Who´s Ahead? Climate Cities Benchmark in Japan, U.S. and Germany

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ABSTRACT

In many countries, major cities set trends by strengthening efforts for climate protection. Nevertheless CO_2 emissions have hardly changed since 1990 in spite of the wide variety of local activities. To interpret the effects of these activities, authorities lack a comprehensive benchmark that represents and evaluates more than just the emissions of CO_2. Within the scope of the project *Local Governments Climate Partnership (LGCP)* such a benchmark was developed and tested, including communities from Germany, Japan and the United States (U.S.). To design a transparent and widely accepted benchmark, previous approaches for evaluating local climate protection activities were discussed. Based on experiences of communities and existing benchmarking tools, a broad and transparent multi-level benchmark was developed. Calibration to different national backgrounds took place by involving various test communities.

The benchmark consists of the following elements: CO_2 emission inventory, activity profile and set of indicators. Each element is evaluated individually and can be merged into a single performance output. At the request of participating cities, focus of the project was not to set a ranking list but to enhance transparency of climate change action of cities and foster the exchange of ideas. The benchmark is expected to become widely accepted, once the data inquiries will have been completed and evaluated.

Introduction

Inspired by the idea to advance climate partnerships of cities based on a new climate benchmark system for Japan, U.S. and Germany, the Federal German Agency for Environment (Umweltbundesamt) commissioned this project to the Climate Alliance (CA) and the Institute for Energy and Environmental Research, Heidelberg, Germany (IFEU). The focus of CA was to turn common partnerships of twin cities into Local Governments Climate Partnerships (LGCP). To enhance future partnerships, the Japanese German Center in Berlin, the Heinrich Boell Foundation and the U.S. International Council on Local Environmental Initiatives (ICLEI USA) were involved as partners. IFEU on the other side designed a new benchmark system that reveals the effects of climate change activities and evaluates outcomes. The LGCP team was supported by Prof. Takeuchi (University of Nagoya) who provided additional academic input from the Japanese point of view. Besides a qualitative assessment of previous actions, quantitative measures allow a direct comparison.

Over the previous project phase, a multilevel benchmark system was developed and partly tested with several municipalities. The test results confirmed that this benchmark assures a good assessment of climate change activities of municipalities. The project has therefore been extended until mid-2009 in order to involve further municipalities and to complete evaluation.

Structural Preconditions

The first part of the project dealt with national country specific conditions and strategies concerning climate protection in Germany, Japan and the U.S. For the project development, it was necessary to understand national frameworks in order to compare and evaluate local activities on a common scale and to derivate primary fields of action. Due to the fact that energy consumption and climate protection are closely linked, the structure of energy consumption became the centre of attention. Typical living conditions and the use of transport systems have been examined in order to grasp the characteristics of energy consumption of households, forming an important target group of climate protection measures. In a second step, national climate policies and legal systems were reflected with respect to the city authorities scope of action to deal with climate protection. The findings were later used to choose appropriate measures and included into activity profiles.

Given that Germany, Japan and the U.S. belong to the most powerful industrial nations, their energy consumption contributes to a major share of global climate problems. While the average per-capita consumption of primary energy in the U.S. sums up to roughly 8.8 tons of crude oil equivalents /EIA 2006a/, the German average (4.1 tons/cap) /BMWI 2006/ is slightly higher than the Japanese one at 4.0 tons per person /JMETI 2006/.

The world average has been estimated around 1.7 tons per capita /IEA 2006/. With this energy consumption, the three states are responsible for roughly 30 percent of CO_2 emissions worldwide /UN Statistics Division 2007/. It is obvious, that successful climate protection strategies will have to cut down the use of energy significantly. In all countries, about one third of overall energy related emissions are produced by the power sector /UBA 2007, National Institute for Environmental Studies 2007, EPA 2006/. Power supply and consumption therefore plays an important role when evaluating national and local climate relevant activities. On a national scale, Germany and U.S. supply structures resemble each other, covering about half of their power demand by coal power plants /EIA 2006b, VEDW 2007/. Additionally, Germany also has gained a relatively high proportion of renewable power sources (14 percent) /BMU 2008/.

While the German government continues to support a nuclear power phase-out by 2020, Japanese politicians anticipate an extension of nuclear power in order to become less dependent on foreign energy. Compared to Germany and the U.S., the Japanese supply system depends less on coal resources but uses liquefied natural gas for power generation instead /ANRE 2005/. Based on the characteristic power mix, average carbon intensity of electricity varies from 555 CO_{2e}/kWh (Japan) to 605g CO_{2e}/kWh (Germany) and 618 g CO_{2e}/kWh (US) /SBMAC, EPA 2007, IFEU 2007a). In all countries, local governments should actively promote sustainable and carbon low supply systems.

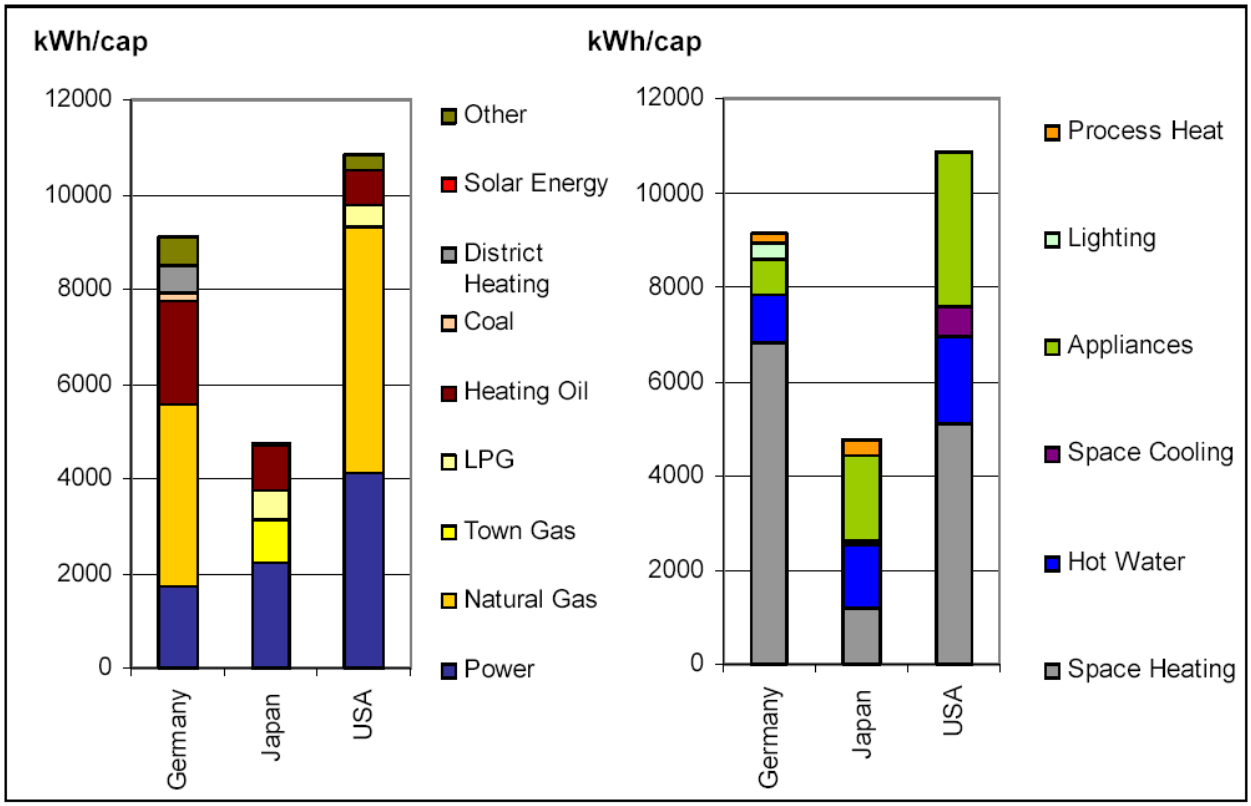
To understand energy consumption patterns, living conditions have been briefly characterised by size and type of housing, living area, household power and heat consumption and mobility features (number of cars, efficiency, average distance covered etc.) for the three countries.

Concentrating on the residential sector, Fig.1 displays the energy consumption of households with respect to energy sources (fuels) and energy sinks (applications). The greatest energy consumer in German households is space heating with 76 percent, representing a fundamental element of climate protection concepts. District heating might gain further importance in urban areas. Japanese households are characterized by a remarkable share of

electricity use (38 percent), partly due to widespread electric space heating and cooling systems. Alternatively, many households buy town gas[1] or liquefied natural gas, which are non-pipeline-bound sources of energy. Cogeneration has not yet gained much attention, so that high potentials can be assumed in the future. The main energy-consuming equipments in Japan are electric appliances and water heating systems. In the U.S., natural gas and electric power constitute favoured site energy sources of households. Gas is mainly used for space heating applications. Power-driven heat generators (for space heating and hot water) as well as air conditioning contribute to high power consumption rates.

From the preliminary study of national preconditions, the housing and transport sectors appear to be the best opportunity for local climate protection policies while the influence of communities on industry and commerce depends on the specific national legal system.

Figure 1. Energy Consumption of Households [kWh/capita] by Fuel Source and by Use



Source: /StBa 2006, ANRE 2006, EIA 2006b/

National Climate Policy

Many German communities support climate protection measures without being tied to a strict separation of tasks on national, regional and local level. Communities may introduce administrative regulations (i.e. energy standards), financial incentives and soft instruments to push local climate protection. In the U.S., climate protection happened mostly trough bottom-up channels, as several states and a rising number of communities have developed climate action

[1] Town gas refers to manufactured gaseous fuels (i.e. from naphta) and sold to consumers and municipalities

plans, while the U.S. government refrained from international agreements. Local governments' possibilities to influence climate protection are manyfold and resemble the policies in Germany.

Important efforts to improve climate protection in Japan come from governmental institutions. Energy efficiency evolved as strategy, resulting in successful instruments like the famous top-runner model[2]. Regional prefectures are legally obliged to set up climate action plans, followed by several communities whose governments involved voluntarily. A strict separation of tasks between national, regional and local actors limits the opportunities of local governments to introduce powerful measures. In fact, activities usually consist of awareness-raising campaigns. Regardless of these legal draw-backs, communities should claim more authority, especially regulative responsibilities, to widen the potential pool of actions.

Benchmark

An important aim of the LGCP project was to design a broad, transparent and widely accepted climate benchmark for municipalities. Therefore existing approaches, previously used to evaluate local climate protection activities and results, were discussed at an initial workshop in Frankfurt, Germany in May 2007. Important findings of this workshop were:

- A benchmark fixed only on comparison of end-use energy and CO_2 emissions may not be sufficient.

Practical experience from more than 20 years revealed that a lack of methodological standards for city-specific CO_2 inventories makes it very difficult to compare city achievements even within Germany. An aggregation of total emissions on the city level is not conclusive, unless additional information about the calculation procedure is available. Some crucial points in estimating CO_2 emissions are defining the power mix and related emissions, accounting for CHP and district heating, determining heat consumption within the city, and defining transport data (cp. CO_2 emission inventory).

- The benchmark should be based on a multi level approach including assessment of city activities and the impact of climate action.
- The benchmark tool has to be developed as a long-term application. Nevertheless elements should cover promising quick action to increase the motivation of participants.
- Intention of the benchmark pilot project should rather be used to advance transparency of climate actions of cities than to implement a ranking list (who´s best?) of communities.
- Last but not least: Benchmark should be as simple as possible but as significant as necessary.

The discussion of existing approaches included major climate protection competitions, currently applied in Germany and well known to German communities: the Energy Award /Forum European Energy Award 2008/, Solarbundesliga (National Solar League) /DUH 2008a/, Bundeshauptstadt im Klimaschutz (National Climate Capital) /DUH 2008b/ and material provided by CA (Climate Compass, Climate Star, 10 Steps) /CA 2000, CA 2007, Amica-

[2] Top Runner model: define the best product on the market as standard, which has to be achieved by products within the same product group in a certain period of time (e.g. 5 years) /BMU 2007/

Workshop 2006/ and ICLEI (Milestones, ökoBUDGET) /ICLEI 2007/. City representatives mainly criticized missing transparency and therefore low synergy effects, a high work load for their administrative staff and the effect that city councils misuse positive 'test results' by giving the topic less priority. The latter means, measurement scales should set high goals with sufficient potential to improve.

Multy Level Approach

To combine all the recommendations from the Frankfurt workshop, a benchmark tool was developed based on a multi-level approach and calibrated by means of various test communities. The benchmark consists of the following parts:

1. **CO_2 Emission Inventory:** The historic development of city wide emissions is a major indicator for climate issues. The main challenge of this part is the comparison of the results in spite of different emission inventory approaches in Germany, Japan, and the U.S.
2. **Activity Profile**: Activity profiles are used to scan the present state of the city's climate protection activities in the categories "climate policy", "energy", "transport", and "waste".
3. **Set of Indicators:** A set of 17 indicators completes the comparison, gathering hard facts about a city's climate impact. This part reveals in which fields a city has achieved significant progress.

CO_2 Emission Inventory

According to the initial project description, this part was considered to be the starting point of any evaluation. However, reviewing existing greenhouse gas (GHG) inventories, including data on site energy and CO_2 emission, confirmed that requirements differ both between countries and within communities. Difficulties due to varying approaches to inventory GHG emissions in the U.S., Japan and Germany had already been stated during the workshop. Faced with a lack of consistent data, a common evaluation has not been possible so far. Instead, the project now contributes to harmonizing CO_2 balancing in all participating countries and to increase transparency of calculation.

Differences occur with respect to time (sometimes data from previous years does not exist), to the level of detail and quality of information given, especially for the use of different energy carriers. There is no standard method how to determine the local energy mix with the result that city specific electricity mixes vary from case to case, referring to national, regional or upstream supply chains. Another crucial point is the number and classification of sectors. In some cases transport is not included at all or private households and the commercial sector appear as one sector.

Therefore it is necessary to develop a benchmarking system that guarantees a maximum of transparency and allows an application to any city, independent from its country of origin. The following principles have been defined to allow reasonable results:

- Data inquiry includes CO_2 emission and corresponding energy consumption according to main sectors (industry, commerce, residential, transport and waste).

- Data inquiry respects the development of emission over a certain period of time (ideally starting from 1990 up to now)
- The field “city facilities” (i.e. own buildings and equipment of the city) is particularly emphasized to underline the direct influence of the local government.

Collecting CO_2 emission data in combination with data on energy consumption offers the opportunity to harmonize results by means of standardized emission factors. Key data, such as the energy consumption or CO_2 emission per inhabitant and year, will be completed by the trend of annual emissions. The correlation of both parameters (CO_2 and energy) also allows to explain significant changes in emission, like the decline of industrial activities, a change in energy supply or actual energy savings[3].

Activity Profile

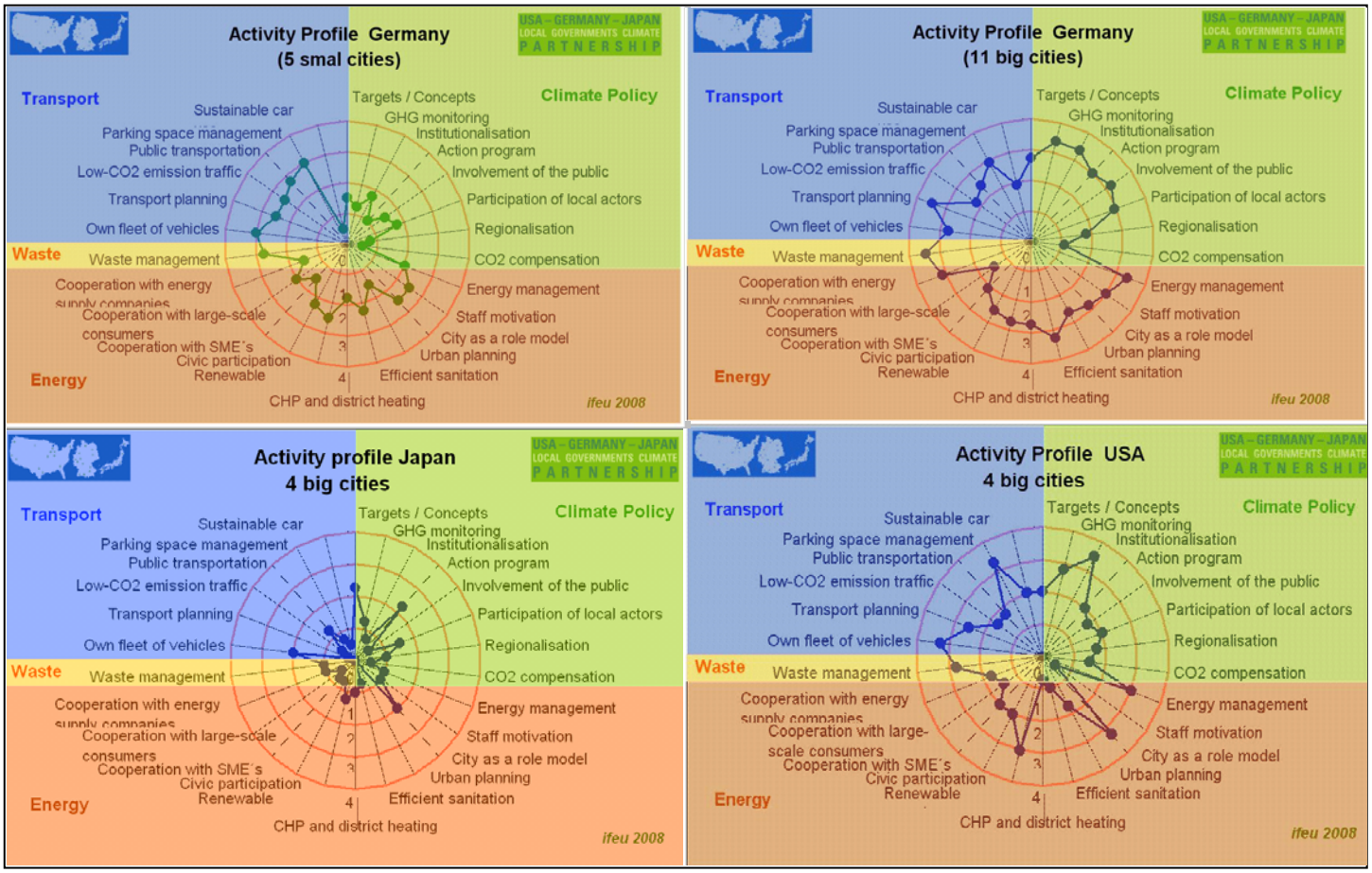
To assure easy access to the benchmark tool an activity profile is used to scan the present state of the city’s climate protection activities. The activity profile is based on the CLIMATE COMPASS Compendium of Measures developed by CA /CA 2006/. As in this project the focus is on climate protection, relevant action fields have been selected and adjusted to design a consistent evaluation system. The derivated matrix of activities finally included 26 action fields in the categories “climate policy”, “energy”, “transportation” and “waste”. Each activity has further been divided into four levels from beginners to climate leaders. The measuring scale indicates the municipality's progress of climate protection in a qualitative way and potentially serves as starting point to exchange different strategies of city governments around the world.

The different action fields and its levels have been adapted in close cooperation with the Japanese partnering team to the needs of this international benchmark system. The activity profile now covers the full range of climate protection measures, useful to city governments. Measures, which imply strategic interest and foster public participation in climate protection, can be found under the category "climate policy". Measures related to "energy" refer to the energy supply system, cooperation with companies, the use of energy in public buildings as well as how energy aspects are introduced into urban planning. Activities within the "transport" sector include an evaluation of the transportation system, public and sustainable traffic planning as well as fuel efficiency and type of cars used within the city. The category "waste" has been introduced due to the fact that activities related to waste management are important components of Japanese and US climate protection schemes. Even before testing the activity profile, it was obvious, that Japanese communities would stay behind in many fields, caused by restricted legal opportunities. However, the aim was to present a full set of possible measures, even if some of them cannot be implemented instantly. During the testing, activity profiles were sent to the respective departments of participating cities and completed by the responsible officer. Evaluation is visualized by means of a spider web, representing no measures (beginner level) in the centre up

[3] From 1990 to 2005, the city of Mainz lowered its energy consumption by 2,2 percent per year. While the consumption of private households and the commercial sector remained almost constant, the effect is mostly due to a dislocation of the industrial sector. In fact, energy consumption is not really decreasing but only shifted from Mainz city to other places in Germany or worldwide. Regarding CO_2 emissions, the annual emission has also improved by 3,2 percent every year. The main factor actually was the change from a coal to a gas-fired power plant. (Currently there are serious plans to reinstall a coal-fired plant in 2014.) The example shows, that it is important to know the local history of energy supply and demand to interpret data properly. /IFEU 2007b/

to climate leaders on the outer sphere. Figure 2 shows the activity profile results of participating cities from the U.S., Germany and Japan.

Figure 2. Activity Profiles of German, American und Japanese Cities



The analysis of German towns distinguishes small from large cities. Except for the fields of regionalization, CO_2 compensation and cooperation with large-scale consumers, big cities achieved a minimum of two points on the activity scale. Especially in the field of climate policy small cities stayed more than one point behind large German cities. Results of big American cities may be rated similar to big German cities, although their average score in the fields of staff motivation, efficient sanitation, combined heat and power (CHP) and public transport remains more than one point below the German average. In contrary, the results of Japanese cities differ strongly. Due to a completely different national framework (see above) most of all fields have been evaluated with only 1 point.

Set of Indicators

From the previous step we have learnt that information to be drawn from a CO_2 emission inventory is very restricted. In general, CO_2 emission inventories alone fail to evaluate the effectiveness of measures due to a dominant role of the industrial sector and energy supply

systems with relative low impact of municipal decision making. Consequently, the benchmark system has been upgraded by a selection of seventeen indicators which assess the municipal progress in implementing effective measures and reveal primary fields of action. In contrary to the activity profile, indicators contain quantitative information regarding energy supply and consumption within the city, transportation, waste management and CO_2 compensation activities. They are separated into two groups, with 10 indicators evaluating the overall situation within the city, plus 7 indicators referring to climate-related activities of the local government itself. The latter signify that city governments should act as role model and promoter of climate action.

Indicators focus on energy aspects and are used to further interpret CO_2 emissions. Important criteria are the share of renewable energies to generate power or heat, CHP applications with improved efficiency as well as the specific energy consumption of different sectors. Therefore information from step 1 can be correlated to standard reference values (e.g. electricity use per inhabitant [kWh/cap], heat consumption per sqm [kWh/m²]). Progress within the transport sector is measured by the transportation choice[4] as a comprehensive indicator determined by infrastructural characteristics, economic decisions and behaviour patterns. In addition to that, the efficiency of the private car fleet identifies the diffusion of carbon low vehicles. Due to the fact that reliable data on transportation is rarely available, indicators remain rather general. Last but not least, waste management plays an important role in climate protection activities and is measured in terms of waste production per inhabitant, resuming the principle of waste reduction.

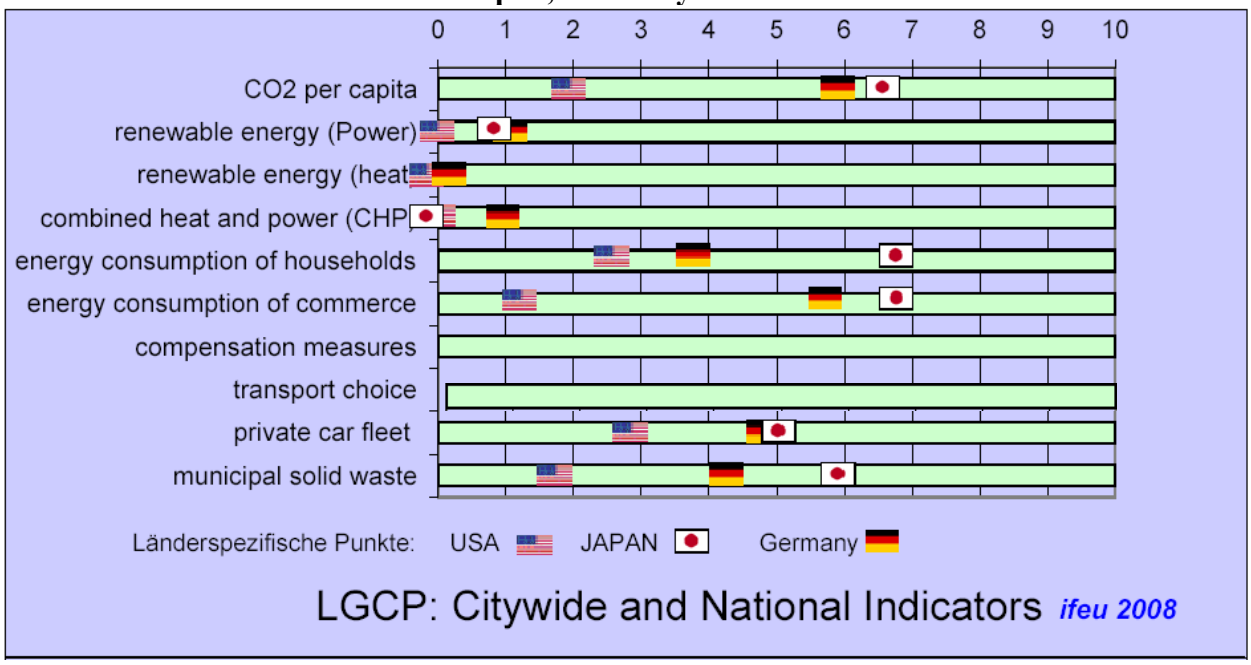
Indicators are essentially based on the existing set of indicators by Climate Alliance /CA 2001/ as well as extensive work experience of IFEU /IFEU 2002/ and take up results from a closed project on indicators initiated by the energy agency NRW /EA NRW 2003/. Again, the selection of indicators has taken place in close collaboration with project partners overseas to integrate different viewpoints. The main criteria was the possibility to eventually collect reasonable data from communities. At the current stage, this data has not been surveyed from communities, but is the essential part of the next round of questionnaires. Overall national averages have been calculated to emphasize different starting points of communities in Germany, Japan and the US.

The conversion of specific data into indicators is subject to the following rules: Each city receives a data file including all necessary information to calculate city-specific indicators. Results are represented on a universal point scale ranging from 0 to 10. The 10 point mark is defined as the theoretical maximum (e.g. 100 percent renewable energy or 0 tons of CO_2) which is not necessarily a practicable one[5]. Each city will then obtain its placement relative to the highest mark, using the same scale for German, Japanese and U.S. cities. Figure 4 displays the evaluation of the ten citywide indicators according to national averages. The remaining indicators are subject to city-government activities and cannot be evaluated on a national scale. Averages will be directly calculated from data collected by participating communities.

[4] The relation of journeys covered in private motorized vehicles, public transportation, by bike and by foot.

[5] The motive behind setting high goals is to provide city representatives with material to discuss long-term strategies and initiate further actions (cp. workshop discussion).

Figure 4. Set of Citywide Indicators including National Average (Flags) of Japan, Germany and USA



As highlighted by national flags in figure 4, Japan leads the field concerning indicators like CO_2 per capita, specific energy consumption of households and commerce, efficiency of private car fleet and municipal solid waste reduction. Germany performs best in terms of integrating renewable energies and CHP. If this picture holds true also on a community level, remains to be seen after the next project phase. Please note, that the indicators compensation measures and transport choice are only available on community level and will be evaluated individually.

Since data may not always be available for each city, results can be completed by general national averages. Estimation methods, like national averages, should only apply in case the city administration has absolutely no access to primary data. The different quality of data are carefully recorded in the evaluation of indicators (classification ranges from A=city specific data to D=national average). Data quality is expected to improve slowly with rising international competition and interest in climate protection.

The reporting of the city government specific indicators refer to the same scale, though it is foreseen to form average coefficients for small, medium and big cities as soon as the amount of data is robust enough to be significant. For city governments, these indicators might be most important as it is less difficult to maximize points because only their own facilities are to be considered.

After having successfully defined contents and reference values for the quantitative evaluation of climate protection measures, the next step will be to calculate indicators with data from participating cities and start the analyzing process.

Outlook

By now, the country comparison, the structural design of the benchmark system, and the first test run is completed. The German Japanese workshop was successfully held in Nagoya in

March, 2008 with the result that the Japanese team plans to extend the benchmark to hundred Japanese cities and prefectures. In the U.S., a project workshop takes place in Albuquerque in May 2008, in connection to the ICLEI local action summit. If interest proves to be similarly high, some dozen American cities could join the project by the end of 2009. The final workshop of the first benchmark period is planned in Germany in June, 2008. The German Agency for Environment already plans to apply the benchmark to hundreds of other German cities and regions. To simplify a future large-scale application, the benchmark system will be upgraded to become more user-friendly and accessible on the internet.

In summary, the results of the first year demonstrated that the benchmark provides a transparent system to assess and evaluate climate change action by cities worldwide. The further development depends essentially on local governments to become engaged and start a discussion of how to approach climate protection from different national backgrounds.

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