Assessing Lifestyle Transformations in Energy-System and Integrated Assessment Models: A Review

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1 Introduction

Mitigation pathways consistent with the goals of the Paris Agreement (PA) often signify the role of lifestyle changes in driving down greenhouse-gas (GHG) emissions for demand sectors, such as transport and buildings, and in achieving sustainable development goals (SDGs). Despite the strong evidence for the importance of demand-side transitions in mitigation pathways, the representation of lifestyle changes in Integrated assessment and Energy-System models (IAMs/ESMs) lacks sophistication and theoretical and/or empirical validation, and it is mostly exogenous. As a result, while IAMs/EMS adequately capture supply-side mitigation options, they are often criticized for the limited insights they provide about consumer-side transitions.

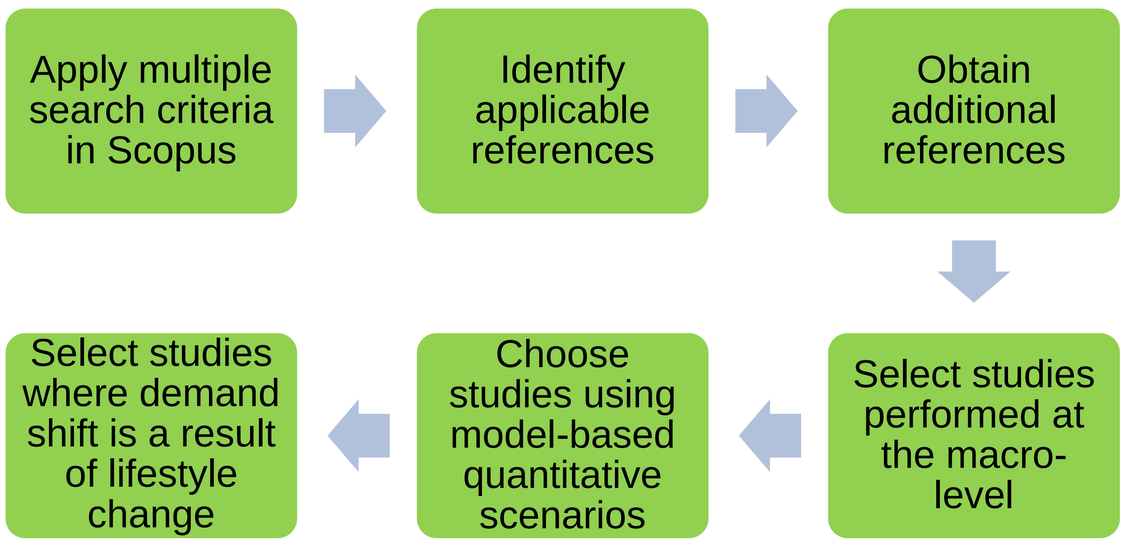
Previous reviews provide a comprehensive description of the general approaches which have been applied to model lifestyles in global scenarios. This review shifts the focus to the specific methods and data adopted to model lifestyle changes in IAMs/ESMs. It seeks **(a)** to identify the common types of lifestyle changes that have been included in IAM-based climate–economy pathways and **(b)** evaluate their relative mitigation potential, and **(c)** review the methodological approaches applied for representing lifestyle transformations in the buildings and transport sectors.

2 Study Design

The review focuses on lifestyles in the transport/mobility and residential/housing domain, and on behaviors belonging to the consumer goods and services category with an indirect effect on other sectors' energy use. Primarily, it aims to improve the modeling of *avoid* and *shift* mitigation actions that require mainly voluntary actions from consumers in their everyday lives, without needing large upfront investments.

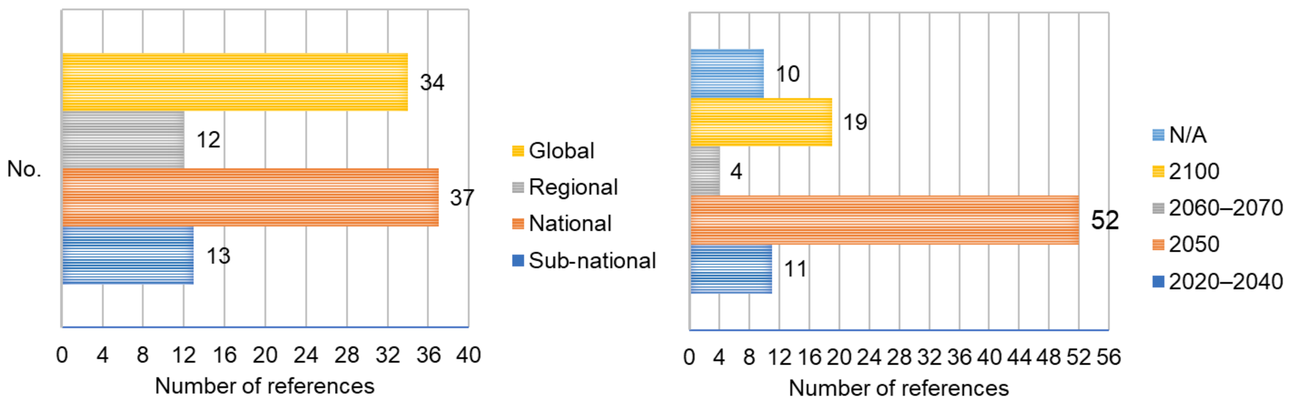
It is based on a systematic, structured review of the academic literature (complemented by scientific gray literature) and aims to source information about the frameworks and implementation techniques that modeling teams used to integrate lifestyle changes in IAMs/ESMs. Information was collected on general publication statistics, the type of modeled lifestyles in covered domains/sectors and the evaluated systemic effects, the structure of modeling tools used in the analysis, and on assumptions about the future transformation in lifestyles in the respective sectors.

Article selection process

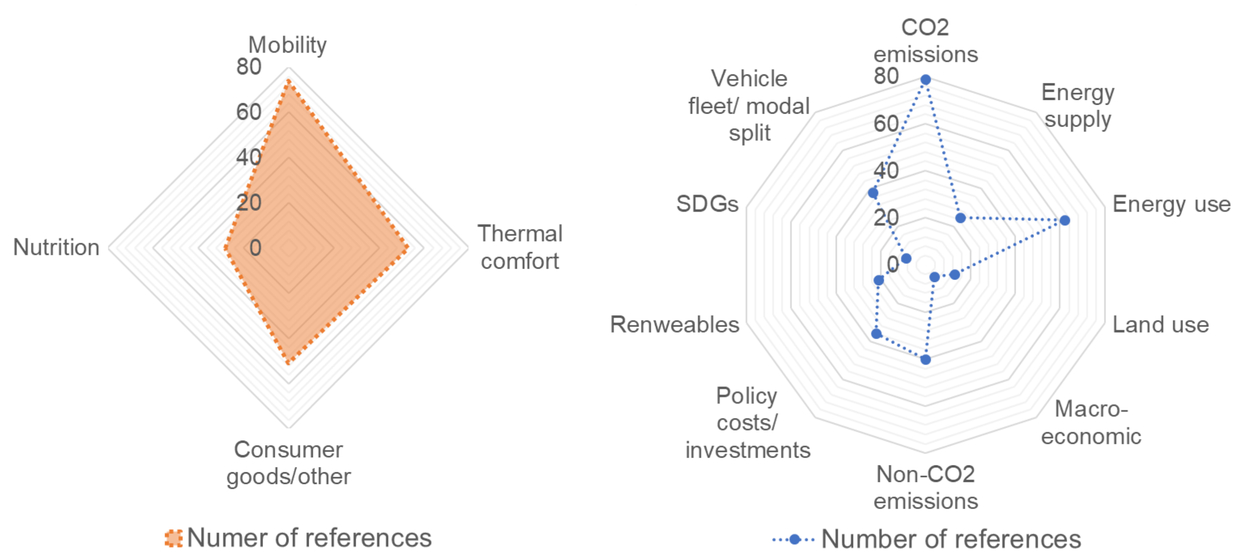


3 Results

Spatial coverage and time horizon of identified studies



Domains of investigated behavioral measures and indicators used to quantify lifestyle effects



The most important lifestyle changes from energy modeling studies for the transport and residential sector

Sector	Domain	Most important lifestyle changes
Transport	Mobility	• Shift from private cars to public transport • Shift from airplane to high-speed trains • Shift to active modes of transport • Carpool commuting/ car-sharing schemes • Eco-driving practices
Residential	Thermal comfort	• Conservation of hot water for showering, clothes, and dish washing • Altering thermostat-temperature set points • Living in smaller dwellings
	Consumer goods	• Re-cycling, re-using, and extending the lifetime of consumer goods

4 Discussion and Conclusions

- **Challenge 1**: The true cost of low-demand transitions cannot be reliably estimated, as the social/behavioral determinants and policy levers influencing behavioral changes remain undetermined.
- **Challenge 2**: Assessments of a broad set of lifestyle changes in IAM-based mitigation pathways accounting for consumer heterogeneity are still lacking.
- **Challenge 3**: The structural changes in the economy brought about by lifestyle changes are difficult to assess using bottom-up IAMs/ESMs.
- Future research could overcome these challenges, mostly through the analysis and integration of big data from apps and other ICT tools in large scale models.

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