IIASA

PBL Netherlands Environmental Assessment Agency

Representation of heterogeneity and consumer behavior in the transport sector

Stylized or Explicit?

O. Y. Edelenbosch, D. McCollum

Non cost barriers in consumer choice

- Adoption of new vehicle technologies rely on consumer purchases
- Energy efficiency research shows that consumers do not purchase energy-efficient technologies based solely on a cost-effectiveness criterion (Mundaca et al. 2010)
- And that choices are heterogeneous as considerations are different for consumers

→ Non Cost Barriers for different types of consumers are captured in the MA^{3}T disutility dataset

Key question

- Most Integrated Assessment Models (IAMs) represent investment decisions in technology as done by a homogeneous and 'unboundedly rational' end user
- How to represent in our models influences on vehicle choices beyond costs and prices.
  - Can we use a simple model to represent this complex issue? (given scope of IAMs, data quality)

Outline Research

1. Implement non monetary factors (disutility costs) disaggregated over consumer 27 groups implemented in IMAGE

Does adding the consumer groups lead to more heterogeneity?

2. Parameterize the multinomial equation in IMAGE vehicle choice model

Can this heterogeneity be approximated or parameterized in a simpler, more stylized way?

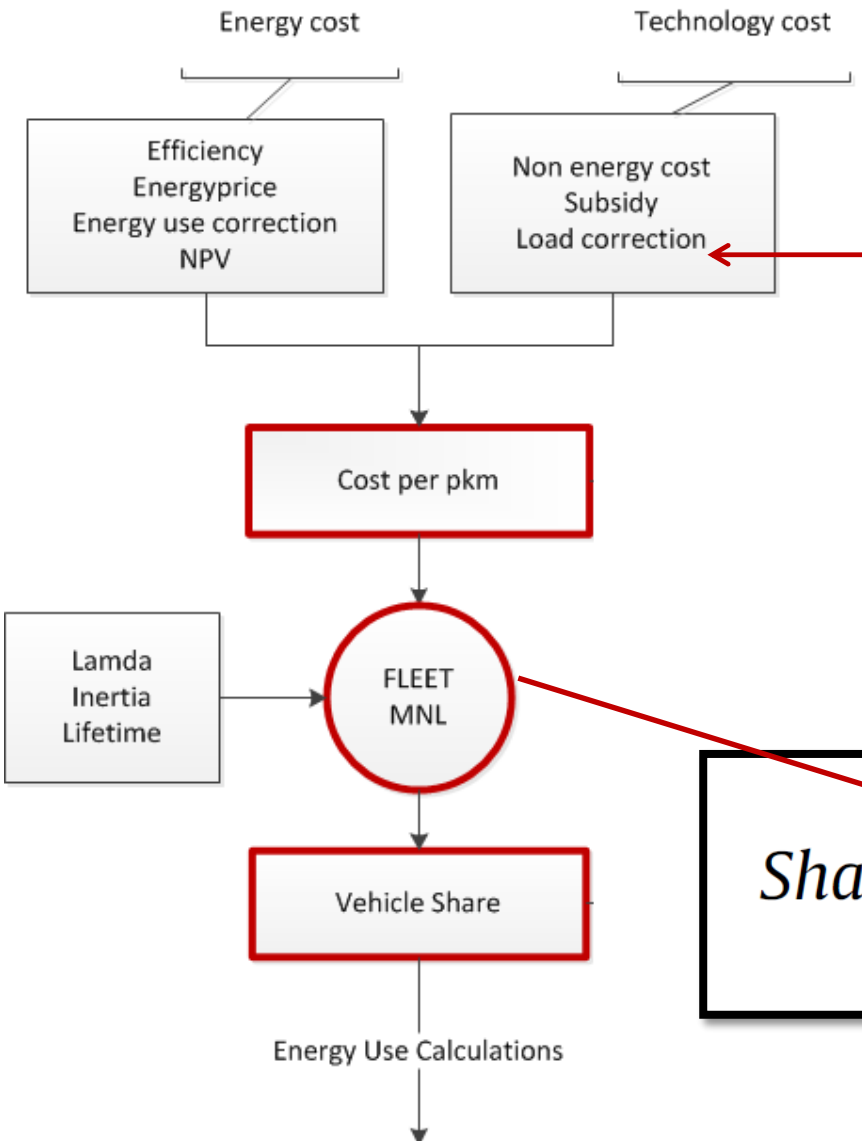
IMAGE transport

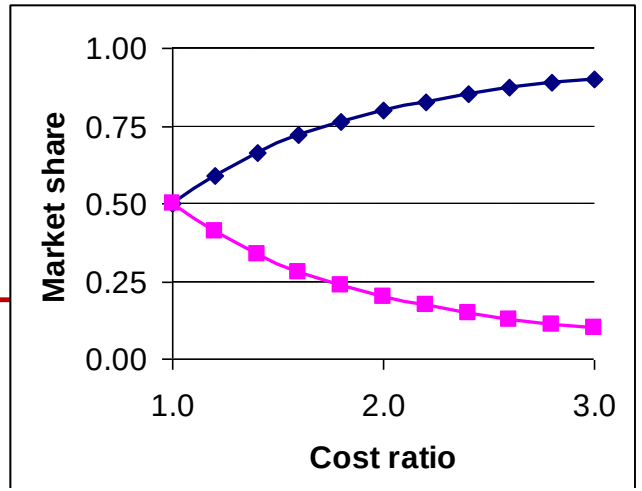
- Transport activity is related to population, income, mode costs, speed
- Techno-economic parameter for each technology are exogenously assumed.
- Technologies compete with each other based cost per passenger km
- Technologies modelled are ICE, HEV, PHEV, Fuel Cell, EV

Focus Research:

- Vehicle choice in passenger road transport (cars)

Vehicle choice model



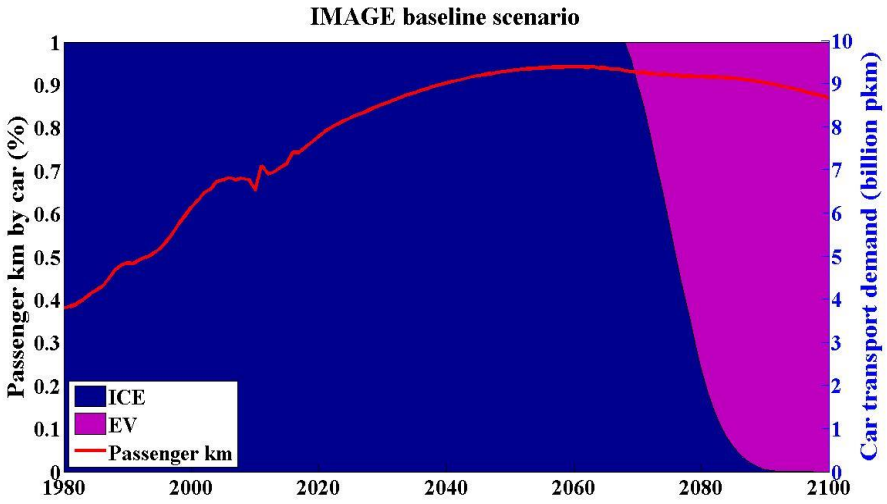


λ = high → full optimisation
λ = 0 → indifferent
λ = low → heterogeneity

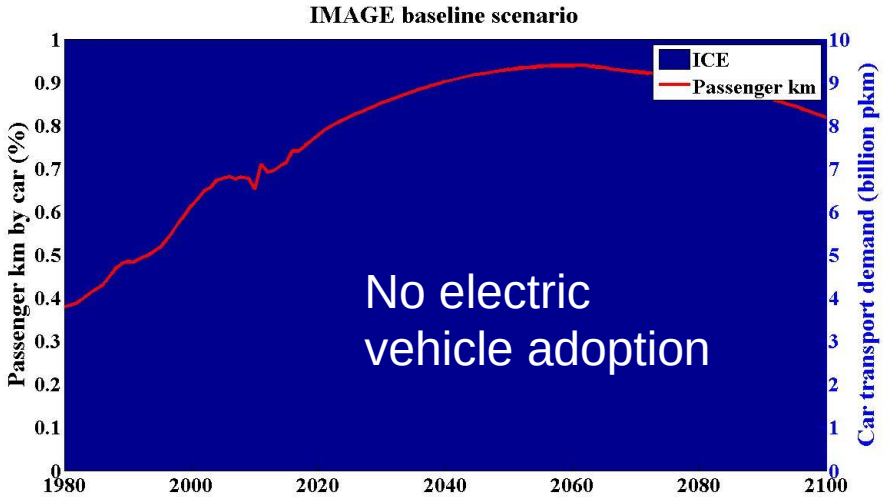
$$Share_{i,t} = \frac{\exp(\lambda \times \text{Cost}_{i,t})}{\sum_i \exp(\lambda \times \text{Cost}_{i,t})}$$

Scenario results US - baseline

27 consumers



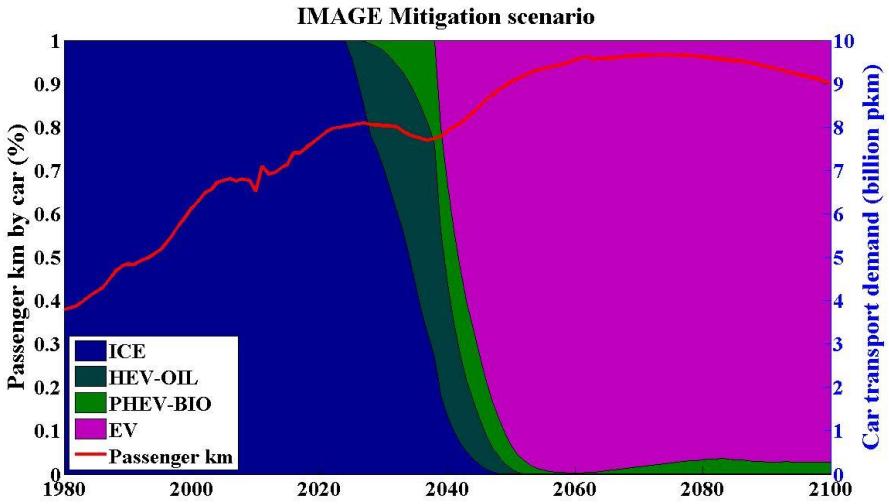
Without disutility cost



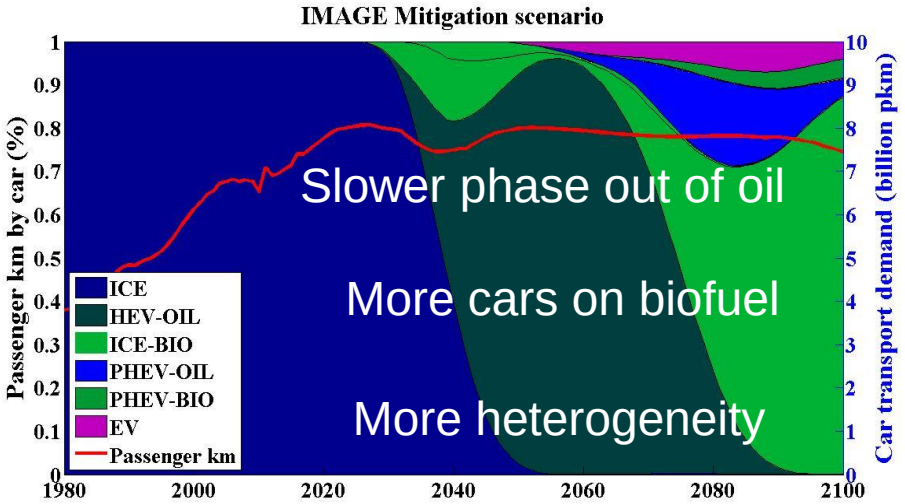
With disutility cost

Scenario results US - mitigation

27 consumers



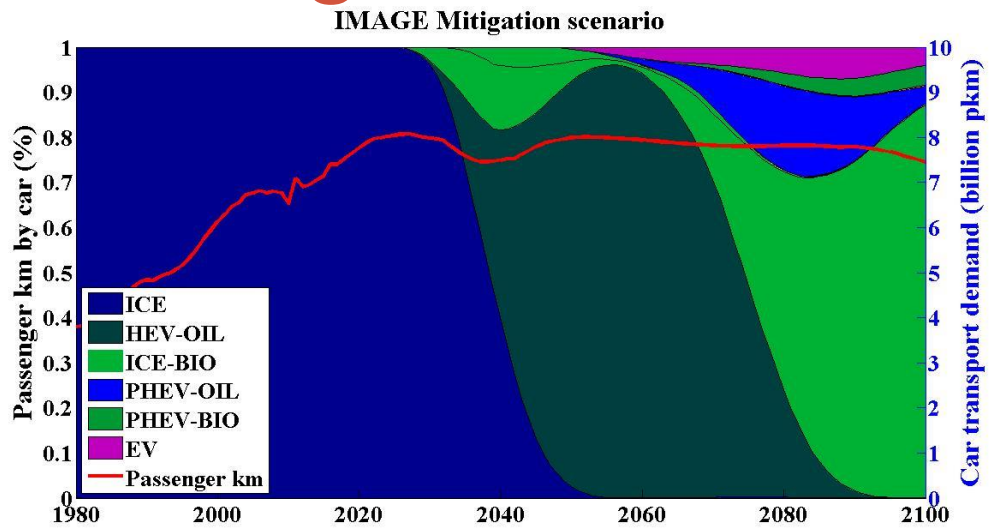
Without disutility cost



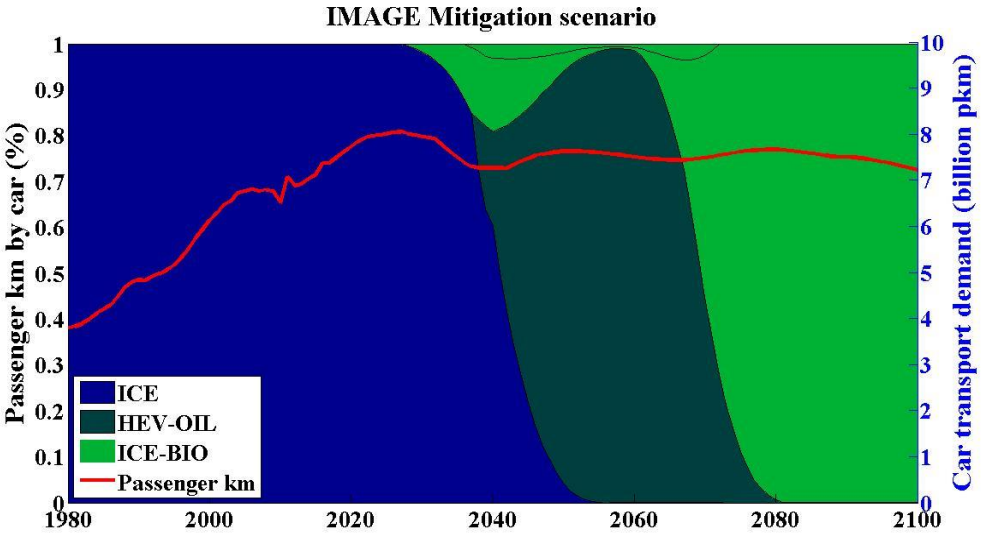
With disutility cost

Parameterizing the MNL

27 groups

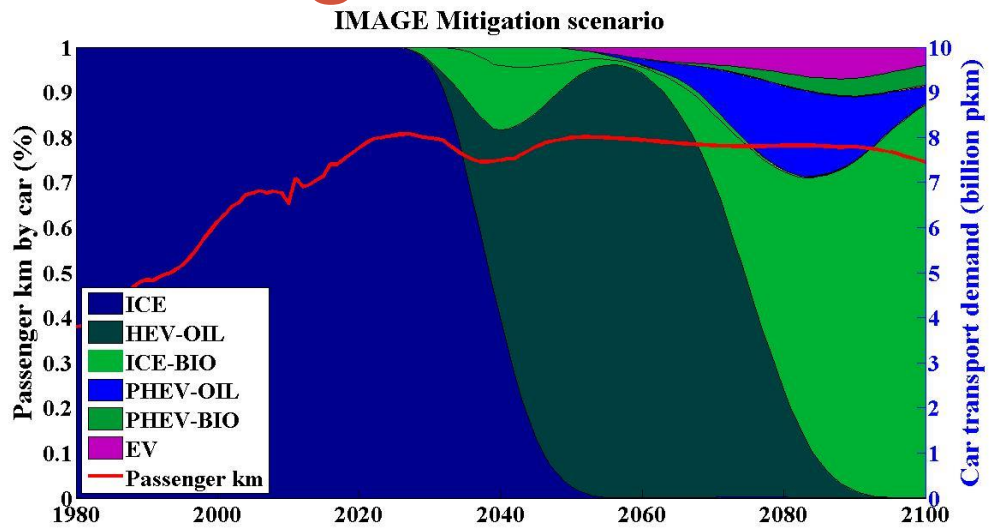


1 group
λ = 100

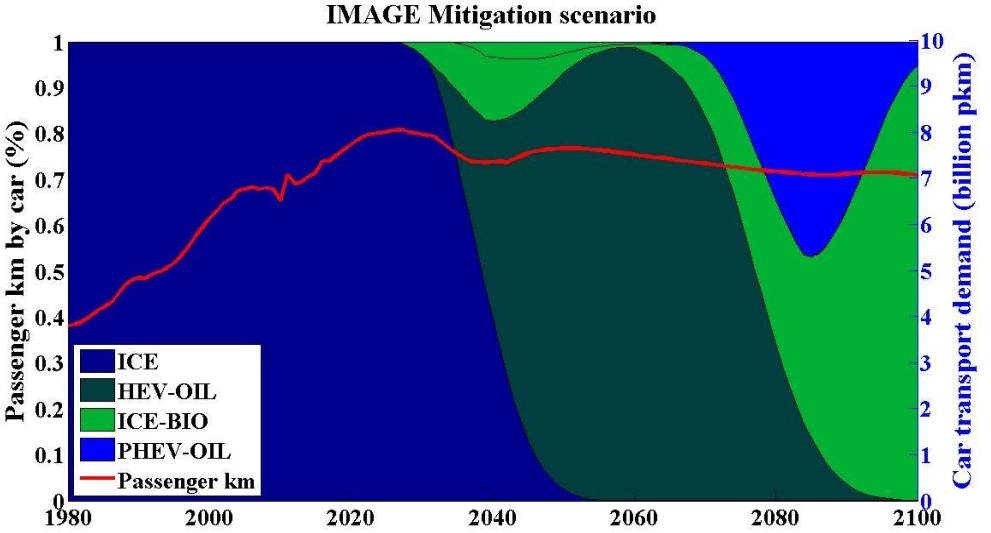


Parameterizing the MNL

27 groups

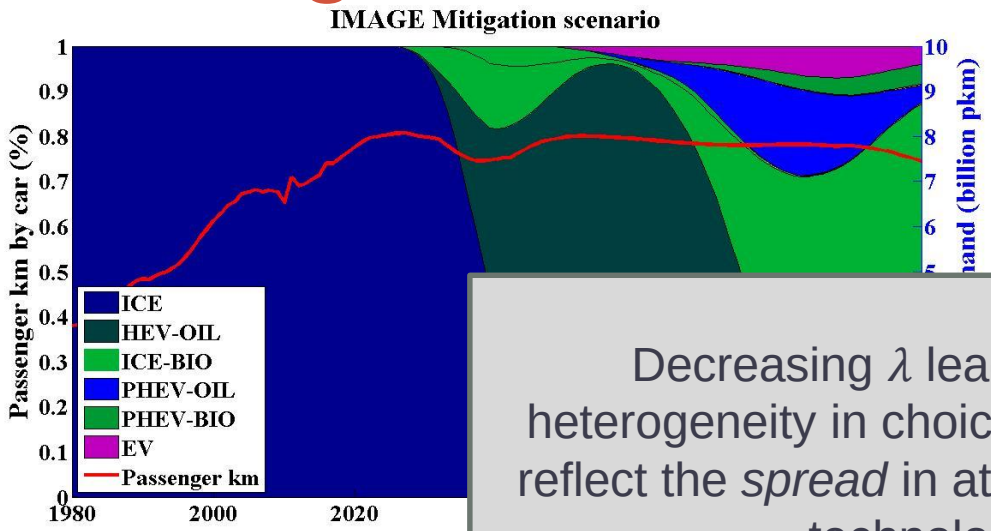


1 group
$\lambda = 50$



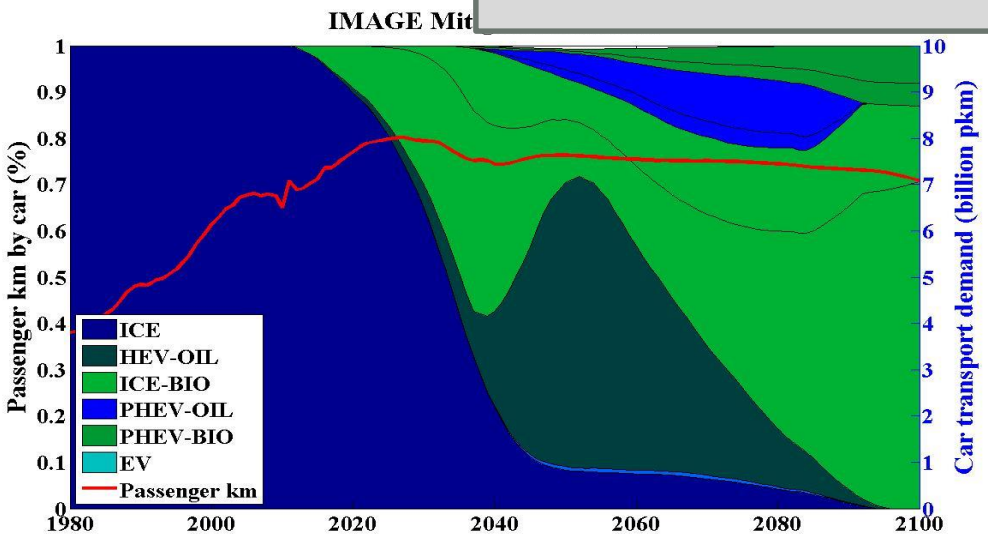
Parameterizing the MNL

27 groups

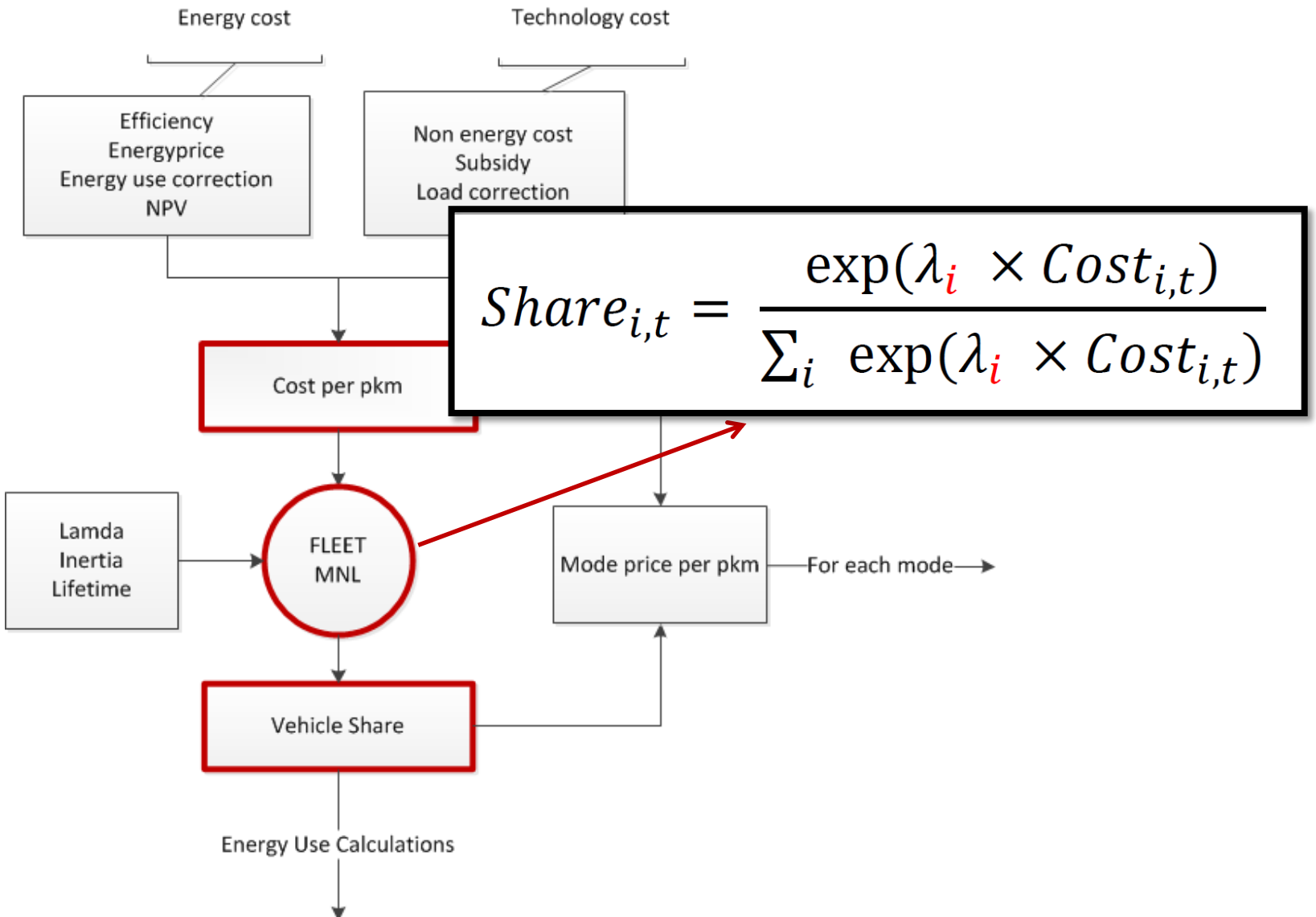


Decreasing λ leads to more heterogeneity in choices but does not reflect the *spread* in attitude towards a technology

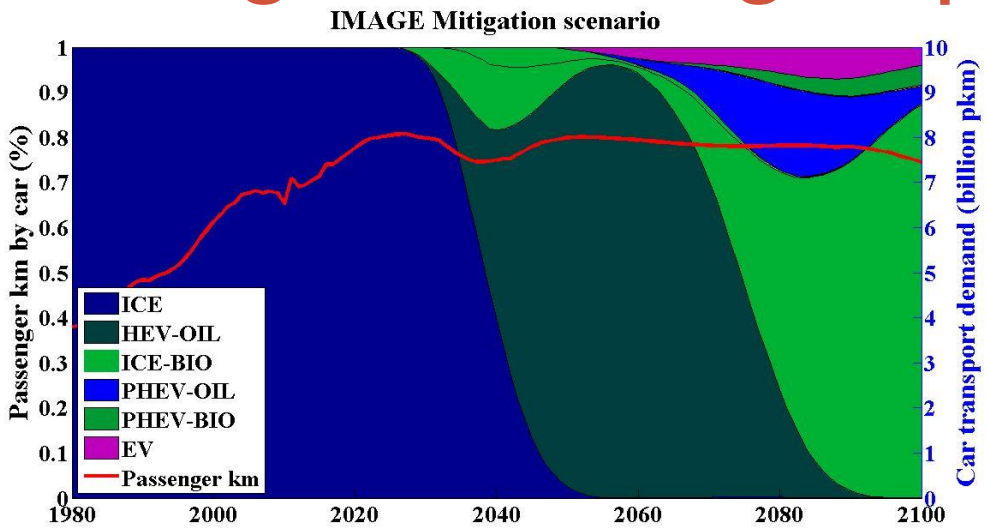
1 group
$\lambda = 10$



Vehicle choice model in IMAGE

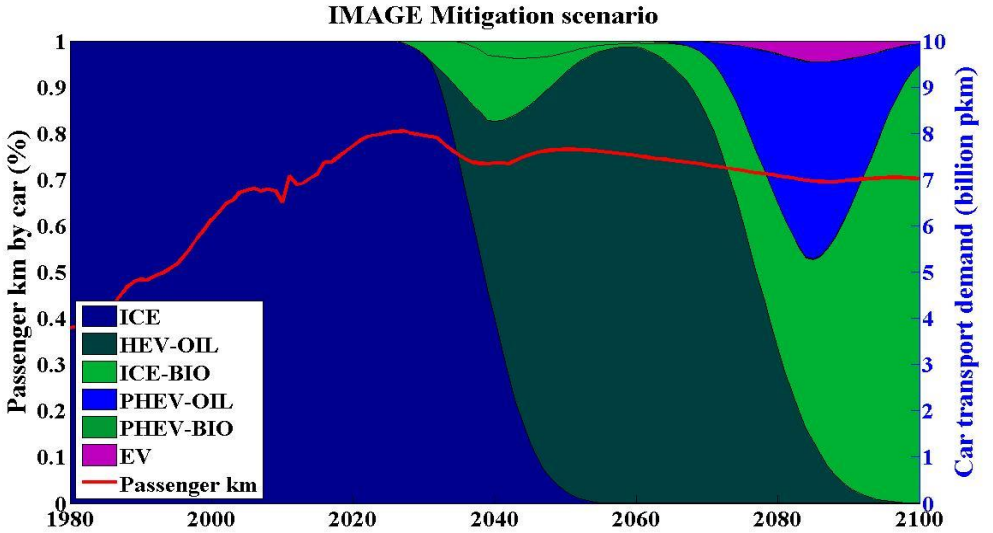


Differentiating in the 27 groups



Resembles 27 groups better than original

1 group



Conclusions and ways forward:

- Logit parameterization can reflect explicit representation of heterogeneity.

→Results improve when λ is technology specific

- Current disutility cost are static which is a barrier for vehicle transition

→ Endogenise disutility cost assumptions on refuelling stations, model availability

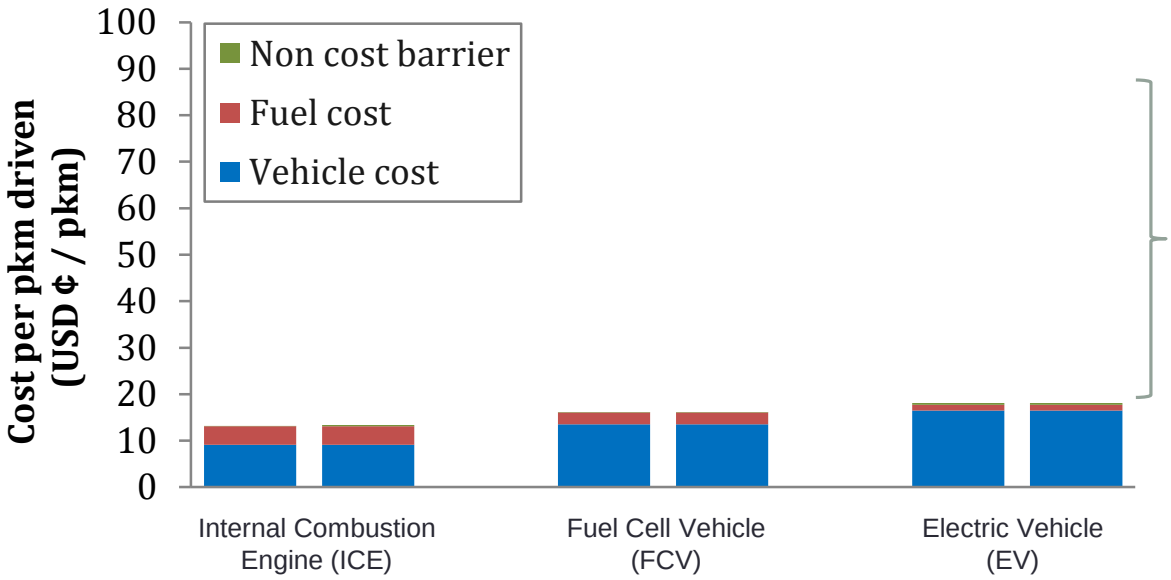
  - Subsidies for early adopters

Thanks for your attention.

Questions?

MA^{3}T Model disutility costs

Lin, 2009. Oakland Ridge National Laboratory



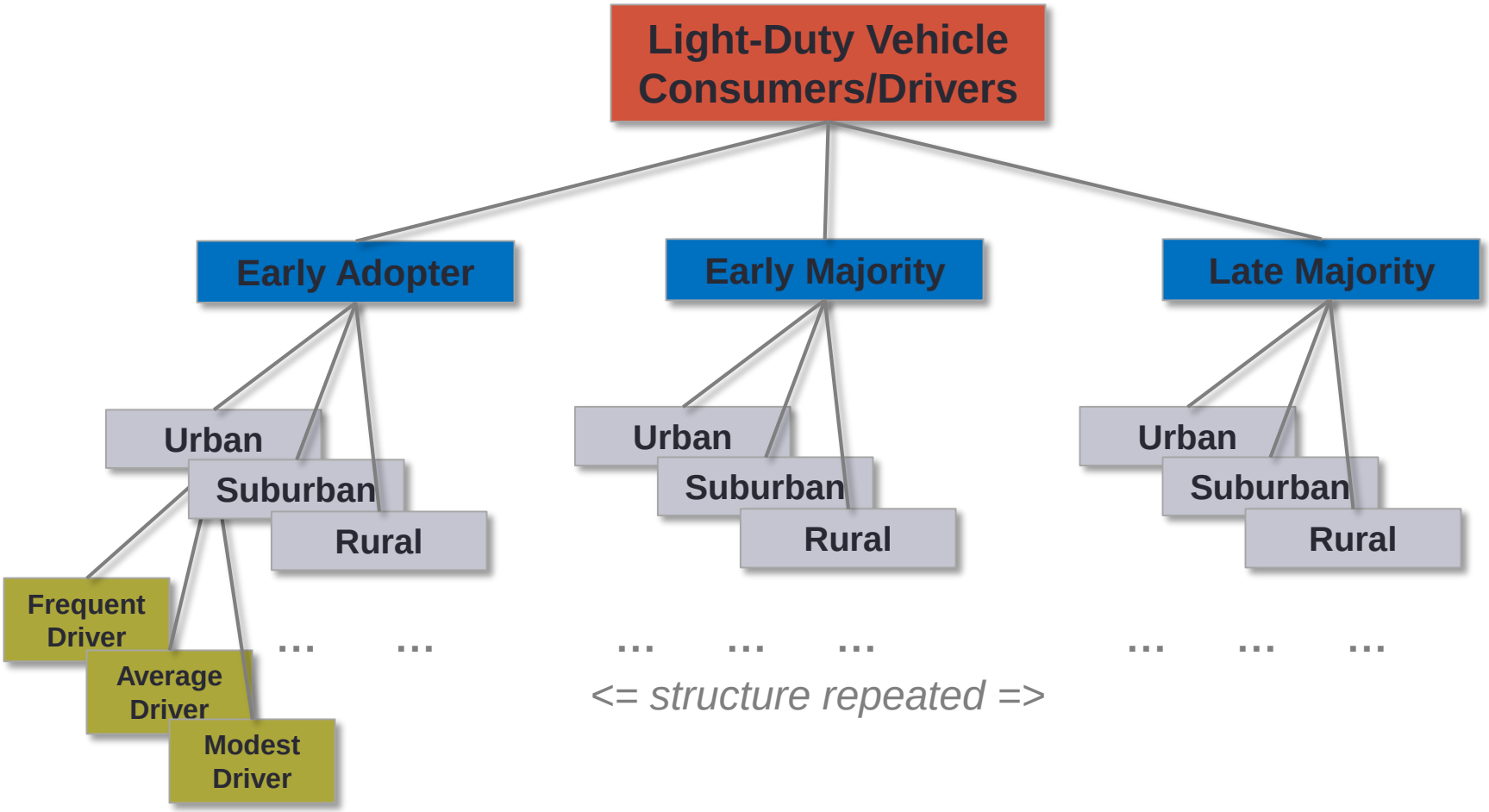
- Limited EV Range “anxiety”
- Refueling Station Availability
- Model Availability
- New Technology Risk Premium

So, this data set only includes additional barriers for electric vehicles

Late technology adopter

Early technology adopter

27 Consumer groups



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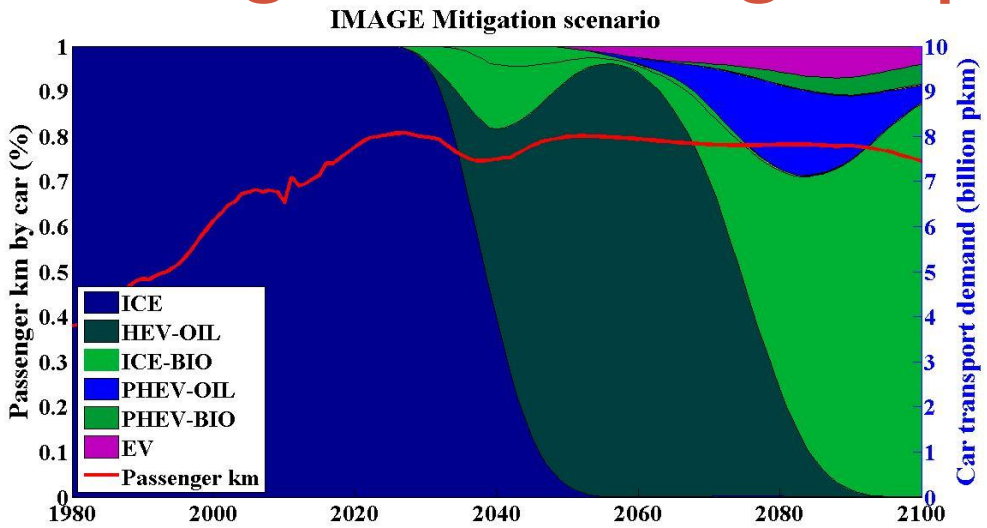
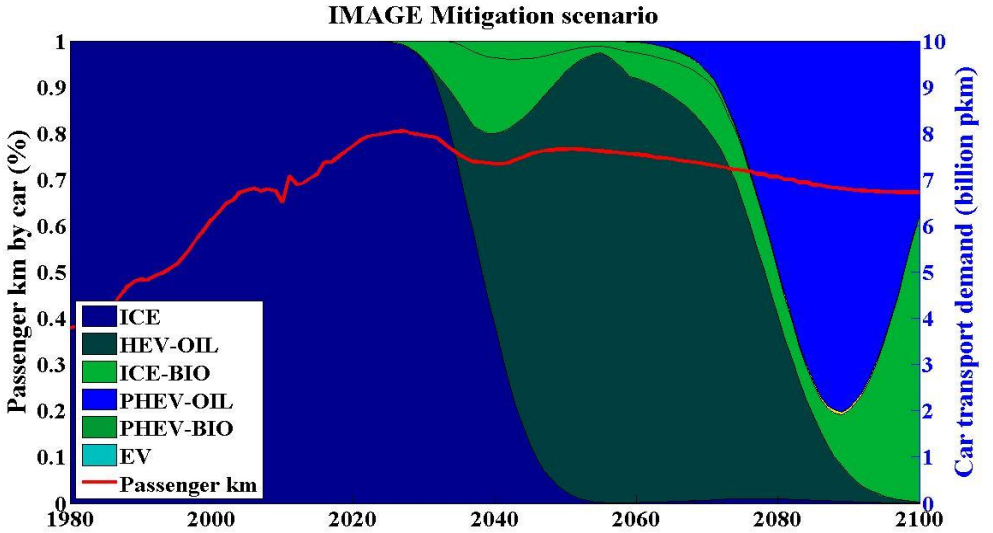


1 group



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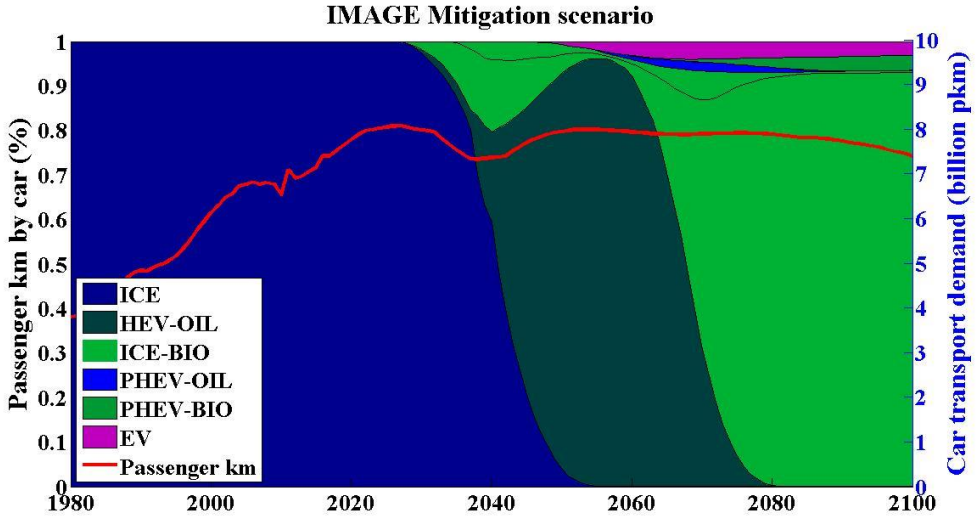
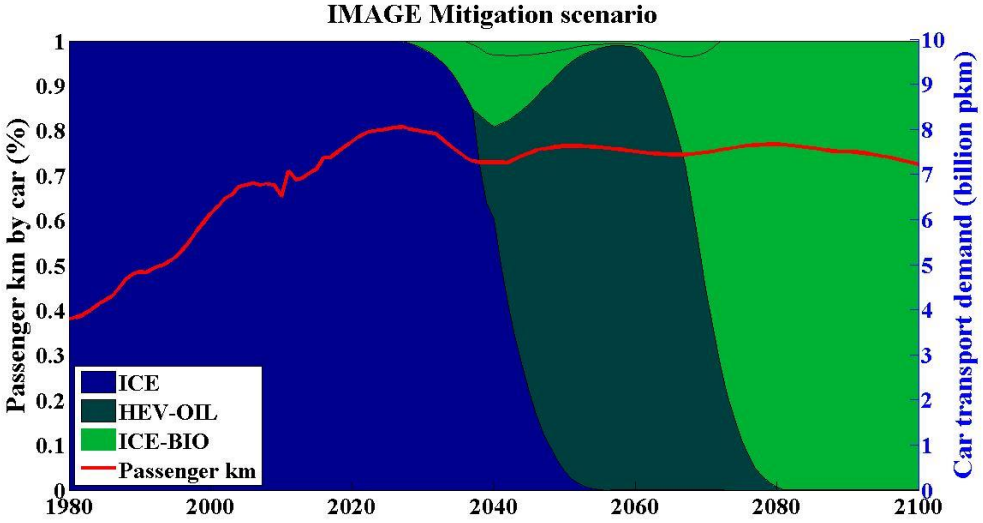


1 group



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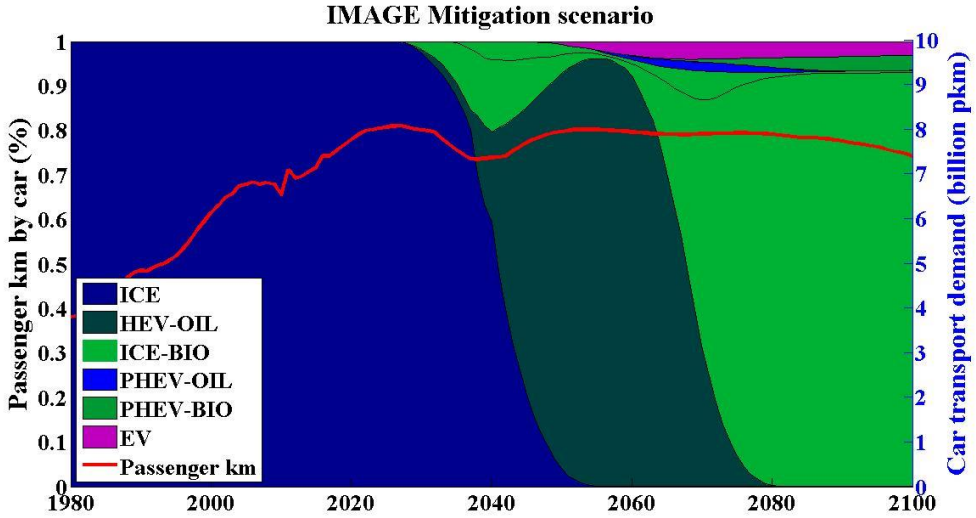
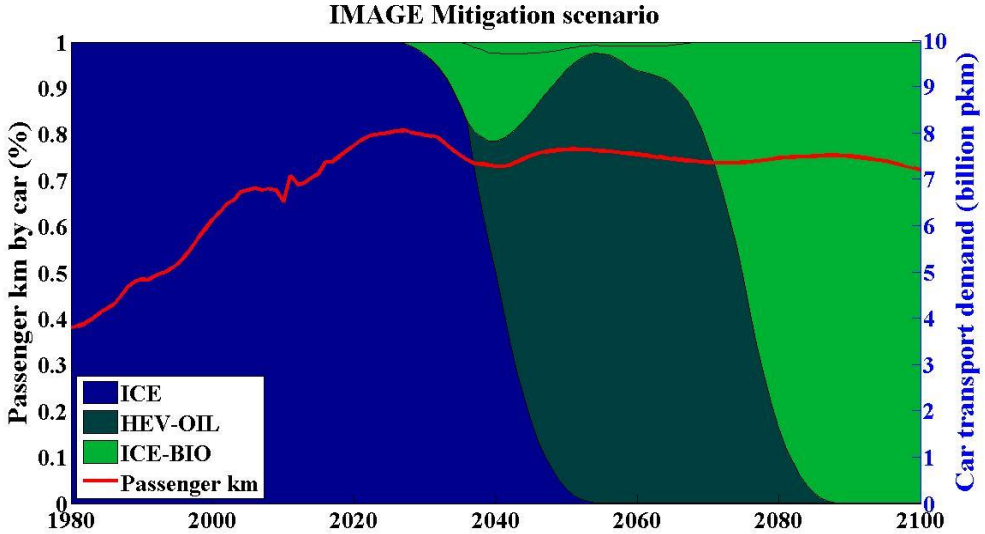


1 group



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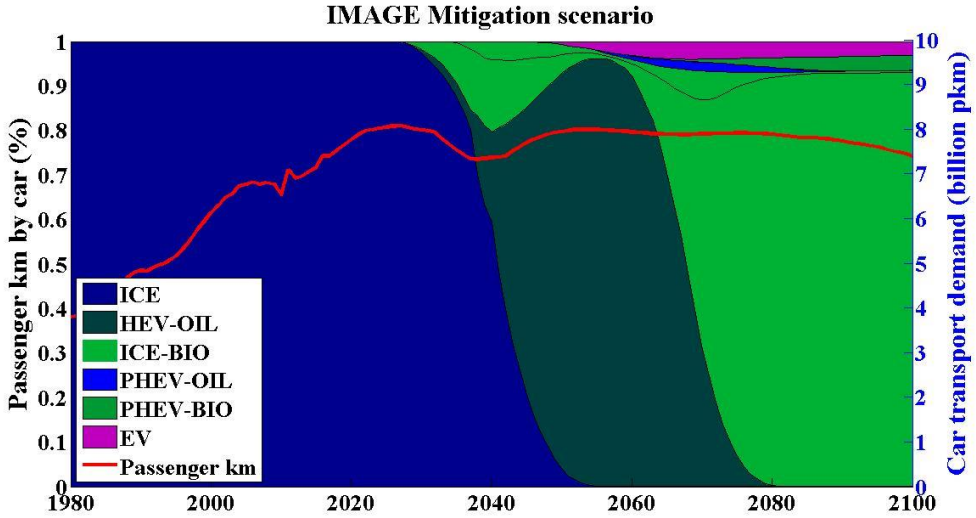
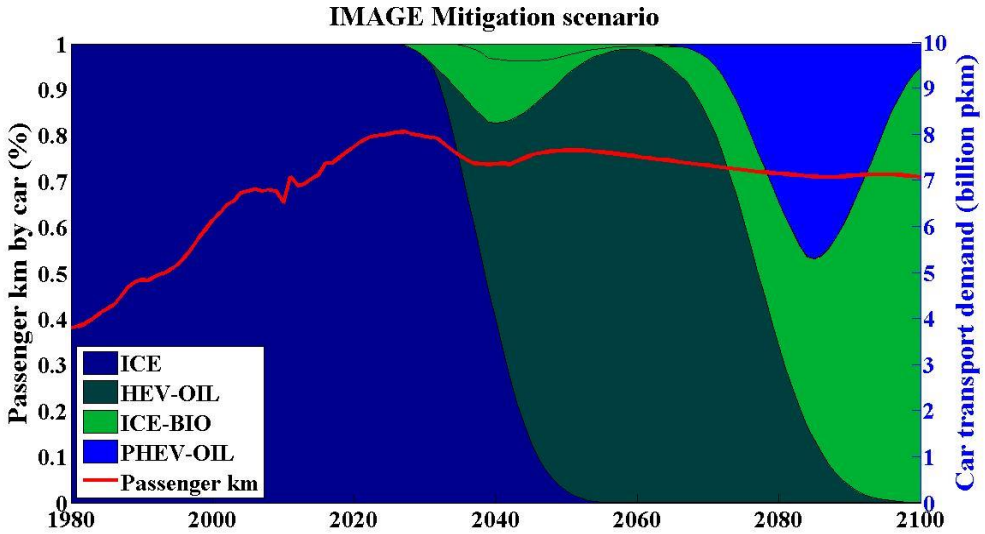


1 group



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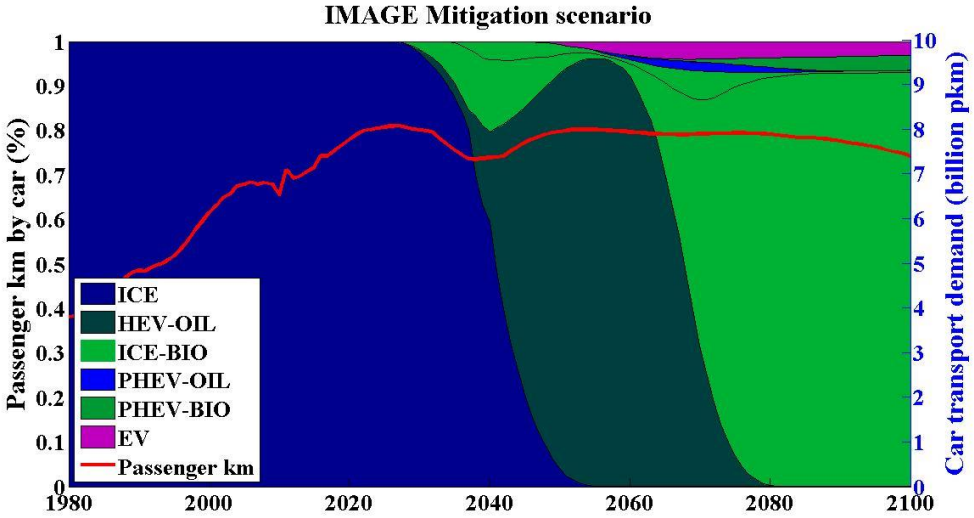
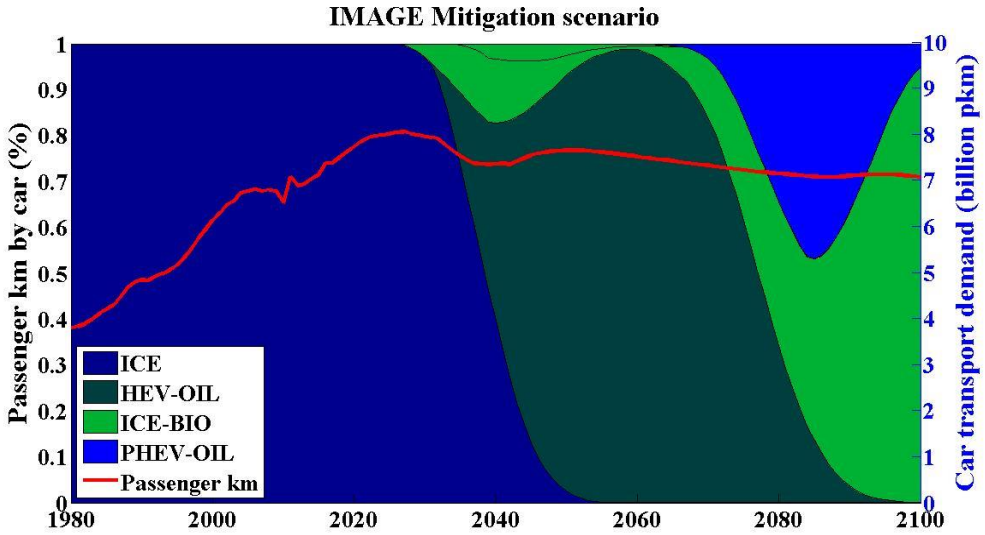


1 group

Does not resembles 27 groups better than original



Comparison model results

	Mitigation No disutillity cost	**Mitigation Disutillity cost**
Electric car deployment	2020-2045	2040-2050
Phase out of fossil ICE	30 – 40 yr	60 – 80 yr
Max % ICE Bio deployment	0 - 8.5 %	57 – 81 %
Cumulative CO_2 emissions (1990-2100)	14 - 15 GtC	17 - 21 GtC