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Local governance of greenhouse gas emissions from air travel

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ABSTRACT

Global greenhouse gas emissions from air travel (GHG-A) are on the rise, and projections point towards a rapid growth in the coming decades. This study aims to examine how local government (cities), addresses GHG-A in their Sustainable Energy Action Plans (SEAP). To fulfil this aim, over 200 SEAPs were analysed focusing on three issues: (1) Treatment of GHG-A in local emissions inventories; (2) Policy initiatives within this domain; and (3) The cities' perceptions of the conflicts of interests. Results showed that more than half of the cities acknowledge the challenge of GHG-A, around one third include GHG-A in their emissions inventories, and more than one quarter have initiated policy interventions. To categorise these interventions, we have added a mode 'governing by agenda setting' to an existing analytical framework, 'Modes of governing'. With their authority limited to the local setting, this mode of governing is a common channel for cities to push changes at higher levels.

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Introduction

Global greenhouse gas emissions from air travel (GHG-A) have increased by on average 3.3% per year since 1990 due to the rapid growth in traffic volumes of 5.2% per year (IATA, 2015, 2017) while the improvements in emission intensities have been more modest at around 1.9% per year (Kamb, Larsson, Nässén, &Åkerman,2016). Researchers have highlighted the need for policies to reduce the rise of GHG-A (Cohen, Higham, Gössling, Peeters, & Eijgelaar, 2016; Hayden, 2014).

A global carbon tax on jet fuel would probably be the most efficient policy instrument, but the Chicago Convention (Article 24) of 1944 prohibits taxes on jet fuel for international flights. Furthermore, fuel for international flights was not included in the Kyoto protocol and relegated to the International Civil Aviation Organization (ICAO) for action (Peeters, Higham, Kutzner, Cohen, & Gössling, 2016). However, fuel for domestic flights is included in national GHG inventories and is therefore also included in national GHG emissions reduction targets (Bows & Anderson, 2007). In 2016, the ICAO decided to implement a carbon offset scheme, whereby additional GHG emissions from global aviation after 2020 will be compensated by abatement activities in other sectors (ICAO, 2016). For the European Economic Area (EEA), the EU Emissions Trading Scheme (EU ETS) covers flights that *both* take-off and land within the EEA (European Commission, 2014). At a national level, policies exist that address domestic flights, and some countries have introduced a passenger tax.

Historically, the focus has been on global and national policies and actions, but Wood, Bows, and Anderson (2010) argue that all levels of governments, including the sub-national level, need to act in order to achieve a reduction in GHG-A. Many cities have ambitious local climate strategies to reduce GHG emissions, often

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documented in a Sustainable Energy Action Plan (SEAP), but whether or not these action plans include GHG-A has not been studied.

Given a need for action at all levels of government and a lack of information about how GHG-A is treated by cities, this study aimed to examine how cities are addressing the reduction of GHG-A in their SEAPs. Three specific issues are taken up by the following research questions: (1) How are GHG-A treated in *local emissions inventories*? (2) What *policy initiatives* have been taken within this domain? and (3) What are, from the cities' perspectives, the *conflicts of interest* related to this domain? Previous research has investigated aviation climate policies at the global and national levels. At the local level, Wood et al. (2010) have studied how GHG-A is treated in the emissions inventories of British sub-national regions. In comparison to Wood et al. (2010), this study has a broader scope because it includes more countries and has added research questions (2) and (3).

Theory

Local climate governance

A basic principle of environmental policy is to match the policy instrument with the scale of the environmental problem at play. In environmental law, this is known as the matching principle (Adler, 2005; Butler & Macey, 1996). It is based on an understanding of environmental problems as externalities or problems of collective action (Brennan, 2009; Young, 2002). From this perspective, local policies addressing the global challenge of climate change, such as measures to limit air travel, are paradoxical. Firstly, such policies would usually not be likely to gain political support, since the costs of introducing such policies would be incurred at the local level while the benefits would be shared globally (Hardin, 1968; Olson, 1965). Secondly, even if local climate policy measures were nonetheless to be implemented, there may be problems in terms of their effectiveness and efficiency due to leakage, i.e. the direct or indirect relocation of polluting activities to outside the area subject to such an environmental policy (Wiener, 2007).

Despite the reasons for non-action mentioned above, we are witnessing a strong level of commitment and action in addressing climate change at the local level (Bulkeley, 2010; Castán Broto & Bulkeley, 2013; Hoffmann, 2011; Jordan et al., 2015). This has partly been explained by the increasingly complex nature of environmental challenges, and the fact that many climate policies come with local co-benefits, such as decreased local air pollution (Ostrom, 2010).

Air travel is a particularly interesting example in this regard. The share of local co-benefits in the form of decreases in air pollution and noise appear more limited than for many other environmental policy areas, and the risks associated with these policy measures, in the form of fewer direct flights for example, which could impact local businesses negatively, loom larger. Policies targeting GHG-A are therefore particularly paradoxical in relation to the matching principle. However, we are still witnessing initiatives in this area as well.

Emissions inventories in local governance

The importance of including GHG-A in emissions inventories has been highlighted by Wood et al. (2010), who argued that this is a prerequisite for (1) identifying emissions reduction opportunities; (2) monitoring the impacts of policies; (3) understanding the proportion of national aviation emissions that are the 'responsibility' of the region; and (4) being able to compare the quantities of aviation emissions with other sources of emissions.

In order to adapt the structure of Wood et al. (2010) to our focus on cities, each city's choice of the territorial or consumption system boundary as the basis for their emissions inventories has been added to this categorisation. The territorial system boundary is often referred to by cities as Scope 1 and the consumption system boundary as Scope 3[1] (Chavez & Ramaswami, 2011). The choice of a consumption or a territorial system boundary for an emissions inventory results in a difference in the prominence of GHG-A. A city with an airport hub within its territory is more likely to allocate more emissions based on a territorial system boundary rather than a consumption system boundary that includes only its own residents' air travel. A city without an airport within its territory, is more likely to allocate more emissions based on a consumption system boundary.

Therefore, each city's choice of system boundary is important to note, as is the reasoning behind their choice. The complexities of proper accounting due to 'emissions serving a region', which is also the case for port cities (e.g. Rotterdam), is emphasised in the Greenhouse gas protocol (GPC) (Fenton, 2017). GPC, a city-scale framework aiming to standardise reporting (Wattenbach et al., 2015), suggests different inventory methods depending on the choice of scope (1,2,3) (Fong et al., 2014).

Modes of governing at the local level

In order to analyse how cities address the reduction of GHG-A in their SEAPs, we drew on a typology of policy instruments into different modes of governing at the local level that was developed by Bulkeley and Kern (2006; see also Kern & Alber, 2008). The original typology distinguishes between four different capacities employed in local governance:

- *Self-governing* refers to instruments based on the capacity to manage the city's own organisation. It includes aspects such as travel policies for municipal employees or the renovation of the municipal building stock to increase energy efficiency.
- *Governing by provision* refers to initiatives based on the local government's role as a provider of goods and services, and may include for example the provision of low-carbon district heating or the provision of public transport.
- When *governing by authority*, local governments rely on their capacity to introduce sanctions if a certain mandate is not followed. This may refer to local regulations, such as those related to road traffic. Also, the municipality's responsibility for spatial planning usually includes some element of governing by authority through legally binding spatial plans.
- In contrast, *governing by enabling* refers to the local government's capacity to persuade and encourage through the use of *positive* incentives such as subsidies or through information campaigns.

Different modes of governing are not mutually exclusive and are often employed in combination (Bulkeley, Watson, Hudson, & Weaver, 2005). While *self-governing* entails the least challenges in terms of the capacity to act, the impact that can be achieved through this mode of governing is limited. In the case of *governing by authority*, the local government's capacity to influence is usually rather limited. Therefore, many municipalities tend to focus on initiatives which can be categorised as *governing by enabling* when seeking to influence outcomes beyond their own organisations. However, *governing by enabling* comes with its own challenges in terms of effectiveness, efficiency and cost.

Some previous suggestions have been made to extend the typology to include an additional mode of governing. Bulkeley et al. (2009) identified a mode as *governing by partnership* in which state and non-state actors work together. This is conceptualised as an extension of *governing by enabling*, in which the state acts on more equal terms with non-state actors. Similarly Holm, Stauning, and Søndergaard (2012) argued that *governing by enabling* could be taken one step further by emphasising the role of local governments as 'strategic actors in shaping local sociotechnical networks, including the shaping of shared visions and goals for such networks'. In addition to policy implementation, the modes of governing may also address outputs in terms of policy formation (Khan, 2013). Policy formation is particularly important in relation to partnership and vision building. Our initial results confirmed the need for extending the typology. Building on the work done by Bulkeley et al. (2009), Holm et al. (2012) and Khan (2013), we add the following fifth mode of governing:

> 5. *Governing by agenda setting*. The local government's capacity to act through various types of partnerships and other fora in order to build visions and influence policy and industry agendas *beyond* the local setting in a direction that supports the overarching goals set by local actors.

With their authority limited to the local setting, such as in the case of GHG-A, governing by agenda setting can be an important channel for cities to express their concerns and support change at a higher level.

While the modes of governing as outlined above are engaged in ways to promote certain developments, Zvolska, Lehner, Voytenko Palgan, Mont, and Plepys (2017) highlight the possibilities for local governments to act both as promoters and inhibitors through these different modes of governing. We attend to this aspect by looking at goal conflicts between different policy areas and how they manifest through the different modes of governing as applied to conflicting goals (Lougheed, Metuzals, & Hird, 2017).

Method and data

The main source of data for this study was a selection of Sustainable Energy Action Plans (SEAP), which is an umbrella term for official documents that describe a city's measurements of emissions as well as plans and activities to reduce them. Different cities use different names for these documents, and the details of their content may also differ. Two networks of cities aiming for sustainability, the Compact of Mayors and the Covenant of Mayors, provide databases of Sustainable Energy Action Plans (SEAP) uploaded by the cities in these networks. These databases have been used as the main sources of SEAPs.

The SEAP documents were searched using specific search words.[2] When a text about air travel was found in a SEAP, it was included in the data material for relevant parts of the analysis. Emissions inventories were sorted according to the schematic outline in Wood et al. (2010) (see Theory section). Policy interventions were characterised and analysed according to the typology of the five modes of governing outlined above.

Our search was limited to German-, English- and Scandinavian-speaking OECD countries, which comprised around 400 cities in the databases[3] mentioned above, of which more than 200 had uploaded SEAP documents. Supplementary searches for SEAPs were carried out on the websites of cities in countries with a low number of SEAPs in the databases. In total, 231 SEAPs were included in the analysis (see Appendix B).

The SEAPs in this study were predominantly from cities and municipalities, with only a handful of exceptions where the SEAPs were from subnational regions (comprising several municipalities/cities). For the convenience of the reader, we refer to local governments as cities. All documents from cities that are used as specific examples in the Results section are listed in Appendix A. In order to understand conflicts of interest and countervailing activities, we have also searched for criticism, and responses to criticism, of cities' SEAPs. These sources are listed in the References list.

Results

A first screening of the SEAPs showed that more than half of the cities acknowledge GHG-A as a climate issue. In their emissions inventories, which is the usual basis for goal setting, 29% include GHG-A, 15% exclude GHG-A with an explicit reason for doing so (such as that it is beyond their policy reach), and 56% do not mention at all how they treat these emissions. Furthermore, 27% of the analysed cities have initiated policy interventions to reduce GHG-A. Interestingly, some of the cities taking action were the same that claimed that they did not include emissions in their inventories. Figure 1 illustrates the overall results and the following sections go deeper into these results and provide specific examples.

Emissions inventory

Table 1 provides an overview of system boundaries of the local emissions inventories described in the SEAPs. 15% of the analysed cities explicitly state that they exclude GHG-A from the emissions inventory. 56% of the cities do not mention how GHG-A are treated in their emissions inventory. It is likely that most of these cities either exclude GHG-A or apply a more conventional, territorial system boundary on GHG-A. The following section elaborates on the system boundaries shown in the table, gives examples of goals for reducing GHG-A, and finishes with future projections of GHG-A. None of the cities refer to other established inventory methods or standards, such as the Greenhouse gas protocol (GPC) or ISO 37120, when describing how they treat GHG-A in their SEAPs. Several of the SEAPs are also older than the GPC system for cities.

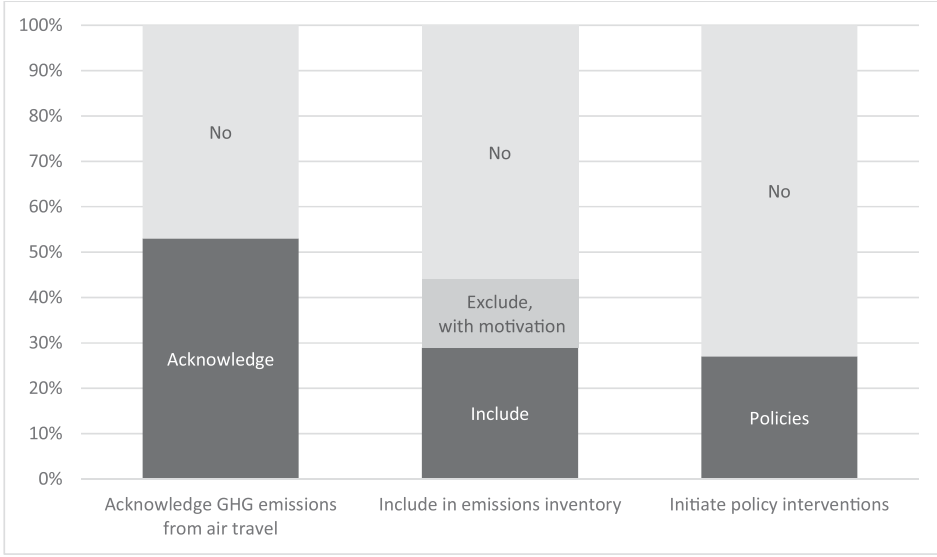

Figure 1. Summary of how sustainability focused cities address GHG emissions from air travel in their Sustainable Energy Actions Plans. Country-specific results are provided in Appendix B.

Territorial system boundary

Different ways of implementing a territorial system boundary were found among the SEAPs analysed. Stockholm (SE) includes take-off and landing emissions up to an altitude of 915 m. Berlin (DE) uses a mixed perspective, allocating 70% of tanked fuel at its local airports in the region of Brandenburg. Berlin also comments that since the Berlin Tegel airport has few international flights, the 'tanked fuel' allocation method allocates lower GHG emissions to Berlin than a consumption system boundary would. Munich (DE) on the other hand, only includes ground GHG emissions at its local airport when considering GHG-A.

Consumption system boundary

For cities such as Manchester (GB) that have a major airport hub within their territorial boundaries, the amount of GHG-A could be seen as unfairly high with a territorial system boundary, since the airport serves a larger area than the city itself. Manchester has therefore chosen a consumption system boundary in the form of the *resident as consumer*. In other cases, such as Gothenburg (SE), the consumption system boundary is linked

Table 1. System boundaries on GHG emissions from air travel in local emissions inventories. Each system boundary is shown with identified alternative implementations and examples of such cities.

System boundary	Example cities
Territorial	
Take-off and landing	Stockholm (SE), Hagfors (SE), Västerås (SE)
Tanked fuel at local airport	Berlin (DE), Lidköping (SE)
Ground operations at local airport	Munich (DE)
Consumption	
Resident as consumer	Gothenburg (SE), Aspen (US)
Tourist as consumer	Aspen (US)
Own organisation as consumer	Haninge (SE), Gothenburg (SE), Reykjavik (IS)
Exclusion of GHG Emissions from Air Travel	Dublin (IE), Wolfurt (AT) Bregenz (AT), Tyresö (SE), San Francisco (US), Philadelphia (US), Gislaved (SE), Knowsly, GB

to the city's climate goal of a fair and sustainable emissions level by 2050 (Hult & Larsson, 2016). With reference to this policy, they argue that they are obliged to include the GHG-A of their residents. As a consequence, inbound visitors by air are excluded from the city's climate strategy efforts, and means there is no formal conflict with the goal of increasing the number of inbound tourists by air, for example, by marketing the destination to far away tourists. A different type of consumption system boundary is used by Aspen (US), namely the *tourist as consumer*, and with this focus outbound tourists are excluded.

Choosing *own organisation as consumer* is a common way of including GHG-A in a city's emissions inventory. With this system boundary, perceived authority is high and interventions such as travel policies restricting air travel in businesses are frequently implemented.

Many cities (Worms DE, Hagen DE, Eppelheim DE, Faxe DK, Vordingsborg DK, Helsingör DK, Naestved DK, Zürich, CH, El Cerrito, US) state that they use national data on per capita emissions as a proxy for emissions at the local level. However, these cities do not specify the scope of this national emissions data. This lack of information means that we cannot determine whether a territorial or consumption system boundary is being used, for example whether the data includes only domestic flights by national residents and visitors (territorial system boundary), or whether all air travel, domestic and international, by national residents is included but visitors are excluded (consumption system boundary). The use of national per capita data is stated as one way of overcoming the difficulty of collection GHG-A data, by El Cerrito (US), for example. On the other hand, it is difficult to track progress with this approach.

Exclusion of air travel from an emissions inventory

In SEAPs where a reason for the exclusion of GHG-A was given, it was one of the following:

(1) Perceived authority to influence was low or non-existent and the city instead points out the need for action at the national and international levels (e.g. Knowsly, GB).
(2) Lack of data or too complicated to collect data, making it hard to monitor the outcomes of goals and interventions (e.g. Dublin, IE).
(3) No airport within their territorial boundaries. Therefore, no perceived scope for action (e.g. Gislaved, SE).
(4) Recommendations from ICLEI and the Compact of Mayors exclude GHG-A from emissions inventories (e.g. Portland, US).

Goals for reducing GHG emissions from air travel

The inclusion of GHG-A in emissions inventories makes it possible to set quantitative goals. Only a few cities specify measurable goals for aviation emissions. Gothenburg (SE) states that the climate impact from its residents' air travel is to be reduced by 20% by 2030 compared to 2012. In Uppsala (SE), the goal is to decrease all business air travel by its residents by 25% by 2050. Munich (DE), on the other hand, has chosen to reduce the scope of its climate goal to only cover ground CO_2 emissions at its local airport, aiming for Munich airport's expansion to be CO_2-neutral in relation to its ground CO_2 emissions.

Future projections of GHG emissions from air travel

Apart from emissions inventories, some cities also undertake future projections of sources and trends in GHG emissions. The examples below show how cities highlight the rising trend in GHG-A, in absolute numbers and in proportion to other sources.

Oslo (NO) concludes that by 2030, the greatest climate impact from its residents will come from international flights and the consumption of goods, and therefore advocates implementing a consumption system boundary for emissions. Zürich (CH) refers to a business-as-usual scenario for transport for 2007–2050, and comments on the striking rise in the share of fuel for aviation in relation to other sources of emissions expected during this period. Manchester (GB) states national carbon footprint targets and their implications:

> Although currently accounting for a relatively small share of the UK's carbon footprint, a Tyndall centre analysis has shown that if air travel continues to grow at the expected rate, with realistic improvements in efficiency, then by 2050 air traffic alone will contribute the entirety of the carbon emissions the UK is likely to be able to allow. (Manchester City Council, 2009)

Stockholm (SE) and Guldborgsund (DK), on the other hand, point out that the increase in GHG-A will be limited by the inclusion of intra-EEA flights in the EU ETS.

Policy interventions

More than one quarter of the analysed cities mention policy interventions aimed at reducing GHG-A. This includes implemented interventions (non-italic in the table) as well as those *under investigation* (italic in the table). Generally, stated ambitions to reduce emissions without specified measures were excluded. The interventions were categorised according to the following three reduction strategies: *(A) Reducing air traffic volume* by for example promoting alternatives, increasing the cost of flying; *(B) Improving the eco-efficiency of aviati*on, by for example technological improvements to aircraft or switching to biofuel; and *(C) Reducing ground level GHG emissions* by for example 'greener' transport to/from airports or fossil-free vehicles at airports. Table 2 shows the interventions found categorised into the five modes of governing (see Theory section) as well as the reduction strategy pursued in each intervention.

Most interventions found were within the modes *self-governing* and *governing by enabling*. *Reducing air traffic volume* is the reduction strategy applied most frequently in these interventions. The modes of governing applied are consistent with the previous results for perceived authority. Cities stated high levels of control of emissions resulting from their own internal activities (*self-governing*) and their capacity to use information to reduce air travel by their residents, tourists and local businesses (*governing by enabling*). On the other hand, not a single intervention could be categorised as *governing by authority,* and only a few interventions were found that focused on improvements in the eco-efficiency of aviation, which some cities state has low potential for influence by a local actor. For interventions focused on reducing ground level GHG emissions at airports and in airport transfers, a few examples were found in every mode of governing. If the city is the owner of the local airport or owns the land on which the airport is located, it also has more scope for influencing GHG-A within the modes *governing by authority* and *governing by provision*.

The analysis also showed a substantial share of initiatives in the fifth mode of governing, *governing by agenda setting*. Many cities mention that they participate in various fora in order to put the reduction of GHG-A on the national, global and aviation industry's agendas. Section 'Governing by agenda setting' below presents the issues being advocated by cities and it can be concluded that all reduction categories are covered.

The following sections provide examples for each mode of governing, starting with examples from reduction strategy A and then B and C for each mode.

Self-governing

The most common intervention found was the reduction of GHG-A from business travel by the city's own staff, in other words some kind of travel policy. A travel policy might include restrictions such as no flying under 400 km (e.g. Dortmund, DE), the provision of technologies for and the encouragement of virtual meetings (e.g. Seattle US, Trondheim NO, Västerås SE, Piteå SE, Aalborg DK, Guldborgsund DK, Gothenburg SE), and/or the introduction of an extra charge when buying an air ticket. This extra charge is either an 'internal tax' where the money usually goes to internal CO_2 reduction projects (e.g. Karlstad SE, Piteå, Bremen DE, Gothenburg, Aberdeen GB, Botkyrka SE) which include equipment for virtual meetings, the purchase of e-bikes, solar panels, etc.; or an extra charge to cover external carbon offset credits for the kilometres flown (e.g. Limerick GB, Melbourne AU, Stavanger, Porsgrunn NO, Munich DE, Dortmund, Düsseldorf DE, Freiburg DE, Bonn DE, Copenhagen DK, Zürich CH).

Some cities own, or partly own, the local airport, which gives the city the opportunity to directly influence ground-level emissions. For example, Karlstad (SE) has eco-certified Karlstad Airport, and Berlin (DE), owner of Airport Berlin-Brandenburg GmbH, wants to introduce compulsory climate compensation for ground GHG emissions.

Table 2. Categorisation of local interventions to reduce GHG emissions from air travel.

Mode of governing Reduction strategy	Self-governing	Governing by provision	Governing by authority	Governing by enabling	Governing by agenda setting
(A) Reducing air traffic volume	Not permitting business air travel under a certain distance Providing virtual meeting technologies/services for employees Internal tax on employees' business air travel External carbon offset for employees' business air travel Individual bonuses for reduction in employees' business travel Procurement avoiding products transported by air– avoiding products transported by air	Providing public transport services to local leisure destinations Investing in alternative modes of transport to air travel Providing the possibility for residents and businesses to buy carbon offsets for their air travel emissions, e.g. at airports or on the city's website.	The use of authority for land use in the planning phase for airports	Including air travel in information about personal GHG footprint, footprint calculator, etc. Providing support to businesses of how to measure and reduce their emissions from air travel Informing about offsetting emissions from air travel Promoting climate-smart holiday travel for residents (marketing for staycation), e.g. at local tourist office, the city's website or in local newspaper. Promoting climate-smart transport for inbound tourists, e.g. at the local tourist office and on the website. Promoting longer stays by inbound tourists, e.g. by extending a business visit with a holiday.	Advocating policies and other measures to reduce GHG emission from air travel through partnerships and in fora with stakeholders including: • Policy makers at the national and international levels • Aviation sector • Academia
(B) Improving eco-efficiency of aviation		Providing a supply system for jet biofuel at owned airports	Introducing differentiated landing/take-off charges at owned airports	Supporting the introduction of jet-biofuels at the local airport	
(C) Reducing ground level GHG emissions at the airport and to/from the airport	Implementing environmental management systems for owned airports Carbon offsets for ground operations emissions from owned airports	Providing 'greener' transport to/from airports, e.g. bus lines using biofuels	Environmental requirements on airports located on land owned by local government	Providing grants for improvements in energy efficiency at local airports ground operations.	

Governing by provision

Another way to reduce air travel is to provide other modes of transport or travel destinations. Increasing access to leisure destinations in the local environs by the provision of public transport services is one way of doing this. Providing alternatives for longer distances, such as high-speed trains, is costly beyond the local area, and such projects are mostly financed and implemented at the national level. Cities might contribute funds or human resources in order to increase the chance of this type of national investment. Many SEAPs include such activities, but do not specify how this support to alternative modes of transport is to be implemented.

Some cities also work with carbon offset credits. Since 2011, Hamburg (DE) has provided a service whereby passengers at Hamburg airport can purchase a EUR 10 carbon offset credit using their mobile phone. Other examples were found in Christchurch (NZ), which is investigating a project called *Plant trees as you travel by air,* and in Aspen (US), which is working with other stakeholders to create a voluntary carbon offset programme for air travel. Salt Lake City (US) mentions concerns about potential double counting of carbon offset credits and does not include its purchases of carbon offset credits in its GHG emission reduction targets.

An example of improving the eco-efficiency of aviation was found in Karlstad (SE), where the city provides a supply system for jet biofuel to its airport. 'Greener' public transport to and from the airport is another common way of using *governing by provision* to reduce ground-level emissions. Transport of passenger to and from airports typically stands for around half of the ground level GHG emissions (Swedavia, 2015).

Governing by authority

No implemented interventions in the SEAPs were found in the *governing by authority* mode. Moreover, the interventions under investigation in this mode are all coupled with ownership of the airport and/or ownership of the land used by the airport. Berlin, as owner of Flughafen Berlin-Brandenburg, is investigating the possibility of introducing differentiated landing/take-off charges coupled to CO_2 emissions as an incentive to improve the eco-efficiency of aviation. In its role as land owner, Västerås (SE) is exploring imposing environmental requirements on the airport operator.

Governing by enabling

In this category, we found the largest number and range of interventions and most of these are also widely used. This is not surprising in a policy area with limited authority. The majority of the interventions target reduction strategy A: reducing air traffic volume. Typical activities in this mode are information about the emissions consequences of air travel and alternatives to travel by air, directed at different target groups, such as school students, outbound tourists and businesses.

The inclusion of GHG-A in information about personal carbon footprint is used in many cities as a way to *govern by enabling*. Examples are calculator services on a city's website (e.g. Freiburg, DE), and pilot groups in projects like the 'Neighborhood Footprint campaign' in Vancouver (CA). Bremen (DE) also encourages its residents to 'Become *a climate saver*', where the 'saver' is encouraged, among other lifestyle changes, to 'manage without flying'. Another target group is local businesses. These are offered support to measure and monitor their air travel emissions (e.g. Seattle, US).

Depending on the scope of emissions inventories, the focus may be on the residents' own leisure travel and/or inbound tourists. Many examples are found where residents are encouraged to travel 'climate smart' during their holidays. The tourist office in Luzern (CH) has a campaign featuring local highlights that targets its own residents, and has also proposed including '*Relaxation and Tourism options without flying*' in standard mobility consultations for residents. Another example is from Rheine (DE), where newly retired people are identified as a target group in a campaign called '*Climate protection in the area of Mobility by older people: Local travel instead of air travel*'.

Governing by agenda setting

The SEAPs reveal that perceived authority to significantly decrease GHG-A is low at the local level, and many cities express the need for national and international policies. Some cities go further and state that they intend to push for action at higher levels. In the right column of Table 2, we list stakeholder groups for these actions. Below we

specify what *issue* cities are advocating to be put on the agenda while participating in these fora and the reduction strategy in focus (see letter references for each issue). Reduction strategies to reduce traffic volume (A) and promote eco-efficiency improvements (B) are being advocated according to the SEAPs. There are seldom more detailed specifications given in the SEAPs about the circumstances and the timing of cities' agenda setting actions.

For the stakeholder category *policy makers*, cities mostly act in the national arena to push for the introduction of national policies or for the state to push for policies at the international level. The following list gives examples of issues and the cities raising them that were found:

- Support alternative transport modes (A)
  Gothenburg (SE) advocates for high-speed trains.
- Stop VAT exemptions on international air tickets (A)
  Berlin (DE) advocates for stopping the VAT exemption on international air tickets in order to harmonise the tax level for different transportation options.
- Harmonise tax levels for different modes of transport (A, B)
  Berlin (DE) advocates for a carbon tax on kerosene in the EU and, until that is in place, an increased passenger tax. Other cities that make similar statements are Bremen (DE) and Zürich (CH).
- Include GHG-A in a global agreement (A, B)
  London (GB) has advocated directly in the international arena for the inclusion of GHG-A in COP15.
- Differentiate landing/take-off fees based on CO_2 and NO_x (B)
  Zürich, Bremen, Gothenburg and Berlin.
- GHG-optimised air traffic management (B)
  New York (US) encourages the Federal Aviation Administration to implement and enable more efficient take-offs and landings.
- Introduction of jet biofuel (B)
  Minneapolis (US) advocates for regulatory actions designed to accelerate the introduction of jet biofuel

For the stakeholders *aviation sector* and *academia*, the following examples were found:

- Support technological development (B)
  Aspen (US) encourage the use of more fuel-efficient jets and discourages the use of less fuel-efficient jets.
- Introduce jet biofuels (B)
  Chicago (US) promotes partnership to support biofuels development through the Midwest Aviation Sustainable Biofuels Initiative, and through continued expansion of the Airports Going Green movement.
- Introduce green landings and take-offs (B)
  Växjö (SE), Småland Airport and airlines operating from it are working together for the introduction of green landings and take-offs.
- Cooperation with academia to increase knowledge (A, B)
  Vancouver (CA), Gothenburg (SE), Berlin (DE), Hamburg (DE), Luzern (CH)

To serve policy makers with transparent credible information, cities can include GHG-A in standardised city emission inventories, as mention in the theory section.

Conflicts of interests

With the reduction strategy of reducing air traffic volume, some cities state that this can be in conflict with other goals. A major concern is accessibility, which is perceived as crucial in order to be an attractive region for business, academia, tourism, and as a city to live in. All these aspects are also coupled with employment and economic growth. The airport itself is also mentioned as an important employer. Some cities also own

the local airport, which means financial gains from an increase in air travel (e.g. Manchester GB, Berlin DE).

Manchester highlights the difficulty of enforcing a reduction in GHG-A at the local level and the need for agenda setting to develop national and global solutions:

> There is a real and immediate challenge in the potential conflict between aviation growth and tackling climate change. Until an appropriate UK, European and international framework is in place which can reconcile aviation growth and climate change strategies, it would not be sensible for Manchester to take action which simply damaged the economy of the city region and transferred aviation growth elsewhere. However, we need to develop and communicate a clear policy stance on this issue and engage at national level to ensure this potential conflict is rapidly and transparently reconciled. (Manchester city council, 2008, p. 10)

Manchester further states that aviation is one of the most controversial factors in climate change. With this awareness of the challenge and the difficulties of tackling it at the local level, a Manchester City Councillor states:

> International connections through Manchester Airport are one of the most important building blocks not only of the Manchester economy but of that of the whole of the North of England. If we are to tackle climate change environmental concerns about aviation cannot be ignored but trying to stop people flying is not the answer. (Leese, 2009)

Zürich further states the conflict between 'attractiveness' and restrictions on air travel. For possible interventions, Zürich has conducted an analysis with a range of parameters. For example, for the case of differentiated landing fees, their results are as follows: impact on CO_2 (high), financial viability (easy), impact on business (negative), impact on society (negative), impact on the environment (positive) and implementation problems (high). In Aberdeen (GB), there is a debate about the expansion of the local airport. The city of Aberdeen acknowledges a conflict with the growth of GHG-A but points to potential gains with more modern aircraft as well as direct flights reducing the need to make multiple flights. Similar examples are found in New York and Chicago.

Countervailing activities

Cities with ambitious climate targets can also have parallel activities that lead to increased air travel, which shows the different interests of the city. The examples listed below are categorised by mode of governing. No example of *governing by provision* was found:

- *Self-governing*: Financial support to local airport to cover economic losses (Gössling, Ficert, & Forsyth, 2017)
- *Governing by authority*: Allow/encourage expansion of airport (Manchester City Councillor, Leese (2009)
- *Governing by enabling*: Target far away tourists in destination marketing (Gothenburg & Company, 2017)
- *Governing by agenda setting*: Lobbying for more flight connections (e.g. Gothenburg, (Go Connect, 2016), hindering national policies to reduce GHG-A by commenting negatively on any such proposals circulated for comment (Göteborgs stad, 2017a, 2017b)

In Manchester (GB), there has been a debate about expanding the airport and the City Council has come in for massive criticism for supporting an expansion while claiming an ambitious climate profile (Manchester Evening News, 2010; Sadler, 2017). In Zürich (CH), there has also been criticism of the inconsistency of climate initiatives and their direct or indirect effects on air travel (Blumer, 2016), and criticism of how the emissions inventory is being done (Häne, 2012). In 2014, Freiburg (DE), which markets itself as a progressive green city, ran a campaign for switching to 'green electricity' in return for a voucher for a flight ticket. This campaign was met with criticism from the Green Party (Grüne Alternative Freiburg, 2014).

Discussion and conclusions

The aim of this study was to examine how cities address reductions in GHG-A in their Sustainable Energy Action Plans (SEAPs). More than 200 SEAPs were analysed with a focus on three specific issues: (1) the

treatment of GHG-A in *local emissions inventories;* (2) *policy initiatives* within this domain; and (3) cities' perceptions of the *conflicts of interests*.

Over half of the cities analysed acknowledge GHG-A as a climate issue in their SEAPs. Limited authority combined with this recognition of a responsibility puts cities in a situation that is difficult to manage in a consistent way. One third of the cities examined include GHG-A in their emissions inventories in one way or another. However, system boundaries and allocation methods varied considerably between cities. Wood et al. (2010) argued that the inclusion of GHG-A in emissions inventories is important as a basis for setting goals and choosing actions, and by providing credible comparable data this serves as a tool pushing policy makers to measure and introduce policies. Our results, however, show that excluding GHG-A in emissions inventories does not necessarily imply that no policy actions are taken. Indeed, some cities stated that they did not include emissions data in their inventories, but still intended to act for a reduction of this source of emissions. At the same time, this raises questions as to how such measures would be evaluated and regarding accountability.

Given the cross-border nature of GHG-A and the strong emphasis on international solutions (Wood et al., 2010), a surprisingly large share, more than a quarter, of the cities are taking policy initiatives to reduce GHG-A. The initiatives chosen mainly rely on *self-governing* or *governing by enabling*. Governing by provision, which has been identified by previous studies as the most important area for local climate action (Castán Broto & Bulkeley, 2013; Franzén, 2013), turned out to have limited relevance for GHG-A reduction. The initiatives were divided into the following three reduction strategies: (A) reducing air traffic volume; (B) improving eco-efficiency of aviation; and (C) reducing ground level GHG-A. The reduction strategies chosen for most of the interventions found in *self-governing* and *governing by enabling* were to reduce air traffic volumes followed by actions to decrease ground-level GHG-A.

Self-governing is the least challenging mode in terms of capacity to act, but has limited impact. It has the advantage of measurable outcomes and an organisation itself can serve as a role model to inspire businesses, other organisations and individuals. But air travel within a city's organisation is not where the greater share of GHG-A is found, which makes the actual emissions savings from *self-governing* relatively small. Private consumption of air travel contributes to the bulk of GHG-A in many developed countries (Kamb et al., 2016; Reichert & Holz-Rau, 2015). Here, cities try to influence consumers through various forms of information (*enabling mode*). Generally, these interventions are weak in comparison to the massive marketing of air travel from other channels, and the outcomes are difficult to monitor.

Many cities try to influence policy and industry agendas beyond the local setting. We have categorised these activities as governing by agenda setting, a fifth mode of governing in addition to the framework by (Bulkeley & Kern, 2006). The fact that many highlight such activities in their SEAPs is likely a result of the limited authority that cities have in the aviation domain. By raising awareness within the local setting (through their own organisation, local business, residents) and placing the challenge on the agenda at higher levels, acceptance for and the likelihood of more efficient policies could rise. It is difficult, however, to monitor how such activities are received and their actual outcome.

Most cities in this study do not host an international airport, but are served by an airport located elsewhere. The location of the airport serving the city, is a key factor for how to handle the emission inventory and what conflicts of interest that might occur. In addition, the databases used in this study mainly include cities that promote themselves as 'sustainable cities'. It is, however, important to recognise that even if their targets and plans are ambitious on paper, cities are typically not accountable to higher level authorities at the national level. If cities would have been obliged to take on shares of the Intended Nationally Determined Contributions to the UNFCCC, then the stakes would have been much higher.

Moreover, a city can work as both a promoter and an inhibitor of a certain issue (Zvolska et al., 2017). What we find in the SEAPs are their 'promoting' activities to reduce GHG-A. Countervailing activities (inhibitors), such as actively lobbying for more flights in order to stimulate growth and employment, are not found in the SEAPs, but in other documents, such as the cities' growth and destination strategies. We studied some criticism of these SEAPs and countervailing activities and found that cities often have different and inconsistent goals and strategy plans, and that activities to increase air travel (implying an increase in GHG-A) exist in cities

which have also introduced interventions to reduce GHG-A. Recent research by Gössling et al. (2017) has highlighted the subsidies to the aviation sector at the international, national and local levels. Since the interventions found in the SEAPs were mostly of the kind that have limited expected impacts, it is possible that cancelling pro-aviation activities, such as subsidies to local airports, might be the most effective local intervention to reduce GHG-A. Here, the city has full authority, but also faces conflicts of interests with other local goals.

Notes

1. Scope 2 is emissions from the consumption of purchased energy.
2. English: aviation, air travel, airport: German: Flug, Flughafen, Luftverkehr, Swedish: flyg, flygplats, Danish: fly, lufthavn, Norwegian: fly, flyplass.
3. Total number of cities registered in the Covenant of Mayors (1000) and the Compact of Mayors (500).

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Appendix A

List of documents from specific cities mentioned as examples in the Results section. If not stated otherwise, these documents can be found in the databases (retrieved September 2017) of either the Covenant of Mayors, the Compact of Mayors or by searching the Internet.

To find examples of GHG emission inventories reported in line with the Global Protocol for Community-scale GHG Emission Inventories (GPC), please visit 'City Greenhouse gas inventory dashboard': http://www.c40.org/other/gpc-dashboard

City	Name of Document
Aalborg	Aalborg Klimakommunerapport 2015
	Energistrategi for Aalborg kommune frem til 2030
Aberdeen	Local Transport Strategy
Aspen	Climate Action Plan
Bergen	Climate and Energy Action Plan
Berlin	Für ein klimaneutrales Berlin
Bonn	Überblick der durchgeführten Klimaschutzprojekte und massnahmen in Bonn ab 1994/1995
Botkyrka	Strategi för energieffektivisering Botkyrka kommun
Bregenz	Aktionsplan für nachhaltige Energie
Bremen	Klimaschutz-und Energieprogramm 2020
	Energie-und Klimaschutzszenarien für das Land Bremen
Chicago	Sustainable Chicago - Action Agenda
Christchurch	Sustainable Energy Strategy for Christchurch
Copenhagen	Kobenhavns Klimaplan
Dortmund	21 Punkte der kommunalen Klimaschutzstrategie
Dublin	Dublin Sustainable Energy Action Plan Monitoring and Progress Report 2014
Düsseldorf	Düsseldorf Klimaberich 2012
	Klimafreundliches Düsseldorf Energie- und CO2-Bilanz Duesseldorf 2007
	Massnahmenprogramm Klimaschutz
	Szenario Düsseldorf 2050 - Technologieoptionen und Pfade für ein klimaverträgliches Düsseldorf
El Cerrito	Climate Action Plan
Eppelheim	Integriertes Klimaschutzkonzept Stadt Eppelheim

(*Continued*)

Continued.

City	Name of Document
Faxe	Kortlaegning af co2-udledninger i perioden 2008–2012 som geografi.
Freiburg	Klimaschutz in Freiburg - Umsetzung Massnahmenplan Klimaschutz
	Klimaschutz-Strategi der Stadt Freiburg
	Statusbericht kommunlaer Nachhaltigkeitsaktiviteten 2009–2012
Gislaved	Klimatstrategi Gislaveds kommun
Göteborg	Klimatstrategiskt program för Göteborg
	Bilagor Klimatstrategiskt program för Göteborg
	Mål och inriktingsdokument för Göteborgs stads budget 2017
	Resepolicy
Guldborgsund	Klimaplan Guldborgsund kommune - virkemidler og scenarieanalyse
	Klimaplan Guldborgsund - Kartlaegning af drivhusgasser
Hagen	Energiewende in Hagen
Hagfors	Energi– och klimatplan 2009–2012
Hamburg	Hamburger Klimaschutzkonzept 2007–2012 Fortschreibung 2010/2011
	Basisgutachten zum Masterplan Klimaschutz für Hamburg
Haninge	Klimatstrategi för Haninge Kommun
Helsingör	Klimakortlaegning af Helsingör Kommune som geografisk enhed, 2008
Herten	Hertener Klimakonzept 2020.
Karlstad	Miljö och klimatstrategi
	Europas första tankanläggning för bioflygbräsnle finns i Karlstad
	The city with the happy sun
	Resfria möten
	Riktlinjer för Karlstads kommuns klimatkompensation
Knowsley	Knowsley Council Sustainable Energy Action Plan
Lidköping	Energistrategier för fossiloberoende kommuner: Lidköpings kommun
Limerick	Sustainable Energy & Climate Action Plan Limerick City
London	Delivering London's energy future
Luzern	Grundlagen für eine Energie- und Klimastrategie der Stadt
Manchester	Manchester. A certain Future.
	Manchester Climate Change – Call to Action
Melbourne	Emissions reduction plan for our operations
Minneapolis	Climate Action Plan
Munich	Energieaktionsplan der Landeshauptstadt München
	IHKM Integriertes Handlungsprogramm Klimaschutz in München
Naestved	Klimaplan del 1 - Kortlægning af drivhusgasser 2007
	Klimaplan del 1 - Resumé
New York City	One New York - The Plan for a Strong and Just City
Ontario	Ontariós five year climate change action plan
Oslo	Fremtidens byer for lavere klimagassutslipp og bedre bymiljo
Philadelphia	Options for Achieving Deep Reductions in Carbon Emissions in Philadelphia by 2050
Porsgrunn	Klimakutt i Grenland
Portland	Climate Action Plan
Reykjavik	City of Reykjavik's Climate Policy
Rheine	Masterplan 100% Klimaschutz
Salt Lake City	Energy and transportation sustainability plan
San Francisco	Climate Action Strategy
Seattle	Getting to Zero: A Pathway to a Carbon Neutral Seattle
Stavanger	Framtidens byer Stavanger
	Cities of the future - City of Stavanger
Stockholm	Stockholm action plan for climate and energy 2012–2015
Trondheim	Energie- og klimahandlingsplan for Trondheim kommune
Tyresö	Energieffektiviseringsstrategi för Tyresö kommun
Uppsala	Färdplan klimatneutralt Uppsala
Vancouver	Vancourver kicks off neighbourhood Footprint campaign
Västerås	Klimatprogram 2012
	Klimatprogram 2017–2020
Växjö	Klimatkommissionens slutrapport
Vordingborg	Klimastrategi for Vordingborg Kommune
Wolfurt	Energiestrategie Wolfurt 2020
Zürich	Roadmap 2000-Watt-Gesellschaft
	Jahresbericht 2011 - Energipolitik der Stadt Zürich

Appendix B

Country specific results from SEAPs.

Country	Number of SEAP	Acknowledge GHG emissions from air travel	Include in emissions inventory	Exclude, with motivation (emissions inv.)	Policy interventions
Australia (AU)	6	2	2	1	1
Austria (AT)	10	3	1	2	0
Canada (CA)	5	4	0	1	4
Denmark (DK)	36	16	11	3	5
Germany (DE)	53	30	16	10	11
Great Britain (GB)	36	15	11	3	7
Iceland (IS)	1	1	0	0	1
Ireland (IE)	6	3	1	2	1
Norway (NO)	7	6	2	0	6
Sweden (SE)	45	25	12	7	15
Switzerland (CH)	6	2	2	0	2
USA (US)	18	14	9	6	9
Total numbers	231	123	68	35	63
Total (%)	100%	53%	29%	15%	27%