car (N > 20):



Phase 2

- Model what effect on emissions these technologies would have to 2050
- How?
  - Scenarios for exogenous variables (e.g. GDP) covering a range or possible futures
  - Model transport demand in these scenarios (Transtools, AIM)
  - Model technology uptake based on stock models, estimated costs, policy variables (TREMOVE, AIM)
  - Elasticity model for changes in demand due to technology or policy (SUMMA)
  - Emissions from TOSCA technology and fuel characteristics



Scenarios

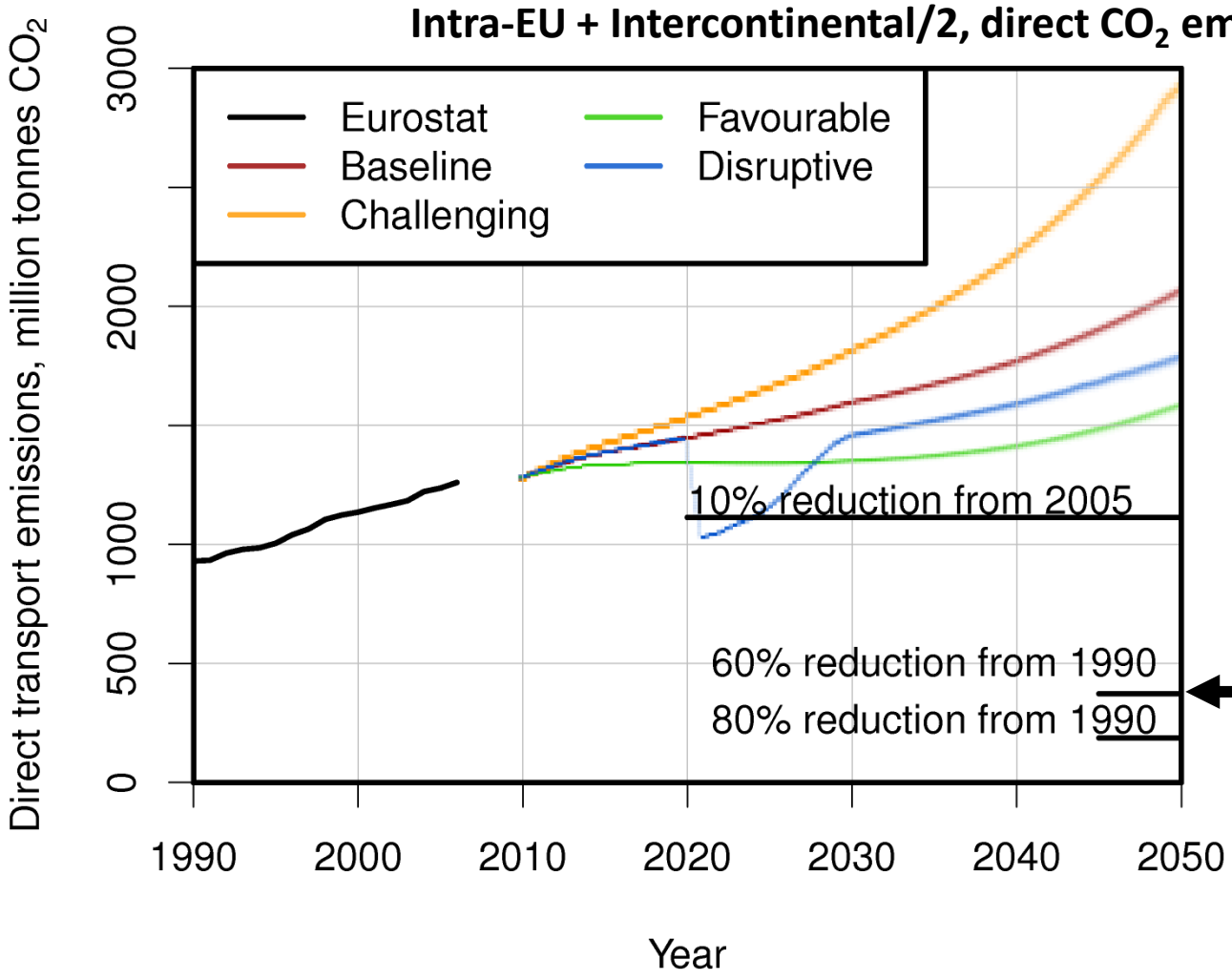
- Three scenarios for exogenous variables:
  - **Baseline**: current trends continue
  - **Challenging**: high demand and emissions likely
  - **Favourable**: low demand and emissions likely
- Plus a sensitivity case – baseline + disruptive event / oil shock in 2020

Scenario	Change in EU27 GDP (%/year)	Oil Price in 2050 (€(2009)/bbl)	Change in CO2 intensity of electricity generation (%/year)
BASELINE	+1.7	113	-1.7
CHALLENGING	+2.5	54	-0.5
FAVOURABLE	+0.7	144	-3.0

Carbon accounting

- Results depend strongly on scope:
  - Intra-EU or intra-EU + intercontinental?
  - Direct, fuel lifecycle, vehicle lifecycle?
  - How are biofuels dealt with?
    - Potential for double-counting
- However, broad outcomes relatively consistent

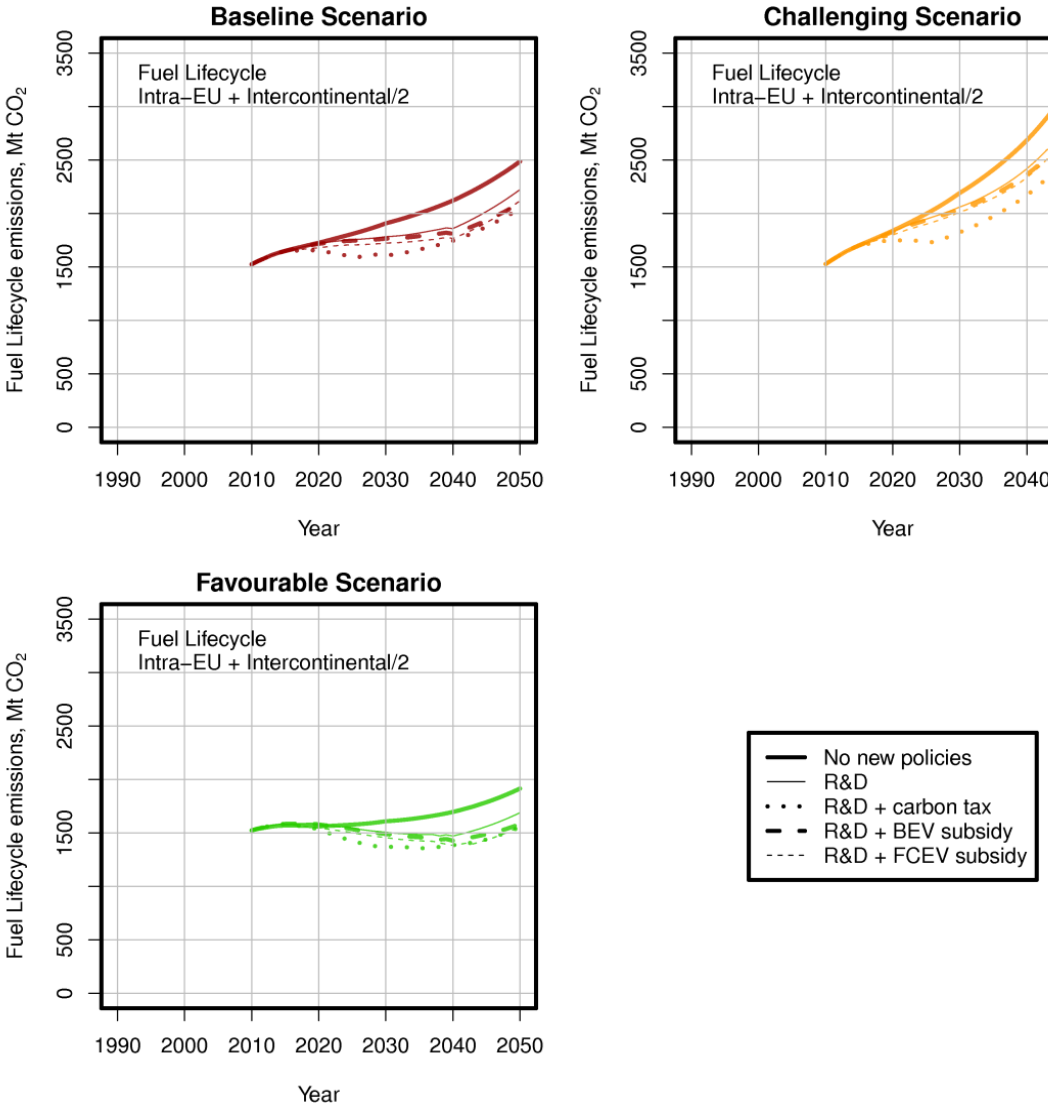
No new policies vs. emissions targets



Recommended by 2011 transport white paper

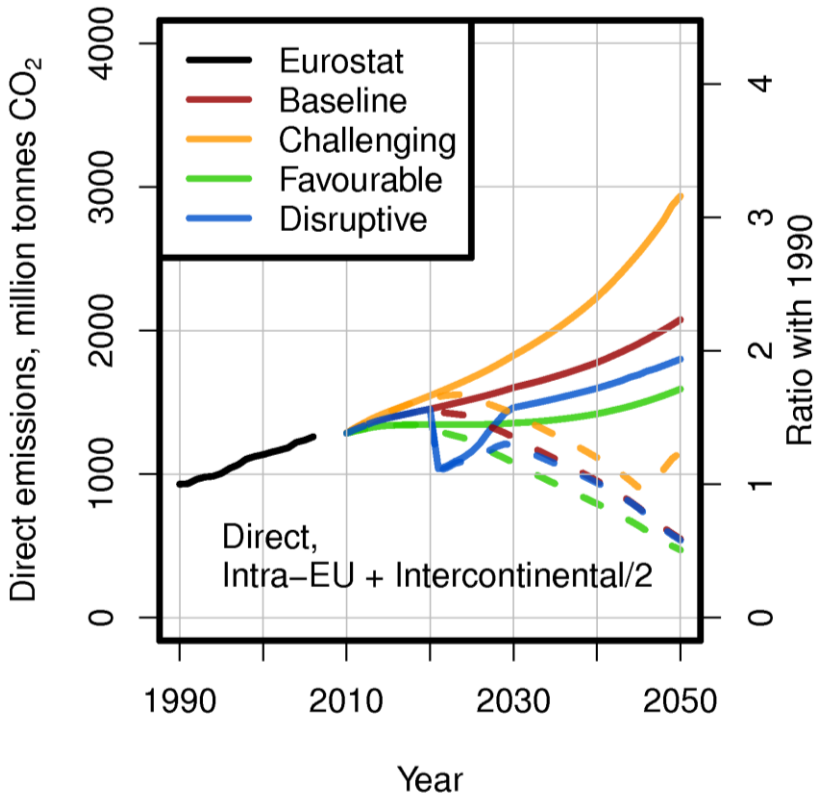
Selected Policies

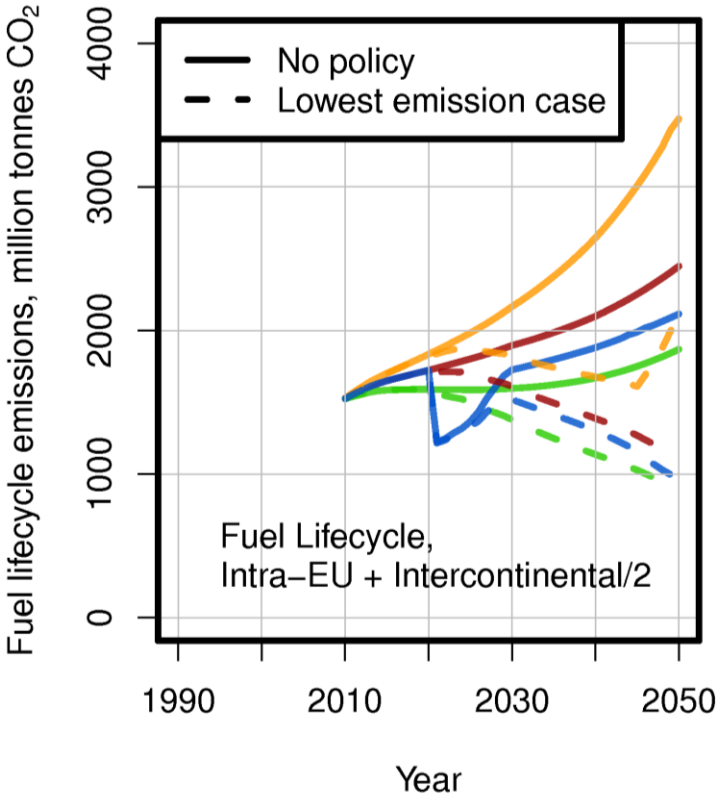
- R&D support
- €100/tCO_2 carbon tax
- €3000/vehicle purchase subsidy
- Effects on total lifecycle emissions typically 10-20%
- Technology adoption limited



What happens if you use ALL the technology?

- Assume policies sufficient for high adoption rates
  - Direct cost excluding R&D >2% of EU27 GDP
  - Biofuel supply limitations – need non-EU imports





Conclusions

- Without new policy intervention, EU transport sector CO_2 will continue to rise
- Promising technologies and fuel options exist, but they have significant extra costs
- Even with these technologies, meeting suggested EU year-2050 emissions goals is hard
  - Theoretically still possible if considering intra-EU transport, strong policy support, global biofuel supply, low demand growth
  - More likely: behavioural change needed

Some recommendations and comments

- Behavioural change is important – further study is needed!
- Total energy system approach desirable
  - Many parts of the solution outside transport sector
  - E.g. Biofuel supply, electricity generation
- Intercontinental aviation is important – high growth, limited mitigation options
- Large-scale technological change may require governments prioritising climate change over other needs