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Review

Grand Narratives for sustainable mobility: A conceptual review

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ABSTRACT

The concept of sustainable mobility has had a relatively short life, first being used about 30 years ago. In that time, some progress has been made, but transport is still not contributing enough to the internationally set reduction targets for carbon emissions. This paper provides a conceptual review that presents nine narratives addressing elements of sustainable mobility, each of which has been derived from a review of the agents and strategies taken over the last 30 years. From these narratives, we develop three Grand Narratives that bring together the key elements identified from the wider set of narratives—low mobility societies, collective transport 2.0, and electromobility. We then assess each of the three Grand Narratives in terms of its feasibility, acceptability, centrality, and compatibility. We conclude that each of the Grand Narratives provides a necessary but insufficient condition for achieving sustainable mobility. Thus, although each one has the potential to make significant contribution to sustainable mobility, it is only through the strong and immediate application of all three that the goal of sustainable mobility can be achieved.

1. Introduction

The Israeli historian Yuval Noah Harari [1] reminded us that the most important things in the world exist only as ideas in our imagination, when he said, 'The real difference between us and chimpanzees is the mysterious glue that enables millions of humans to cooperate effectively. This mysterious glue is made of stories, not genes'. Ideas are immensely important, because they enable us to imagine things collectively. When people collectively imagine such ideas, history changes. The American economist Robert Heilbroner [2] claims that when ideas enter our minds, they are a greater force for change than presidents, armies, and laws. However, ideas need stories (or narratives[1]) about the future that people find understandable, attractive, motivational, and possible, so they can believe in them and subsequently support them [3]. This paper presents narratives about one of the most important ideas at our time—sustainable mobility.[2]

The aim of this paper is twofold. First, we present nine sustainable mobility narratives. The narratives, each of which tells a distinct story of how to achieve sustainable mobility, emerge from a literature review of the main strategies and key agents [4]. The narratives are not merely neutral and descriptive concepts, but each has the power to influence how societies seek to achieve sustainable mobility. They are told by their professional and political proponents. Second, we suggest three Grand Narratives of sustainable mobility which cut across and synthesize the nine narratives and assess their credibility. The Grand Narratives could make a real contribution in the transport sector towards the achievement of sustainable development on a scale that has not been evident in the past.

Sustainable mobility is not a new idea—it was first presented in the 1992 EC Green Paper on the Impact of Transport on the Environment [5], which followed up on the seminal report *Our Common Future* and its discussion of the global challenge of sustainable development [8]. The Green Paper recognized that although transport had brought huge benefits to the global economy and had opened up world trade and travel, there were substantial costs, particularly in terms environmental impacts (e.g. CO_2), social costs (e.g. from accidents), and a complete

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[1] The literature makes several distinctions between 'stories' and 'narratives'. However, we agree with Riessman [6] that these distinctions are of little practical importance.

[2] The literature on transport and sustainable development uses terms such as 'sustainable transport' and 'sustainable mobility'. Sustainable transport seems to be preferred in North America and sustainable mobility in Europe [7]. We consider that these terms entail the same ideas and policy implications.

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dependence on non-renewable resources (i.e. oil). The Green Paper concluded that the then-current state of the transport system was unsustainable (see Box 1).[3]

Box 1
An unsustainable transport system

Insufficient progress has been made towards achieving sustainable mobility since the EU Green Paper. While transport and mobility are widely acknowledged as important elements in economic growth and accessibility, the negative social and environmental impacts of increased motorized mobility—in particular, road and air travel—have been broadly acknowledged.

- Transport is a major consumer of energy and material resources. About 31.6% (2016) of the world's final energy consumption is used for transport, mostly from non-renewable energy resources [9].
- The production of motor vehicles requires large amounts of materials (e.g. ferrous and non-ferrous metals). Currently (2017) motor vehicle production consumes 7% and 3% of ferrous metals in OECD and non-OECD countries, respectively (the amounts are similar for non-ferrous metals). Demand for metals in these regions is expected to grow by a factor of 2.2 and 3.5, respectively, between 2017 and 2060 [10].
- Transport is a major contributor to local, regional, and global pollution of air, soil, and water. For example, transport is currently (2016) the source of 24% of global CO_2 emissions [11].
- While transport networks and infrastructures cover only 3% of built-up land in Europe [12], the associated impacts can have dire consequences (e.g. land fragmentation, which affects biodiversity).
- About 1.35 million people worldwide are killed in road traffic crashes, with a cost of about 3% of Gross Domestic Product in most countries [13].
- Access to mobility services has been uneven, resulting in more unequal access to public and private services and instances of social exclusion [15–17].

Transport systems and prevailing travel behaviour are still unsustainable in most developed countries [14,18–22]. Moreover, several developing countries are on an unsustainable-mobility trajectory [23].

Thus, there is an urgent need to think differently about mobility in the coming decades. The focus in this review paper is on the richer countries and passenger travel because this is where leadership and action are required most urgently. The equally important challenges of achieving sustainable goods transport and achieving sustainable mobility in developing countries, however, should not be forgotten. The thinking behind the narratives presented here (as well as several of the narratives themselves) should be relevant to the freight sector and should also be applicable to developing countries.

There is no commonly agreed upon definition and operationalization of either sustainable mobility as a concept or its mother concept of sustainable development.[4] Despite this, we argue that any attempt to develop narratives of sustainable mobility must address the three imperatives of sustainable development: satisfying human needs, ensuring social justice, and respecting environmental limits [24]. Subsequently, these imperatives must be translated into criteria for assessing the sustainability of the narratives. We argue that there are three such criteria: providing accessibility to basic transport (needs), ensuring equal access to transport services (justice), and ensuring that impacts of transport activities do not threaten environmental sustainability (limits) [25]. The narratives focus on sustainable mobility's environmental imperative because this is the main challenge richer countries face in their attempts to achieve sustainable mobility [18].

This is a conceptual review of sustainable mobility narratives. Although we argue that narratives are important for steering policy direction, they should nevertheless be translated to guide practical policy. To do so, they must be translated to scale (e.g. national, regional, or local) and then they must be translated, or operationalized, into concrete policies and measures. This was beyond the scope of this paper, but the narratives provide a starting point for location-specific application. There could be a review and monitoring process, and changes to the most appropriate combinations could be made when necessary. Even without the translations, we are able to suggest several concrete policies and measures relevant for the narratives throughout the text.

The paper is organized as follows. Section 2 presents a typology of sustainable mobility, building on three main strategies and three main agents (an agent being one who has the potential to exert power). This typology forms a matrix in which the nine sustainable mobility narratives emerge. Section 3 presents the three Grand Narratives, which combine elements of the nine narratives. These Grand Narratives present more realistic futures and illustrate that the nine individual narratives are simplifications that are well-suited for analytical purposes but are unlikely to appear in isolation in the real world. Section 4 assesses the credibility of the Grand Narratives in terms of their feasibility, acceptability, centrality, and compatibility, and Section 5 concludes.

2. A typology for achieving sustainable mobility

To achieve sustainable mobility, three elements must be simultaneously addressed: what, who, and how. *What* focuses on the strategies, whereas *who* focuses on the agents that should take the lead. By combining these two elements, we can create a matrix populated by narratives of *how* sustainable mobility can be achieved. Combined, the rows (what), columns (who), and cells (how) of Table 1 provide a typology for understanding sustainable mobility. The conceptual simplicity of Table 1, however, conceals substantial grey areas between elements. This means that, in practical policy terms, the strategies, agents, and narratives are all likely to overlap. Nevertheless, each strategy, agent, and narrative reflects a main area of contemporary interest.

2.1. The main strategies (What needs to be done?)

Logically, mobility can become sustainable if we travel more efficiently, travel differently, and/or travel less. From this, the three main strategies for sustainable mobility can be distinguished as efficiency, alteration, and reduction [27–34]. These strategies (elaborated on below) are well established within the literature, for example, the IPAT [9,35]; the Kaya identity [10]; the ASIF equation [11]; the ASI model [12]; the SMART model [29]; social, technical, and infrastructural emission drivers [13]; and the STPM index [7].

The efficiency strategy suggests that environmental performance and accessibility can be improved through more efficient novel technologies, where technology is used in a broad sense that includes the use of both 'hard technology' (e.g. more efficient vehicle technology and fuel shifts) and 'soft technology' (e.g. information, trip linking, apps, and logistics). Efficiency technologies can be implemented in all parts of the transport system, including motorized transport vehicles (e.g. electric vehicles), transport infrastructure (e.g. charging stations), and the

[3] Shortly after the 1992 Green Paper, sustainable mobility received greater attention from many international institutions (e.g. the United Nations, the Organisation for Economic Co-operation and Development, the World Business Council of Sustainable Development, and the World Bank). Moreover, many research projects on sustainable mobility were started [14].

[4] Although the UN 2030 Agenda [26], with its sustainable development goals, managed to re-establish sustainable development on the international agenda, the apparent absence of transport and its impacts in this document is both striking and alarming [14].

Table 1
Nine sustainable mobility narratives.

		Agents (Who?)		
		Leave it to the experts (*homo bureaucratis*)	Leave it to the people (*homo civitus*)	Leave it to the firms (*homo economicus*)
Strategy (What?)	Efficiency (improve)	1. The green government	2. The green purchaser	3. The clean vehicles
	Alteration (shift)	4. The public transport provider	5. The responsible traveller	6. The shared mobility schemes
	Reduction (avoid)	7. The compact city	8. The essential life	9. The travelling electrons

energy system (e.g. renewable energy resources).

The alteration strategy attempts to change existing transport patterns through a modal shift. Accordingly, the prevailing transport patterns that are currently dominated by automobiles and airplanes need to shift towards more collective forms of transport, namely an affordable and well-functioning public transport system[5] which would induce the substitution of car and air travel with the increased use of buses, trains, and trams—which, under present occupancy rates, are all more energy efficient than cars and planes [30]. Moreover, an affordable and well-functioning public transport system would increase accessibility for low-mobility groups. This strategy also encompasses the idea of increased shared mobility and substituting walking and cycling for individualized motorized travel.

Although the previous two strategies are necessary and would provide some reductions in energy consumption and emissions, these reductions are not large enough to achieve sustainable mobility. Moreover, continuous transport *growth* may negate any reductions in energy consumption and emissions achieved by implementing new technology and altering transport patterns. Thus, the *reduction strategy* encourages efforts to reduce motorized travel (except for those whose basic transport needs are not yet met) by travelling less and making shorter trips, for example, through compact land-use planning, telecommuting, and changing established travel preferences.

2.2. The main agents (Who should take the lead?)

A sound strategy for achieving sustainable mobility is imperative, but someone must take the lead to enact the strategy (or strategies). A single agent may not have either the responsibility or the ability to implement a particular strategy. On the contrary, forming strategic alliances and aligning interests between agents are vital [15]. Thus, all agents at all levels must contribute, including national and local authorities (politicians and bureaucrats), small and large companies, and the public. Nevertheless, someone must *take the lead*, notably key agents with the necessary powers (and resources) to take the first steps to drive the necessary changes forward. Who are these agents and what are their rationales?

In order to identify key agents, we draw on Dryzek's [16] framework of environmental discourses. A discourse is a common way to see the world, where it constructs meaning and contexts, defines common sense, and determines legitimate knowledge. A discourse thus rests on a set of assumptions about how we understand and solve a particular problem.[6] A discourse also embodies assumptions about who are the key agents and a rationale to justify their particular role in problem solving. Not unexpectedly, different discourses will respond differently to questions about how to deal with, say, climate change. Some believe that business is best suited to finding good solutions, whereas others rely on command and control strategies provided by experts within science and public administration. Others point to the power of the people.

Dryzek [16] presents three dominant (and competing) discourses—revealing different conceptions about how to organize environmental problem solving.[7] Each discourse has a specific approach to coordinating the solutions through bureaucracy, democracy, and markets, respectively. The discourse that correspond to these three coordination mechanisms are administrative rationalism (leave it to the experts), democratic pragmatism (leave it to the people), and economic rationalism (leave it to the market). Dryzek frames the key agents in each discourse as *homo bureaucratis, homo civitus*, and *homo economicus*, respectively. Our typology rests heavily on Dryzek's discourses, solutions, and coordination mechanisms, but it specifies firms rather than the market as the third main agent.[8] Thus, our typology aligns with other studies about the main agents that can activate (green) transformation: public actors (politicians and bureaucrats), civic actors (people), and private actors (firms) [15,36–38].

Leave it to the experts (homo bureaucratis): The first discourse puts administrative rationalism at the forefront and politicians (creating policies) and bureaucrats (implementing policies) as the key agents. Scientists, professional administrators, and bureaucrats working collaboratively with a hierarchical structure form the foundation. The experts' solutions and the bureaucracy's implementation of the solutions are more important than the solutions preferred by businesses and the general public. This discourse draws on the experiences of established institutions, instruments, and practices, such as professional pollution control agencies, regulatory policy instruments, environmental impact assessments, expert advisory commissions, policy analysis techniques, and public R&D programs.

Leave it to the people (homo civitus): The second discourse puts democratic pragmatism at the forefront and people are the key agents. Whereas the first discourse typically is a top-down approach, this discourse is a bottom-up approach. Administrative rationalism is based on

[5] Although travel by plane is a collective form of transport, its high energy consumption per passenger kilometre makes travel by plane comparable to travel by car.

[6] Mitigating climate change is a good example. If the dominant discourse on climate change is one where human-induced greenhouse gas emissions are insignificant as compared to natural emissions, there is no need to do anything (except perhaps adapt to the changes). On the other hand, if the dominant discourse is one where human-induced emissions do cause climate change, there is every reason to act.

[7] The three discourses acknowledge that environmental problems exist (not all discourses do), but they believe that it is possible to solve them within the prevailing political system in today's industrial society. Dryzek also mentions some more radical and imaginary discourses that are not discussed here.

[8] We do not consider the market to be an agent with the potential to exert power. Rather, there are several agents in the marketplace: politicians/bureaucrats who design it, firms who supply it, and people who demand from it. The firms operate in the market, and the coordination mechanism for firms operating in the marketplace is economic rationalism.

central leadership and hierarchy, whilst democratic pragmatism is based on dialogue between networks of local agents, for example, local officials, non-governmental organizations, lobbyists, activists, journalists, corporations, and international organizations. This discourse draws on devices such as public consultation, alternative dispute resolution, policy dialogue, lay citizen deliberation, public inquiries, and right-to-know legislation. The power of social movements provides an important element of this discourse.

Leave it to the firms (homo economicus): The third discourse puts market mechanisms at the forefront and firms as the key agents. It is the market—based on voluntary transactions between competing players—which offers the solutions to achieving sustainable mobility. Administrative rationalism and democratic pragmatism are seen as being more based on political or social priorities, and they can overlook the good solutions that the market offers. However, the relationship to administrative rationalism is two-fold. Hard-line economic rationalists will minimize the role of the authorities, introduce private property rights (including those related to natural resources and pollution), and put transactions between market actors in the forefront. The more moderate economic rationalists acknowledge that authorities must *design* (create even) markets by using financial instruments and thus make the rules to which market transactions must comply. The authorities have numerous instruments to design a market, such as negotiable quotas, green taxes, fines, and incentives. Whereas democratic pragmatism appeals to the citizen, economic rationalism addresses the consumer, who can use his or her power to choose environmentally friendly products and solutions, thus affecting the products and solutions that firms offer. Naturally, the most environment-friendly firms will prosper in such a market.

2.3. The narratives (How is it to be done?)

Achieving sustainable mobility can be characterized as a 'wicked problem' [17]. A wicked problem is perceived as difficult or impossible to solve because there are numerous agents involved and they often have contradictory preferences. Obviously, finding appropriate solutions to a wicked problem requires knowledge in terms of data and information, but knowledge is more than just data and information. It is information that is understood and contextualized within a specific setting, thus giving *meaning, motivation,* and *opportunities* to the information, without which the audience may not pay attention. Boushey [39] states that the less complex and more understandable and acceptable an idea is for people, the more meaningful (emotionally important) the information becomes. Furthermore, we agree with Hák et al. [3] that well-formulated narratives are needed to give meaning to ideas and should be a priority for achieving sustainable mobility.

A narrative is a (short) well-written, trustworthy story of what we need to do to achieve something or solve a problem. A narrative typically has five parts: setting, moral, plot, character, and resolution [40,41]. In this case, the setting is passenger transport in developed countries, the moral is sustainable development, the plot is to change the present unsustainable transport system and behaviour, the character is the lead agent, and the resolution is the action needed to solve the problems presented by the plot. Thus, a sustainable mobility narrative uses these elements and the available evidence to provide a coherent set of actions to achieve sustainable mobility, in addition to the roles played by the main strategies and key agents involved in its implementation.

Based on the review of the main strategies and the main agents from the previous sections, we derive nine sustainable mobility narratives (Table 1). As described below, each narrative builds on one strategy and one agent. The strategies, agents, or narratives are not ranked in the table, which merely presents the dominant narratives found in the literature.

The green government (1): Governing bodies at the national, regional, or local level take a top-down approach, imposing regulations, standards, taxes and/or subsidies on existing modes of mobility. This is perhaps the most common current approach. Whereas the majority of contemporary actions have focused on emission control (e.g. the European Emission Standards and the Motor Vehicle Air Pollution Control Act [Clean Air Act]), this approach would also entail taxes on emissions and providing or subsidizing more efficient technology. The transition is often slow, but it can be effective and requires little alteration to contemporary infrastructure and habits. Thus, it is similar to Bergman's 'central narrative' [42].

The green purchaser (2): An 'enlightened'—but slightly hesitant—population engage themselves in choosing greener and more efficient technologies. However, the green purchaser's choices should not come at the expense of their perceived travel habits. As such, the 'green purchaser' does not seek travel alternatives, but 'cleaner' options. The purchase of voluntary carbon offsets for air travel, and the proliferation of EVs in affluent areas are some examples.

The clean vehicle (3): In this narrative, sustainable mobility is achieved through companies taking the lead role. These companies will cover a broad spectrum from opportunistic (i.e. bidding to appease regulatory bodies and/or appeal to individual's green ambitions) to altruistic. Clean vehicles do not entail transforming business models to alternative modes of mobility, but rather, safe incremental or more comprehensive improvements in existing technology. Current examples are Ford Motor Company's [43] plan for reducing vehicle emissions.

The public transport provider (4): National, regional, and local governments provide basic infrastructure for collective transport, such as buses, trains, and trams. Governments can own and operate the transport systems or they can buy services from private companies. There are several means by which governments can increase the use of public transport, including subsidizing fares, dedicating lanes for public transport, and imposing a toll on private cars in specific areas, with the aim of ensuring access to basic transport needs for people without cars and to encourage car users to travel by public transport instead of using their own cars.

The responsible traveller (5): An enlightened population consciously chooses more sustainable alternatives for mobility, exchanging old mobility habits for new routines (e.g. bicycling instead of driving). In this approach, people are able to satisfy general *needs* and *wants* involving mobility—albeit slightly modified—often with added benefits (e.g. health). In some instances, these decisions are part of a grassroots innovation where bottom-up solutions are developed by activists and organizations responding to the interests and values of the community (e.g. car pooling). Given the reality of climate change, low-carbon lifestyles are an aspirational goal for responsible travellers.

The shared mobility schemes (6): Unlike the sustaining technologies (incremental improvements) used in narrative 3, in this case, leading companies are those who develop and introduce disruptive technologies (i.e. technologies that significantly alter prevailing travel behaviour based on private car ownership). These arise as intra- or intermodal disruptions, such as within an existing mode of transport or as completely novel modes. Uber's take on car sharing and autonomous road vehicles are examples of the former, and drone delivery vehicles exemplify the latter.

The compact city (7): The compact city[9] proposes a high-density built-up environment and intensification of activities, efficient land-use planning, and diverse and mixed land uses, with clear (non-sprawling) boundaries. Transport systems are efficient and rely primarily on public transport and active forms of transport (cycling, walking, scooters). The compact city seeks to increase quality of life in its city quarters and to repurpose road space to urban parks, cafés, and stores. Shorter trip

[9] 'The compact city' is here used as an allegory for concentration and compactness. The compact city is not necessarily a large monolithic city; it also includes urban forms such as the polycentric city and decentralised concentration.

lengths make active travel attractive and desirable. In essence, the compact city is inspired by Jane Jacobs's influential book *The Death and Life of Great American Cities* [44] and is an antithesis of Wright's Broadacre City [45–48].

The essential life (8): To a much greater degree than the previous *homo civitus* narratives, the essential life requires a transformation in how we define and fulfil *needs*, and in consideration of the Sustainable Development Goals and their perspectives on sociality, equity, work, and environment. It requires extending the current 'local' trend to new dimensions—both in breadth (e.g. entertainment and tourism) and depth (e.g. the low carbon economy or the 'tight' circular economy). Digital solutions will allow us to remain global citizens.

The travelling electrons (9): Information and communications technologies make it possible to let electrons travel instead of people. Telecommuting, the use of video conferences, and exchanging all types of information on the internet could reduce people's need for physical travel. True, the necessary infrastructure and equipment needed to make electrons travel have a large amount of embedded energy use and emissions. Moreover, some studies show that increased use of information and communication technologies can increase the need (and desire) for travel. Nevertheless, this narrative bears the *potential* to offer great reductions in energy use and emissions.

These nine narratives all introduce key elements into the sustainable mobility debate, emphasizing the different strategies and agents involved. On their own, however, they are unlikely to make a real difference, and it is only when they are combined that the true potential can be realized [34].

3. Three Grand Narratives

The transport sector needs to make a substantial contribution to the achievement of sustainable development, and this means going beyond the individual narratives outlined above (Table 1). It is only when the individual narratives are combined that the scale of action needed can be achieved over the next 10–20 years. Combining the narratives also brings together the different actions and agents that will be needed to meet the requirements for sustainable mobility. The underlying argument here is that the transport sector requires coordinated and supportive actions from all agents on a scale and immediacy that has not been evident in the past.

We propose the following three Grand Narratives for achieving sustainable mobility: electromobility, collective transport 2.0, and low-mobility societies. Each of the three Grand Narratives builds on the three main strategies by combining the actions of key agents. This means that complementary actions can be taken at all levels of decision making and that solutions requiring intervention from experts, the full support of citizens, and the market can operate effectively.

The Grand Narratives rest on two ideas. The first is to 'think big'. As David MacKay puts it: 'Don't be distracted by the myth that "every little [bit] helps." *If everyone does a little, we'll achieve only a little*. We must do a lot. What's required are *big* changes in demand and in supply' ([49]: 3, italics in original). Thus, the Grand Narratives must deliver big changes in the present unsustainable system of transport and travel behaviour. The second is to 'think inside the box'. We already have much of the technology and knowledge we need. The more that the Grand Narratives can make use of existing systems, the greater chance of success. Having said this, the Grand Narratives must not hesitate to challenge the prevailing systems and travel behaviour when needed.

In our grouping, we bring together the key elements of each—so the compact city, the 'essential' life, and the travelling electrons provide input to the low-mobility society Grand Narrative; the public transport provider, the responsible traveller, and the shared mobility schemes provide input to the collective transport 2.0 Grand Narrative; and the green government, the green purchaser, and the clean vehicles provide input to the electromobility Grand Narrative.

3.1. Electromobility

Electromobility implies replacing existing fossil-fuel based vehicles with electric vehicles (EVs). EVs come in many configurations, including battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV), range-extended electric vehicles (REV), and fuel-cell electric vehicles (FCEV). Thus, the electromobility narrative also includes hydrogen vehicles, but importantly, electromobility is not restricted to replacing fossil-fuel based private cars. Ultimately, electromobility implies replacing all existing fossil-fuel based vans, buses, heavy-duty vehicles, rail, ships, and short distance planes with corresponding EV drive-trains.

Though the emission profiles of the different configurations vary, EVs are generally more energy efficient and easier to maintain than fossil-fuel based vehicles. Moreover, EVs have the *potential* to significantly reduce greenhouse gas (GHG) emissions, while simultaneously reducing local air pollution [50]. Importantly, electromobility does not reduce pollution from tires, brakes, and road wear as compared to fossil-fuel based vehicles. Also, electromobility introduces a set of environmental issues regarding the use of rare metals in batteries. Furthermore, electromobility still faces user challenges such as altered driving habits, new safety issues, limited driving range, and time-consuming charging. Nevertheless, the implementation of EVs in many countries such as Norway [50] and France [51] has shown success.

Importantly, replacing fossil-fuel based vehicles with EVs is both about developing and deploying EVs. Someone must produce (and sell) EVs and someone must use (and buy) them. Moreover, it would be hard to sell EVs that are much more expensive than fossil-fuel based vehicles.[10] Actions taken by national and local bureaucracies (i.e. Dryzek's experts) are therefore key to connect producers and users by providing demand-stimulating support measures (e.g. Langhelle et al. [52]). Such measures include tax reductions/exemptions, free access to bus/taxi lanes, reduction or exemption from road tolls or parking fees, provision of public recharging points, and support to R&D projects and field tests [53].

However, electromobility is by no means restricted to developing and deploying EVs [54]. First, an increased number of EVs must be accompanied by the availability of charging points, generation capacity, and sufficient grid capacity. Second, EVs require a carbon-free electricity (and hydrogen) production system to deliver the potential emission reductions. Thus, for electromobility to be a successful part of a decarbonization strategy, infrastructure systems and energy production systems must also undergo necessary changes.

The need to simultaneously change several physical and political systems underlines the vital role of national and local governments and their scientific and administrative expertise. We do not see any other agent that can take the lead here. Initially, the rationale for electromobility rests on *homo bureaucratis*. Eventually, electromobility must be further developed in the marketplace, which opens up for *homo economicus*, where firms offer electromobility services to *homo civitus* demanding such services.

Electromobility is the preferred Grand Narrative for people who rely on greener, sustainable, more efficient, improved, or simply 'better' technology to achieve sustainable mobility (the improve strategy). Thus, technological optimists definitely feel comfortable in this narrative because it does not challenge the way we travel or demand us to travel less.

3.2. Collective transport 2.0

Sustainable mobility challenges contemporary individual travel

[10] On average an EV currently costs at least 40% more than a comparable conventional vehicle. For certain brands and models, this difference can exceed 100% [52].

patterns and suggests increased forms of collective travel. Traditionally, *public* collective transport (such as buses, trains, and trams owned by national or local governments, herein referred to as public transport) has been the answer to this challenge. This does not change—we still need public transport. In fact, we need to *dramatically increase* the number of trips by public transport, and even such increases are unlikely to replace the present high level of individual car transport. We therefore need to think about new forms of collective transport, and this thinking implies a shift from 'ownership' to 'usership' [55], which has also been defined as part of the concept of 'mobility as a service' [56]. We suggest a collective transport 2.0 narrative that increases load factors and occupancy rates on both public transport *and* cars, referring to the latter as shared mobility.

Although the numbers in studies vary wildly, shared mobility schemes could significantly reduce trip frequencies, travel lengths, and emission levels [57]. There can be no doubt that shared mobility represents a sensible (though not necessarily acceptable) alternative to private cars. According to the UN Habitat [58], private cars remain parked about 95% of the time and when they are moving, their average occupancy rate is well below two persons per car. Thus, the potential for more efficient use of private automobiles and a reduced need for parking space is massive.

Santos characterizes shared mobility (or mobility in the sharing economy) by 'the sharing of a vehicle instead of ownership, and the use of technology to connect users and providers' ([57]: 1). Based on a literature review, she identifies four emerging models: peer-to-peer provision of vehicles with a company as a broker; short-term rental of vehicles managed and owned by a provider; companies that own no cars themselves but sign-up ordinary car owners as drivers; and on-demand private cars, vans or buses, and other vehicles, shared by passengers going in the same direction. Machado et al. [55] suggest these same four models but also include 'bike-sharing' as a fifth model of shared mobility.

Although shared mobility services develop in the interface between businesses and users, some sort of public incentive design is needed initially. Incentives can be command-and-control (e.g. restrictions on access for privately owned vehicles in certain areas), financial (e.g. taxes and/or subsidies), or in-kind (e.g. access to bus lanes). At the very least, incentives designed to tip the balance in favour of shared mobility must tip generalized costs by changing the monetary out-of-pocket costs and not increasing, or even decreasing, travel time [55]. At present, however, no government anywhere has any incentives in place to increase shared market penetration, except for small pilot projects.

Autonomous vehicles and autonomous driving have been claimed as the next big disruptive transport innovation [59,60], and they are highly relevant for this discussion of shared mobility because it is fair to assume that people who are not interested in owning a car also are less interesting in driving.

Though there is clearly a need for a regulatory framework and start-up incentives, shared mobility belongs to the realm of businesses and the public. Business must develop feasible schemes and, most importantly, people must alter their current preference for private car ownership and use. Thus, we must leave this Grand Narrative to *homo civitus* and *homo economicus* and reserve a place in the back seat for *homo bureaucratis*.

3.3. Low-mobility societies

Low-mobility societies must address the prevailing high and increasing amount of travel by cars and planes, and this represents a new challenge. Whereas electromobility, shared mobility, and autonomous vehicles challenge the way we travel, low-mobility societies challenge our way of life. Thus, suggesting or even thinking of, for example, car-free societies seems bold. Nevertheless, it is hard to see how we can achieve sustainable mobility without also thinking in terms of reducing or eliminating cars. Although thinking in 'car-free' terms is the litmus test in this narrative, we hasten to add that a low-mobility society *also* rests on fewer and/or shorter trips by cars (and planes), preferably electric ones.

Car-free *cities* should be a sensible first step for two reasons. First, people in cities experience daily the negative consequences of car use, such as congestion, noise, and pollution, and would benefit most from getting rid of them. Second, due to higher population density and generally shorter distances to private and public services, people in cities have reasonable alternatives to cars, such as walking, cycling, and well-functioning public transport systems.

Car-free cities means banning cars from *significant* areas, including housing, shops, restaurants, and work places. Such a ban must apply to residents, employees, and visitors in those areas (although a ban must allow access for emergency vehicles, waste collection, and delivery vehicles). Madrid is a frontrunner in this field. From November 2018, all non-resident vehicles have been barred from a zone that covers the entire city centre (approximately 1 km^2). The only vehicles allowed in this zone are cars that belong to residents who live there, zero-emissions delivery vehicles, taxis, and public transit. Similar car-free areas are being considered in some other European cities, including Oslo, Brussels, Copenhagen, Stockholm, Nuremberg, Zurich, Gothenburg, Freiburg, Groningen, Strasbourg, Utrecht, Gent, Dublin, Glasgow, and Helsinki [61,62].

Although there is significant *political* interest in car-free cities, academia has remained relatively silent on this issue. Khreis et al. [63] found almost nothing in the academic literature on the creation of car-free cities. Rather, the literature focuses on creating (small) car-free zones within cities, including pedestrian areas. Khreis et al. [63] argue that we need more knowledge to describe the rationale, prerequisites, barriers, and potential strategies for creating car-free cities. Specifically, we need to know more about how to create public acceptance for car-free areas, and we need to know how businesses will respond to car-free cities.

Politics and policies are vital in this narrative. However, it is hard to envision governments in democratic societies putting restrictions on car ownership, travel distances, or modal choices in the foreseeable future. Ultimately, it is the individual who chooses to buy (or not buy) a car, and it is the individual who decides how and where to travel. Moreover, it is the people as voters who legitimize governmental actions in favour of actions such as car-free zones. Thus, we see the people as the main agent in transition to a low-mobility society. In the end, realizing a low-mobility society rests on actions by *homo civitus* justified by democratic pragmatism.

4. The credibility of the Grand Narratives

Narratives should be something to strive for, but they must nevertheless have a credible basis. We argue that there are three crucial criteria by which narratives must be assessed: their feasibility (are they possible?), acceptability (do we approve of them?), and centrality (do they deliver sustainability?). All three are needed because it is of little help for a narrative to deliver sustainability but fail to be feasible or acceptable. On the other hand, a narrative that is feasible and acceptable but fails to deliver sustainability is useless. Here, we discuss their credibility as well as compare their compatibility.

4.1. Electromobility

Feasibility: Electromobility is a challenging but highly feasible narrative. All major car companies now deliver (or are planning to deliver) a large selection of electric cars and will continue to do so. Experiences from Norway show that, given the incentives, it is possible to penetrate the market with a large proportion of electric cars in less than a decade [50,64]. By the end of 2018, there were 200,000 registered battery electric cars in Norway, and battery electric and plug-in hybrid vehicles together held a 50% market share of new cars. Moreover, electric vans,

trucks, buses, ferries, and even planes, are developing fast. Thus, we regard electromobility as a highly feasible Grand Narrative.

Acceptability: Electromobility is also a broadly acceptable narrative. Studies show that EVs initially bought as a second car, quickly were upgraded to the preferred primary use vehicle [65]. Drivers report driveability, comfort, and environmental performance to be superior to their conventional fossil-fuel based car [66]. Studies show that a large majority of EV and plug-in hybrid owners said they would 'definitely' or 'probably' buy electric if they ever bought another car [67]. In addition, potential future car-owners seem well informed and receptive to electromobility [68].

Centrality: Electromobility is central to achieving environmental sustainability. First, although the emission reductions of the different configurations vary, EVs are generally more energy efficient than fossil-fuel based vehicles. Second, EVs have the potential to significantly reduce global emissions [50]. For example, given the present electricity mix in the EU, EVs reduce GHG emissions by 50–60% as compared to internal combustion engines [69]. Increasing the renewable energy portion of the electricity mix (which is likely to happen) will lead to addition emission reductions. Third, EVs eliminate harmful pollutants from vehicle exhaust, including nitrogen oxide, carbon monoxide, hydrocarbons, and particulate matter.

On the other hand, electromobility introduces a set of environmental issues regarding the use of rare metals in batteries. Furthermore, electromobility still faces user challenges such as changing driving habits, new safety issues, limited driving range, and time-consuming charging. Moreover, electromobility has no significant effect in terms of satisfying accessibility to basic transport needs and ensuring equal access to transport services. In the short term, electromobility could even have negative effects on accessibility and equal access because of the EVs' limited driving range, lack of charging stations, and greater initial cost.

4.2. Collective transport 2.0

Feasibility: Collective transport 2.0, which includes dramatically increased conventional collective transport and various models for shared mobility, is a more challenging narrative than electromobility, but it still could be feasible. Although modest in scope, several shared mobility models have proven successful, such as HiyaCar, Car2Go, Uber, and Via [55,57]. Broadening the scope of shared mobility from pilot projects to extensive use rests, however, on local and national governments providing incentive packages and regulatory schemes, which is highly achievable. Thus, collective transport 2.0 is a feasible Grand Narrative.

Acceptability: Given the current dominance of the car, the acceptability of the collective transport 2.0 narrative represents a challenge. How do you persuade users to substitute private car ownership and use with shared mobility schemes, especially those that entail sharing a vehicle with strangers and compromising on departure and arrival times and travel duration? The aspiration to buy a car is still high for many people, even though there are signs of a change in attitude among younger people. For example, millennials (b. 1981–1996) show less interest in obtaining a driver's licence and owning a private car, and instead prefer conventional collective transport and various shared mobility schemes. Notwithstanding the technical issues pertaining to autonomous vehicles, the most challenging issue would probably be to increase user acceptance for autonomous driving. Despite assumptions about the potential benefits of self-driving cars, to date little is known about the factors that will affect drivers' acceptance or rejection of this emerging technology [70,71].

Centrality: Collective transport 2.0 is important in achieving environmental sustainability, and studies have shown that an increased modal shift from cars to collective transport could lead to a 20% reduction in CO_2 emissions [72,73]. The impact of various shared mobility models on CO_2 emission is difficult to estimate, but studies for Helsinki suggest a reduction between 2 and 62% [74,75]. The higher number assumes a 100% replacement of all car and bus trips by new shared modes and should only be used as a threshold for reference or as 'a conversation starter'. The lower number, probably a more realistic number for Helsinki, makes the assumption that 20% of car and taxi trips were replaced with shared mobility.

Collective transport 2.0 is crucial to reach the goal of satisfying accessibility to basic transport needs and ensuring equal access to transport services. People who cannot afford (or for some reason abstain from owning) a private car need affordable collective transport to get to work, school, shops, and health care. Shared mobility schemes could provide the flexibility in travel not offered by conventional collective transport. Autonomous EVs will also be part of a shared mobility scheme. Compared to conventional vehicles, autonomous vehicles are predicted to reduce traffic accidents and associated fatalities and injuries [76]. In addition, vulnerable populations such as the elderly and disabled may be able to realize greater independence and social interaction [77].

4.3. Low-mobility societies

Feasibility: Low-mobility societies and cities are feasible for several reasons. Residents in European and (high-income) Asian cities travel less than half the daily distance than their counterparts in U.S. cities [78], and the initial experiences from car-free zones in cities all over the world show that travel without a car is entirely possible. In addition, the use of information technology has a large potential to reduce the need for physical travel. The necessity of travel is, however, embedded within the context of social practices. For example, there may be social expectations about physical presence at the work place or for social occasions [79]. Thus, care should be taken when comparing personal travel among countries and cities.

Acceptability: Owning and using a car are deeply culturally embedded into most modern societies, and the question is how to change this culture to promote the acceptability of car-free areas. A recent study in Berlin showed that, given the current infrastructure, about 60% of the respondents were willing to accept a car-free city centre [80]. When the infrastructure for cyclists is improved, the willingness to accept a car-free city centre strongly increases. Similarly, improving the network of bus stops and train stations as well as dedicating the newly car-free streets to recreational uses would contribute to a higher acceptance of a car-free city centre.

We also need to know how businesses will respond to car-free cities. Local retailers depend on vehicles to deliver goods to their stores, and their customers depend on cars to take their purchases home. It is entirely possible that shoppers could move away from the city centre, preferring instead to shop in some other areas, leading to shops and businesses closing down. Thus, Khreis et al. [63] suggest that retailers and the auto industry may be some of the biggest opponents of car-free cities. It is therefore vital to find strategies that include the interests of businesses.

Centrality: Low-mobility societies would, by definition, lead to reductions in GHG emissions and local pollutants. The size of the reductions depends on the feasibility and acceptability of the various policies and the means by which low mobility is promoted. For example, compact urban planning could reduce GHG emission by 5–40%, whereas campaigns, marketing, information and tailored new-services aimed at lowering mobility could reduce emissions by 10% [72]. Low-mobility societies could, on the other hand, potentially threaten people's accessibility to basic transport needs in modern societies. Moreover, low mobility could threaten equal access to transport for low-income or other disadvantaged groups. Securing equal access to basic transport needs for all is therefore a prerequisite in low-mobility societies.

4.4. Compatibility

None of the Grand Narratives tell the complete story of how to achieve sustainable mobility. Rather, the narratives must be told and unfold simultaneously. Equally important, they must be compatible, which means that we must assess the relationships between the Grand Narratives. First, we argue that the Grand Narratives must be put in a *ranked order* (i.e. be prioritized) as follows: (1) low-mobility societies, (2) collective transport 2.0, and (3) electromobility [see also 28]. This means that the first priority is to curb transport volume and promote car-free cities. In circumstances where low mobility is inadequate (e.g. to satisfy accessibility to basic transport), efforts should be made to increase collective transport and various shared mobility schemes. Finally, in circumstances in which low mobility and increased collective transport is neither feasible nor acceptable (e.g. in sparsely populated rural areas), electromobility should be prioritized.

A second relationship is about *time and space*. We argue that the narratives must be told and unfold simultaneously. Thus, we cannot postpone electromobility while we promote low mobility. Nevertheless, there are two reasons to start locally: (1) low mobility (first priority) ultimately requires the involvement of and acceptance by individuals, and (2) low mobility and collective transport 2.0 are easier to implement in cities and local communities. Having said that, the collective transport 2.0 narrative requires the use of electric trains, buses, and shared cars (electromobility).

The third and fourth relationships are about *complementarity* (which means that more of one narrative means more of another narrative) and *substitutability* (which means more of one narrative means less of another). These relationships are conditional. Moving in order of prioritization, low-mobility, car-free societies mean more need for collective transport, which again means more electromobility (i.e. electric buses and shared cars). Correspondingly, more low-mobility societies and increased collective transport mean less private car ownership and use.

Moving in the *reverse* ranked order, however, the narratives could easily complement or substitute each other negatively. More electromobility in terms of electric private cars could well mean more private car ownership and use, and subsequently lead to less collective transport and counteract the promotion of car-free societies. Thus, promoting generous incentive packages for EVs (e.g. as they do in Norway) encourages people to buy and drive privately owned cars instead of taking the bus or participating in shared mobility schemes [81].

Policies must address the conditions under which narratives complement or substitute for each other positively or negatively. For example, car-free zones should not be opened to EVs. Moreover, instead of promoting incentive packages for EVs, conventional vehicles should be taxed more heavily. Finally, policies should discourage deeply ingrained habits of private car ownership and use wherever possible.

5. Conclusion

Three decades ago, the EC's Green Paper on the Impact of Transport on the Environment identified 'transport as a major contributor to energy and environmental problems since it is one of the main consumers of fossil fuels and is responsible for considerable nuisance and damage to the environment' ([5]: 2). In essence, they described an unsustainable mobility system. The Green Paper did not mince words. Its authors argued that we need 'to go to the very root of the problem—human behaviour', and that doing so requires 'fundamental changes in human values towards the environment and in patterns of behaviour and consumption'. Moreover, they argued for 'promoting fast, safe, and convenient urban and regional transport services and *reducing urban car traffic*' and were even bold enough to suggest 'the need to *encourage low transport demand*' (p. 1, our italics). This is a far cry from the 2011 EU White Paper, which stated that 'curbing mobility is not an option' [82].

Alas, the unsustainable mobility system still exists today. Fortunately, we have the knowledge, technology, and policies we need to change the mobility system into a sustainable one. Unfortunately, at present, the will-power to do so is lacking. That inertia must change and we now need sustainable mobility narratives that governments, people, and firms find understandable, attractive, and motivational so they can believe and subscribe to them [83,84].

This review paper has shown that there currently are nine dominant sustainable mobility narratives. However, to make a substantial contribution to the achievement of sustainable development, we need to go beyond the individual narratives. It is only when the individual narratives are combined that the scale of action needed can be achieved over the next 10–20 years.

We present three Grand Narratives: electromobility (of all modes), collective transport 2.0 (resting on various forms of shared mobility), and low-mobility societies (resting on car-free cities). Told simultaneously and in mutually supportive ways, these narratives tell a story about how to achieve sustainable mobility. Each narrative builds on a strategy, a set of agents, and a rationale that justify the needed actions. In practical policy terms, the strategies, agents, and Grand Narratives are likely to overlap. Nevertheless, there is a *main* strategy and a *key* agent involved in each Grand Narrative.

The electromobility narrative rests on an efficiency strategy and the use of experts and is justified by administrative rationalism. The collective transport 2.0 narrative rests on a modal shift strategy and relies on market mechanisms, and it is justified by economic rationalism. The low-mobility societies narrative rests on a reduction strategy and depends on the people, and it is justified by democratic pragmatism. Indeed, some of the Grand Narratives are more easily told than others, though this also depends on the question: who holds the power over the narratives? The answer to this question is not self-evident. We have seen industry leaders question the combustion engine and set in motion the quest for a future that includes the electric automobile (Elon Musk). We have seen politicians question our reliance on automobiles and advocate for bicycles and public transport (Boris Johnson). And we have seen unassuming teenagers insist on low-carbon societies, creating worldwide movements in their wake (Greta Thunberg). These examples show that all three Grand Narratives are socially possible, and that in working together, they may achieve sustainable mobility.

There may be other Grand Narratives, but we argue that the ones suggested here are robust and well-established in the literature on sustainable mobility. Moreover, as we have demonstrated, they are credible in terms of their feasibility, acceptability, and centrality.

The three Grand Narratives presented here are not a roadmap or a blueprint to sustainable mobility. We have not presented a detailed list of the necessary means or actions (although we have identified several). Our aim was to present an idea (sustainable mobility) and feasible and acceptable Grand Narratives that subsequently could achieve this idea. The difficulty, however, does not lie in telling these narratives. The difficulty lies in convincing all agents to believe in them. Researchers can tell them, but they need help from writers, artists, dedicated individuals, and charismatic politicians and business leaders to make everyone believe in them. Notwithstanding the importance of politicians, bureaucrats, firms, and social structures, it is ultimately the people that are key to creating the credibility and the acceptability of the narratives. People decide where and when to travel. People decide to travel by bike or bus. People decide which car to buy or not to buy. People select politicians who subsequently design policies. Achieving sustainable mobility is truly in *our* hands.

Declaration of Interest

None

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References

[1] Y.N. Harari, Sapiens. En kort historie om menneskeheten, Bazar Forlag, Oslo, 2017 [in Norwegian].
[2] R.L. Heilbroner, The Worldly Philosophers: the Lives, Times and Ideas of The Great Economic Thinkers, seventh ed., Touchstone Publishing, New York, 1999.
[3] T. Hák, S. Janoušková, B. Moldan, A.L. Dahl, Closing the sustainability gap, Ecol. Ind. 87 (2018) 193–195.
[4] B.K. Sovacool, J. Axsen, S. Sorrell, Promoting novelty, rigor, and style in energy social science: towards codes of practice for appropriate methods and research design, Energy Res. Soc. Sci. 45 (2018) 12–42.
[5] EC, A community strategy for 'sustainable mobility', Green Paper on the Impact of Transport on the Environment, COM (1992) 46 Final, Commission of the European Communities, Brussels.
[6] C.K. Riessman, Narrative Methods for the Human Sciences, SAGE Publications Ltd., Thousand Oaks, CA, 2007.
[7] W.R. Black, Transportation: a Geographical Analysis, Guilford Press, London, 2003.
[8] World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press, Oxford, 1987.
[9] P.R. Ehrlich, J.P. Holdren, Impact of population growth, Science 171 (1971) 1212–1217.
[10] Y. Kaya, K. Yokobori, Environment, Energy, and Economy: Strategies for Sustainability, United Nations University Press, Tokyo, 1997.
[11] L. Schipper, C.M. Lilliu, Transportation and CO2 Emissions: Flexing the Link. A Path for the World Bank, The World Bank, Washington, DC, 1999.
[12] H. Dalkmann, C. Brannigan, Transport and Climate Change, Sourcebook Module 5e, Federal Ministry for Economic Cooperation and Development, Eschborn, 2007.
[13] J. Sager, J.S. Apte, D.M. Lemoine, D.M. Kammen, Reduce growth rate of light-duty vehicle travel to meet 2050 global climate goals, Env. Res. Lett. 6 (2) (2011).
[14] E. Holden, G. Gilpin, D. Banister, Sustainable mobility at thirty, Sustainability 11 (7) (2019) 1965.
[15] I. Scoones, P. Newell, M. Leach, The politics of green transformations, in: I. Scoones, M. Leach, P. Newell (Eds.), The Politics of Green Transformations, Routledge, London, 2015, pp. 1–24.
[16] J. Dryzek, The Politics of the Earth: Environmental Discourses, third ed., Oxford University Press, Oxford, 2013.
[17] C. Churchman, Wicked problems, Manag. Sci. 14 (4) (1967) 141–146.
[18] R.H. Pereira, T. Schwanen, D. Banister, Distributive justice and equity in transportation, Transp. Rev. 37 (2) (2017) 170–191.
[19] D. Banister, Unsustainable Transport, Routledge, London, 2005.
[20] W.R. Black, Sustainable Transportation: Problems and Solutions, Guilford Press, New York, 2010.
[21] H. Castillo, D.E. Pitfield, ELASTIC—a methodological framework for identifying and selecting sustainable transport indicators, Transp. Res. D: Transp. Environ. 15 (4) (2010) 179–188.
[22] T. Litman, D. Burwell, Issues in sustainable transportation, Int. J. Global Env. Issues 6 (4) (2006) 331–347.
[23] R. Sietchiping, M.J. Permezel, C. Ngomsi, Transport and mobility in sub-Saharan African cities: an overview of practices, lessons and options for improvements, Cities 29 (3) (2012) 183–189.
[24] E. Holden, K. Linnerud, D. Banister, V. Schwanitz, A. Wierling, The Imperatives of Sustainable Development: Needs, Equity, Limits, Routledge, Abingdon, 2017.
[25] E. Holden, K. Linnerud, D. Banister, Sustainable passenger transport: back to Brundtland, Transp. Res. A: Pol. Pract. 54 (2013) 67–77.
[26] UN, Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015. United Nations General Assembly, New York, 2015.
[27] D. Banister, The trilogy of distance, speed and time, J. Transp. Geogr. 19 (4) (2011) 950–959.
[28] D. Banister, The sustainable mobility paradigm, Transp. Pol. 15 (1) (2008) 73–80.
[29] E. Holden, Achieving Sustainable Mobility: Everyday and Leisure-time Travel in the EU, Ashgate, Aldershot, 2007.
[30] MiSA, Norwegian High Speed Railway Project: Phase III, Bane Nor. (2012). Available from:https://www.banenor.no/contentassets/e5401672df4b438e80539b2719b78ab7/summary-report-final-report-atkins.pdf (Accessed 12 June 2019).
[31] G. Inturri, M. Ignaccolo, M. Le Pira, S. Caprì, N. Giuffrida, Influence of accessibility, land use and transport policies on the transport energy dependence of a city, Transp. Res. Procedia 25 (2017) 3273–3285.
[32] T. Schwanen, M. Dijst, F.M. Dieleman, Policies for urban form and their impact on travel: The Netherlands experience, Urban Stud. 41 (3) (2016) 579–603.
[33] M. Stevenson, J. Thompson, T.H. de Sá, R. Ewing, D. Mohan, R. McClure, J. Woodcock, Land use, transport, and population health: estimating the health benefits of compact cities, Lancet 388 (10062) (2016) 2925–2935.
[34] S. Gota, C. Huizenga, K. Peet, N. Medimorec, S. Bakker, Decarbonising transport to achieve Paris Agreement targets, Energy Effic. 12 (2) (2019) 363–386.
[35] B. Commoner, The environmental cost of economic growth, in: R.G. Ridker (Ed.), Population, Resources and the Environment, Government Printing Office, Washington, DC, 1972, pp. 339–363.
[36] A. Dunsire, Implementation in a Bureaucracy, Martin Robertson, Oxford, 1978.
[37] J. Hamari, M. Sjoklint, A. Ukkonen, The sharing economy: why people participate in collaborative consumption, J. Assoc. Inform. Sci. Tech. 67 (9) (2016) 2047–2059.
[38] J.A. Schumpeter, Capitalism, Socialism and Democracy, Harper and Brothers, New York, 1942.
[39] G. Boushey, Policy Diffusion Dynamics in America, Cambridge University Press, New York, 2010.
[40] M.D. Jones, D.A. Crow, How can we use the 'science of stories' to produce persuasive scientific stories? Palgrave Comm 3 (2017) 1–9.
[41] M.F. Dahlstrom, Using narratives and storytelling to communicate science with nonexpert audiences, Proc. Natl. Acad. Sci. USA 111 (4) (2014) 13614–13620.
[42] N. Bergman, Stories of the future: Personal mobility innovation in the United Kingdom, Energy Res. Soc. Sci 31 (2017) 184–193.
[43] Ford Motor Company, Sustainability Report 2017/2018, Ford Motor Company, 2018. Available from: https://corporate.ford.com/microsites/sustainability-report-2017-18/customers-products/reducing-emissions/plan.html (Accessed 23 January 2019).
[44] J Jacobs, The Death and Life of Great American Cities, Random House, New York.
[45] J.K. Leon, What Broadacre City can teach us, Metropolis(2014). Available from: https://www.metropolismag.com/cities/what-broadacre-city-can-teach-us/ (Accessed 24 January 2019).
[46] G.B. Dantzig, T.L. Saaty, Compact City—A Plan for a Liveable Urban Environment, W.H. Freeman, San Francisco, CA, 1973.
[47] M. Jenks, Compact City, in: A. Orum (Ed.), The Wiley Blackwell Encyclopedia of Urban and Regional Studies, Wiley Online Library, Hoboken, NJ, 2019.
[48] E. Holden, I.T. Norland, Three challenges for the compact city as a sustainable urban form: household consumption of energy and transport in eight residential areas in the Greater Oslo Region, Urban Stud. 42 (12) (2005) 2145–2166.
[49] D.J.C. MacKay, Sustainable Energy: Without the Hot Air, UIT Cambridge, Ltd, Cambridge, 2009.
[50] E. Figenbaum, T. Assum, M. Kolbenstvedt, Electromobility in Norway: experiences and opportunities, Res. Transp. Econ 50 (2015) 29–38.
[51] M. Castelli, J. Beretta, Development of electromobility in France: causes, facts and figures, World Electr. Veh. J. 8 (4) (2016) 772–782.
[52] O. Langhelle, J. Meadowcroft, D. Rosenbloom, Politics and technology: deploying the state to accelerate socio-technical transitions for sustainability, in: J. Meadowcroft, D. Banister, E. Holden, O. Langhelle, K. Linnerud, G. Gilpin (Eds.), What Next for Sustainable Development: Our Common Future at Thirty, Edward Elgar Publishing, Cheltanham, 2019, pp. 239–259.
[53] A. Tsakalidis, C. Thiel, Electric vehicles in Europe from 2010 to 2017: Is full-scale commercialisation beginning? An Overview of the Evolution of Electric Vehicles in Europe, Publications Office of the European Union, Luxembourg, 2018.
[54] B.K. Sovacool, Experts, theories, and electric mobility transitions: toward an integrated conceptual framework for the adoption of electric vehicles, Energy Res. Soc. Sci. 27 (2017) 78–95.
[55] C.A.S. Machado, N.P.M. De Salles Hue, F.T. Berssaneti, J.A. Quintanilha, An overview of shared mobility, Sustainability 10 (2018) 4342.
[56] P. Jittrapirom, V. Caiati, A.M. Feneri, S. Ebrahimigharehbaghi, M.J. Alonso González, J. Narayan, Mobility as a service: a critical review of definitions, assessments of schemes, and key challenges, Urban Plan. 2 (2) (2017) 13–25.
[57] G. Santos, Sustainability and shared mobility models, Sustainability 10 (2018) 1–13.
[58] UN Habitat, United Nations Conference on Housing and Sustainable Urban Development, Policy Paper 9 (2016), Urban Services and Technology, United Nations, Quito, Ecuador.
[59] J. Rosenzweig, M. Bartl, A review and analysis of literature on autonomous driving, E-J.: Mak. Innov. (2015) Available from: http://www.michaelbartl.com/article/a-review-and-analysis-of-literature-on-autonomous-driving/ , Accessed date: 11 June 2019.
[60] F. Sprei, Disrupting mobility, Energy Res. Soc. Sci 37 (2018) 238–242.
[61] O.H. Hagen, A. Tønnesen, K. Fossheim, Car-Free City Solutions in Three Nordic Cities, TØI Rapport 1552/2017 [in Norwegian], Norwegian Centre for Transport Research, Oslo, 2017.
[62] A. Tønnesen, S. Frislid Meyer, E.G. Skartland, H.B Sundfør, European Cities With Car-Free City Centres, Norwegian Centre for Transport Research, Oslo, 2016 [in Norwegian].
[63] H. Khreis, M. Nieuwenhuijsen, J. Bastiaanssen, Creating car free cities: rational, requirements, facilitators and barriers [supplementary material], J. Transp. Health 5 (2017) S65–S66.
[64] J. Fagerberg, S. Laestadius, B.R. Martin, The triple challenge for Europe: the economy, climate change, and governance, in: J. Fagerberg (Ed.), Innovation, Economic Development and Policy, Edward Elgar Publishing, Cheltanham, 2016.
[65] M. Ryghaug, M. Toftaker, A transformative practice? Meaning, competence, and material aspects of driving electric cars in Norway, Nat. Cult. 9 (2) (2014) 146–163.
[66] L. Ingeborgrud, M. Ryghaug, User perceptions of EVs and the role of EVs in the transition towards low-carbon mobility, Proceedings of the ECEEE, Belambra Les Criques, Toulon/Hyères, France, 2017 Available from: https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2017/4-mobility-transport-and-smart-and-sustainable-cities/user-perceptions-of-evs-and-the-role-of-evs-in-the-transition-towards-low-carbon-mobility/ , Accessed date: 15 January

2020.
[67] M. Anfinsen, V.A. Lagesen, M. Ryghaug, Green and gendered? Cultural perspectives on the road towards electric vehicles in Norway, Transp. Res. D: Transp. Environ. 71 (2018) 37–46.
[68] J. Kester, B.K. Sovacool, V. Heida, From flying cars to Tesla: examining the personal automobile preferences of primary schoolchildren in Denmark and the Netherlands, Energy Res. Soc. Sci. 56 (2019) 101204.
[69] A. Moro, L. Lonza, Electricity carbon intensity in European Member States: impacts on GHG emissions of electric vehicles, Transp. Res. D: Transp. Environ. 64 (2018) 5–14.
[70] E. Fraedrich, B. Lenz, Societal and individual acceptance of autonomous driving, in: M. Maurer, J.C. Gerdes, B. Lenz, H. Winner (Eds.), Autonomous Driving. Technical, Legal and Social Aspects, Springer Verlag, Berlin, 2016, pp. 621–640.
[71] M. Nees, Acceptance of self-driving cars: an examination of idealized versus realistic portrayals with a self-driving car acceptance scale, Proc. Hum. Factors Ergon. Soc. Annu. Meet. 60 (2016) 1449–1453.
[72] F. Creutzig, Evolving narratives of low-carbon futures in transportation, Transp. Rev. 36 (3) (2015) 341–360.
[73] International Energy Agency, World Energy Outlook 2012, International Energy Agency, Paris, (2012) Available at: https://www.oecd-ilibrary.org/energy/world-energy-outlook-2012_weo-2012-en , Accessed date: 11 June 2019.
[74] F. Furtado, L. Martinez, O. Petrik, Shared Mobility Simulations for Helsinki, International Transport Forum, Paris, 2017. Available from: https://www.itf-oecd.org/shared-mobility-simulations-helsinki (Accessed 26 March 2019).
[75] J. Viegas, L. Martinez, Transition to Shared Mobility: How Large Cities Can Deliver Inclusive Transport Services, Corporate Partnership Board Report, International Transport Forum, Paris, 2017. Available from: https://www.itf-oecd.org/sites/default/files/docs/transition-shared-mobility.pdf (Accessed 26 March 2019).
[76] D.J. Fagnant, K. Kockelman, Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations, Transp. Res. A: Pol. Pract. 77 (2015) 167–181.
[77] D. Rojas-Rueda, M. Nieuwenhuijsen, H. Khreis, Autonomous vehicles and public health: literature review [supplementary material], J. Transp. Health 5 (2017) S13.
[78] ITF, Key Transport Statistics, International Transport Forum, Paris, 2018 Available from: https://www.itf-oecd.org/sites/default/files/docs/key-transport-statistics-2018.pdf , Accessed date: 13 June 2019.
[79] J.O. Nijhuis, Consuming Mobility: A Practice Approach to Sustainable Mobility Transitions, Wageningen Academic Publishers, Wageningen, 2013.
[80] A. Gundlach, M. Ehrlinspiel, S. Kirsch, A. Koschker, J. Sagebiel, Investigating people's preferences for car-free city centers: a discrete choice experiment, Transp. Res. D: Transp. Environ 63 (2018) 677–688.
[81] K.Y. Bjerkan, T.E. Nørbech, M.E. Nordtømme, Incentives for promoting battery electric vehicle (BEV) adoption in Norway, Transp. Res. D: Transp. Environ 43 (2016) 169–180.
[82] EU, Roadmap to a Single European Transport Area – Towards a Competitive and Resource Efficient Transport System, White Paper on Transport, COM (2011) 0144 Final, European Union, Brussels.
[83] D. Banister, R. Hickman, Transport futures: thinking the unthinkable, Transp. Pol 29 (2013) 283–293.
[84] M. Tight, P. Timms, D. Banister, J. Bowmaker, J. Copas, A. Day, D. Drinkwater, M. Givoni, A. Gühnemann, M. Lawler, J. Macmillen, A. Miles, N. Moore, R. Newton, D. Ngoduy, M. Ormerod, O'Sullivan M., D. Watling, Visions for a walking and cycling focussed urban transport system, J, Transp. Geog. 19 (6) (2011) 1580–1589.