

Rudolph, Sven; Kawakatsu, Takeshi

Working Paper

Tokyo's greenhouse gas emissions trading scheme: A model for sustainable megacity carbon markets?

MAGKS Joint Discussion Paper Series in Economics, No. 25-2012

Provided in Cooperation with:

Faculty of Business Administration and Economics, University of Marburg

Suggested Citation: Rudolph, Sven; Kawakatsu, Takeshi (2012) : Tokyo's greenhouse gas emissions trading scheme: A model for sustainable megacity carbon markets?, MAGKS Joint Discussion Paper Series in Economics, No. 25-2012, Philipps-University Marburg, Faculty of Business Administration and Economics, Marburg

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<https://hdl.handle.net/10419/73045>

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MAGKS



**Joint Discussion Paper
Series in Economics**

by the Universities of
**Aachen · Gießen · Göttingen
Kassel · Marburg · Siegen**

ISSN 1867-3678

No. 25-2012

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This paper can be downloaded from
http://www.uni-marburg.de/fb02/makro/forschung/magkspapers/index_html%28magks%29

Coordination: Bernd Hayo • Philipps-University Marburg
Faculty of Business Administration and Economics • Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

TOKYO'S GREENHOUSE GAS EMISSIONS TRADING SCHEME

A MODEL FOR SUSTAINABLE MEGACITY CARBON MARKETS?¹

Sven Rudolph, Takeshi Kawakatsu²

Abstract

Megacities already account for a major part of global energy-related CO₂ emissions with a strong tendency to increase; hence, future climate policy has to put a special emphasis on reducing big cities' energy consumption, especially in a world, where global climate negotiations are deadlocked. Tokyo, the world's biggest metropolis and emitter of greenhouse gases roughly comparable to Scandinavian countries, started the world's first megacity carbon market in 2010, the design of which is unique, due to its focus on end-energy use in buildings. While the program only started in 2010, the first results are now available. Hence, the paper answers the question to what extent Tokyo's new carbon market can be considered a worthwhile model for other cities as well as an additional building-stone in a bottom-up global climate policy regime. By applying up-to-date sustainability economics reasoning, the paper evaluates the design and the recent results of Tokyo's carbon market, showing that, while there is still room for improvements, Tokyo has the potential to be a world leader in sustainable local climate policy.

JEL-code: D62, Q48, Q54, Q58, R59

Keywords: climate policy, ETS, local, city, Tokyo

¹ This paper is a result of the research project „Linking Emissions Trading Systems: Towards Socially und Ecologically Acceptable Cap-and-Trade Policies in Europe, the USA, and Japan (LETSCaP)“, carried out at the Competence Center for Climate Change Mitigation and Adaptation (CliMA) of Kassel University, sponsored by the German Federal Ministry of Education and Research (BMBF).

² Dr. Sven Rudolph is Assistant Professor at the Faculty of Economics and CliMA of Kassel University, Germany. Takeshi Kawakatsu, PhD, is Associate Professor at the Faculty of Public Policy at Kyoto Prefectural University, Japan.

1 Introduction

Many studies by renowned institutions such as the World Commission on Environment and Development (WCED 1987), the Intergovernmental Panel on Climate Change (Metz et al. 2007) the World Business Council for Sustainable Development (WBCSD 2007), the International Energy Agency (IEA 2008), the Organisation for Economic Co-operation and Development (OECD 2009) and the World Bank (2010) have emphasized the key role of cities for future climate protection. Cities already account for around two thirds of global energy consumption and more than 70% of global energy-related carbon dioxide (CO₂) emissions, while on the other hand the potential for cost-efficient emission reductions is amongst the highest in buildings. In 2010, half of the world's population lived in cities and the number is expected to increase to reach 70% by 2050, thus also increasing the climate impact of cities. Hence, future climate policy has to target energy consumption in big cities as one major focus.

On the other hand, although there are small steps forward, global climate policy at the international level is in a deadlock. Neither the Copenhagen summit nor the follow-up meetings in Cancún and Durban were able to deliver a binding global climate policy regime with absolute emission targets and including all major emitting countries. Hence, bottom-up initiatives appear to become more important. One major strategy could be to globally interlink activities on the national, regional, or even local level. This strategy has been intensively discussed in the area of linking greenhouse gas emissions trading schemes (GHG ETS) (Flachsland et al. 2008, Jaffe/Stavins 2008, Mace et al. 2008, Roßnagel 2008, Sterk/Schüle 2009). Apart from linking existing supranational (EU ETS), national (New Zealand, Australia ETS), and regional (Regional Greenhouse Gas Initiative, RGGI; Western Climate Initiative, WCI) ETS, linking megacity ETS could be a worthwhile strategy for promoting global climate protection, especially in countries and regions where national climate policy has failed so far. Initiatives for cooperation amongst cities already exist, e.g. under the C40 Cities Climate Leadership Group and could be utilized for linking megacity GHG ETS.

Also from the economic perspective on intergovernmental relations and environmental federalism (Oates 2004) local climate protection activities appear to be reasonable, since early argu-

ments in favor of the centralization of responsibilities in environmental policies due to geographical externalities and the deregulation race (Stewart 1977) are currently turned down by the second generation of environmental federalism and empirical evidence. Morotomi (2012: 6ff) summarizes the economic arguments by emphasizing that municipalities could act as policy laboratories, while tailoring policies to the preferences of their residents and the particular infrastructural needs in order to increase welfare of local communities. This would also foster competition between municipalities and the “voting by feet” (Tiebout 1956), which in turn would increase citizens’ utility from the provision of public goods. Apart from economics’ arguments, also scientific studies in other fields emphasize the role of cities for global climate protection (Betsill/Bulkeley 2007).

Emissions trading as an environmental policy instrument has already convincingly proven its effectiveness. While economic theory has been making the argument for the economic efficiency and ecological effectiveness of tradable permit systems since the late 1960s (Tietenberg 2006), despite of some start-up problems, emissions trading systems such as the US SO₂ and NO_x trading programs or the EU GHG ETS have even proven their merits in practice (Ellerman 2000, Ellerman et al. 2010). It has also been shown, that in principle GHG ETS can be designed in such a way that they fulfill ambitious sustainability criteria (see Table 3) (Rudolph et al. 2012), hence, not only satisfying requirements for economic efficiency and ecological effectiveness (Boemare/Quirion 2002, Fankhauser/Hepburn 2010) but also for social justice (Lerch 2011). However, obviously many political barriers exist for implementing sustainable GHG ETS, which are compulsory, have a comprehensive coverage, implement a stringent absolute volume cap and auction-off all allowance, while using the revenues for redistributive, mitigation, and adaptation measures (Rudolph 2009a, b; Rudolph/Park 2010).

Tokyo, Japan’s capital, is still the biggest metropolitan area in the world with a total population of around 13 Million; it also has the strongest metropolitan economy with a total Gross Domestic Product (GDP) of 868 billion US\$ in 2007, thus representing 20% of Japan’s GDP and ranking as the 15th largest economy in the world (TMG 2010, TMG 2012d). In environmental policy, Tokyo has been a leader for the Japanese national government in many fields such as vehicle

emissions standards and even climate policy (Morotomi 2012: 4, TMG 2006). The Omnibus Decentralization Act of 1999 allows local governments in Japan to adopt their own environmental policies, an idea that has been taken up by many prefectures, e.g. in implementing forestry taxes (Koichi Prefecture, 2003) and industrial waste taxes (Mie Prefecture, 2002) (Sugiyama/Takeuchi 2008). In climate policy, Japan's capital Tokyo has put up its own climate protection strategy including a greenhouse gas cap-and-trade system (GHG ETS), which is outstanding in three ways: First, it represents the only mandatory GHG ETS with an absolute volume cap in Japan; second, it is the first local GHG ETS focusing on commercial activities and the end-use of energy; third, it is the first megalopolis GHG ETS following supranational (EU ETS), national (NZ ETS), and regional (RGGI, WCI) initiatives.³

Hence, with the city of Tokyo being a major economic and climate policy player in Japan and the world and local GHG ETS representing a promising bottom-up initiative for global climate protection, the following questions arise:

- (1) What are the major design features of Tokyo's GHG ETS and how can they be judged?
- (2) What are initial experiences with Tokyo's GHG ETS and how can they be evaluated?
- (3) What are the major lessons for other city GHG ETS and potential intercity linkages?

This paper answers these questions by applying design and implications analysis as well as sustainability and political economics' reasoning. This paper goes beyond earlier ex ante analysis of Tokyo's GHG ETS (Wakabayashi/Kimura/Nishio 2011), because, besides economic and ecological criteria, it also includes the social dimension, thus judging the design of Tokyo's carbon market based on ambitious sustainability criteria for emissions trading schemes (Rudolph et al. 2012). In addition, it makes use of the first actual performance data of the TMG

³ The UK also introduced a trading program for reducing GHG emissions from commercial sources within the Carbon Reduction Commitment (CRC) program (UK DECC 2012); for a comparison with the TMG ETS see Institute for Building Efficiency (2012). In addition, city ETS have already been used for other pollutants in Los Angeles, Chicago, and Santiago de Chile (World Bank 2010: 2).

ETS based on criteria developed in environmental economics (Endres 2010) such as ecological effectiveness (accuracy of reaching the target, innovation incentives) and economic efficiency (cost-efficiency, administrative costs, transaction costs). In addition, some political economy lessons for implementing city GHG ETS can be learned.

2 Design of the Tokyo Metropolitan Government Emissions Trading System

2.1 Framework Data and Precursors of the TMG ETS

Japan is the third biggest economy in the world resulting in being the seventh biggest emitter of total GHG emissions and the fifth biggest emitter of CO₂ (GoJ 2010, UNFCCC 2011). Japan committed to a 6% reduction by 2008-2012 compared to 1990 in the Kyoto Protocol, increased its GHG emissions by 9% by 2007, but lowered emissions due to the economics recession to a level of 1% above 1990 levels in 2008. Emissions trading has been used in Japan since 2005, but all trial programs were voluntary in nature, did not have a top-down absolute volume cap, and are supposed to end in 2012 anyway; albeit without achieving major emission reductions at low costs (Mochizuki 2011, Rudolph/Park 2010, Watanabe 2011).

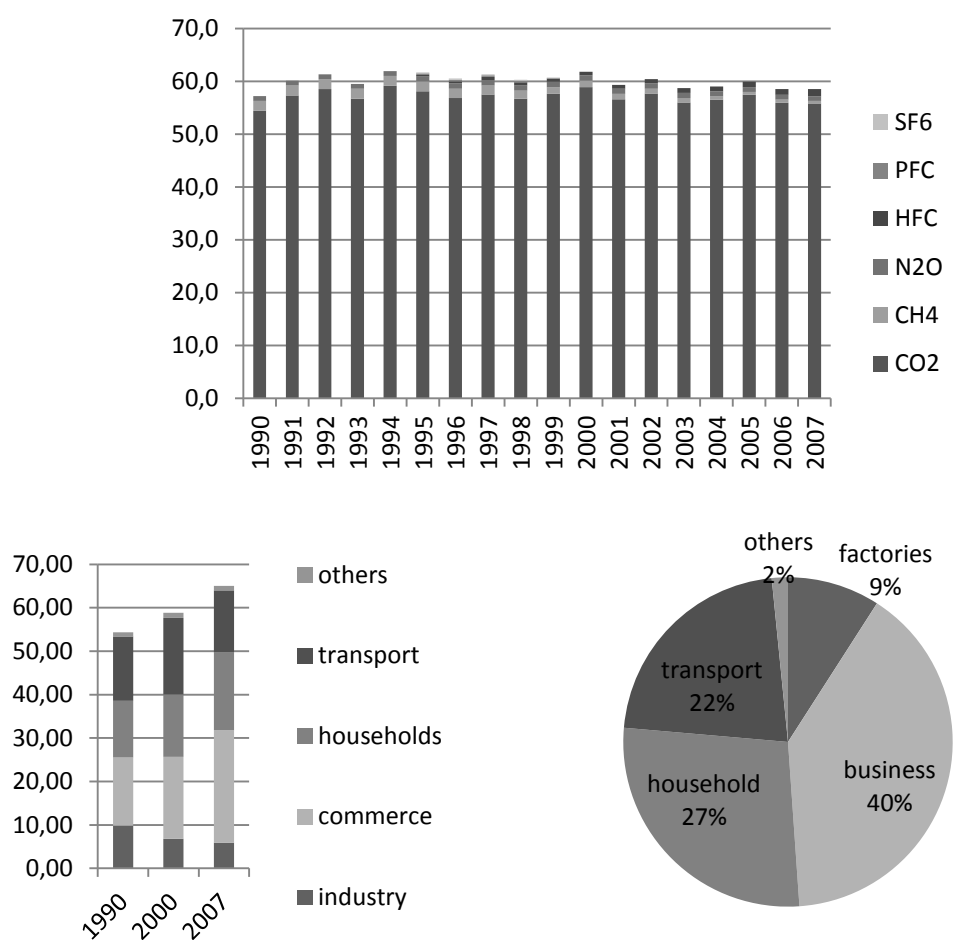
Japan's capital Tokyo alone accounted for GHG emissions of 59.63 million tons in the year 2006, placing it between Sweden (28th place) and Norway (29th place) in the international ranking of GHG emissions in that year (TMG 2010). Energy-related CO₂ emissions accounted for 56.67 Mio. t., representing 95% of Tokyo's GHG emissions; per capita emissions were 4.89 tons of CO₂ and thus much lower than the national average of around 10 t. Tokyo's carbon intensity is 146 kilo tons of CO₂ per Billion US\$ and thus amongst the best of the world's big cities. However, total energy-related CO₂ emissions have increased by 6.2% between 1990 and 2006, while they have been decreasing in recent years.

In 2007 22% of CO₂ emissions originated from transportation, 27% from households and 49% from economic activities (TMG 2011a). The major part of emissions from economic activities originates from commercial activities (40%), while only 9% come from industrial productions. Of the 49% emissions from economic activities, 40% originate from large facilities and 60%

from small and medium-size facilities (TMG 2012d). Also, while emissions in industry have decreased since 1990, emissions in the commercial sector have increased.

In terms of energy type, electricity accounts for 50% of Tokyo's CO₂ emissions, followed by oil (28%) and city gas (17%). While emissions from city gas have grown rapidly by 43.5% between 1990 and 2006 due to the fuel switch from oil to gas, electricity emissions increased by 14.5% and emissions from oil, LPG and others (incl. coal) decreased by more than 20%.

Figure 1: GHG Emissions in Tokyo by Gas and Source (in Mio. t) Including Shares



Source: data based on TMG 2008b

Already in December 2000 the Tokyo Metropolitan Government (TMG) established the Tokyo Metropolitan Environmental Security Ordinance (TMG 2012c). In December 2006 Tokyo published its climate policy target of a long-term GHG reduction of at least 50% by the year 2050 and a mid-term reduction of 25% by 2020 compared to the 2000 level as a part of “Tokyo’s Big Change – The 10-Year Plan”. In June 2007, Tokyo adopted its Climate Change Strategy, al-

ready announcing the introduction of a cap-and-trade program. In March 2008, the TMG set sector targets within its Environmental Master Plan as given in Table 1:

Table 1: Tokyo's GHG emission reduction targets for 2020 by sector

sector	target against 1990 level	target against 2000 level
industry, commercial	-16%	-17%
residential	-11%	-19%
transport	-31%	-42%

Source: TMG 2010: 13

Concrete policies such as the CO₂ Emission Reduction Program and the Tokyo Green Building Program even started in the first half of the 2000s. These programs apply a mixture of voluntary, regulatory and market-based instruments such as voluntary emission reductions, minimum energy standards, compulsory reporting as well as energy rating, reporting and labeling in order to target all sectors.

Particularly the CO₂ Emission Reporting Program can be taken as an important precursor of Tokyo's cap-and-trade program (TMG 2012d, e). Already from April 2002 onwards around 1,000 large facilities (300 factories, 700 buildings) with an annual energy consumption of 1,500 kiloliters crude oil equivalent or more were required to report their GHG emissions annually to the TMG.⁴ While emission reductions were voluntary, the reports had to include energy consumption data broken down by month and energy sources. Also, facilities had to hand in a 3-year CO₂ Emissions Management Plan. In a step-by-step process of "Administrative Guidance" the TMG checked the reports and plans, gave advice to the facilities and made them resubmit revised versions, which were then officially announced and made open to the public. The program was revised in 2005, adding an energy audit based on questionnaires, research and on-site visits. The TMG rated facilities' activities on a scale from C (TMG proposed measures not implemented) to A (all TMG proposed basic measures implemented), even certifying facilities with A⁺ if the reduction target was 2% or more and AA if the reduction target was 5% or more. By this process, e.g. in 2006, facilities improved their plans significantly to the end that the percentage of ratings of A or above increased from 48% to 98%. A-ratings or above were made

⁴ Since 2010 a similar program applies to small and medium-size facilities.

public and facilities received information on their position compared to others. Also added was a compulsory report on details of energy saving equipments, estimates of the expected reductions from the equipment, and additional information such as type and age of the equipment. While the gathering of information was of utmost importance for establishing the cap-and-trade-program, the mandatory reporting program including voluntary emission reductions only accounted for CO₂ reductions of around 2% between 2002 and 2005.

2.2 The TMG ETS

In June 2007 the Tokyo Metropolitan Government announced the introduction of its climate policy cap-and-trade program, the Tokyo Metropolitan Government Emissions Trading Scheme (TMG ETS) to be implemented in June 2008 and to start from April 2010 (TMG 2010, 2011a, 2012a). Major motivations were the transformation of Tokyo into a low carbon city in order to be able to compete internationally with other big cities, but also to show the way to the national government. Due to the big share and the increasing trend of CO₂ emissions from the commercial sector, the TMG ETS focuses on CO₂ emissions from the end-use of energy in large buildings and factories. In total, the program covers around 1,300 facilities (1,000 commercial incl. public buildings, 300 factories), which consume energy of more than 1,500 kiloliter crude oil equivalent per year.⁵ While differentiated emissions factors apply to fuels used in factories, electricity use is treated by one emission factor attributed to the exclusive power supplier, Tokyo Electric Power Company (TEPCO) by the following formula:

$$\text{CO}_2 \text{ emissions (t of CO}_2\text{)} = \text{electricity usage (kWh)} \times \text{emission factor (t of CO}_2\text{/kWh)}$$

Hence, the program covers roughly 13 Mio. t. of energy-related CO₂ representing a share 40% of all CO₂ emissions from the commercial and industrial sector in Tokyo and a share of 20% of

⁵ Thus, all major skyscrapers and central government buildings are covered including the Prime Ministers residence, the Diet Building, major Ministries such as the Ministry of the Environment (MoE) and the Ministry of Economy, Trade, and Industry (METI) as well as parts of the Imperial Palace.

Tokyo's total CO₂ emissions. The program is mandatory for all targeted facilities without any opt-in or opt-out possibilities.

The absolute volume cap for the participating facilities was set at a level of 6% below base-year emissions for the emission average of the first trading phase (2010-2014) and a total of 17% below base-year emissions in the second trading period (2015-2019). Calculations of the TMG resulted in a cap of 10.44 million tons of CO₂ in 2020, of which 9.7 Mio. t. go to existing facilities and 0,74 to the new entrants reserve. The cap is split yet again, requiring factories to reduce their emissions by 6% in the first trading period and commercial buildings by 8%; individualized second period targets for the sectors will be decided at the end of the first period. In addition, in order to account for early action, facilities that have achieved a high level of energy efficiency can apply to be certified as "Top Level Facilities", which allows for lowering the reduction requirement to 50%. Base-year emissions are set as the average emissions of three executive years between 2002 and 2007, whereat the exact base period can be picked by participants and might even be changed if major changes in the floor size or the use of buildings occur. Hence, basically the TMG ETS sets facility caps which add up to the economy-wide cap.

In terms of individual allocation of emission rights to facilities, in fact, the TMG ETS allocates annual reduction obligations at the beginning of each compliance period following the formula

$$\text{Reduction Obligation} = \text{BY} \times \text{CF} \times \text{year of the compliance period}$$

with: BY = average emissions of three consecutive base years of 2002 to 2007

CF = compliance factor (Period I: 6% for factories, 8% for buildings)

However, basically, from this calculation the amount of total emission rights granted to facilities for specified compliance period can be calculated in the following way:⁶

$$\text{Compliance Period Allocation} = (\text{BY} - (\text{BY} \times \text{CF})) \times 5$$

⁶ Example: Given base year emissions were 10,000 tons per year and the compliance factor is 8%, that leaves $(10,000 - (10,000 \times 8\%)) \times 5 = 46,000$ worth of emissions allowances for the first five year compliance period.

Hence, emission rights are granted free of charge based on a grandfathering approach at the beginning of each compliance period. However, emission rights are not handed out to facilities as certified emission allowances at the beginning of a compliance period, but they are only used for calculating the amount of access credits available to every facility for trading on an annual basis.

Banking of credits is allowed from Period I to Period II, while borrowing is not permitted. Besides credits originating from the TMG ETS itself, three types of offsets can be used to cover emission reduction obligations; all of which have to be verified by external agencies. No credits from national crediting systems are accepted due to their minor quality:

- Emission Reduction Credits from energy savings in small or midsize facilities in Tokyo not covered by the TMG ETS (unlimited)
- Renewable Energy Credits from electricity production by solar (heat, electricity), wind, geothermal, hydro (under 1,000 kW), biomass (biomass rate $\geq 95\%$) etc.; due their positive effects, renewable energy credits are counted 1.5 times the value of regular credits.
- Emission Reductions Credits from outside Tokyo but within Japan; credit sellers must be large facilities with less than 150,000 tons of base year emissions; the company has to be regulated under the TMG ETS; credits are only accepted for one third of facilities' reduction obligations.

New entrants do not fall under the TMG ETS immediately after construction, but only after these facilities have increased their emissions to a level of beyond 1,500 kilolitre crude oil equivalent per year for three executive years. They receive allowances free of charge from a reserve, endowed with a total of 0,74 million allowances. The individual allocation is calculated on the basis of historical emissions over two to three executive years, in which energy saving measures specified by the TMG have to be implemented in order to prevent facilities to increase their emissions by purpose in order to receive more allowances. Facilities are allowed to leave the TMG ETS if one of the following three conditions applies:

- energy consumption of the previous year below 1,000 kilolitre

- energy consumption below 1,500 kilolitre for the past 3 consecutive years
- shutdown or suspension of operation

The compliance period is then shortened up until the last year prior to when the change occurred, and as allowances are not allocated in advance, they do not have to be given back.⁷

Trading of credits is allowed between participating facilities and any other legal entity. However, only excess emission reductions beyond the annual reduction obligations can be traded from 2011 onwards. Hence, excess credits are only issued, if the following formula delivers a positive result:⁸

$$\text{Excess Credits} = \text{Actual Annual Reduction} - \text{Annual Reduction Obligation}$$

Credits have to be issued by the TMG on application by facilities. Also, the TMG is planning to provide a list of accepted brokers and stock exchanges, which themselves show a lot of interest in the program. However, at the time of writing, trading is only possible on a bilateral basis. In order to facilitate trading, the TMG publishes the annual emissions and the actual reductions of each facility on its Information Disclosure Website each year and has also registered five intermediaries as brokers. Trading periods are five years each, the first period lasts from 2010 to 2014 while the second lasts from 2015 until 2019. Market interventions such as an increased acceptance of offsets and even the inclusion of Kyoto offsets may apply, if a price surge occurs.

⁷ E.g. if the facility shuts down in mid-2013, the first compliance period is changed to 2010 to 2012. Emission allowances are then only granted until 2012.

⁸ Example: Given the above example of base year emissions of 10,000 tons and a compliance factor of 8% as well as annual emissions in the first year of the compliance period of 8,500 tons, no trading is allowed, because actual reductions of 500 t are lower than reduction obligations of 800 t. However, if in year two of the compliance period emissions are 8,000 t, 400 tons worth of credits can be transferred, because reductions (2,000 t.) exceed obligations (1,600 t).

Compliance responsibility and reporting is based on the owner of each individual facility,⁹ following TMG Monitoring, Reporting, and Verification Guidelines set by the Governor in 2009 (TMG 2010, TMG 2012e). While the TMG considered using internationally acknowledged standards such as ISO, due to the specific focus on end-use, existing standards were insufficient (TMG 2012a). TMG came up with its own methodology, which incorporates experiences from international standard setting, but even strengthens requirements for their own MRV guidelines by combining measuring and calculating emissions. The facilities had to write a base-year emission report by September 2010 before entering the TMG ETS and they have to submit annual emission reports. Emissions are calculated based on energy consumption measured by effective gauges and verified by energy bills. Both base-year and current emission reports have to be verified by external agencies. Around 30 of such agencies are registered with Tokyo's Governor after a rigorous approval process in 2009. The verifiers check energy consumption data comparing it with facilities' energy bills as well as facilities' calculation of emissions from energy data. The verified reports must be submitted to the TMG. In order to be allowed to trade credits, facilities have to open an account in a registry provided by the TMG at the price of 13,400 Yen. The account contains information on base-year emissions, actual emissions, reduction obligations, and excess credits. In the case of non-compliance or a failure to submit the reports facilities are faced with a financial penalty of up to 500,000 ¥ for breaching the law. In addition, 1.3 times the amount of excess emissions has to be covered by a deadline determined by the Governor. If this regulation is violated, the Governor buys the respective amount of credits from the market and charges the costs to the facilities. Ultimately, the names of the facilities are made public in a "name and shame"-scheme.

⁹ However, tenants are required to cooperate with building owners, and in the case of large rented floor areas, specified tenants renting rooms with more than 5,000m² floor area usage or with an electricity use per year of more than 6 Mio. kWh even have to submit their own emission reduction plans to the TMG via the owner and implement the plans.

In terms of expansion and linking, the TMG follows three strategies: First, the TMG urges the national government to implement its own ETS. The TMG published its own policy proposal, suggesting a national ETS with an absolute volume cap and mandatory participation (TMG 2010: 28ff). The TMG proposes a two-tier system, in which the national scheme covers big direct emitters of GHG such as utilities and energy-intensive industries, while regional or local systems cover the end-use of energy in office buildings and public facilities. So far, however, the Japanese government seems to be rather reluctant to implement such a kind of scheme soon (Rudolph/Park 2010). Second, in order to facilitate the bottom-up approach to emissions trading, the TMG intends to expand its system to the neighboring prefectures such as Saitama, Kanagawa, and Chiba. A linkage to the Saitama prefecture, a neighboring prefecture with a similar economic structure, has already been accomplished by accepting Saitama's emission reduction credits in the TMG ETS. Saitama had implemented its own crediting system on a voluntary basis, but apart from the non-bindingness, the program design closely followed TMG rules. The cooperation with Kanagawa and Chiba, however, appears to be more difficult due to differing economic structures.¹⁰ In Kansai, the region including the cities of Osaka, Kyoto, and Kobe, the "Union of Kansai Governments" was founded in 2010, besides others including a regional environment committee aiming at ambitious climate policy measures and considering a local GHG ETS. Kyoto itself is still considering the use of a cap-and-trade scheme and has already come up with its own crediting system. Third, internationally, the TMG supports the implementation of local ETS in other big cities. Many big cities such as New York and Paris have already published their own climate protection plans and the Climate Leadership Group (C40), consisting of major cities of the world, cooperates on climate protection initiatives including local GHG ETS. Sydney, Singapore, Taiwan, and Bangkok as well as cities in developing countries such as China have already shown big interest in the TMG ETS (TMG 2012a). In terms of international linkages with existing ETS, in 2009, the TMG became the first Asian official

¹⁰ While Tokyo's and Saitama's emissions mainly originate from office building, Kanagawa and Chiba have large energy-intensive industry sites, which increases political opposition by Japan's major industry organization Keidanren (TMG 2012a).

member of the International Carbon Action Partnership (ICAP), a global initiative and network for fostering a global carbon market. However, due to the focus on the end-use of energy in the TMG ETS, linkages to existing markets in the EU and the US, which have a focus on utilities and energy-intensive industries, seem to be difficult. In addition, even the TMG itself is not eager to implement such a linkage, because it expects an influx of low-price allowances, hampering domestic emission reductions (TMG 2012a).

3 Evaluation of the TMG ETS and Political Economy Lessons

The TMG ETS is the first urban carbon market in the world focusing on the end-use of energy. In addition, the TMG ETS is the first mandatory cap-and-trade system in Japan, a country that has only reluctantly relied on market-based instruments in the past (Mochizuki 2011, Rudolph/Park 2010). Thus, the TMG ETS has to be considered a pilot project in many ways, whereat naturally still many lessons have to be learned.

3.1 Evaluation of the TMG ETS Design

Evaluating the TMG based on the design requirements for sustainable carbon markets (Rudolph et al. 2012), the following conclusions can be drawn: While the program is mandatory for the targeted sectors without opt-in or opt-out possibilities, it only covers CO₂ emissions from buildings and factories in Tokyo downstream.¹¹ Thus, it only partly fulfills the sustainability criteria for coverage and bindingness of GHG ETS. The TMG ETS only covers a small share of Tokyo's GHG, making it just partially effective in climate protection. Also, it allows for only taking advantage of limited differences in marginal abatement costs across sectors and gases, hampering its economic efficiency. In addition, it does not treat all emitters equally in making the polluter pay, violating the social justice criteria. However, increasing administrative cost and measurement difficulties may justify less comprehensive coverage even from a theoretical sustainability perspective. Because of these reasons, the TMG ETS consciously focused on CO₂

¹¹ However, for the future, the TMG already considers other GHG to be included, the reporting of which is already mandatory.

from large buildings and factories (Nishida/Hua 2011, TMG 2012a). Further more, according to studies commissioned by the TMG, sizable emission reduction potentials mainly exist in Tokyo's buildings, if lighting fixtures are replaced, insulation measures are strengthened, and the overall operation of the building is re-examined (Morotomi 2012: 11f). The bindingness of the program guarantees equal treatment of the covered facilities, also preventing competitive distortions amongst the covered facilities. In addition, it gives incentives to optimize on emission abatement for allowance sellers and suppliers, thus allowing a market with demand and supply to develop. Ultimately, only mandatory participation guarantees the achievement of absolute volume emission reductions, thus not only supporting the protection of the world climate but also the safeguarding of future generations' from heavy burdens from climate change.

The TMG ETS cap is set partly top-down in absolute volume terms, it is expected to create scarcity and produce major emission reduction, and it includes a dynamic reduction, thus fulfilling the sustainability requirements for cap-setting in a GHG ETS. If compared to other emissions trading schemes such as the Regional Greenhouse Gas Initiative (-10%) and the EU ETS (-21%) or even to the EU's or German targets for non-ETS sectors (EU -10%, Germany -14%), the cap appears fairly stringent. As a consequence, the TMG expects allowance prices to increase to up to 100 to 150 US\$ per ton in the second trading phase (TMG 2012a), a high level compared to expected US or EU prices. Hence, the TMG ETS is capable of implementing a real ceiling to emissions not endangered by economic growth, thus contributing to climate protection and the safeguarding of future generations, while also reflecting real scarcity into the market.

The reduction of the total amount of emissions in the two phases lowers initial costs of transformation and burdens to current generations while sharpening incentives for efficient emission reductions in the long-run (Meyer 2000). While the TMG's cap setting includes a bottom-up fragment – facilities can pick the base-year, which in turn might lead to uncertainties in reaching an overall emission reduction (Wakabayashi/Kimura/Nishio 2011) –, the TGM is well-informed about facilities base-year emissions in the relevant period, so that it were capable of estimating the total cap reliably (TMG 2012a). Also, the TMG might tighten the individual sector caps for

the second compliance phase, once facilities have picked their base-years, so that at least for the second phase the cap is entirely set top-down.

In terms of the initial allocation, the TMG ETS hands out emission allowances for free, does not create revenues for further use, allows banking while prohibiting borrowing, and accepts ambitious offsets. While the latter two design features comply with sustainability criteria for the initial allocation in GHG ETS, especially the free allocation is problematic. Though the functioning of the market is not seriously hampered, the scarcity price is only created at the secondary market, raising at least short-term uncertainties and delaying investments in innovation; also administrative costs increase. In justice terms, polluters do not have to pay the full costs of using nature's resources and windfall profits may arise, if building owners are able to pass on the opportunity costs to tenants. In addition, there is a good chance of not treating all emitters equally if grandfathering is used, e.g. in the case of early action. Revenues are not generated and thus cannot be used in order to create a Double Dividend (Bovenberg 1999) or support redistributive, climate mitigation, or adaptation measures in order to lower the burden on people most affected by climate change or increasing energy prices (Barnes 2001). On the other hand, allowing banking and prohibiting borrowing is reasonable, because this combination sets incentives for early reductions and the exploitation of inter-temporal differences in marginal abatement costs, while not endangering the effectiveness of the cap and its safeguarding-value for future generations. The acceptance of high quality offsets such as renewable energy or energy saving offsets on the one hand and the refusal of accepting highly disputed Kyoto and national Japanese credits on the other hand encourage facilities to take advantage of differences in marginal abatement costs between covered and non-covered facilities as well as between domestic facilities and those outside of Tokyo. It may even induce money and technology transfers to less developed facilities without hurting the system's credibility. However accepting offsets increases administrative costs and unlimited acceptance may reduce domestic incentives for emission reductions.

Concerning the trading system, the TMG fixes five year periods with annual reporting, allows any legal entity to engage in the market, but only makes case-by-case credited excess allowanc-

es tradable; so far, it relies on bilateral trading and even considers market interventions in the case of a price surge; hence, the TMG ETS only partly fulfills sustainability criteria for the trading system in a GHG ETS. A five year trading period allows enough flexibility for facilities to optimize on their emission situation inter-temporally, thus fostering efficiency gains (Wakabayashi/Kimura/Nishio 2011). Annual reporting of emissions enables the TMG to keep control of the emission developments and target achievements in reasonable time horizons, protecting the total emission limit and the safeguarding-value for future generations. However, although the market is equally accessible to everybody, the actual trading of allowances and thus the achievement of efficiency improvements might be hampered by the restrictions on trade, the crediting process, and the lack of an institutionalized market (Wakabayashi/Kimura/Nishio 2011). In order to cope with these problems and lower transaction costs, the TMG offers help in matching supply and demand and has even registered five intermediaries for brokering transactions (TMG 2012a). Still, transaction costs are expected to be high, especially for small and mid-size emitters. They may add up to 2,500 ¥ per ton of CO₂ reductions for the smallest emitters, a number significantly above the levels for CDM credits (1,500-2,000 ¥) (Wakabayashi/Kimura/Nishio 2011). The probability of market interventions such as a safety valve creates uncertainty and may interfere with the price signal as well as the optimal allocation of reduction measures (Wakabayashi/Kimura/Nishio 2011); also, they might loosen the ecological stringency, thus even reducing the safeguarding-value of the cap for future generations.

Monitoring, Reporting, and Verification (MRV) follow stringent and reliable procedures combining measuring and calculating as well as external verification. Penalties are set at a level above expected allowance prices also including the ex post compensation of excess emissions. Thus, the monitoring system fulfills the requirements for sustainable MRV in GHG ETS. Reliable MRV guarantee compliance with regulations, leading to real emission reductions, efficiency gains, and the protection of future generations as well as making the polluter pay. Penalties above the allowance price including ex post compensation prevent the fine to be considered a quasi price and a cheap way of compliance. They also act as a punishment for breaching the law

and an ex ante discouragement of non-compliance, thus protecting the cap and making the polluter pay.

3.2 Evaluation of Initial Results and Political Economy Lessons from the TMG ETS

After evaluating the design and giving some estimation of effects to be expected, this section analyzes actual data on the performance of the TMG ETS. In terms of ecological effectiveness: the most recent emissions data available dates from the year 2009, the last year prior to the start of the TMG ETS but two years after the announcement of the TMG ETS (TMG 2011b, 2012b). This data indicates that the cap for the first trading phase 2010-2014 was comparably loose. Table 2 shows the actual emission amounts in the base-year and 2009 as well as the change between the base-year and 2009

Table 2: TMG ETS participants' emissions

	base-year emissions (in t. of CO ₂)	2009 emissions (in t. of CO ₂)	change (in %)
industrial sources (199)	2.98	2.5	-16
commercial facilities (974)	8.47	7.79	-8
all participants (1,173 out of 1,269)	11.45	10.29	-10

Source: data based on TMG 2011b, 2012b

In total, emission reductions of the participants (-10%) were far bigger than the intended reduction for the first phase (-6%). While factories achieved reductions of more than 5.2 times their target (6%), commercial buildings exactly complied with their goal (8%). Of the 1,173 reporting facilities, 697 facilities (59%) achieved reductions beyond their actual targets, while 476 (41%) were not in compliance. 260 facilities (22%) even achieved reductions of more than 17%, which is the reduction target for the second compliance phase (2015-2019). These reductions can be partly attributed to the suffering of Tokyo's businesses from the global economic crisis. Still, major reductions were induced by the announcement effect of the TMG ETS. However, still, of the ex ante set sector caps, only the cap for commercial buildings was binding, while the factory cap was not. Having achieved reductions of 10% in total already, the TMG ETS reduction target of 6% in the first period and its corresponding cap is not expected to be binding even if there is

some recovery from the global economic crisis. This is particularly true, because the energy rationing measures in Tokyo after the Fukushima nuclear accident might even lead to more emission savings from 2011 onwards, especially if the emission factors will remain unchanged even though fossil fuel use in power production has significantly increased after Fukushima. Thus, under the given circumstances, which admittedly could not be foreseen by the TMG at the time of sector target setting in March 2008, the cap for the first phase appears to be relatively lax. The target of a 17% reduction by 2020 for the second trading phase at first sight seems to be more stringent, because major economic disturbances might be at least partly overcome by then. However, already in 2009, 22% of the covered facilities achieved even the overall reduction for the second phase, which can be taken as a first indication that even the cap for the second phase is not too tight. Altogether, taking early data into account, while the TMG ETS appears to be able to achieve its pre-set targets accurately, additional reductions seem to be possible by strengthening the cap. Also, if the cap is non-binding for some sectors, innovation incentives are not as strong as they could be.

In terms of economic efficiency, data on the issuance of credits and trading is available from February 2012 (TMG 2012f). Looking at trading volumes and prices, by that time, only one transfer of 360 tons of CO₂ had occurred in 2010. While trading information including prices is usually kept secret by the TMG, some sources mention a price of 142 US\$ per ton for this trade (Nishida/Hua 2011: 525). In addition, 14 individual cases of credit issuance have occurred worth of 31,306 tons of CO₂-reductions. However, all issuances were related to external offsets, while no excess emission reduction credit from within the TMG ETS has been issued so far. Of the issued offsets, two issuance worth of 66 t. CO₂ come from small and mid-sized facilities and 12 worth of 31,240 t. come from renewable energy projects. Another indication of the reluctance to trade is the number of accounts already opened by facilities; by April 2012 only 200 facilities (17%) had opened an account, which would allow them to apply for tradable credits and (TMG 2012a). Altogether, in terms of actual trading volume and price signals, the TMG ETS has so far not been able to establish a full-fledged market, which would facilitate cost-efficient emission reductions and incentives to innovate. There is some hope that trading vol-

umes might increase at the end of the first compliance period, but even at that point of time the lack of scarcity and the banking option might limit the trading volume (Wakabayashi/Kimura/Nishio 2011). So far, data on transaction and administrative costs is not available, but due to grandfathering and case-by-case approval of credits as well as the lack of an institutionalized trading platform these costs can be expected to be high.

Apart from economic, ecological, and social effects of the TMG ETS, the decision making process also provides important lessons. While generally political economy theory predicts that ambitious emissions trading schemes are hardly feasible because the most influential political actors such as industry, politicians, and even the environmental bureaucracy oppose carbon markets (Kirchgässner/Schneider 2003), empirical studies have shown under which circumstances policy windows for the introduction of such systems may open (Rudolph 2009b). In the case of the TMG ETS the following political economy lessons for implementing urban GHG ETS can be learned (Nishida/Hua 2011: 525, TMG 2012a).

In terms of interests, as expected 14 major business groups led by Japan's major industry organization Keidanren were opposed to the introduction of a cap-and-trade program, fearing that the absolute volume emissions cap would limit economic growth, price fluctuations comparable to the EU experiences might occur, and a fair initial distribution of allowances would be impossible. (Nishida/Hua 2011: 527f). Industry also claimed that the already high energy efficiency of Tokyo's facilities would not allow for further emission reductions and that a voluntary program could achieve the targets as good as a mandatory one. Initially, this position was also backed by the Tokyo Chamber of Commerce, representing mainly small and mid-size facilities. The political counterparts of industry, environmental NGOs voiced their strong support for the TMG ETS, mainly because for the first time in Japan the TMG ETS would implement a mandatory trading program with an absolute volume cap and rather ambitious targets (Kiko Network 2012, WWF Japan 2012). Tokyo's Governor Shintaro Ishihara, known for his decisive character and confrontations with the national government, expressed his will to transform Tokyo into a low carbon city especially in the application process for the Olympic Games. Also the TMG Bureau of Environment, officially responsible for the development of climate change strategies,

plans, and programs, as well as emission inventories and well equipped with between 10 and 30 highly competent staff members, favored a mandatory cap-and-trade system, because earlier experiences with voluntary reduction targets had failed to deliver significant results.

Against this background the TMG initiated a consultation process including the relevant political stakeholders but also academics. Closely cooperating with pro-active environmental economists as well as NGOs at the preparation and the implementation stage— a rare case in Japanese national climate politics, where there is a deep rooted distrust in NGOs (Rudolph/Park 2010: 175) – and building upon the detailed data on energy consumption, emissions, and technological possibilities gathered in the mandatory reporting program, the TMG was able to come up with answers to all of industry's arguments. Thus, the TMG was well prepared for open discussions with industry, which were conducted in three stakeholder meetings in July 2007, October 2007 and January 2008 (TMG 2012d, e). Participants included business groups, individual companies, NGOs and the TMG. Stakeholder meetings were held publicly – also a rare case in Japanese politics, where usually internal consensus building takes place before debates go public (Rudolph/Park 2010: 170) – and the audience consisted of about 200 citizens of Tokyo in each session. Also all the collected data and the stated interest of stakeholders were made public by the TMG. Already before the stakeholder meetings, the Tokyo Chamber of Commerce had changed its position from opposition to support of the cap-and-trade program, because it expected major economic advantages for its clientele from the offset option within the TMG ETS and from the accompanying subsidy programs for energy efficiency and renewable energy measures announced along with the ETS. Also, as the Tokyo metropolis does not host many energy-intensive industries' production or utility sites, Keidanren, an organization dominated by the political voices of utilities such as TEPCO and steel companies such as Nippon Steel, was not as influential as on the national level. Hence, in the stakeholder meetings, the business groups were faced with well-prepared counterarguments by the TMG showing reductions potentials in the targeted facilities and the ineffectiveness of the voluntary approach in the past, a strong will to move forward by the Governor and the TMG Bureau of the Environment, surveillance by representatives of Tokyo's general public preventing industry to openly state its narrow

self-interest, and even support for the TMG ETS out of business groups' own ranks. In the end, the cap-and-trade program was unanimously approved by the Metropolitan Assembly in June 2008.

4 Conclusions

Megacities such as Tokyo already play a major role in climate protection and will increase their importance in the future. Hence, the Tokyo Metropolitan Government Greenhouse Gas Emissions Trading Scheme (TMG ETS) can be considered an important step forward in terms of not only using market-based climate policy instruments in Japan, but also in terms of paving the way for applying the instrument of emissions trading to reducing greenhouse gas (GHG) emissions at the end-use level in big cities. The current design of the TMG ETS already fulfills a good share of sustainability criteria for GHG ETS (Table 3). Naturally, as the TMG ETS represents a global pilot project, there is room for improvements. In order to fully take advantage of ETS's ability to foster climate protection in an economically efficient, ecologically effective, and socially just way, the TMG ETS could be enhanced by

- extending the scope to other sectors and gases
- tightening the cap
- phasing-in auctions for emission allowances
- allowing trading of all allowances and institutionalizing an allowance market

Extending the scope would allow a more comprehensive coverage and emission limitation, greater potentials for efficiency gains, and a fairer distribution of reduction responsibilities.

Tightening the cap would make a bigger contribution to climate protection, the safeguarding of future generations, and innovation incentives. Auctioning would send early price signals, make the polluter pay, and allow for the revenues to be used for re-distributional or climate mitigation and adaptation measures as well as a Double Dividend. Fostering the trading of allowances has the potential of greater efficiency gains.

Table 3: Design of Sustainable ETS vs. TMG ETS

	Sustainable ETS	TMG ETS
Coverage and Bindingness pollutants emitters upstream vs. downstream bindingness opt-in, opt-out	all GHG; if selective, then most important all; if selective, then biggest polluters upstream; if downstream, then comprehensive mandatory yes, no	CO ₂ from combustion, electricity use, 20% of total CO ₂ 1,300 facilities; 80% buildings, 20% factories downstream mandatory no
Cap target and total amount of emissions dynamics absolute volume vs. intensity target	top-down, scarce, target-oriented, fair ¹² devaluation of cap or allowances ¹³ absolute volume target	-6% by 2014 (base 2002-2007), -17% by 2019; base-year by emitters two-step decreasing cap absolute volume
Initial Allocation, Validity free of charge vs. for purchase revenue use banking and borrowing offsets new entrants shutdowns	full auctioning per capita dividend, adaptation measures ¹⁴ banking, no borrowing limited (amount, quality), below cap auctioning; if free, reserve from the cap no new allowances, return of allowances	grandfathering (allocation of reduction obligations instead of allowances) no revenues unlimited banking, no borrowing 3 kinds of ambitious offsets, partly limited grandfathering from reserve below the cap no allowances after drop-out
Trading System compliance period marketplace market interventions	short; if long, then annual reconciliation established markets none	2 phases of five years (2010-2014, 2015-2019); annual monitoring bilateral trading of excess credits possible if price surge
Monitoring and Penalties MRV penalties	IT-based, continuous, reliable >allowance price + compensation	externally verified facility reports and registries penalty up to 500,000 ¥; 1.3 times compensation, “name and shame”

¹² E.g. as proposed in the Budget Approach (WBGU 2009) and the Contraction & Convergence Proposal (Meyer 2000).

¹³ E.g. as proposed in the Contraction & Convergence Proposal (Meyer 2000).

¹⁴ E.g. as proposed in the Sky Trust Model (Barnes 2001).

In order to spread the use of local GHG ETS to other large cities, the following (political) success factors can be derived from the TMG ETS (Nishida/Hua 2011: 524ff):

- availability of data via ex ante mandatory comprehensive reporting¹⁵
- cooperation between pro-active forces in the government and the civil society
- strong and well-informed leadership by the local government
- publicly held, transparent stakeholder meetings
- appropriate design taking into account local circumstances

Altogether, even if political barriers for introducing national or even supranational ETS will be overcome in the future, megacity schemes should be a supplementary method of reducing GHG especially from the commercial sector and at the end-use level. For such a purpose, despite of some design flaws, the TMG ETS is a worthwhile model, which should be seriously considered by other major cities in the world in order to foster a sustainable bottom-up approach to global climate protection.

References

- Barnes, P., 2001, *Who owns the Sky?* Island Press, Washington.
- Betsill, M./Bulkeley, H., 2007, Looking back and thinking ahead: a decade of cities and climate change research. *Local Environment* **12**(5), 447–456.
- Boemare, C., Quirion, P., 2002, Implementing greenhouse gas trading in Europe. *Ecological Economics* **43**, 213-230.
- Bovenberg, L.A., 1999, Green Tax Reforms and the Double Dividend. *International Tax and Public Finance* **6**, 421-443.
- Ellerman, A.D., et al., 2000, *Markets for Clean Air*. Cambridge University Press, Cambridge.

¹⁵ An earlier attempt by the TMG to implement a cap-and-trade system in 2005 failed because of the lack of data.

- Ellerman, A.D., et al., 2010, Pricing Carbon. Cambridge University Press, Cambridge.
- Endres, A., 2010, Environmental Economics. Cambridge, University Press Cambridge.
- Fankhauser, S., Hepburn, C., 2010, Designing carbon markets. *Energy Policy* **38**, 4363-4370, 4381-4387.
- Flachsland, C., 2008, Developing the International Carbon Market – Linking Options for the EU ETS. PIK, Potsdam.
- GoJ, 2010, Japan's Fifth National Communication Under the United Nations Framework Convention on Climate Change. GoJ, Tokyo.
- IEA, 2008, World Energy Outlook 2008. IEA, Paris.
- Institute for Building Efficiency, 2012, CO₂ Cap-and-Trade for Buildings and Factories – A Comparison of United Kingdom and Tokyo Programs. In: <http://www.institutebe.com/energy-policy/CO2-Cap-and-Trade-for-Buildings-and-Factories.aspx?lang=en-US> (April 11th).
- Jaffe, J./Stavins, R., 2008, Linkage of Tradable Permit Systems in International Climate Policy Architecture. Harvard Project on International Climate Agreements, Cambridge (Discussion Paper 08-07).
- Kiko Network, 2012, Interview with Kimiko Hirata, Director. Kiko Network, Tokyo (March 30th).
- Kirchgässner, G. And F. Schneider, 2003, On the political economy of environmental policy. *Public Choice* **115**(3), 369-396.
- Lerch, A., 2011, CO₂-Emissionshandel – effizient oder gerecht? *Zeitschrift für Sozialökonomie* **170/171**, 39-47
- Mace, M.J. et al., 2008, Analysis of the legal and organisational issues arising in linking the EU Emissions Trading Scheme to other existing and emerging emissions trading schemes. EU Commission, Brussels.
- Metz, B. et al. (eds.), 2007, Contribution of Working Group III to the Fourth Assessment Report of the IPCC. Cambridge University Press, Cambridge.
- Meyer, A., 2000, Contraction and Convergence. Green Books, Totnes.

- Mochizuki, J., 2011, Assessing the designs and effectiveness of Japan's emissions trading scheme. *Climate Policy* **11**, 1337–1349.
- Morotomi, T., 2012, Climate Change Policy from the Bottom Up – Tokyo's Cap-and-Trade Scheme and Multi-Level Governance. Kyoto University, Kyoto (Discussion Paper).
- Oates, W.E., 2004, Environmental Policy and Fiscal Federalism – Selected Essays of Wallace E. Oates. Edward Elgar, Cheltenham/Northampton.
- OECD, 2009, Cities, Climate Change, and Multilevel Governance. OECD, Paris.
- Roßnagel, A., 2008, Evaluating Links between Emissions Trading Schemes – An Analytical Framework. *Carbon and Climate Law Review* **4**, 394-405
- Rudolph, S., 2009a, The Sky is the Limit or Limits to the Sky? A Political Economy Perspective on Market-Based Environmental Policy Instruments in EU Aviation. In: Cottrell, J. et al. (ed.): *Critical Issues in Environmental Taxation – International and Comparative Perspectives Vol. VI*. Oxford University Press, Oxford, 265-282.
- Rudolph, S., 2009b, How the German Patient Followed the Doctor's Orders. In: Lye, L.H. et al. (ed), *Critical Issues in Environmental Taxation Vol. VII*. Oxford University Press, Oxford, 587-606.
- Rudolph, S., Park, S.-J., 2010, Lost in Translation? The Political Economy of Market-Based Climate Policy in Japan. In: Dias Soares, C. et al. (ed), *Critical Issues in Environmental Taxation Vol. VIII*. Oxford University Press, Oxford, 163-184.
- Rudolph, S. et al., 2012, Towards Sustainable Carbon Markets. In: Kreiser, L. et al. (ed): *Critical Issues of Environmental Taxation Vol. X*.: Edward Elgar, Cheltenham (forthcoming).
- Sterk, W./Schüle, R., 2009, Advancing the climate regime through linking domestic emission trading systems? *Mitigation and Adaptation Strategies for Global Change* **14**(5), 409–431.
- Stewart, R.B., 1977, Pyramids of Sacrifice ? Problems of Federalism in Mandating State implementation of National Environmental Policy. *Yale Law Journal* **86**(6), 1196-1272.

- Sugiyama, N./Takeuchi, T., 2008, Local Policies for Climate Change in Japan. *Journal of Environment Development* **17**, 425-441.
- Tiebout, C., 1956, A Pure Theory of Local Expenditures. *Journal of Political Economy* **64**(5), 416-424.
- Tietenberg, T., 2006, Emissions Trading. Resources for the Future, Washington.
- TMG, 2006, Environmental White Paper 2006. TMG, Tokyo.
- TMG, 2008a, Tokyo's GHG Emissions by Gas. TMG, Tokyo.
- TMG, 2008b, Tokyo's CO₂ Emissions by Sector. TMG, Tokyo.
- TMG, 2010, Tokyo Cap-and-Trade Program – Japan's First Mandatory Emissions Trading Scheme. TMG, Tokyo.
- TMG, 2011a, On the Path to a Low Carbon Society – Tokyo Climate Change Strategy. TMG, Tokyo.
- TMG, 2011b, The Provisional Emissions Data for Fiscal 2009. TMG, Tokyo.
- TMG, 2012a, Interviews with Kenji Suzuki, Satoshi Chida, Yuko Nishida, Kanako Sakai, and Yoshie Saito of the TMG Bureau of the Environment. TMG, Tokyo (March 22nd, 28th).
- TMG, 2012b, Tokyo's Climate Actions –Cap and Trade Program and Green Building Program. TMG, Tokyo.
- TMG, 2012c, The Development of Tokyo's Climate Change Measures. TMG, Tokyo.
- TMG, 2012d, Tokyo Climate Strategy – The Development toward the Introduction of Tokyo Cap and Trade Program. TMG, Tokyo.
- TMG, 2012e, Tools and Methodology for the Data Collection & Inventory Generation. TMG, Tokyo.
- TMG, 2012f, Information Regarding the ETS. TMG, Tokyo.
- UNFCCC, 2011, Compilation and synthesis of fifth national communications – Executive summary. UNFCCC, Bonn.
- UK DECC, 2012, CRC Energy Efficiency Scheme. In: http://www.decc.gov.uk/en/content/cms/emissions/crc_efficiency/crc_efficiency.aspx (April 11th)

Wakabayashi, M./Kimura, O./Nishio, K.-I., 2011, Ex-ante evaluation of Tokyo Cap-and-Trade Program. CRIEPI, Tokyo (Discussion Paper).

Watanabe, R., 2011, Climate Change Policy in Germany and Japan – A Path to Paradigmatic Policy Change, Routledge, London/New York

WBGU, 2009, Solving the climate dilemma. WBGU, Berlin.

WCED, 1987, Our Common Future. Oxford University Press, Oxford.

World Bank, 2010, Cities and Climate Change – An Urgent Agenda. World Bank, Washington.

WBCSD, 2007, Energy Efficiency in Buildings – Business Realities and Opportunities. WBCSD, Geneva.

WWF Japan, 2012, Interview with Naoyuki Yamagishi, Climate Change Program Leader. WWF Japan, Tokyo (March 29th).