

CITIES AND CLIMATE CHANGE: BETWEEN RHETORIC AND ACTION

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Abstract

Cities have worked on the sidelines of international climate negotiations for many years. While recognizing their role as both leading emitters of greenhouse gases and as drivers of climate change policy, the 2018 IPCC-sponsored inaugural Cities and Climate Change Science Conference also underscored the significant lacunae of data about the climate actions of cities and their outcomes.

The current study employs meta-analytic methods to explore the climate policies of 217 cities around the world, and the actions they have taken to mitigate their GHG emissions. The data were collected from the official websites of two transnational urban networks for climate change, from an international registry of the climate change actions of various political entities and the corporate sector, and from peer-reviewed research.

The analysis is based on five diagnostic categories, all widely-used measures of urban climate policy (e.g., green construction), and six more diagnostic categories that reflect processes of good climate policy (e.g., transparency and participation). Data on the cities' follow-up on their plans (reviews, revisions), and data on changes in their GHG emissions as tangible outcomes were also recorded.

Many cities have set emission reduction targets that are pointedly higher than their national governments, and many have begun to implement their climate action plans. But they often encounter obstacles in translating their commitments, whether external (e.g., insufficient funding) or internal (e.g., resistance by interest groups). Networking between cities, particularly networking to improve policy-learning, accompanied the praxis of many of the cities' climate actions. Engagement with residents (e.g., participatory involvement), on the other hand, is a less-favored derivative of climate action plans in most cities. The most widely deployed strategy to mitigate GHG emissions is changes in the public transport sector, followed by green construction and land use. Education is the most common tool municipalities apply to engage with residents. At this point, reductions in GHG emissions are too small to establish a reliable trend.

Keywords: *climate change and cities, climate change policy, climate governance, mitigation*

1. INTRODUCTION

1.1 The prospects of mitigating climate change

At the end of the day, the only thing that truly matters about the future of climate change is straightforward: we need to cut greenhouse gas emissions as much as possible, as fast as possible.

The rhetoric of the world's nations, which declare that they collectively foster the reduction of greenhouse gas emissions (GHGs), is failing the test of reality. In the absence of national and international leadership, the world's cities draw growing attention in this context. Are cities indeed effective drivers of climate change policy and GHG emissions reductions as they and their advocates assert?

Science is skeptical in any case about the plausibility of the ultimate objective of 2015 Paris Agreement, "...holding the increase in the global average temperature to well below 2°C above pre-industrial levels..." [1 (Article 2.1(a))]. In a recent interview with the British Guardian, eminent professor Bill McGuire of the University College London put it vividly: "There is not a cat in hell's chance" [2], he said. Other researchers still venture to specify empirically under what conditions a 2°C scenario [3] or even a 1.5°C future [4] might still be possible. Perhaps the most potent argument of the often fierce

criticisms of these studies [5, 6] is that these models pose politically and socioeconomically unfeasible conditions.

There are good reasons to be skeptical. Global GHG emissions rose again in 2017, after a two-year hiatus; they grew by 1.4% to a historic high of 32.5 gigatons [7] (Figure 1). In many countries around the world, emissions continue unabated, even among climate and renewable energy leaders like Germany. And then, of course, there is the shadow of the pending US withdrawal from the agreement, estimated to increase the global temperature rise by 0.3°C [8], and to cause other collateral damage.

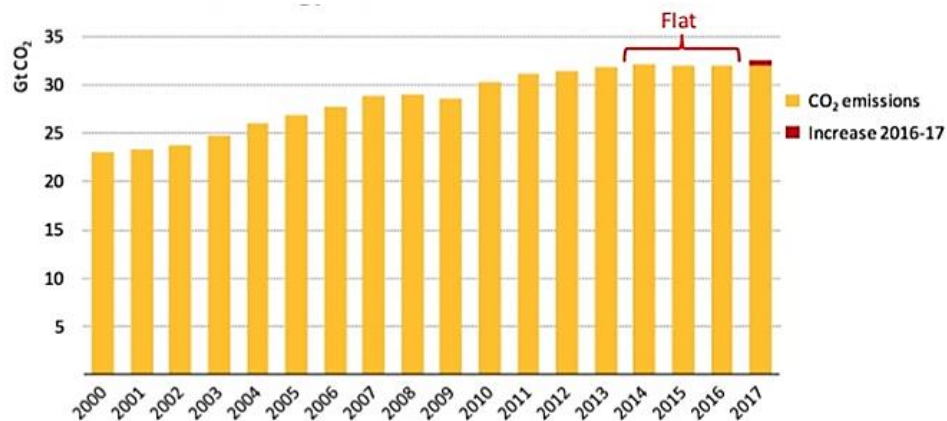


Fig 1. Global energy-related CO₂ emissions, 2000-2017

Source: International Energy Agency. 2017. *World Energy Outlook 2017*,
<https://www.iea.org/weo2017/> [9]

Notwithstanding the positive messages that spokespersons of the United Nations Framework Convention on Climate Change (UNFCCC) convey in their announcements and press releases, there are additional signs that things have not been going well since the 2015 Paris Agreement.

Most nations are not on track to meet the commitments—Nationally Determined Contributions (NDCs)—they made in Paris, which collectively would have allowed global temperatures to rise well past 3°C over the course of this century (see Figure 2 below). The first tangible product of the post-Paris ‘Talanoa Dialogue’ [10]—taking stock of the countries’ progress and informing the preparation of more ambitious NDCs to be submitted by 2020—appears to be stuck before it even started. Even dimmer are the longer-term prospects of cutting GHG emissions by 80% in 2050 to achieve “...a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century” [1, *ibid*, Article 4.1].

Undeniably, there are also positive signals, rare as they may be. The UK has committed to a target of reducing GHG emissions by eighty percent by 2050 [11], and political entities like the EU Commission [12] and the state of California [13] are drawing roadmaps on how to reach this ambitious objective. But these cases may also represent more rhetoric than action: they are not legally binding (except in Sweden [14]), and they may change with economic or political vicissitudes. These roadmaps may look impressive on paper [15], but they do not reduce GHG emissions. The only genuine change comes from heavyweight China: its carbon intensity—the amount of carbon dioxide emitted per unit of economic growth, a measure of energy efficiency—reportedly fell in 2017 by 5.1% compared to the previous year [16] (though its overall GHG missions still increased by 1.8%).

UN Secretary-General António Guterres’ recent call to world’s leaders “...to be bold in [their] deliberations and decisions,” and to “...embrace low-carbon climate-resilient policy-making” [17] is not heeded much. “Where you lead, business and civil society will follow,” he said. Well, we are waiting.

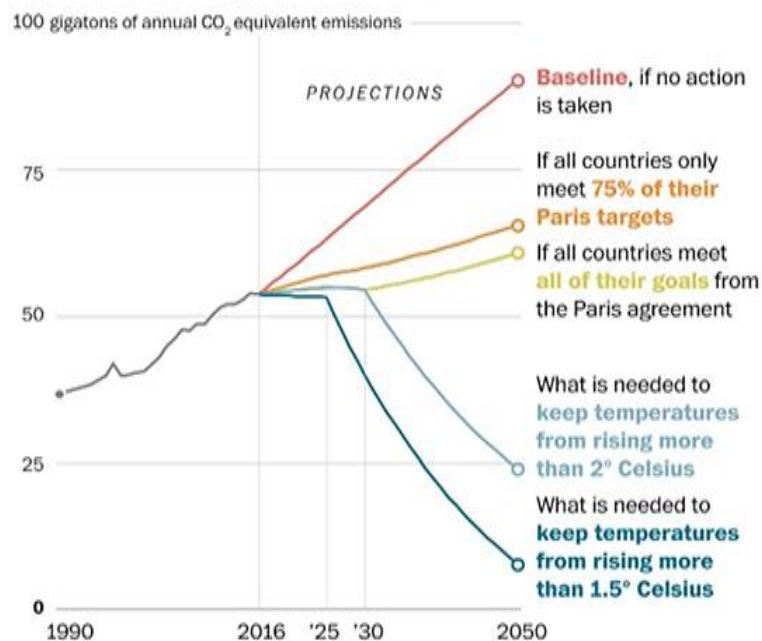


Fig 2. Global GHG emission targets under different scenarios

Source: *Climate Interactive* <https://www.climateinteractive.org/programs/scoreboard/> [18]

Less than three years have passed since the Paris Agreement, too short a time to assess where the multilateral UNFCCC process is headed. But it certainly does not look like most national governments are poised to cut greenhouse gas emissions as much as possible, as fast as possible.

To add insult to injury, the respected annual *World Energy Outlook* [9, *ibid*] projects that global CO₂ emissions will continue to rise until 2040, and perhaps beyond. Oil demand will continue to grow, albeit at a steadily decreasing pace, and coal consumption will decline gradually, a decrease currently delayed by the US\$373 to US\$473 billion in fossil fuel subsidies granted annually by national governments [19]. The share of renewables in total power generation will reach a mere forty percent (Figure 3). These outcomes are far from adequate to prevent severe impacts of climate change. In a recent report, the International Renewable Energy Agency (IRENA) maintains that renewable energy needs to be scaled up at least six times faster to meet the decarbonization and climate mitigation goals set out in the Paris Agreement [20].

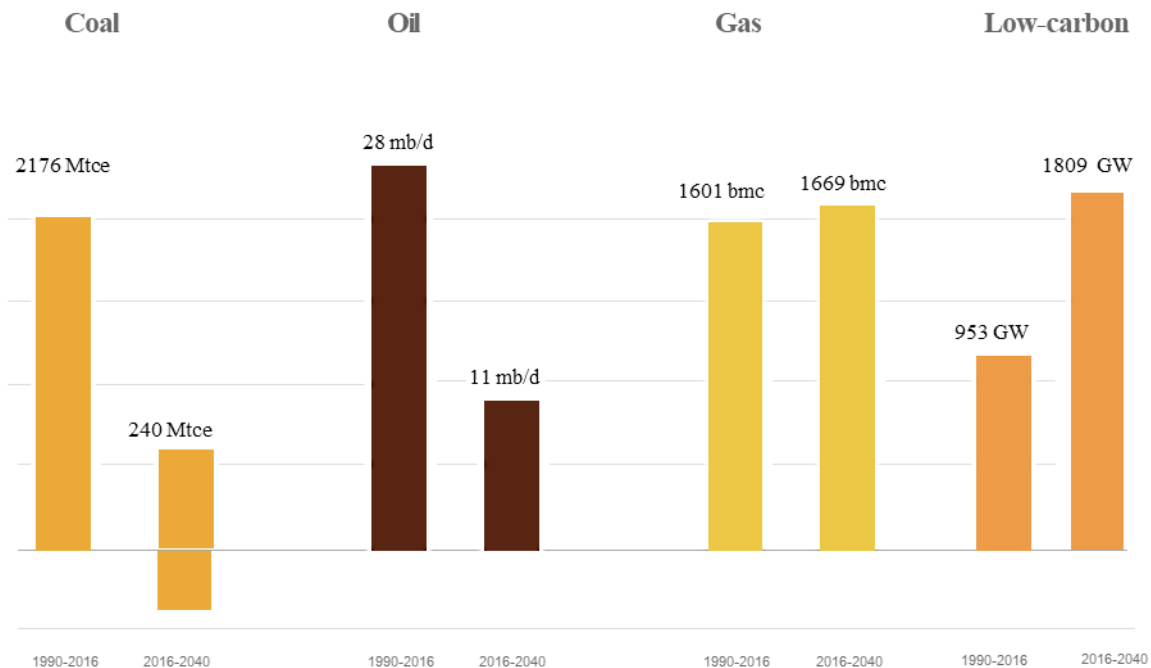


Fig 3. Change in world primary energy demand by fuel, 1990-2040 (projected)

Adapted from International Energy Agency. 2017. *World Energy Outlook 2017*
<https://www.iea.org/weo2017/> [9, *ibid*]

The global renewable energy market, which will define much of the outcome of mitigation, shows no signs of meeting these lofty targets. True, investments in renewable energy and energy-smart technologies are growing, the price of solar installations is falling rapidly [21], and renewable energy capacities increased by a respectable 6.3% (380 TW/h) in 2017 [9, *ibid*]. But this is a mere drop in the vast ocean of GHG emissions. The global economy is expanding by 3.4% per year, world population will grow from 7.4 billion today to more than 9 billion in 2040, and urbanization occurs at a rate equivalent to adding a city the size of Shanghai to the world's urban landscape every four months. Global energy needs now rise more slowly than in the past, but will still expand by thirty percent by the year 2040 [9, *ibid*]. This is the equivalent of adding another China and India to current global energy demand.

Nonetheless, renewable energy is sourced increasingly; and growing markets are always driven by rising demand. Undoubtedly, the corporate sector and especially hi-tech firms, who are both investors in and end-users of renewable energy, generate much of this demand. For example, Google and Apple recently announced that they now base their entire energy consumption on renewables [22].

But there are other stakeholders in the climate game, foremost amongst them the world's cities. The declarations and press releases of their networks are no less upbeat than those issued by the UNFCCC. Are the announced ambitious GHG reduction plans of cities also only rhetoric? Or do they translate into implementation and climate action that already have, or will have a real impact on urban emissions?

1.2 Cities and climate change

Cities and their networks have worked on the sidelines of international climate negotiations for many years. By now, they have become essential partners in the multilayered global governance of climate change. The *Global Covenant of Mayors for Climate and Energy*, an alliance of cities and local governments around the world "...committed to climate action," [23], was signed in 2014, one year before the Paris Agreement. According to the Covenant's website, the voluntary GHG reduction commitments made by alliance members could reduce emissions by well over 700 megatons by 2020.

More recently, in 2018, the Intergovernmental Panel on Climate Change (IPCC) co-sponsored the first *Cities and Climate Change Science Conference* [24]. Hundreds of experts convened to assess the state of academic and practice-based knowledge related to the issues involved, and to establish a global research agenda based on the joint identification of key knowledge gaps. The outputs are intended to contribute to the *Special Report on Cities and Climate Change* to be issued toward the IPCC's Seventh Assessment Report (AR7).

Why are cities so crucial in mitigating climate change? Because they account for over seventy percent of global CO₂ emissions [25], though this figure is contested [26]. Because sixty percent of the world's population will live in cities in 2030, rising to 70 percent by 2050 [27]. And because some metropolises grow into global cities [28], serving as hubs of economic wealth, commerce, technological innovation, productivity and sociocultural development, while others struggle to expand their infrastructures and services to keep up with their growing populations. Whatever the form and shape of urban growth, it adds to the city's already sizeable energy consumption.

Cities also have a vested interest to mitigate their GHG emissions. Branding the city as 'green,' 'smart' or 'climate-friendly' attracts hi-tech firms and an educated workforce [29], which in turn stimulates economic growth [30]. Moreover, cities are vulnerable hotspots of climate change impacts [31], and some have already experienced climate change-related disasters. Finally, cities can often put forward ambitious mitigation and adaptation measures that are hard to legislate and implement at the national level [32].

Cities are in a unique position as both leading emitters of greenhouse gases and as the potentially most effective drivers of climate change policy. The strategies, policies, and actions of the thousands of cities around the world that now directly engage with climate change reflect this duality.

Some actions are already bearing fruit. Forty-three showcase cities are now powered entirely by renewables, most in South America. In another 101 cities, 70% of energy consumption rests on renewables. Looking at this list of *World Renewable Energy Cities* [33], one can see these as encouraging cases; but they are inconsequential for the aggregate impact of thousands of cities around the world on the atmosphere.

The real question is whether the world's cities are collectively up to the task. Do or will their policies and actions significantly reduce global GHG emissions? The current study seeks to provide a preliminary answer to this question. The research field is complex and multifaceted, and while a robust methodology was employed in the collection of data and the analysis, the research reported here should be taken as exploratory.

2. METHODS

2.1 Selection and sampling of cities

This study examines the climate policies and actions of a random sample of 217 cities around the world and their progress toward realizing their reduction targets. An analysis of these cities' adaptation policies vis-à-vis the projected local risks of climate change (aka resilience) is reported in a separate paper [34].

Two primary sources, both transnational city networks for climate change, served as the sampling frame: the C40 Cities Climate Leadership Group [35] and Local Governments for Sustainability (ICLEI) [36]. The former connects over 90 of the world's megacities, representing more than 650 million people and one-quarter of the global economy. The latter includes over 1,500 cities, towns, and regions, which represent over 25 percent of the global urban population. Both are allied with The Global Covenant of Mayors for Climate and Energy [23, *ibid*], which claims a membership of over 7,400 cities and local governments around the world committed to climate action. We supplemented these data with relevant indicators from peer-reviewed academic articles [37-42]. Supranational networks such as the EU Covenant of Mayors [43], or organizations like the American Council for an Energy-Efficient Economy (ACEEE) [44], which collects similar data on US cities, were of no added value, as most of the cities listed there also associate with the C40 or ICLEI.

This procedure yielded 1,631 potential cases. Of these, 176 cities (10.8%) were dropped from the analysis because they had not, or had not yet, launched a GHG inventory. These inventories record the annual volume of GHG emissions by source (transport, heating and cooling, etc.), and are therefore of utmost importance to policy planning and implementation. Another 587 cities—36% of all cases—were excluded because they had not, or had not yet, formally adopted a climate action plan (CAP) with a time-bound GHG emission reduction target. Energy savings and renewable energy targets bound to a specific year were considered as equivalents of CAPs. Finally, we omitted eight cities with irretrievable figures on either population growth, city boundaries, or urban sprawl. Sustainable planning of land use or transportation is impossible in the absence of these statistics.

Of the remaining 868 cities, we drew a random sample of 217 (25%). Data on the climate policies and actions of the sampled cities were supplemented by the *carbonn® Climate Registry* [45], an online portfolio which also includes entities other than cities. The database contains GHG inventories and reduction targets and dates, as well as mitigation and adaptation actions.

Taken together, these multiple data sources, which record details directly reported by the cities, generate a reasonable level of reliability compared to earlier studies based on surveys of informants, usually municipal climate administrators [37, 40, *ibid*]. The combined information from our sources included data on all the measures delineated in section 2.2 in all the cities. In other words, we encountered no missing data.

2.2 Data collection and empirical indicators

Urban climate policies and actions were divided into five diagnostic categories, each consisting of a number of components. Some components of the category ‘Action’ below were adapted from the recently published *America’s Pledge* [46], which reports the climate actions of US cities, states, and businesses.

1. *Monitoring*: mandated reviews and updates of progress of the climate action plan.
2. *Process*: transparency, participation, education, outreach/incentivization of the local business community, funding and financing, networking with other cities or institutions.
3. *Planning*: sustainable transportation plan, climate-friendly development and land use planning.
4. *Action*: energy- and fuel efficiency requirements for municipal buildings and public fleets, bicycle programs, mandatory green construction and building retrofit requirements for the residential and/or commercial sector, waste and wastewater management, energy-efficient procurement. Other climate actions, such as developing electric vehicle infrastructure, were too infrequent to analyze separately.
5. *Outcomes*: change in GHG emissions.

Since there are no theoretical or empirical grounds to weigh these diagnostic categories and their subsidiary components, the analysis is based on dichotomous distinctions (plan, action or process absent/present). This constraint, of course, allows only for categorical analyses [47].

3. RESULTS AND DISCUSSION

3.1 GHG emission reduction targets

Recall that the two fundamental conditions for including cities in the sample were the existence of a GHG inventory and an official CAP. We first present the GHG emission reduction targets of these cities.

Almost half of the cities (100, or 46%) aligned themselves with their national emissions targets. The remaining 117 cities stipulate targets higher than those of their respective national governments, as stated in the Nationally Determined Contributions (NDCs) to the 2015 Paris agreement. Of these, 41% (48 cities) pose markedly higher targets, a 40-50% reduction by 2030 as compared to the 30% national target. Finally, 28 cities incorporated long-term 2050 objectives in their CAPs, usually an 80-90% reduction in emissions, or becoming ‘carbon-free’ or ‘carbon-neutral.’

Cities that specify targets higher than their national government are relatively prevalent in the US (39 of 60, or 65%), mainly following the announcement of its pending withdrawal from the Paris Agreement (the US NDC pledged a relatively modest 26-28% reduction of GHG emissions by 2025, compared to 2005).

The number of ambitious cities, many of them metropolises with two-digit millions of residents and a booming economy, is remarkable. The two transnational networks calculate that the aggregate reduction in emissions will be around 1.5 Gt CO₂e/yr. by ICLEI members, 2.4 Gt CO₂e total by 2030 by the megacities of the C40. These projections are promising but probably overstated: both networks presuppose that all their member cities will achieve their climate targets.

3.2 Climate action

What measures did the 217 cities take to attain their emission targets? While this study could not delve into these actions in any depth (e.g., what does the city's procurement policy consist of?), our data on the cities' climate actions are unique.

Given the relatively short time that most urban CAPs exist, our distinction between the diagnostic categories 'Planning' and 'Action' turned out to be moot in most cases. If approved by the city council and especially if already partially budgeted—as transport and land use planning were in most cities—these plans can be seen as the commencement of action even before anything changes on the ground.

Figure 4 displays and summarizes the findings from this combined analysis.

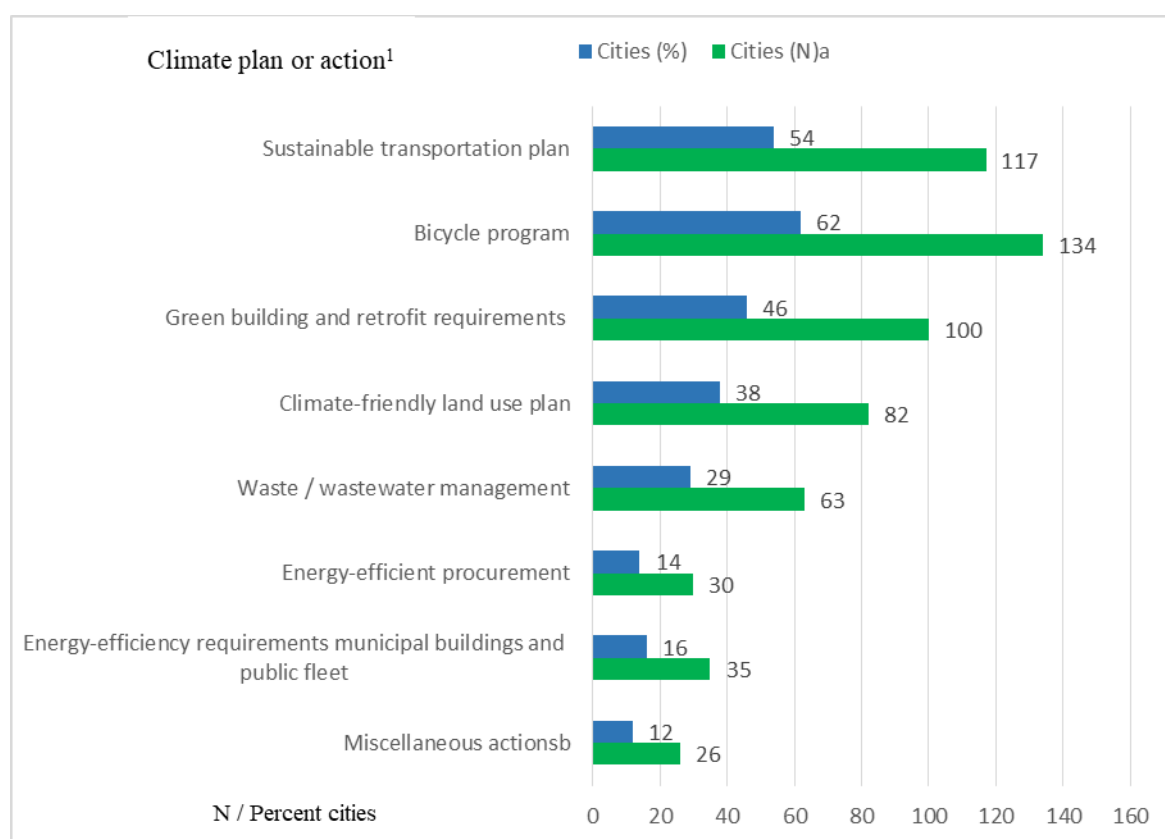


Fig 4. Types of climate planning and action in the sampled cities (N=217)^a

^a Cities that have included this action or plan their CAPs.

^b These actions were too infrequent to analyze separately.

Source: Author

The 217 cities undertook a total of 587 climate plans and actions as part of their CAPs, 3.7 implementation-oriented policies on average. The fact that many municipalities have already embarked on implementing their CAPs, often by engaging in multiple activities, points to a serious commitment. It remains to be seen whether these commitments are enough to realize the cities' GHG reduction targets.

Of the seven climate actions, two—public transport blueprints and dedicated bicycle infrastructures—were intertwined in over 90% of the cities. Transport infrastructures, approved and budgeted plans and work on the ground, received the uppermost attention (54% public transport and 62% bicycles). Ordinances regarding green construction and mandatory retrofitting of residential and commercial buildings came a close second (46%).

These choices are understandable and potentially effective. Public transport takes carbon-emitting private vehicles off the road, reduces traffic congestion and pollution, and improves livability. In cities with growing populations, there is a rising demand for housing, and the construction of new homes and office buildings is a primary potential source of non-carbon GHG emissions. Green building and retrofitting are also less costly than many infrastructures in the public transport sector.

Sustainable land use and development planning (neighborhoods, green space, landfills, brownfields) also feature highly in the CAPs of 38% of the cities. Sustainably planned neighborhoods and high-rise buildings are energy-efficient, and the management of landfills can reduce greenhouse gases other than carbon dioxide, such as methane.

Needless to say, the cities' priorities and specific measures are context-dependent; this is true for all the other components of their climate action plans examined here. In the case of public transport, for example, the solutions range from dedicated bus lanes to electric buses to new subway and light rail lines. Poorer cities only now embark on these projects, more established cities focus on the connectivity of existing public transport systems (light rail, buses, subways, rail). Still, note that the construction of dedicated bicycle lanes and relevant substructures (traffic lights, bike parking, etc.) has become somewhat of an urban fashion. In many cities, hundreds of kilometers of lanes have been, are or will be constructed in the coming years. These upgraded infrastructures often intersect with other improvements in residents' mobility.

Waste and wastewater, together with landfills, are significant sources of the potent greenhouse gas methane, which constitutes about 26% of urban GHG emissions [48]. In less developed countries, the widespread indiscriminate disposal of waste products still causes many evils, such as the spreading of vermin and threats to public health. As can be seen in Figure 4, only 29% of the 217 cities engage in sustainable waste and wastewater management as part of their CAPs; but this does not reflect the full picture. Eighty-three of the sampled cities (40%) are located in less developed and developing countries. In this group, over 90% plan and already implement measures to improve waste and wastewater management. In the cities of the developed world, where these were common problems of the past that have mostly been coped with, only 19% do. This is the only climate action that evinces such differences, and another example of the context-dependency of urban CAPs mentioned earlier.

The full implementation of these—transportation infrastructures, the energy-efficient construction and maintenance of buildings, an overhaul of obsolete waste and wastewater disposal systems—is lengthy and costly. As we shall see below, even though external investments are often crucial in realizing public transport and land use projects, cities do not excel in raising the necessary funds.

Fuel-efficient public fleets, together with energy-efficient municipal buildings, cut emissions only marginally but set an example for residents and other cities. As these measures are relatively inexpensive, one would expect many cities to adopt them. Not so: merely 16% of the municipalities incorporated improvements in their own energy efficiency in their CAPs.

The last component of the diagnostic category 'Action,' climate-friendly and energy-efficient procurement, is surprisingly underrated and underused: only 14% of all CAPs refer to this element. Green procurement requires the inclusion of explicit and verifiable environmental criteria for products and services purchased by public authorities, and *"...incorporates human health and environmental concerns into the search for high-quality products and services at competitive prices."* [49] Green

procurement also reduces the environmental externalities that the city imposes beyond its boundaries, a relevant consideration since these are part of its GHG inventory. Perhaps many cities are unaware of these potential benefits; otherwise, the neglect of this straightforward policy measure is inexplicable.

One final point regarding climate action. Education, which we had initially categorized as part of the processes that accompany climate policy, turned out to be a major action component of cities' CAPs. More on this below.

3.3 Monitoring climate action

Most cities specify dates for review, 2-3 years, and for the next update of the plan, usually five years (both 83%). This resemblance is due to the cities' membership in the two transnational networks; both stipulate periodic reviews and updates in their voluntary guidelines. As of yet, many cities' CAPs exist for too short a time to have been reviewed or updated. Still, the large proportion of cities that intend to review or have already reviewed and updated their CAPs can be taken as a sign of their determination to succeed.

3.4 The processes of climate policy

The findings regarding the six components of the diagnostic category 'Process' are presented in Figure 5. The academic literature recognizes these processual variables as principal facilitators of successful climate policy because they increase public involvement, generate resources, and encourage policy learning [50, 51].

As noted education, both formal in schools and informal in community centers and the like, is a very dominant component of the cities' CAPs. 189 cities, fully 87%, engaged in educational activities. In the course of the data collection, we learned that cities do not see education as a process adjunct to implementation as we had surmised, but primarily as a policy tool to advance and carry out projects associated with their CAPs. Education is the most common tool municipalities use to engage with residents.

In our judgment, the data on the two networks websites and carbonn® were sufficiently transparent for the vast majority of the cities (90%). The diagnostic categories and the other measures used in this study could be extracted easily from the network websites for most cities. After all, without transparent, accessible, and high-quality information we could not have conducted this study.

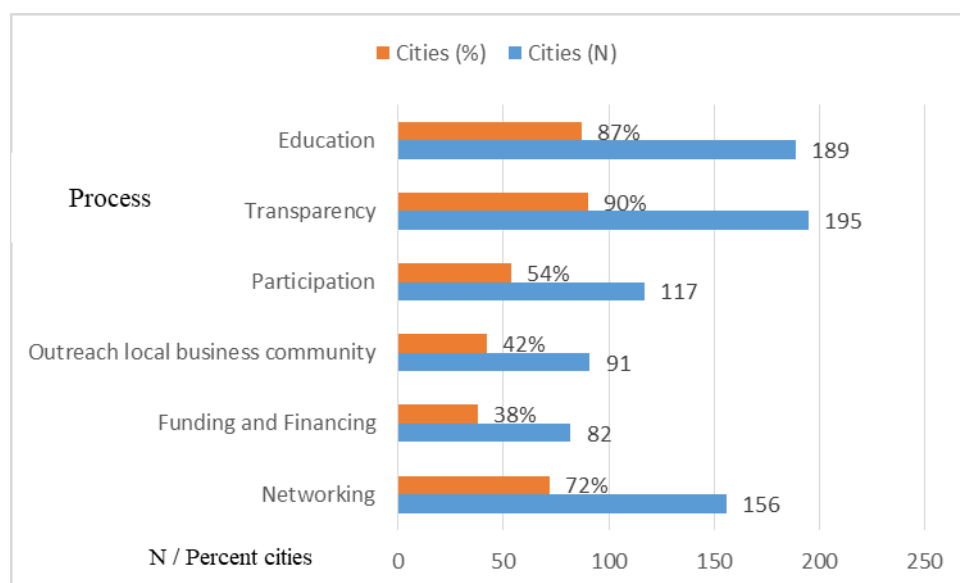


Fig 5. Policy processes in the climate actions plans of 217 cities

Source: Author

Participatory governance, the many ways to involve residents directly or indirectly in decision-making on the future of the city [52, 53] is considered crucial in advancing almost any policy at any level of government [54]. The cities in the sample take limited advantage of this process: only 54% include public participation in their CAPs. The opportunities for public input are significantly higher in the cities of the developed world (77% versus 15%), a divergence that should draw empirical attention. Outreach to the local business community is less widespread (42%), its incentivization virtually absent.

We coded the municipalities' efforts to secure financing for their CAPs by trying to evaluate the details of already guaranteed funding—how well does it match financial needs, how was it done professionally, etc. Partial as these data may be, the findings are not encouraging: fundraising efforts can be considered adequate in only 38% of the cities. The importance of this shortcoming cannot be underestimated. A recent study of urban adaptation to climate change revealed that the capacity to use budgets to launch green projects and to leverage external monies to fund such projects is imperative for the progress of climate action in (American) cities [55].

As in many previous studies [56-59] and as expected, networking is a central element how cities in our sample conduct themselves vis-à-vis climate change. Networking is also a more multifaceted phenomenon than we had thought. We defined city-to-city networking at least one post on the ICLEI or C40 websites in the past year, which we took as a measure of the city's activity and involvement in networking. 72% or 156 cities satisfied this criterion. Although some posts appeared to serve self-promotion via the dissemination of unique achievements or events, most dealt with sharing information to facilitate policy-learning [60, 61]. We encountered little evidence of active networking with regional and national government or NGOs.

3.5 Trends in GHG emissions

A respectable number of 29 cities, over 13% of the sample, show evidence of gradually decreasing GHG emissions, though not always in line with their emission targets. As a rule, cities with early launch times of their CAPs (some in the early 1990s) were more likely to manifest tangible outcomes over time. But only as a rule: the emissions of several megacities with CAPs dating in the 1990s are continuing to rise. At this point, the average annual GHG emissions of the 217 cities in the sample are still increasing, only a bit more slowly.

4. CONCLUSIONS

4.1 Who is active in climate policy?

The discrepancies between different sources on how many and which cities engage in climate change action are themselves an interesting finding. Of the over 7,400 cities and local governments which, according to the Global Covenant of Mayors, are committed to climate action, almost 80% are not members of the two leading transnational city networks from which the sample was drawn, C40 and ICLEI. Of the latter, 1,631 municipalities, almost 50%, had not yet established GHG inventories or adopted a climate action plan with a GHG emission reduction target. These statistics suggest that urban climate action is not as widespread as the public profiles of global intercity networks would have us believe. For the time being, only the cities active in reducing GHG emissions should be tallied as part of the urban engagement in climate change.

4.2 Policy tools

Demand-side solutions for mitigating climate change include technology choices, consumption behavior, lifestyles, coupled production–consumption infrastructures and systems, service provision and associated socio-technical transitions [62]. There are promising disciplinary and interdisciplinary frameworks to estimate and apply demand-side, consumption-based approaches to climate change [63-65].

Cities in our sample employ technology-related demand-side solutions, such as public transportation systems, but they underutilize the many techniques to influence demand directly and immediately. The limited use of energy-efficient procurement is only one example. Municipalities also do not put much

faith in taxation and tariffs to regulate demand, such as inner-city traffic restrictions, or in more energy-efficient municipal services. These actions are so rare that they landed in the ‘Miscellaneous actions’ rubric in Figure 4.

4.3 Barriers and criticisms

The dataset did not allow an in-depth examination of obstacles to the implementation of climate action plans, which exist in any institutional campaign. Eighty-three cities (38%) report unforeseen delays in decision-making or enactment. These setbacks may have been caused by government interference, insufficient funding, internal resistance by local interest groups, or other impediments. In a recent study of adaptation to climate change in Dutch cities [66], the authors identified lack of urgency and limited knowledge and capacities as main barriers to policy-making. Whether these are also factors in disrupting GHG mitigation policies is a question for future research.

One common criticism of urban climate action is that cities fail to integrate components of mitigation policy [67], and to synergize mitigation and adaptation, thus reducing their effectiveness [68]. The data do not enable us to contribute to the debate what an integrative urban mitigation policy is; we examine the synergies between mitigation and adaptation elsewhere [34, *ibid*].

4.4 Caveats

4.4.1 Representativeness

Asian cities may be underrepresented, not only in this sample or in the networks from which it was drawn, but more generally as global actors in climate change. Many coalesce in the Asian Cities Climate Change Resilience Network (ACCCRN) [69], which does not record its members’ climate actions. There is also no record of the climate policies and actions, if any, of most Southeast Asian and African cities with less than 500,000 residents, which will have a paramount impact on future emissions. According to *World Urbanization Prospects* [70], they represent the fastest-growing urban population in the world. By 2025, 231.8 million people or 62.6% of the ASEAN urban population will live, consume energy, and possibly discharge greenhouse gases there. On a humbler scale, uncounted informal settlements in less developed countries are not even mapped, let alone have records relevant to climate change. In short, there is much we do not know, lacunae already pointed out in the recent Cities and Climate Change Science Conference [24, *ibid*]. It remains to be seen if these countless communities will join the climate effort, and whether their capacities will enable them to model their policies and actions after their more advanced peers.

4.4.2 Costs, benefits, and other unknowns

This being an exploratory study of the actual climate actions of a random sample of cities around the world, we may have gleaned some preliminary answers what cities are doing to mitigate their GHG emissions. But many voids of knowledge must be filled by future research. Among them are, for example, better evidence of cities’ institutional capacities and capacity-building, which are a precondition of successful policy-making [72, 73]; and answers to questions about the internalization of socioeconomic considerations into their CAPs [74]. Residents’ employment, health, and quality of life, and the equitable distribution of natural resources and municipal services depend on how climate policies are implemented.

4.4.3 Measurement

The limited range of data in this exploratory study naturally restricted the analysis. The five diagnostic categories and their constituents should be refined to support statistics other than categorical analyses of dichotomous variables. Additional methodological tools, such as content analyses of municipal websites or online interviews with city administrators, may be advisable to gain more in-depth insights into the cities’ climate action plans.

In short, not only is there an urgent need to know more about what the world’s cities are doing to mitigate climate change; there is also an urgent need to develop better methodological tools to study these questions.

4.5 Epilogue

What can we learn from this study of the climate actions, plans, and practices of cities around the world to reduce their GHG emissions?

We dropped a considerable number of cities from the analysis because they lacked GHG inventories and ratified climate action plans, despite being members of the C40 and ICLEI. As we sampled from a much smaller sampling frame than the over 1,600 members of these two leading networks, our sample of 217 cities does, of course, not represent this combined membership anymore. We can only generalize to the 868 cities from which we drew a 25% sample.

No grand conclusions can be drawn from this number of cases, and no far-reaching projections can be made about the role of the world's cities in mitigating climate change. If this were the way of the over 7,400 members of the Global Covenant of Mayors presumably committed to climate action, we might be able to draw firmer conclusions; unfortunately, it is not (yet?). Even then, the climate actions of many ASEAN cities with rapidly growing populations and industrial bases would remain hidden from view.

In general, the cities we studied posed ambitious targets, because they can and because they have a vested interest to do so. Their multifaceted implementation-oriented actions are quite intense, on the average 2.7 substantial and practical plans and applications per city, all with sizable effects on future emissions. Most of the cities' choices of action are potentially effective and compelling. They focus on transportation, the leading source of CO₂ emissions in most cities; green construction, which helps to reduce energy consumption and reduce other GHGs; and sustainable land use, among others to reduce methane emissions. A vast majority of cities in less developed countries emphasize sustainable waste and wastewater management in their CAPs, still problematic in this part of the world. The cities are serious about monitoring and updating their CAPs over time, and highly involved in educational activities to convey the message, at least to the next generation.

In some cases, the rationality of their judgments is less apparent. We cannot explain their neglect of the relatively modest but effective measure of energy-efficient procurement. The inattention of most municipalities to improvements in their own energy efficiency is also surprising, perhaps even a NIMBY phenomenon. Participatory governance, a recognized facilitator of climate policy, is employed by only a small minority of cities in less developed countries, an obstacle for them and a conundrum for us. In contrast, networking, another well-studied enabling condition of urban policy, receives considerable attention. It appears to not only promote policy-learning, but also enhance visibility, and perhaps assist in financing.

We end on a positive note. The engagement of cities in climate change action has proliferated in recent years and, given the drivers delineated earlier, is likely to continue to grow. It is therefore reasonable to focus on cities, not their procrastinating national governments, as having the highest potential to reduce GHG emissions in the future. An interim testimonial to this development would be a much higher-than-projected growth of the renewable energy market, driven by urban (and corporate) demand. *Ceteris paribus*, the final outcome would be a noticeable reduction in global GHG emissions before long.

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