1 The JEPIX Project

The Japan Environmental Priority Index (JEPIX) Project is a voluntary initiative of several organizations and private persons from the field of Environmental Accounting, Environmental Management, Environmental Reporting, Eco-Rating and Ecobalancing as well as Life Cycle Impact Assessment.

It was initially carried out based on the voluntary contributions by the experts involved with support of the **Japan Science and Technology Corporation (JST)**, and has been succeeded in the JEPIX Forum project of the 21Cetury Center of Exellence (COE) Project of International Christian University (ICU) by the **Japan Ministry of Education and Science** for the further development of the method, practical implementation, and company benchmarcs of the method.

Project Team

The JEPIX project was initiated with financial and administrative support by the Japan Science and Technology Corporation as a project within the RISTEX Research Institute for Science & Technology for Society, followed by the support by the Japan Ministry of Education and Science.

It was originally administrated by the Sustainable Management Forum Japan and the Sustainable Management Rating Institute by Dr. Tetsuro Fukushima, President of JACO Japan Audit and Certification Organization for Environment and by Takeshi Tsuji, Manager of the SMRI Project.

The research survey has been supervised by the environemtnal accounting expert team under the leadership of Prof. Nobuyuki Miyazaki from ICU, advised by Prof. Thomas Schoenbaum also from ICU, and the development of the method and the calculation of the Ecofactors has been carried out by the research team under leadership of Associate Prof. Claude Siegenthaler from Hosei University (Sinum AG Switzerland) together with environmental experts from Yamatake Inc..

JEPIX-Project Setting

・Financial Assistance and Disclosure:

Japan Science and Technology Corporation (JST)

Sustainable Management Rating Institute (SMRI) / Sustainable Management Forum (SMF)

Japan Ministry of Education and Science

・Development Team:

Nobuyuki Miyazaki, Prof. Dr. of International Christian University (ICU) (with the assistance of: Kentaro Azuma, Assistant of ICU, Graduate School of Hitotubashi University / Mannheim

Univertsity; Nakamura Remi, Graduate School of St. Gallen University)

Thomas Schoenebaum, Prof. Dr. of International Christian University, ex Virginia Rusk Professor of Geogia University, USA

Yoshiro Furukawa, Chief of Sustainable Managemnent Department, Nitto Denko Inc. Lecturer of Sophia University

Makiko Yamazoe, US CPA, Consultant, ERM Japan

・Research Team:

Claude Siegenthaler, Research Fellow of ICU/SSRI, Associate Professor of Hosei University, CEO of Sinum AG - EcoPerformance Sistems, Switzerland

Eiichi Shinozuka, Yamatake Environmental Business Systems, Tokyo

Satoshi Kumagai, Associate Prof. of Musashi Institute of Technology

Ayako Nagayama, Yamatake Research and Development Department, Fujisawa

* Report and Data will be available free of charge for everybody: www.jepix.org

Acknowledgments

The JEPIX project team would like to express it's sincerest gratefulness not only to JST, SMRI and JACO for their continued financial and administrative support.

For providing us with data, verification of data and qualified guidance we thank the following governmental bodies for their kind assistance:

Ministry of the Environment

Ministry of Land, Infrastructure and Transport

Ministry of Economy, Trade and Industry

AIST National Research Centre for Life Cycle Assessment

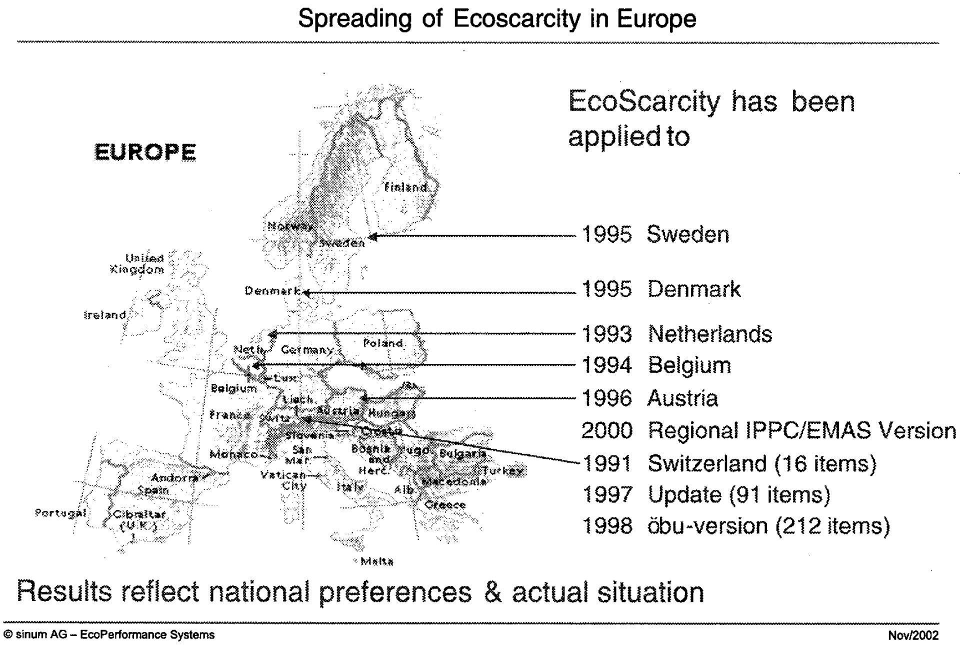
NIES National Centre for Environmental Studies

We are furthermore grateful to many environmental experts that assisted and supported this project by giving useful advice, providing data and sharing their expertise: Prof. Ryoichi Yamamoto and Prof. Itaru Yasui at Tokyo University, Dr. Atsushi Inaba and Dr. Norihiro Itsubo at National Institute of Advanced Industrial Science and Technology, Dr. Yuichi Moriguchi, Keisuke Nansai and Atsushi Terazono at National Institute for Environmental Studies, Prof. Hiroshi Mizutani at Nihon University, Prof. Hidefumi Kurasaka at Chiba University, Prof. Dr. Karl-Heinz Feuerherd at Kobe Yamate University, Prof. Nobuyuki Kimata at Tottori University for Environmental Studies and Prof. Terue Ohashi at Reitaku University.

2 Introduction to EcoScarcity Method

2.1 Background

JEPIX was inspired by the Swiss EcoScarcity Method. This Ecoscarcity method has been developed in Switzerland. Initially, Ruedi Müller-Wenk has been working on a method for Ecological Accounting published 1978 [1]. In this outstanding publication, several principles of corporate ecobalancing have been established. One of these principles was to create a single-score index, an ecological currency, which shall express priorities for action. The Ecoscarcity method as it is used today, was published in 1990 as BUWAL SRU 133 [2]



The method was used for Life Cycle Assessment of products and processes first, then it was integrated into the so called ÖBU-Method developed by the Swiss Association for Environmental Management [3] and published again by Braunschweig and Müller-Wenk. This publication has been translated into Japanese by Prof. Dr. Miyazaki.[4] Today the method is used in an updated version (BUWAL SRU 297) and has spread to several other countries as illustrated in the graph above. In

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[1] Müller-Wenk, R.: *Die ökologische Buchhaltung – Ein Informations - und Steuerungsinstrument für umweltkonforme Unternehmungspolitik* –, Frankfurt 1978（宮崎修行『環境指向経営のためのエコロジカル・アカウンティング』中央経済社，1994年）.

[2] Ahbe, S., Braunschweig, A., Müller-Wenk, R.: *Method for Ecobalancing based on ecological optimisation*, BUWAL 133, 1990.

[3] Braunschweig, A., Müller-Wenk, R.: *Ökobilanzen für Unternehmungen – eine Wegleitung für die Praxis*, Verlag Paul Haupt, Bern, 1993.

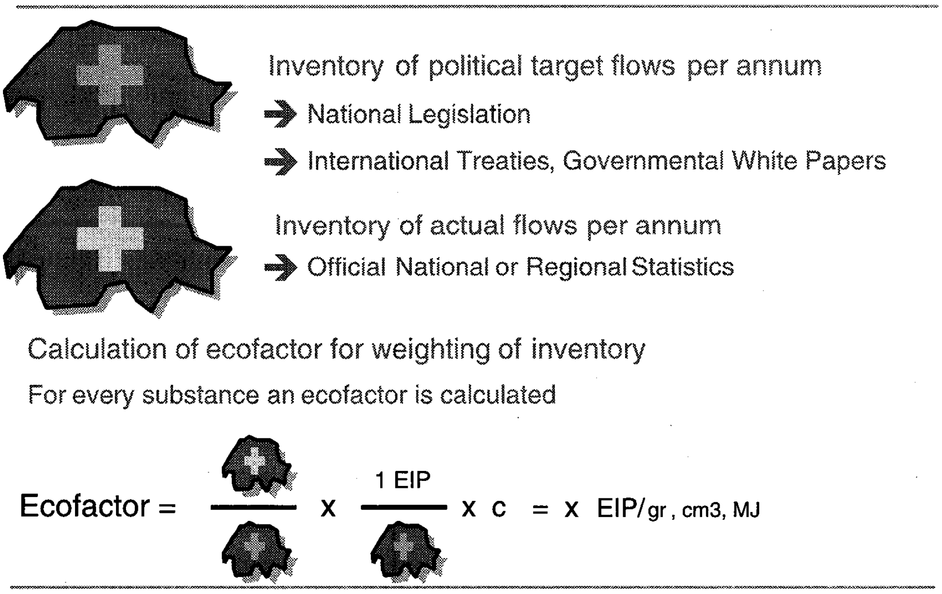
[4] Miyazaki, N.: *Kigyono Ekobaransu*, Hakutoshobo, 1996（宮崎修行『企業のエコバランスー環境会計の理論と実践ー』白桃書房）.

2002 there was an additional version developed for highly populated areas in South America.[5]

2.2 The basic Idea of the Method

The basic concept of the method[6] is to assess the distance to target - the environmental policy versus actual environmental situation - based on mass flow data. Therefore political targets are used to estimate the target flow of a certain substance or substance group. Then the ratio between the actual and the target flow indicates the distance to target whereas the second term of the formula is weighting the substance considered on the basis it's ratio to the target flow. The "virtual" unit Environmental Impact Points EIP is introduced as the single score index .

Calculation of EcoFactor for Weighting



2.3 Why developing JEPIX

In Japan, many companies are publishing environmental reports and many companies are implementing environmental accounting systems.[7] Since the government has published guidelines on environmental accounting, many companies are introducing single-score environmental indices.

Some advanced companies in Japan have already started to apply European LCIA methodology such as Swedish EPS, Dutch EcoIndicator99 or Swiss EcoScarcity for monitoring the Eco-Efficiency

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[5] Eugster, M., Siegenthaler, C.: *Ecofactors for Colombia*, unpublished, EMPA Sustec, sinum AG, 2002.

[6] For a detailed discussion on different types of Life Cycle Impact Assessment LCIA methods look at: Braunschweig, A., Forster, R., Hofstetter, P., Müller-Wenk, R.: Developments in LCA Valuation, IWOE-Discussion Paper Nr. 32, St.Gallen, March 1996.

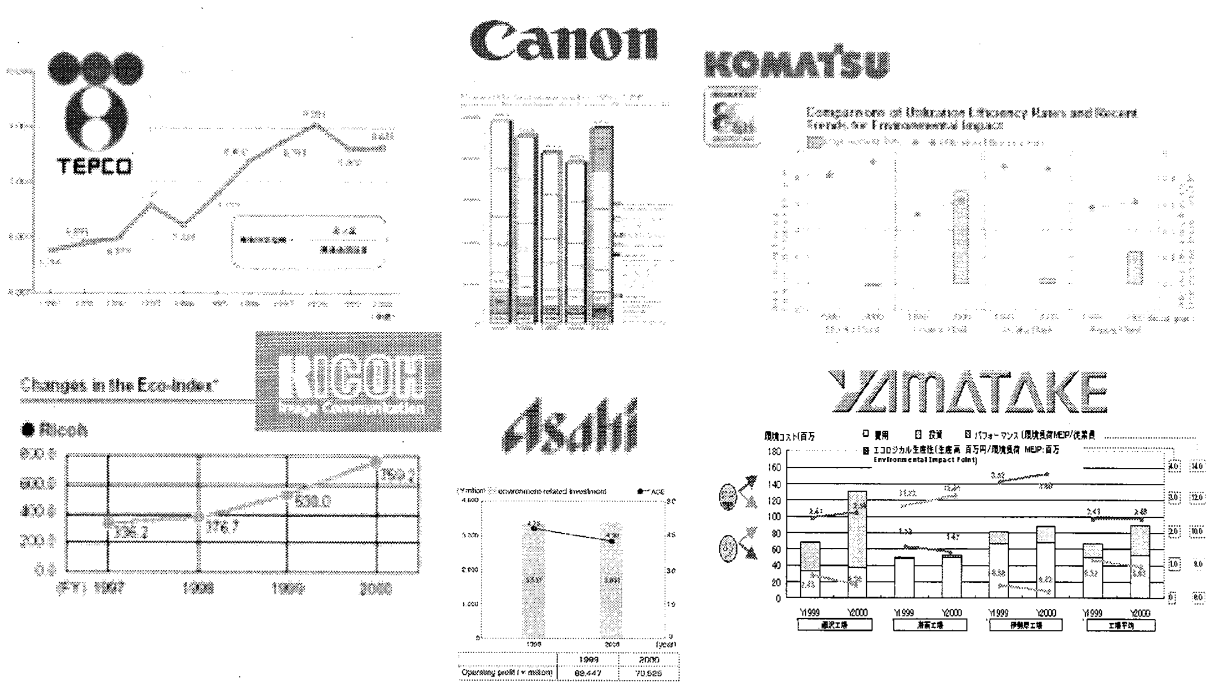
[7] Kokubu, K., Nashioka, E., Hirayama, K.: "An Analysis of Environmental Reporting and Accounting in Japan," *Proceedings of the 5th Intern. Ecobalance Conference, Tsukuba*, p. 585. December 2002.

of their business.[8] Their step has been appreciated by stakeholders, whereas some self-made and therefore very subjective single-score trials of other companies have not. Yet, there is no consensus nor a standard for these inter-subjective LCIA methods to be the one feasible approach. But there is growing acceptance of such a concept.

The current practice by the most advanced Japanese companies faces the basic problem, that they refer to European data and methods, such as European fate and damage models or the political targets and pollution levels of some European countries. Hence, the results require sophisticated skills in interpretation and can easily lead to wrong conclusions.

The JEPIX project was initiated to overcome this situation and deliver an easy to understand and easy to apply LCIA method drawn on publicly available data for Japan. As there will soon be damage-function-oriented methods available for Japan, which are based on complex scientific research in the interface of environmental and social sciences, the JEPIX project will contribute to make the current political priorities accessible for LCIA. It is therefore seen as complementary and beneficial for the consensus building on single-score LCIA in Japan.[9]

Single Score Eco -Index becomes popular in Japan



[8] For details look at: Miyazaki, N.: *Integrated Environmental Accounting*, Soseisha, 2001（宮崎修行『統合的環境会計論』創成社）

[9] Siegenthaler, C., Kumagai, S., Shinozuka, E.: “Development of Ecoscarcity Japanese Version,” *Proceedings fo the 5th International Ecobalance Conference, Tsukuba*, p. 581. December 2002.

3 Method for Calculating Ecofactors for Japan

3.1 Scoping

The premium goal of the JEPIX project is to provide an easy to use method for environmental accounting and rating of companies, which is reflecting the distance to target of the Japanese Environmental Policy.

The method identifies environmental aspects of high political priority by comparing the official statistics on various environmental issues with the explicit target of the Japanese Government. Based on a set of principles, it allows to quantify these priority issues and to derive priorities for action.

As the safe guard subject of this method, the population and ecosystems of Japan are considered. This means JEPIX is focussing on human health and ecosystem health, rather than other safe guard subjects such as material welfare and resources. By principle, safe guard subjects like resources can be integrated into the method, but as there are not many resource targets by the government, for this report we concentrated on emissions.

The relevant legislation is identified and statistics from official sources are used to create indices for the expression of priorities for as many substances as possible.

The results of JEPIX are Ecofactors for a large number of substances. When one substance is relevant for several differing environmental aspects, the highest value is finally chosen. All substance flows are normalized on the level of the whole country or the entire area addressed by certain legislation. A regional differentiation is developed, when big regional differences exist, so users in a very special region can configure their set of indicators accordingly.

3.2 Application

The results of JEPIX method shall be used, where economic decision making is needed. Because the nature of monetarization is very similar to the task to evaluate the environmental priorities, JEPIX results should not be considered as precise as research in natural science. It is rather a valuation method which is pragmatic and allows to see the "rough big picture".

The fields of application are environmental accounting, corporate ecobalancing, eco-rating, eco-efficiency analysis and performance evaluation.[10]

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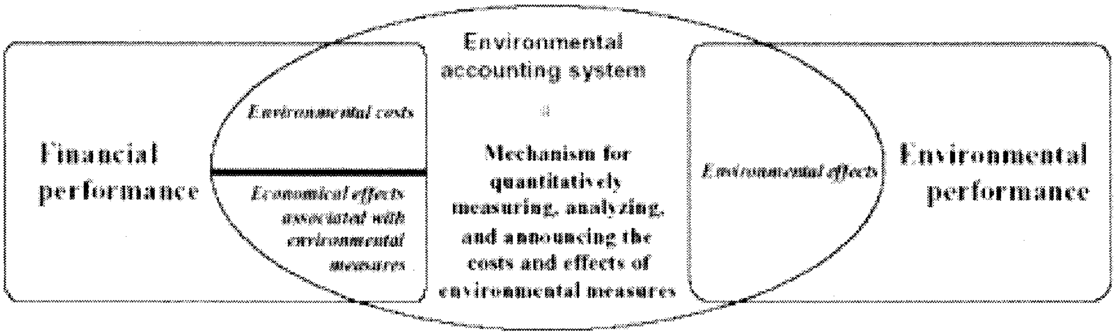
[10] For details on these terms, look at Miyazaki: *Integrated Environmental Accounting.*

[11] Ministry of the Environment:
Environmental Reporting Guidelines (FY2000), February 2001.
Environmental Performance Indicators for Businesses (FY2000), February 2001
Developing an Environmental Accounting System (FY2000), March 2000
Environmental Accounting Guidebook II, March 2001
Environmental Accounting Guidelines 2002, March 2002

➔ Environmental Accounting (MoE Guideline 2000)



➔ Evaluation of Environmental Aspects (ISO14001)

➔ Calculation of EcoProductivity for Environmental Program (ISO14001)

➔ Environmental Performance Evaluation (ISO 14031/32)

➔ Evaluation of Eco-Efficiency for EcoRating and Eco-Funds

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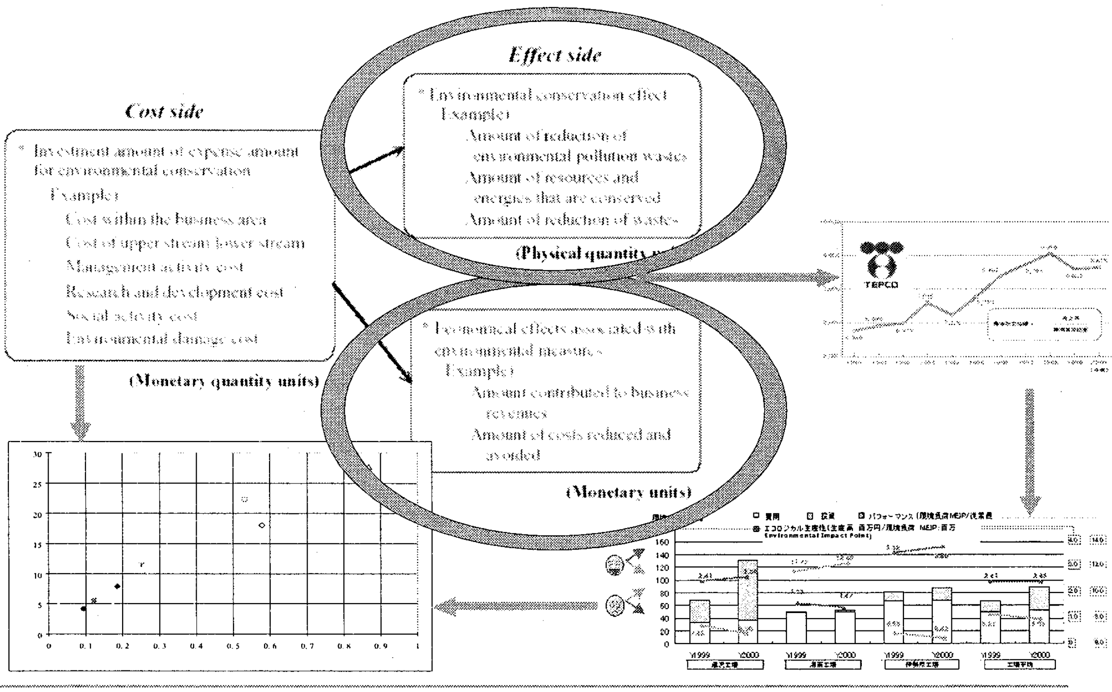
The method is especially designed to assist managers, investors, consumers and politicians as they are all non-experts in environmental respect.[12]

What is Integrated Environmental Accounting?



[12] On the needs for environmental information from a user's perspective, look at: Inaba, A., Hunkeler, D., Rebitzer, G., Finkbeiner M., Siegenthaler, C., Saur, K.: "The 5th International Conference on Ecobalances, Practical Tools and Thoughtful Principles for Sustainability," *International Journal of Life Cycle Assessment*, Vol.8, No. 1 2003, Ecomed publisher, p. 1.

3.3 Basic Principles of JEPIX

Management Relevance

The purpose of JEPIX is to supply decision-makers within or outside the company with comprehensive information on overall improvement of environmental performance within the legal framework but beyond the compliance of specific regulations, such as emission effluent standards (concentration levels for substances, e.g. x milligram per m3 of air or water effluent).

> JEPIX needs to cover all relevant mass and energy flows, which are regulated and might lead to tightening of the regulatory measures in the near future, if Japan as a nation or a specific region/prefecture is not meeting the legal standards. Therefore the priority of JEPIX - quite different from LCA and more specific methods such as risk analysis or toxicity testing of single substances - is to express political, rather than ecological relevance and especially the trend of the legal framework.

JEPIX shall help managers to answer the question: where do we have to improve to avoid future regulatory measures and costs stemming from such additional political pressure ? Which activities will enter the focus of the administration in the near or mid-term future ?

Inside the organization, the application of JEPIX shall help to detect activities of high political relevance and enhance the definition of targets and thereby action plans looking at the criteria of cost effectiveness.

The principle of Management Relevance leads to a clear focus for the assessment of environmental aspects, that need coordination of many actors within and outside the company and huge numbers of activities. It does not try to cover special hot spot fields such as very small amounts of a very specific substance, that are only emitted by a very small number of activities and actors. For these cases, there do exist more sophisticated tools, as more sophisticated chemical and ecological knowledge is required to take proper decisions. And from experience it is also clear, that political measures for single hot spots are also highly selective, directly affecting the specific actor and process or substance. To deal with the problem of a single process or substance is not the purpose and scope of JEPIX.

But there are, as a matter of fact, a high number of substances, processes and actors which need coordination to live up to the legal targets: global warming, ozone depletion, overall toxification of air, water and soil or eutrophication of rivers, lakes and closed sea areas. There, many substances are involved, thousands of companies are required to change and millions of micro actions by millions of people in every day live are relevant to address the problems. These problems urged the administration of Japan, but also more and more other countries and international bodies (e.g. OECD) to implement mass flow targets for an increasing number of substances and monitor the distance to these targets. This situation is the basis of JEPIX.

Cost-Effectiveness

JEPIX is a science-based tool for managers and not science itself. It enhances decision-making and coordination of people and organizations by integrating the already existing environmental information of the organizations in an economical and easy to understand process. Therefore JEPIX is addressed more towards the normal, rather than the outstanding, highly sophisticated user of such tools.

Whereas the very advanced companies may have people on the board, that have a deep understanding of ecology and the resources to spend for an in-depth and complex analysis, JEPIX shall primarily enhance normal companies, especially small and medium sized companies and beginners rather than "cracks". To build an outstanding ecological knowledge is seen as to give a competitive advantage to the company by shaping actors understanding and values (consumers, politicians, administrators or even scientists). Yet, it is recognized, that this is highly desirable to be done, the majority of actors are not ready for this and not expected to do it in the near, nor in the mid-term future. The actual situation is rather more problematic, as these sophisticated tools are seen to be too complex and too expensive to be implemented by normal companies.

> It is the core mission for JEPIX: to enable normal people to generate more benefit from things they are already doing (e.g. data that is already collected and ISO procedures already installed), or can be done without remarkable investments.

The principle of Cost-Effectiveness leads to a concentration on integrating existing data sources across the company and dedicated to a pure and simple application of the JEPIX method, so people who want to use it, can do with a brief training or even self-learning.

Best Available Consensual Knowledge

Environmental Experts, from natural science as well as from social science, are well aware, that nature is a rather abstract concept and does not by itself define the ideal state of the environment. It is evident, that society must define the state of the environment, that seems to be favourable for humans and other species. The values of the people, their preferences for a certain environmental quality are defining, what society understands by the terms "environmental friendly" or "environmental pollution". This implies, that there will always be a diversity of values and interpretations. The ecological truth does simply not exist. Whereas nuclear technology is seen as not acceptable for some people because they fear risks and radiation, others believe it to be environmentally friendly, because it does not emit as much CO_2 as fossil fuels. Nature gives no answer to this question.

On the other hand ecology is a very complex field of science and involving many highly specialized areas of natural and social science. Very often, normal people can not really judge and do not feel capable to do so. Therefore they delegate this task to institutions, which they consider as reliable and trustworthy. To asses the environment is a necessity to take action, so we can not omit to asses environmental burden. But as we can learn just now with the danger of climatic change, to build consensus on environmental issues needs time, although many of us would wish to speed up this process. To take action as a consumer or citizen, based on the personal judgment of data sources relied on, is done by every single person. The same process of priority setting and ecological learning is happening within organizations, but it needs indeed data to support and to enhance this process. For companies and other organizations, it is quite different to judge, whom to trust and which direction to go. Therefore many tools have been developed to build an ecological sense for organizations. JEPIX does not intend to compete with this variety of tools. It rather intends to add an important dimension: the dimension of politics and reflect the result of the political/administrative bargaining process in which experts, administrators, politicians and companies themselves negotiate about priorities to be lived up to. As a matter of fact, this will always reflect some conservative result and not reflect real ecological pressures. But it is historically evident, that in democratic systems, learning and improvement occurs into the right direction.

JEPIX is based on the principle of what can be considered as Best Available Consensual Knowledge. It is first of all, based on what governments have to live up to. This is in fact reality rather than speculation. The legal framework evolves and changes and this is made visible and can be taken into account by decision-makers. But JEPIX is also based on some scientific methods, that reach the level of consensus among environmental experts, although these models are themselves evolving and their results changing.

This is the case, as JEPIX takes into account the results of e.g. fate modelling and the calculation of toxicity indices. JEPIX does not favour one specific model in one period nor for ever, but it rather takes into account the diversity of models and their evolution as well as - and especially - the evolution of consensus building among experts. JEPIX is hence based on a flexible framework of models, which can be complemented as new models reach consensus or existing models are improved. In combination with the Principle of Cautiousness and the regular updating of JEPIX as a method makes it trustworthy for non-expert decision-makers.

Looking at the two basic data sets that are gathered to calculate Ecofactors, there is the actual flow and the target flow. Concerning the actual flow, data sources related to governmental bodies are always given priority as far as they are clearly explained, monitored and published on a regular basis and sufficiently complete with reference to the national system boundary. Concerning the target flow, priority is given as well to governmental sources, such as the Ministry of the Environment (MoE) or the Ministry of Economy, Trade and Industry (METI), with highest priorities to laws and the legally binding documents with reference to the respective law. Voluntary Agreements between such authorities and industry are also considered as official and legally binding documents.

Cautiousness

When researching societal consensus on environmental issues and political priorities, it is an obvious fact, that there is not one, consistent set of targets. As already explained (see discussion above), political targets in terms of environmental quality standards as well as total pollution load targets are the result of bargaining processes. Same is true for recommendations of scientists, as there is also no value-free research by principle. But for an efficient and easy to understand method, there is a need for a coherent set of indicators and Ecofactor values. The Principle of Cautiousness can solve this problem by selecting the most stringent target, if for some substance there do exist several non-consistent sources, such as different laws addressing the same environmental issue or affecting the same substance.

But not only the political targets for a certain substance might be divers. Much more inconsistency can sometimes be observed when researching the current state of the environment. The influence of measurement techniques, the availability of research results - especially when it comes to publicly accessible statistics - demonstrate, that one may end up with contradicting results from several sources, that are by themselves widely accepted as trustworthy. The description of the state of the environment is still in its early years and knowledge is limited as are monitoring techniques and scope. There might be quite reliable data available, but only for some limited areas rather than for the country as a whole. Here again, the Principle of Best Available Consensual Knowledge in combination with the Principle of Cautiousness can help to select the data needed to calculate trustworthy Ecofactors.

The Principle of Cautiousness leads JEPIX to calculate several Ecofactors for one single substance (e.g. NOx), if there exist several relevant target flows (e.g. derived from laws combating Toxicity, Photochemical Oxidants and NOx itself). From the results, the most severe, meaning the highest Ecofactor shall be selected for application.

Adequate Timeframe

Another important dimension for the creation of JEPIX is the definition of adequate timeframes. As every method is drawing on data from the past, but decisions will take effects in the future, it is important to take a sound and transparent argumentation for dealing with time. Concerning JEPIX time is relevant for the selection of actual flows, the definition of target flows and for the proper interpretation of results in specific fields of application of JEPIX such as Performance Evaluation, Evaluation of action plans or Eco-Rating.

Time Scope of Actual Flow data

The data and methods that are used to calculate Ecofactors shall always be based on most recent statistics. As for JEPIX version 2003, most actual flows are based on data sources published in 2001 or 2002 which cover flows within the period of 1999, 2000 or 2001. To get a complete set of official data, it takes probably some time, e.g. the results of this report are all referring to 1999. For this year a complete set of indicators was available. Data on actual flows, which might be taken from older statistics shall be adjusted by some adequate parameter, such as number of inhabitants, Gross Domestic Product or simply by extrapolating the trend based on a stable pattern learned from history. In the future the actual flows of certain substances will be substantially reduced, as the imposed legislation will be successfully implemented. In the past, this was true for some high priority substances, e.g. benzene emissions were reduced within 5 years by 40% or dioxin emissions within even less time by 50%. For other pollutants, such as SOx and CO it took some 10 to 20 years to successfully implement the Environmental Quality Standards (EQS) and for some, the targets could not be reached, such as for NOx. As such changes in actual flows can affect the Ecofactor and if JEPIX is applied to judge long-term effects of activities, the trends of scenarios should be taken into account, e.g. the OECD Outlook on the Environment, which tries to forecast most relevant emissions till 2020.

Time scope of existing Target Flows

Concerning the target flows, the situation is somehow more complex: some legal targets are bound to specific timeframes, such as in voluntary agreements between government and industry, the total water pollutant legislation or the Kyoto protocol. Whereas some targets seem to come close to what is currently politically considered to be a sustainable level, others are bound to a step by step improvement approach clearly not derived from such a sustainable level - e.g. the target values for COD are currently set within the fifth amendment of this law [13]. In every period some 10% reduction of emissions is set as target flow, but still the Environmental Quality Standards in terms of concentration levels are far from being met. This approach reflects the political bargaining of feasible adjustments as well as the search for the sustainable level, in which adverse phenomena - such as

[13] Water Pollution Control Law 1970, for details look at: *OECD: Environmental Performance Reviews - Japan, 2002,* OECD, Paris, 2002, p.85.

algae bloom - may disappear. For other substances this is even explicitly made clear in the legal document, such as in the documents related to combating climatic change. As the Intergovernmental Panel on Climatic Change IPCC as well as the Japanese government in its legal documents make clear, much higher reduction targets should be applied to avoid severe climatic change. The Kyoto Protocol is clearly been seen by the government of Japan as just a first step to limit the CO_2 emissions.[14] But yet it is unclear, which target politics will set beyond 2008-12 as this will be evaluated, bargained and set around 2008-12. In such cases, the calculation of critical flows must explicitly choose a priority and clear principle on which time frame targets are taken into account.

In the future, some new substances might be added to the list of legally relevant substances (e.g. some of the many class 2 chemicals called "designated to limitations in production and use"). Furthermore, it is very likely, that new adverse phenomena not yet clearly known and understood will lead to new legislation (e.g. endocrine disrupters, a category of substances that is currently at the focus of many research projects around the world)[15]. These changes may affect the priorities covered by JEPIX and lead to relevant changes in the Ecofactors from a past to a long-term future perspective.

Historically, it seems that legislation usually is reviewed and amended within some 5 (+/-2) years as a rule of thumb. If some problem is very severe, the frequency might be higher, but this is more the case with single, hot spot problems, which are not the core of JEPIX as already discussed under the principle of Management Relevance.

Relevance of Timeframe for Application of JEPIX

With respect to the Principle of Management Relevance, another time bound aspect needs to be addressed: to what timeframe refer the data to be evaluated by JEPIX ? Obviously, there are three major applications of JEPIX:

One application is the evaluation of environmental performance EPE carried out for environmental accounting of an organization and hence the data will be referring to the past or present substance and energy flows. In this case, there is no specific problem.

When it comes to the evaluation of action plans by the principle of Eco-Productivity, JEPIX is applied to forecasted data - e.g. estimated emissions after implementation of certain measures.

Action plans have a short-term, mid-term and long-term perspective in most cases. This will result in substance flows in short-, mid- and long-term. For example investments in buildings will have effects during 30-50 years. Heavy machinery will also be in use for some 10-20 years. As in financial

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[14] Japan's Third National Communication under the framework Convention on Climate Change, 2002.

[15] For more details concerning Endocrine Disruptors look at: http://www.env.go.jp/en/topic/edcs.html

investment planning, management usually has to make assumptions on future prices of materials or fuels when planning specific investments, it would be appropriate to evaluate measures looking at the environmental situation and political pressure along the lifetime of the investment. So for short term (1-5 years) it might not be so severe, if the Ecofactors used refer to the present or past as they are derived from Best Available Consensual Knowledge. But for investments that have mid- to long-term effects, the trends of environmental situation may result in substantially different priorities. To take proper long-term-decisions, some kind of scenario analysis should be carried out to take adequate decisions.

When it comes to EcoRating, a more sophisticated view might be needed. The basic question of EcoRating is similar to the view of the financial investment perspective: The stock price of a company's shares are by theory defined by the future profits of this company (capital asset pricing model) or by the discounted future cash flows. But in practice, many investors take decisions on investments based on the past performance of the company and referring to the technical chart analysis method of financial analysts, the past is a quite reliable indicator for the future performance.

When it comes to EcoRating, the environmental performance can be judged on the track record of the company by looking at the environmental performance and some Eco-Efficiency ratios (e.g. Impact per Cash Flow). But if an investor or consumer wants to select the company that will outperform others in term of ecology in the future, some indicator for forecasting the impacts in a mid-term or long-term perspective is needed. In this case, not only the substances legally relevant are to be taken into account, but also substances with future relevance looking at the technology and product portfolio of a company and taking into account the market life cycles of their future products and services.

Today, EcoRating is at a very early stage. Many organizations only look at qualitative criteria and are mainly focused on the implementation of policies and management systems.[16] Some Rating methods may take into account some specific indicators such as energy intensity or CO_2-Intensity [17], but there are not yet any organizations performing comprehensive quantitative ratings. But with the data availability continually improving, there will soon be some Rating methods covering EPE comprehensively and also integrating forecasts on the future performance. Therefore JEPIX can be seen as a major step forward by allowing the evaluation of past performance as well as allowing to draw a consistent forecast on future priorities when scenarios for the mid- and long-terms are used to calculate a set of Ecofactors for the future.

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[16] Siegenthaler, C.: Eco-Rating and Eco-Banking in Europe, in: *Proceedings of Yamatake Symposium Tokyo May 2002*.

[17] Ikari, M., Kumita, J., Takahashi, S.: "Outline of the new Investment Fund Product 'Eco-Balance: Sea and Sky' Ecobalance," in: *Proceedings of the 5th International Ecobalance Conference, Tsukuba*, p. 617. December 2002.

How to deal with time in JEPIX ?

As the discussion above should have demonstrated, the definition of an adequate timeframe is vital from various points of view. To provide a clear and transparent solution, it is recommended to use two different sets of Ecofactors depending on the application of JEPIX:

Ecofactor 2005

This set is the very strict and pure application of JEPIX. It is calculated on the basis of actual data (2001, 2000, 1999) and legally binding target flows. By the principle of Cautiousness, targets are taken into account independently from their time frame and not allocated to various timeframes. This means that a target value for 2010 is not cut into targets for two periods such as 2005 and 2010, but fully taken into account. It can be used for most applications and is valid till 2005. As this report is a feasibility study for JEPIX and as we can see major improvements in data availability within the next fiscal year (2003) we recommend that the values calculated and published in this report are only considered as a draft set. We strongly recommend to update the Ecofactors at the end of fiscal year 2003, because at that time the results form the newly implemented PRTR Law as well as state of the art research results from the National LCA Database Project by JEMAI will allow to enhance the number and quality on the data set remarkably [18]. Hence we put a flag on the results of this project: Ecofactor $_{2005\text{-Draft}}$

It is recommended to update the Ecofactors every 5 years.

Ecofactor $_{2015\text{-Forecast}}$

For the applications of JEPIX to long-term decisions, it is recommended to use a second set of Ecofactors which are calculated based on scenarios and based on assumptions derived from the political agenda of the government. This set shall take into account future level of actual flows and projections on the future targets of legislation.

The purpose of the above discussion of basic principles shall help to understand the underlying paradigma of the JEPIX method and assist in correct interpretation.

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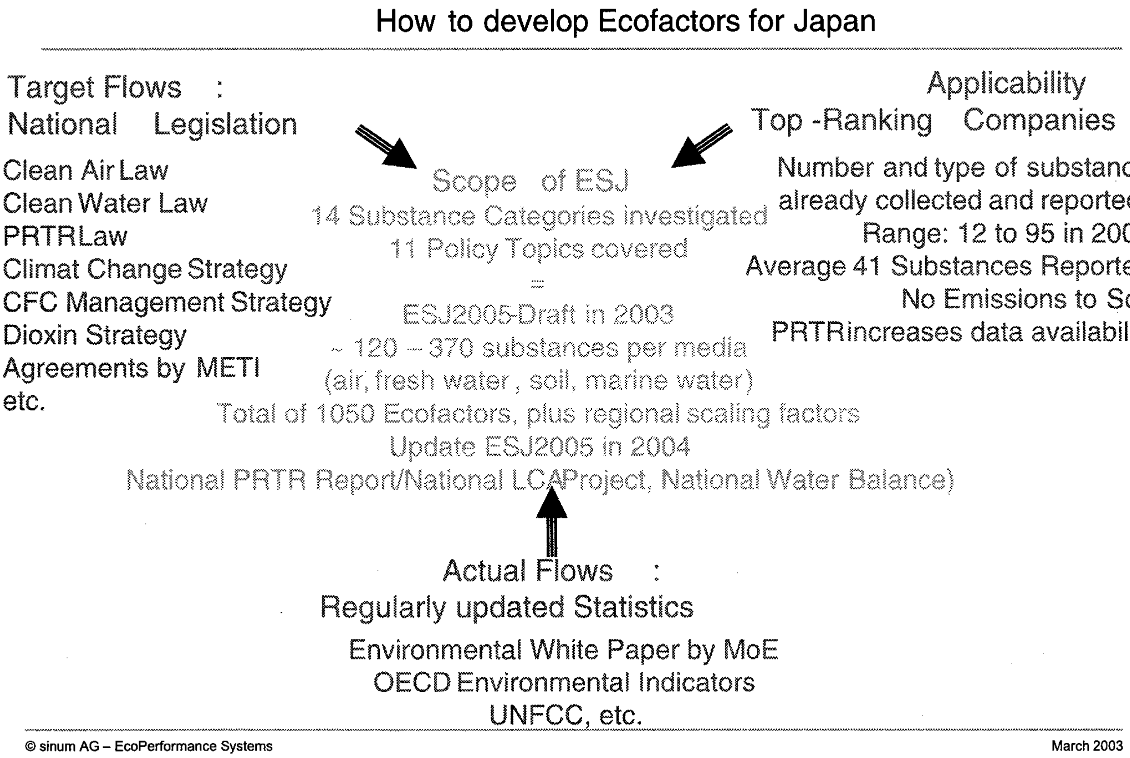
[18] Nakahara, Y., Morimoto, M., Narita, N.: Current Status of National LCA Project in Japan, in: *Proceedings of the 5th Intern ational Ecobalance Conference, Tsukuba*, p. 125. December 2002.

4 Calculation of Ecofactors for Japan

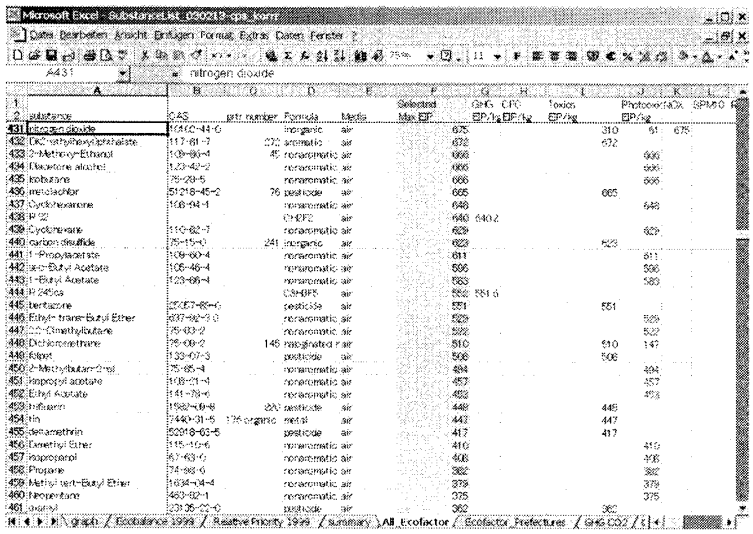
In this chapter, the procedures to define actual annual flows as well as target flows are described in detail. Based on these data, Ecofactors are calculated and scaled to specific regional situations.



To demonstrate, how we select the final procedure from alternative ways of calculation, the method to derive Ecofactors for GHG is discussed in the very details. To keep the report brief and clear, for all other Ecofactors only the procedure finally chosen is presented together with the result.

During 2001 and 2002 the project team searched for data and studied the legal framework in detail. Furthermore, many experts have been interviewed on data resources and method design. Many data was verified and completed with support of the ministries responsible. In this report, we only list the documents, which finally have been used for calculation to keep the report clear and simple. This shall allow readers and users interested in studying the raw data and legal documents in more detail to focus on what really has been taken into account. All data and calculations are available as excel file, including raw data (concentration values from monitoring stations, etc.), calculation and regional scaling for all 47 prefectures and most important water bodies (as data was available).

Ecofactor 2005draft Excel Sheet contains all Raw Data and Calculations



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Please note, that there might occur small differences between the values listed in the report and the values in the excel sheet. This is due to the number of digits displayed in excel and rounding functionality of excel. As a precise reference, please use the values from the excel sheet.

4.1 Overview: Environmental aspects to be covered by JEPIX 2005 draft

The following environmental aspects have been identified and selected for Ecofactor calculation:

・Global Warming by Green House Gases GHG

There is a strong policy focus on global warming to comply with the Climate Convention and the Kyoto Protocol. Specific legislation has been enacted.

・Ozone Depletion by Ozone Depleting Gases ODG

There is a strong policy focus on controlling and reducing the Ozon Depletion and to comply with the Vienna Convention and the Montreal Protocol. Specific legislation has been enacted.

・Hazardous Chemicals by Toxic Substances including Dioxins

A strong policy focus on the management of hazardous substances has been enacted and there are voluntary agreements between the government and industry on eliminating or reducing certain toxic substances.

* Clean Air by Photochemical Oxidants

The clean air legislation in Japan is a traditional field of environmental policy and has set Environmental Quality Standards EQS. Photochemical Oxidants are still exceeding these EQS and are therefore a policy focus.

・Clean Air by NOx

The EQS for NOx is still far from being met especially along roads and in highly populated areas. New total pollutant control legislation has been amended recently, why it is considered as a policy focus.

- Clean Air by SPM10

  The EQS for SPM is not met in many areas of Japan although EQS are not as severe as in other countries. With the amendment of the Automobile NOx Law SPM 10 emissions from diesel vehicles are integrated. This is why SPM10 is considered as a policy focus.

- Water Quality for River by BOD

  The legislation for the protection of water quality is a traditional field of environmental policy and has set EQS for Rivers. As EQS for BOD can not be met by many rivers, it is a policy focus.

- Water Quality for lakes and closed sea by COD

  The EQS concerning COD for many lakes and also for the closed seas show severe problems. In addition to the EQS, total pollutant control was enacted and steadily refining target flows for designated areas, which make it a policy focus.

- Water Quality for lakes and closed sea by N and P

  The EQS concerning nutrients such as N and P many lakes and also for the closed seas show severe problems. In addition to the EQS, total pollutant control was enacted and steadily refining target flows for designated areas, which make it a policy focus.

- Waste Management by Landfill Capacity

  The waste policy is traditionally a policy focus in Japan. As for waste incineration the focus is on reducing hazardous emissions covered by the legislation concerning toxic substances, the problem of missing capacity for landfill disposal is a specific policy focus.

- Noise Pollution by Road Traffic Noise

  The noise pollution in Japan is still high and EQS by the Noise Regulation Law are far from being met. Road traffic is a major cause of this situation and noise levels along roads are high. Therefore the still increasing road traffic is a policy focus

These environmental aspects with a policy focus are taken into account by the JEPIX project as in all this areas, clear distance to target situations occur.

National Flow Targets, Regional Flow Targets and Exceeding EQS

National Flow Targets

CO2, CH4, N2O and by GWP other Greenhouse Gases: SF6, PFCs, HFCs, etc.
Ozon Depleting Substances by ODP: CFCs/HFCs
Dioxins by ToxicEquivalents => as summ parameter from waste incineration
12 High Priority Toxics (Benzene, Dichloromethan, etc.) by Voluntary Agreements
Waste to Landfill by Waste Management Strategy and Voluntary Agreement

Prefectural Flow Targets (Total Pollutant Control /Automotive NOx Law):

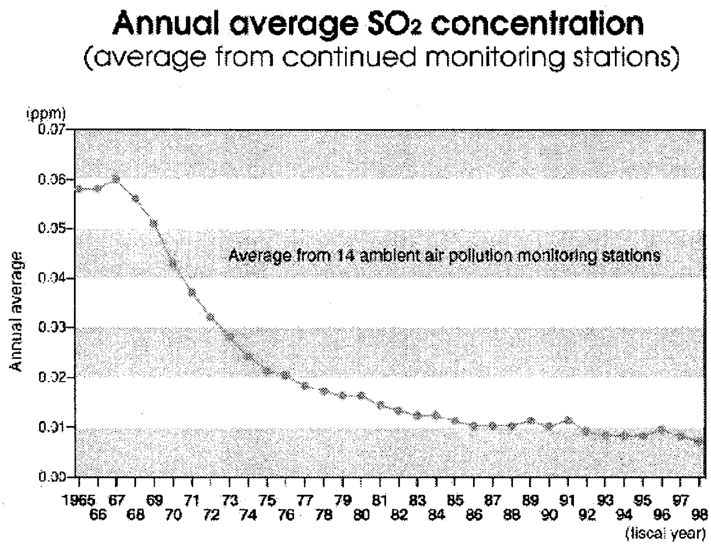
NOx (6 Prefectures), Environmental Quality Standards not met in many regions
COD, Phosphorous and Nitrogen (18 Prefectures), EQS not met in many regions

Substantial Non-Compliance with EQS Environmental Quality Standards

Photochemical Oxidant concentration levels are exceeding throughout the country
SPM10 are exceeding throughout the country
BOD are exceeding throughout the country
Road Traffic Noise are exceeding throughout the country

As for many environmental aspects, there do exist explicit substance flow targets, this is not the case for all to be covered. Instead, the Ecofactors are calculated based on regional explicit substance flow targets or by deriving substance flow targets based on the actual environmental data (e.g. concentration levels at environmental monitoring stations).

Other environmental aspects - e.g. clean air by SOx - are not specifically addressed, as there was no significant distance to target found on the national level: e.g. the EQS for SOx are met and the recent rise of SOx concentrations during 2000 in some regions are caused by volcanoes and not by human activities.



Ecofactors for a specific environmental aspect of Japan are only calculated, if the specific governmental policy focus (e.g. clean air law) compared to the data available shows, that the annual substance flow does exceed the annual target flow.

4.2 Global Warming by Green House Gases GHG

The Greenhouse Gases consist of a variety of substances that are mainly linked to energy conversion, cooling and foaming as well as agricultural and forestry processes. Most important substances are CO_2, CH_4, N_2O, SF_6, PFCs and HFCs.

Actual flow of GHG

There do exist a series of data sources on the international level as well as on the national level, which vary in the reported annual flows of substances to some extent. Due to the Convention on Climate Change and the Kyoto Protocol, there are official, national and international binding data sources available. We refer to "Japan's Third National Communication under the Framework Convention on Climatic Change" from the Ministry of Environment 2002:

Table 4.2. Actual emissions and future outlook for greenhouse gases by sector

(unit: million tons of CO_2)

Sector	Actual emissions			2010 projection			
	Base year	1999	% Change	Without measures	With measures	With additional measures	% Change
CO_2 from energy sources	1,053	1,148	9.0%	※2	1,126	1,052	-0.1%
Following 3 substances	128 (123)	127 (121)	-0.1%	140	122※3	122※3	-4.8%
CO_2 from non-energy sources	77 (72)	77 (77)	-0.3%	88	85	85	10.1%
CH_4	29 (30)	25 (27)	-12.4%	25	24	24	-18.2%
N_2O	22 (21)	25 (17)	10.6%	27	16	16	-27.1%
Other greenhouse gases	48	39	-19.3%	107	73	73	51.4%
HFC	20	19	-2.7%				
PFC	11	11	-3.4%				
SF_6	17	8	-50.1%				
Development of innovative technology, further extensive efforts by the public	—	—	—		-4	-26	—
Sinks	—	—	—		—	-48	—
Total	1,229 (1,224)	1,314 (1,307)	6.9% (6.8%)		1,317	1,173	-4.6%

※1 : Figures in parentheses ( ) are the reported values (Chapter 2) of the inventory submitted in 2001 (refer to the footnote of 4.2 Future outlook)

※2 : Forecast for 2010 of CO_2 from energy sources (case without measures) has not been carried out.

※3 : The reason why it is 3 million tons of CO_2 less than total CO_2 from non-energy sources, CH_4 and N_2O is because there is considered to be a reduction of 2.60 million tons of CO_2 due to measures that do not specify the amount of reductions resulting from the expanded use of mixed cement, etc., in this sector in the Guideline.

Target Flow for GHG

The official documents related to the Kyoto Protocol stipulate target values as for CO_2 Equivalents of all relevant substances. Japan agreed to reduce GHG in terms of CO_2Equivalents in general by 6% within the Kyoto Protocol.[19] According to Japan's Third National Communication under the framework Convention on Climate Change[20] , this results in a target flow of 1'155 Mio. tons CO_2-Equivalents based on GWP 100 and the base year 1990.

Within the Kyoto Protocol reduction target, the Japanese government does formulate more detailed target values for some substances and substance groups: targets for energy related CO_2, targets for a group consisting of non-energy related CO_2 together with CH_4 and N_2O and targets for another group PFCs, HFCs, SF_6 are formulated in terms of CO_2 Equivalents. It does furthermore specify, which sectors shall contribute how much to the achievement of the reduction targets. The New Climate Change Policy Programme adopted in March 2002 outlines a quantitative target for CO_2 emissions from the energy sector (+/- 0%), - 0.5% of emissions of CO_2, CH_4 and N_2O from non-energy related sources, the use of CO_2 sinks (- 3.9%) as well as a reduction of - 2% from new technologies and lifestyles. The emissions from PFC/HFC/SF_6 may rise by + 2% in terms of CO. Equivalents.

However, in it's official communication the government makes clear, that further reductions beyond Kyoto Protocol will be needed to avoid climate change, but yet there do not exist political agreements on how much further to go. However, the scenarios carried out by the Intergovernmental Panel on Climate Change IPCC[21] provide the basis to calculate target values on a scientific basis. IPCCThere are already some governments in Europe, which have officially announced targets beyond Kyoto Protocol (e.g. UK Energy White Paper of the Department for Trade and Industry in London: -60% by 2050 for UK as published in February 2003).

Calculation of Ecofactor for GHG

From this background, there are particularly four alternative ways to calculate the Distance-to-Target based Ecofactor for the substances covered:

1. based on the national target of 6% from 1990 in terms of CO_2-Equivalents
2. IPCCbased on the more detailed substance bound targets in terms of CO_2-Eq. for each

[19] The government of Japan has enacted a comprehensive legislation concerning global warming:
Law Concerning the Promotion of the Measures to Cope with Global Warming (9 July, 1998)
Japan's Third National Communication (31 May,2002)
The Bill on Amendments of the Climate Change Policy Law(29 March,2002)
The New Climate Change Policy Programme(19 March,2002)

[20] Japan's Third National Communication under the framework Convention on Climate Change, 2002.

[21] IPCC: Third Assessment Report of the Intergovernmental Panel on Climate Change, Geneva 2001.

substance or group

3. based on the sectoral targets for various industries from the New Climate Change Policy Programme
4. based on the IPCC stabilization scenarios, which allow to define an emission level which should prevent most severe climatic changes.

According to the basic principles of JEPIX it is most convincing to choose alternative 4):

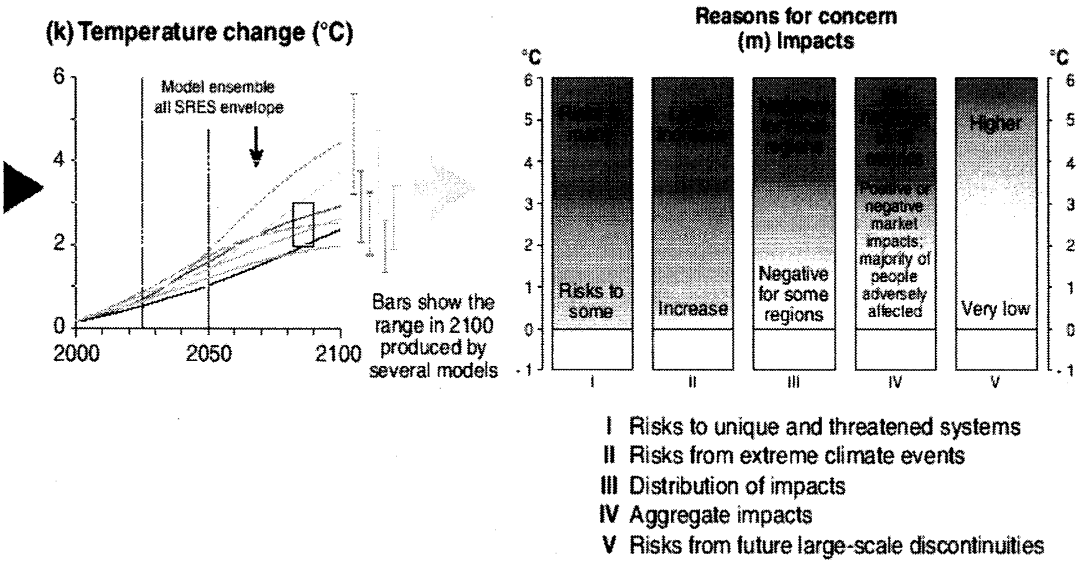
Technically 1) and 4) could be put into practice, because it is as specific as possible within the available data collected by companies. The data available in companies today is not favourable for 3) as this would require the users to collect additional data and characterize the source of CO_2, especially for upstream and downstream processes as stipulated in the Environmental Accounting Guidelines 2001. This is not the case in most companies today. In 2) we face the problem, that some substances are summarized, which do have very differing Global Warming Potential GWP and therefore can not be assed by their climatic relevance separately.

As alternative 1) reflects current legislation based on Kyoto Protocol, the timeframe is clearly set to 2008-2012 and therefore just a first step towards a somehow much smaller emission target. Alternative 4) is therefore more suitable from a long term perspective. However, it's legal status is somewhat more abstract, as it can be derived from the aim of the Climate Convention to prevent severe damage from global warming. Therefore, the IPCC stabilization scenarios are scientifically more suitable to define a sustainable level of target emission. Politically it is also more favourable, as the official position of the Japanese Government makes clear, that the mission of national GHG legislation is to prevent severe climatic change and Kyoto Protocol reflects only a starting point for much more strict legislation.

Therefore Ecofactors are calculated based on alternative 4):

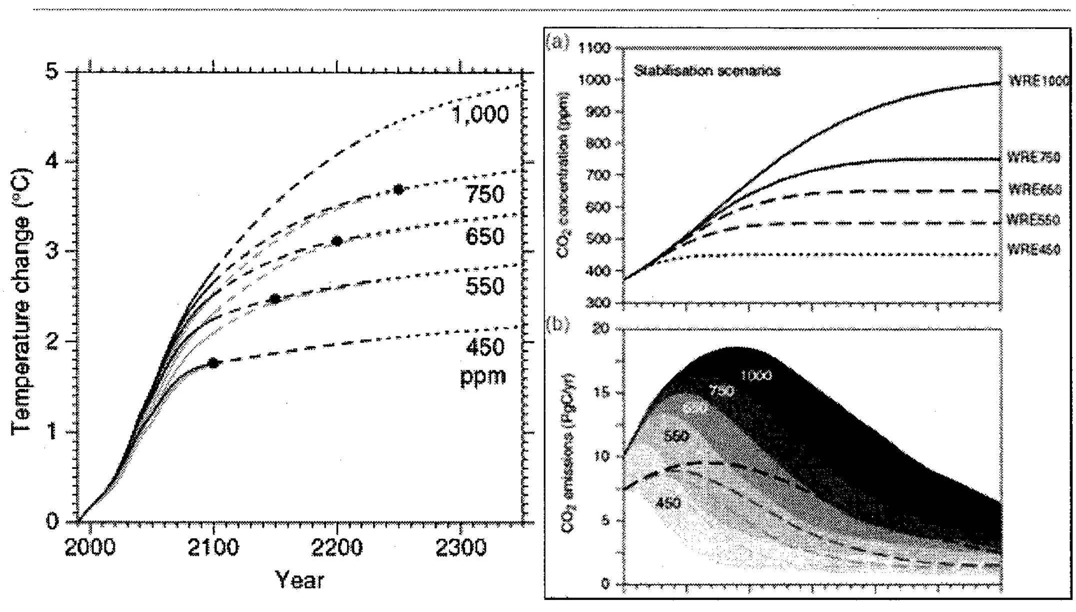
The IPCC stabilization scenarios do reflect the most recent and comprehensive best available consensual knowledge, as 2500 scientists have contributed to the 2001 Third IPCC Assessment Report. IPCC is not politically setting any target levels, but it provides a wide range of scenarios, which reflect the expected changes within the climate system and their consequences for biosphere and society. It is up to the user of IPCC results to decide politically by choosing a desirable scenario.

To derive a target flow from IPCC scenarios, it is appropriate to define the degree of climatic change, which should be able to avoid severe damage. From the synthesis report of IPCC it can be learned that the expected severity of several impact categories is a function of temperature change. From the graph shown below, a temperature change of 1 - 2 Degree Celsius seems to minimize risks. There do exist stabilisation scenarios, which result in such a limited temperature change, which seems to be recognised as the best desirable scenario from a risk avers perspective.



IPCC Synthesis Report - Summary for Policymakers, Geneva 2001, page 11.

The desirable temperature change allows to select the stabilization scenarios. These scenarios define the long term concentration of CO_2 and calculate the pathways for the reduction of anthropogenic CO_2 emissions. By nature, these scenarios produce for each path a bandwith of results, because of model uncertainties. For JEPIX and the target of a risk minimizing temperature change around 2 degree Celsius, the 450 ppm and the 550 ppm CO_2 concentration scenarios were selected (+ 1.8 - +2.2 degree C) and the average of bandwith was used to determine the total amount of CO_2 emissions around 2050 and 2100. Although the 450 ppm scenario reflects an average expected temperature change of + 1.8 degree Celsius, the minimal value of the 550 ppm scenario could turn out by 2050 to keep change below 2 degrees as well.



IPCC: The Scientific Basis - Technical Summary F.10 Projections of Future Changes in Response to CO_2 Concentration Stabilisation Profiles, Geneva 2001

From the global emissions, the emission level for Japan is derived by the principle, that each human should have the same right to pollute. According to the most recent United Nations Population Division's medium scenario[22], world population is projected to reach 8.9 billion humans in 2050. The 450 ppm / 550 ppm averaged scenarios result in a reduction of global emissions of carbon to 7.27 Gt C by 2050 and 4.07 Gt C by 2100, which is multiplied by a factor of 3.664 to get the CO_2-Equivalents of 26.65 Gt CO_2, 14.91 Gt CO_2 respectively.

As the population of Japan is expected to drop dramatically till 2050, the medium scenario from the projections of the National Institute of Population and Social Security Research Japan[23] are used to derive the sustainable target level of CO_2 emissions at 2.99 t per capita by 2050 and finally at 1.24 t by 2100. Compared to the Kyoto Protocol reduction target, this is a further reduction of 75% by 2050 and ca. 90% in 2100. As there do exist uncertainties concerning the models, it seems reasonable to choose 2050 as a directional safe timeframe. This procedure takes into account, that a change of knowledge and refined models may affect the scenarios within the next 50 years. To choose a value beyond 2050 would rise uncertainties dramatically, as the IPCC simulations as well as the recent changes in the world population outlooks demonstrate.

The selected 2050 timeframe is also in accordance with the targets of UK and other nations, that have already specified their target levels beyond Kyoto.

The Ecofactor is calculated based on the CO_2 emissions only. The resulting Ecofactor for CO_2 then is used to derive the Ecofactor of all other greenhouse gases by multiplying the Ecofactor for CO_2 by the GWP100 [24] of each substance.

F target	F actual	EIP / kg CO_2
299'449'662'921	1'147'945'000'000	12.80

CO_2	CO_2	1	12.80
Methane	CH_4	21	268.84
N_2O	N_2O	310	3'968.58
R 23	CHF_3	11'700	149'781.88
R 32	CH_2F_2	650	8'321.22

[22] United Nations Population Division: *World Population Prospects - The 2002 Revision*, 2003.

[23] National Institute of Population and Social Security Research Japan: *Population Projections for Japan 2001- 2050, 2002.*

[24] GWP 100 is taken from Centre for Environmental Science Leiden University: *CML 2000, version 2.6* July 2002, www.cml.nl

R 41	CH_3F	150	1'920.28
R 43-10mee	$C_5H_2F_{10}$	1'300	16'642.43
R 125	C_2HF_5	2'800	35'845.24
R 134	$C_2H_2F_4$	1'000	12'801.87
R 134a	$C_2H_2F_4$	1'300	16'642.43
R 152a	$C_2H_4F_2$	140	1'792.26
R 143	$C_2H_3F_3$	300	3'840.56
R 143a	$C_2H_3F_3$	3'800	48'647.11
R 227ea	C_3HF_7	2'900	37'125.42
R 236fa	$C_3H_2F_6$	6'300	80'651.78
R 245ca	$C_3H_3F_5$	560	7'169.05
Perfluormethane	CF_4	6'500	83'212.16
Perfluorethane	C_2F_6	9'200	117'777.21
Perfluorpropane	C_3F_8	7'000	89'613.09
Perfluorbutane	C_4F_{10}	7'000	89'613.09
Perfluorcyclobutane	c-C_4F_8	8'700	111'376.27
Perfluorpentane	C_5F_{12}	7'500	96'014.03
Perfluorhexane	C_6F_{14}	7'400	94'733.84
R 22	$CHClF_2$	1'500	19'202.81
R 124	$CHFClCF_3$	470	6'016.88
R 142b	$C_2H_3ClF_2$	1'800	23'043.37
sulfur hexafluoride	SF_6	23'900	305'964.70

4.3 Ozone Depletion by Ozone Depleting Substances ODS

Ozone Depleting substances have been widely used in cooling, foaming and cleaning processes. The most important categories are Chlorofluorocarbons (CFC) Halons, Hydrochlorofluorocarbons HCFC and Hydrofluorocarbons (HFC). Japan was one of the leading producers of these substances as 1988 total CFC productions peaked at 150'000 tons per year.

As the Vienna Convention for the Protection of the Ozone Layer 1985 and the Montreal Protocol 1987 installed a system to take control of the Ozone Depleting Gases, Japan enacted the Ozone Layer Protection Law in 1987 and formulated a CFC Strategy published in 2001. In these documents, there is a clear roadmap for phasing out production and use of these substances and thereby the emissions of this substances to air. [25]

Actual Flow of Ozone Depleting Substances ODS

There are no exact and comprehensive data on CFC emissions available. But there are statistics on the amounts produced and imported or exported. Since 1995 the production was phased out. The emissions occurs mainly during application and are therefore closely linked to the life time of the equipment or application using these substances. The CFC Management Strategy of Japan (July 2001) report tried to estimate the amounts of ODS used in various sectors (stocks). Furthermore, the recovery rates are estimated for each field of application and the average life time of each application. Officially it is estimated, that current stocks of CFC in Japan account for some 62'000 tons of CFC (22'000 in refrigerate applications and 40'000 tons in foams)[26]. The 22'000 tons are used as follows: 8'000 tons in commercial, 4'000 tons in domestic refrigerators and 10'000 tons in Mobile Air Condition used in cars. These values are also reported by OECD. Somehow, these stocks seem to be low compared to the amounts produced during the 90ies and when taking into account leakage of MAC's and the entire population of MACs used. Furthermore there seems to exist a black market for CFC imported illegally from China, but no official data on this issue is currently available [27]. The official stocks may therefore represent a conservative estimation at the lower end of real amounts still in use.

From the data on stocks of CFC, the emissions occurring can be estimated. The total amount handled per year can be derived from the recovery rates. The amounts handled, which are not recovered and destroyed are accounted as emissions. Our estimation results in some 512 tons for commercial refrigerators, 265 for domestic and 1'865 tons for MAC from vehicles, a total of 2'642 tons for all cooling applications.

The amounts recovered are flowing back into the stock or are destroyed in specialized facilities. By dividing the remaining stock by the amount handled we could get the life time of stock and compare it to the life time of application/equipment. The figures we found seem to be quite consistent,

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[25] Japan has enacted a series of legal documents concerning ODG:
Destruction of Fluorocarbons (Fluorocarbons Recovery and Destruction Law) (promulgated in June 2001)
Enforcement Ordinance of The Law Concerning The Protection of The Ozone Layer Through The Control of Specified Substances and Other Measures
The Law Concerning The Protection of The Ozone Layer Through The Control of Specified Substances and Other Measures

[26] CFC Management Strategy of Japan based on Ozone Layer Protection Law (July 2001).

[27] John L. Perry, Newsmax, August 28, 2001, reporting on case of smuggling 10'000 bottles CFC-12.

showing a life time of refrigeration stocks of approx. 14 years.

But the main source of CFC emissions are the not yet recovered stock of CFCs used for foaming. Here emissions are estimated assuming, that these stocks are expected to diffuse during the lifetime of the foam to a certain percentage (4% of 75% of all stocks during a lifetime of 30 years physical life time and 10% of deconstruction/waste processed foams)[28]. As the political timeframe of the CFC strategy of Japan is now mainly focussed on the elimination of CFC emissions from cooling till 2015, we adjust the foam emissions to the same timeframe and assume therefore, that the total stock will be diminished within 20 years. This estimation results a yearly emission from foams of approx. 1'400 tons. This estimation is by nature arbitrary and rough, but it proves, that emissions from foam are occurring at a non negligible magnitude per year.

It seems reasonable to assume, that the emissions are occurring proportionally during the remaining phase out period of around 14 years for CFC as recycling and reuse loops circulate the stock not emitted. As a result, the existing 61'690 tons of CFC in stock leads to some 4'042 tons of yearly emissions of ODP (R11-Equivalents). This value may be reduced, when recovery rates and destruction amount is improved.

For HFCs, PFCs etc. there are official estimations available from METI [29], which are calculated for reporting to the Kyoto Protocol Organization as these substances also have a global warming impact. The total annual flow is estimated at app. 11'500 tons of emission per annum, which results in 627 tons of ODP (R11-Equivalents). Taking into account the destruction capacity of 480 tons HFCs (27 tons in ODP), the estimated net flow of emissions is 600 tons of ODP per year.

Target Flow of ODS

There does not exist an explicit target amount of CFC or ODS emissions. But by banning the production amount and by requiring more and more businesses to recover these substances, a quantitative target can be derived from the strategy of the governmental policy. The government follows a principle of avoiding emissions by recollection, recycling and destruction. The target flow is based on the governmental statement, that all CFC stock from cooling appliances shall by law be collected, recycled and destroyed [30]. As for foams, which are already installed, there are no similar

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[28] Foam Emission based on Life Cycle Data from A.D.Little on Foam Insulation with reference to Johnson 1999, that during lifecycle 75% of blow agent is emitted in a relevant time frame (assuming landfill), data from www.arap.org/adlittle-1999/9.html.

[29] Japan's Countermeasures for the control of Emissions of HFCs, PFCs and SF_6, METI, May 2000, data used for calculation taken from attachment to www.meti.go.jp/english/information/data/cOzone01e.thml

[30] Fluorocarbons Recovery and Destruction Law (June 2001), Law for Recycling of specified kinds of Home Appliances (June 1998).

efforts compared to refrigerators. Therefore a major percentage of the CFC stock in foams of 40'000 tons is regarded as tolerable to diffuse into the air during the lifetime of foam applications.[31] To this emissions from foam stocks the net emissions of HFCs, PFCs and SF_6 are added as there are no special targets defined for their reduction. The target flow in ODP is therefore estimated to account for 2'300 ODP tons of CFC plus 600 ODP tons of HFCs as a total of 2'900 ODP tons.

Calculation of Ecofactor

The time frame of governmental action is mainly focused on the life time period of the refrigerant stocks and the legal requirements are met at best, when these stocks have reached zero. Therefore the ODS problem would at that time be solved and not require further action. By assuming this same time frame for all stocks, we assume that the foam emissions also occur during this 14 year period to calculate the target flow. These results in app. 2900 tons of CFC emissions per year, which are tolerated as there are no rules to recover and destroy this stock.

F target	F actual	EIP / kg ODP R11-Eq.
2'902'777	3'617'180	429'282

By using the ODP values for each ODP substance, the Ecofactor for a series of substances can be derived (see excel sheet for details).

4.4 Toxic Substances including Dioxins and Furans

In Japan, chemical substances have to be notified to the government when introduced into the market. Each substance has to be classified based on several environmental criteria, such as biodegradeability, bioaccumulation and long-term toxicity. A list of specified chemicals are banned from production and import. Others are subject to possible control on the amount of production/import as well as on allowable uses. Designated chemicals make up a third class and are kept under surveillance through reporting obligations on the amount produced/imported.

As of the year 2000 there were 11 substances registered in Class 1 and therefore banned. An additional 23 substances were listed in Class 2 whereas 422 were classified as designated chemicals. On the other hand Dioxins are considered as highly toxic chemicals, which are emitted from combustion processes. Main sources in Japan include waste incinerators and metal processing facilities such as electric steel-making furnaces or sintering facilities for the steel industry. Dioxins are chemicals, defined as a group of extremely toxic substances consisting of 75 kinds of Polychlorinated Dibenzo-p-Dioxins (PCDDs) and 135 kinds of Polychlorinated Dibenzofurans

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[31] CFC Management Strategy of Japan based on Ozone Layer Protection Law (July 2001).

(PCDFs) as well as more than 10 dioxin-like compounds called Co-planar PCBs.

From the perspective of Toxicity, it makes sense to take an integrated view on all toxic substances within one Ecofactor, similar to ODP or GHG. The safe guard subject is to avoid toxic exposure to humans and the environment.

Actual Flow of Toxic Chemicals including Dioxins

In July 1997 the Law for PRTR and Promotion of Chemical Management was promulgated, with the annual PRTR reporting obligation to start in 2002. This will improve the availability of annual flow data for 354 hazardous substances, including VOCs, organic chlorides, dioxins, pesticides, metal compounds and ozone depleting substances. Most important companies will have to report their annual flows and furthermore, METI and MoE will together publish estimations on the remaining sources, which are not required to report by the new legislation because of their minor scale (households, farms, small businesses). [32]

By now, the new system is just in its implementation phase and the existing data sources show quite big inconsistencies in the data. Today, it is not yet possible to draw reliable and officially published total flows per year for Japan. This is illustrated by the following table, which compares the most comprehensive studies available yet:

Substances	METI Report 1998 ton/year	Keidanren -Pilot 1998 ton/year	Diff.	METI WG Document 1999 ton/year	OECD[33] 1999 ton/year	Diff.	METI WG Document 2001 ton/year	PRTR-Pilot 2001 ton/year	Diff.
Acrylonitrile	1'521	1'631	7%	1'094	1'015	7%	726	61	92%
Acetaldehyde	122	224	84%	195	85	56%	111	77	31%
Vinyl Chloride	1'831	1'520	-17%	1'595	1'620	-2%	764	22	97%
Chloroform/ Trichloromethane	1'724	2'309	34%	525	1'538	-193%	428	470	-10%

[32] Japan has enacted a series of legal documents concerning PRTR:
Outline of the Law Concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management
Law Concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management
Cabinet Order for Law Concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management
Law for Ascertaining the Amount of Specified Chemical Substances to be released into the Environment and for Promoting Improved Controls

[33] OECD: *Environmental Performance Reviews - Japan, 2002*, p. 66

1,3-butadiene	1'177	869	-26%	769	711	8%	576	5	99%
Benzene	10'781	3'346	-69%	1'814	9'055	-399%	903	458	49%
1,2-dechloroethane	2'087	1'662	-20%	2'017	1'635	19%	942	35	96%
Dichloromethane	22'598	19'303	-15%	11'281	19'221	-70%	8'037	3'958	51%
Tetrachloroethylene	1'521	1'601	5%	288	1'353	-370%	163	249	-53%
Trichloroethylene	4'594	3'211	-30%	228	4'094	-1696%	144	672	-367%
Formaldehyde	416	480	15%	82	295	-260%	86	69	20%

Beyond the comparison of these selected substances, also total flows into media such as air, water or soil show big differences: whereas the Keidanren report 1999 [34] shows some 740 tons of chemicals released into soil, the discharge into soil accounts only for 10 tons in the PRTR Pilot Project for the year 2001. It is also recognized, that the substances making up the biggest emissions for each media vary greatly from study to study. Therefore comprehensive, reliable and official data can be expected during 2003, when the PRTR reporting will be implemented and cover all businesses required to report their data.

Data on actual emissions of Dioxins in Japan are available for most important sources based on estimates of METI and MoE. The total amount of emissions is expressed in TEQ, Toxic Equivalents, which characterises each compound by it's toxicity relative to the toxicity of 2, 3, 7, 8-TCDD - the most toxic dioxin compound known. There is no data available on the total amount of each single compound. It is also important to note, that the official statistics does not take into account illegal sources such as "wild burning" of wastes by households, which seems in other countries to be a source of importance. Nevertheless, the Japanese emissions have been the highest in the world during the 1990ies accounting for some 7'000 g TEQ.[35]

Target flows for Toxic Chemicals and Dioxins

The clean air and clean water legislation of Japan defines Environmental Quality Standards EQS for some toxic chemicals. The monitored substances cover air concentration levels of benzene, trichloroethylene, tetrachloroethylen and dioxins; surface water monitoring covers 23 toxic chemicals. The required concentration levels are almost met for all substances investigated, expect

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[34] Keidanren: *The 3rd PRTR Survey*, http://www.keidanren.or.jp/japanese/policy/2000/027/index.html

[35] Dioxins are normally not reported by LCA Inventory Databases as well as in Environmental Reports. But the calculation of an Inventory for Dioxins is relatively easy to be added by using emission factor as follows:
Total Emissions of Dioxins by Waste Treatment Facilities 1999: 2'400 gr TEQ
Total Waste processed by Waste Treatment Facilities 1999: 450 Mio. Tons
This results in 0.0053 picogram / ton of waste

for benzene (only 77% of all monitoring stations meeting the EQS).

Beyond these EQS approach, the government of Japan has adopted a more precautious approach in recent years: The main purpose of the recent enacted PRTR Law is to prevent "the environment from hazardous chemical substances regardless of the evidence about their hazardous effects on human health and/or the environment." [36] The law outlines how to make this effective: it requires reporting, scientific toxicity assessments and quantitative targets for most important substances.

Whereas the reporting will be implemented fully in 2003, the assessment of toxicity will be an ongoing process of continual improvement of knowledge. Today, there are several groups involved in the assessment of toxicity, such as the formulation of a comprehensive Toxicity Index to compare and aggregate the PRTR substances. The research also includes Japan Fate Modelling, which takes into account the specific climatic and ecologic environment. Furthermore, research on the damage to humans and the ecosystem are under development. Within a few years, it will be possible to assess the Human-Toxicity and Eco-Toxicities as well as the Potential Damage to Humans or the Ecosystem based on Japan specific methods and data.[37] Therefore it is recommended to make use of these models as soon as they are available to calculate the target flow of Toxicity Potential of all reported substances.

A target flow of toxic chemicals can be derived from two official sources: on the one hand, the "Governmental Law on Dioxins" [38], which stipulates the target to reduce emissions by 90% from the level of 1997.

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[36] *Outline of the PRTR Law of Japan*, January 2001, Art. 1. Page 1.

[37] Relevant Research on Fate Modelling for Japan can be found in:

Pennigton, D.W., Jolliet, O., Tauxe, A.: *Construction of a Chemical Fate & Human Exposure Model of Toxic Substances for Japan - Data Collection for Japan's National Life Cycle Assessment Initiative*, unpublished, 2001.

Kawamoto, K., MacLeod, M., Mackay, D.: *Evaluation and comparison of multimedia mass balance models of chemical fate: application of EUSES and ChemCan to 68 chemicals in Japan*, Chemosphere, 2001.

Fushimi,A., Kajihara, H., Yoshida, K. and Nakanishi, J. : Approach to Risk Assessment for Air Pollutants Using PRTR Data and Atmospheric Dispersion Model, *Proceedings of the 3rd International Workshop on Risk Evaluation and Management of Chemicals*, pp.106-118, 2000.

[38] Law Concerning Special Measures against Dioxins July 1999.

Table 3 Target Amount of Reduction Relating to Estimated Dioxin Release of Each Business Sector in Japan

(Using WHO-TEF (1998))

Business Sector	Target Amount of Reduction (g-TEQ/year)	(Reference) Estimated Discharge	
		Amount in 1997 (g-TEQ/year)	Amount in 1999 (g-TEQ/year)
1 Waste Disposal Sectors	576~622	6,841~7,092	2,320~2,522
(1) General Waste Incineration Facilities	310	5,000 "Water" 0.037	1,350 "Water" 0.028
(2) Industrial Waste Incineration Facilities	200	1,500 "Water" 0.51	690 "Water" 0.50
(3) Small-scale waste incinerators	66~112	340~591	279~481
2 Industrial Sectors	264	454	293
(1) Electric steel-making furnaces	130.3	228.5	141.5
(2) Steel industry Sintering process	93.2	135.0	101.3
(3) Zinc collection industry (roasting furnaces, sintering furnaces, smelting furnaces, melting furnaces and dry kilns)	13.8	42.3	18.4
(4) Aluminum base alloy manufacture industry (roasting furnaces, melting furnaces and dry kilns)	11.8	21.3	13.6
(5) Other businesses	15	26.7	18.0
3 Others	3~5	3.32~5.92 "Water" 0.093	3.42~6.12 "Water" 0.093
Total	843~891	7,300~7,550	2,620~2,820

Note 1: Target amount of reduction is the amount of discharge after reduction measures for emission gas and effluent described as annual discharge

Note 2: Total of target amount of reduction is down by 88.2 ~ 88.5% compared with the estimated amount of discharge of 1997.

Note 3: "3 Others" indicates crematoriums, smoke from cigarettes, emission gas from cars and terminal treatment facilities.

On the other hand, flow targets for specified chemicals are due to the already established system of voluntary agreements between industry and the government. The so called self-management substances have been due to quantitative targets since 1997. In its recent amendment, there are again 12 substances listed, for which quantitative targets for the businesses involved are set [39].

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39 METI, 2002, Reference in the fifth contermeasure WG for Hazadarous Air Pollutants, Manufacturing Industries Bureau, METI, 2002. 10. 22.

Substance	CAS	PRTR Number	METI WG 2005 ton/year	METI WG 1999 as base line ton/year	Target Flow in % of Base Flow
Acrylonitrile	107-13-1	7	693	1'094	63%
Acetaldehyde	75-07-0	11	118	195	61%
Vinyl chloride(monomer)	75-01-4	77	461	1'595	29%
Chloroform/Trichloromethane	67-66-3	95	373	525	71%
1,3-butadiene	106-99-0	268	466	769	61%
Benzene	71-43-2	299	850	1'814	47%
1,2-dechloroethane	107-06-2	116	735	2'017	36%
Dichloromethane	75-09-2	145	8'442	11'281	75%
Tetrachloroethylene	127-18-4	200	202	288	70%
Trichloroethylene	79-01-6	211	160	228	70%
Formaldehyde	50-00-0	310	71	82	87%
Ethylene oxide	75-21-8	42	81	142	57%

Calculation of Ecofactor

Other environmental aspect such as ODP or GHG are calculated based on some kind of Index (GWP100 or ODP). The Indices are explicitly stated in the relevant legal documents (such as IPCC guidelines and Montreal Protocol Guidelines). Such official guidelines do not yet exist for toxic substances. Nevertheless, chemical science has developed such kind of indices based on the chemical properties of substances and their distribution and behaviour in nature. By now, most comprehensive assessments in LCA and Ecobalancing are carried out using already established models such as EUSES Fate model and Toxicity Potential according to Hujibregts 1999/2000.

Most of this research has yet been carried out for the United States or Europe. Japan specific versions are expected to be available within the next one to three years [40]. Therefore, this report is limited to calculating a draft version of Ecofactors based on already established methods. This Ecofactor should be updated as soon as new data is available. Therefore this report makes use of the Humantoxicity Index HTP inf. by Hujibregts 2000 [41] to demonstrate the basic principle and prove the validity of such an approach.

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[40] Pennigton, D.W., Jolliet, O., Tauxe, A.: *Construction of a Chemical Fate & Human Exposure Model of Toxic Substances for Japan - Data Collection for Japan's National Life Cycle Assessment Initiative*, unpublished, 2001.

[41] Humantox Inf. by Hujibregts 2000 Data taken Excel sheet from Centre for Environmental Science Leiden University: *CML 2000, version 2.6* July 2002, www.cml.nl

As target value the 12 substances covered by the amendment of the self-management program of METI are assessed by their Human Toxicity for each environmental media [42]. The result is expressed in kg, Dichlorobenzene Equivalents and aggregated to the total target value as well as the actual flow in terms of kg, Dichlorobenzene. The calculation is based on the 1999 base year as this is in line with all other data. This can also be done to cover Dioxins as there are quantitative targets set in TEQ and Hujibregts has calculated respective Dichlorobenzene Equivalents also for Dioxin emissions to air and water.

The actual flow is derived from the Human Toxicity Equivalents summed up from all 12 self-management substances as well as dioxins.

The target flow is calculated from the Human Toxicity Equivalents derived by the target values 2005 for the 12 self-management substances as well as from the governmental target flow for dioxins.

F target	F actual	EIP / kg Dichlorobenzene-Eq.
7’986’677’544.54	16’454’961’481.506	258

Applying the Ecofactor EIP per kg Dichlorobenzene Equivalent for all substances covered by CML2000, results in a comprehensive coverage of some 860 emissions into air, fresh water, marine water, agricultural soil or industrial soil (see excel sheet for details).

From these approx. 180 substances covered, almost 100 are listed by the PRTR Law of Japan. From the available statistics on these substances, the total annual flow of human toxicity potential for 1999 can be calculated. The values calculated showed a high consistency when compared to the priorities of the Japanese government: dioxins and the 12 priority substances covered by the voluntary agreements make up more than 95% of the total score in EIP for 1999 and from these 13 substances, all of them are located among the highest 21 EIP loads. In addition to the top priority substances, other prominent chemicals such as toluene, styrene and heavy metals are high ranked. This is reasonable, as there are huge amounts emitted and toxicity is high.

4.5 Clean Air Law: Photochemical Oxidants

Photochemical Smog has become a major issue in Japan with only 0.6% of the monitoring locations complying with the governmental standards in 2001 [43]. Photochemical smog is hence no longer recognized as an issue of the metropolitan centres, but across the country. This smog results from complex chemical processes occurring when sunlight and various chemicals such as Volatile

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[42] The PRTR categories for public water was assessed as freshwater, the category soil as agricultural soil; emissions to air match both data sources without any assumption.

[43] *Japan Times*, 28. Sept. 2002, p. 2.

Organic Compounds (VOC) and nitrogen oxides react.

Actual Flow of Photochemical Oxidants in POCP

As Photochemical Oxidants such as O_3 are not directly emitted, but are recognized as the harmful product of other types of emissions, it is helpful to estimate the total annual flow of emissions contributing to Photochemical Smog. In LCA and Ecobalancing this is usually done by assessing the POCP of substances as POCP stands for "Potential to Create Ozon Photochemically". The actual flow of POCP is calculated by applying the POCP Index (Jenkin & Hayman, 1999; Derwent et al. 1998; high Nox) from CML 2000, which is available for some 123 substances. POCP is expressed in kg Ethylen Equivalents. This approach is widely accepted, e.g. some industries are recommending to use this method[44].

For estimating total POCP in Japan, data currently available on flows of POCP substances can be used: priority substances from voluntary agreements (12 toxic chemical, see Toxicity), SOx, NOx, CO and NMVOC. The total flow of POCP has been estimated using the POPC of each of these substances and for the group NMVOC the average POCP of all substances (0.48 kg Ethylen Equivalents per kg). This results in an annual POCP of 1'097'247'394 kg Ethylen Eq.

Substance	POCP per kg	Emissions 1999	POCP 1999 in kg Ethylen Equivalents
Chloroform/Trichloromethane	0.023	525	12'075
Tetrachloroethylene	0.029	288	8'352
Vinyl Chloride	0.027	1'595	43'065
Dichloromethane	0.068	11'281	767'108
Benzene	0.218	1'814	395'452
Trichloroethylene	0.325	228	74'100
Formaldehyde	0.519	82	42'558
Acetaldehyde	0.641	195	124'995
1,3-Butadiene	0.851	769	654'419
Total Self-regulated POCP		16'777	2'122'124
OECD minus Self-regulated Substances	0.48	1'833'223	898'279'270
So_x	0.049	870'000	41'760'000
No_x	0.028	1'996'000	55'888'000
CO	0.027	3'674'000	99'198'000
TOTAL POCP Flow 1999		kg Ethylen-Eq.	1'097'247'394

[44] For example the Responsible Care Initiative of the Chemical Industry, www.cefic.be/activities/hse/rc/guide/10.thm

Target Flow for Photochemical Oxidants in POCP

Japan has enacted EQS for Photochemical Oxidants, but not yet an annual target flow for POCP. The situation in recent years showed, that the annual average of daytime values was met at 100% of all monitoring stations. Some 0.25 % of all locations could not meet the annual average of the maximum value among the daytime hours. But only 3 out of 1185 monitoring stations met the EQS of daytime maximum. The Photochemical Oxidant issue is therefore mainly a problem of peaks in maximum concentration values. All across the country, these peaks are recognized as a problem for the handicapped persons, which suffer under these special situations during some days per year. The situation is no longer concentrated in the big metropolitan areas, but observed also in rural areas.

To derive an annual target flow, it is therefore useful to establish a link to the emission flows which are responsible for the development of peak values. Therefore the maximum value occurring (0.13588 ppm) exceeds the EQS of 0.06 ppm by 226% in 1999. To break this peak, the level of POCP emissions should be reduced by 126%. But this adjustment should be applied to the continual hourly average. Therefore the relation between the maximum average (0.10743 ppm) and the annual hourly average (0.02987 ppm) was used to calculate the percentage of reduction of the continual flow of emissions (-126%/(0.10743 ppm / 0.02987)= -35%).

Calculation of Ecofactor

The calculation indicates the amount of flow, which should be removed from the level of average concentration to avoid peaks of daytime maximums. Of course, many parameters including weather conditions define, if peaks occur locally. The indicator created here is just a conservative proxy for estimating the reduction of continual flow of POCP that is required to avoid peaks exceeding EQS. In other countries, the situation is similar and targets for NMVOC have been set, e.g. in Switzerland, Austria, Germany to reduce NMVOC by 70 - 80% from the levels of 1980. The assumption that a reduction of 35 will meet the EQS is therefore probably at the lower end of required reduction.

F target	F actual	EIP / kg Ethylen-Eq.
711'447'591	1'097'247'394	2'168

The regional distribution of Photochemical Oxidants shows a high variety even when almost all maximum values are exceeding the EQS. Therefore the Ecofactor for POCP was differentiated by prefectures using the ratio of maximum daytime value versus the average maximum daytime value. For each prefecture a specific Ecofactor is expressed as EIP per kg Ethylen Equivalents (see excel sheet for details). It varies between a minimum of 1'581 EIP for Kagoshima prefecture to a maximum of 2'742 in Gumma. By multiplication of POCP potential of each of the 123 substances covered, specific EIP values can be obtained for each prefecture.

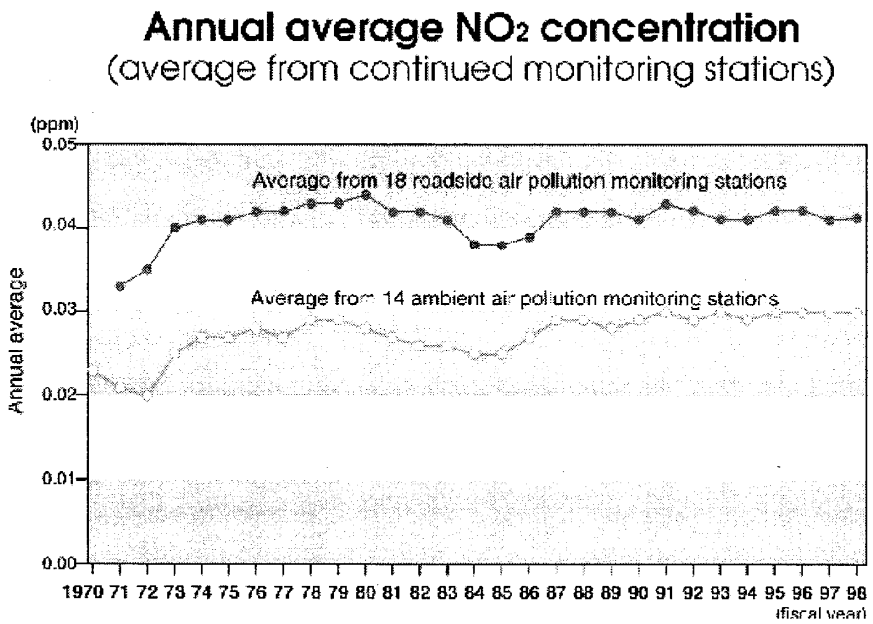
4.6 Clean Air Law: NOx

Nitrogen Dioxide NOx is traditionally a high priority substance within the environmental policy of Japan. NOx is produced during combustion processes and therefore largely emitted by heating facilities, waste incinerators and especially hard to combat: mobile sources such as cars, trucks and airplanes.

Although the EQS compliance has been continually improved at general monitoring stations and reached (2000) a level below the WHO guidelines with a total of 99% compliance to the EQS. But there still exist fields of non-compliance: In general, 21% of roadside monitoring stations are still exceeding the EQS in 2001. And large areas such as Tokyo or Osaka are far from meeting the standards.

Actual Flow of NOx

The actual flow of NOx is reported by the Japanese government to the UNFCCC secretariat on an annual basis. The total amount for 1999 is estimated at 1'996'000 tons.



http://www.env.go.jp/en/jeg/air/p_air.html

Target Flow of NOx

Beyond the EQS for NOx there are special regulations implemented by the government to reduce the emissions by mobile sources. Under the umbrella of the Automobile NOx Law [45] enacted 1992,

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[45] The Law Concerning Special Measures for Total Emission Reduction of Nitrogen Oxides from Automobiles in Specified Areas

six prefectures have set their specific targets for total annual flow of NOx, whereas there are explicit reduction targets enacted for the mobile sources. But due to the strong growth of car traffic, the targets have not yet been met: from 1992 till 1997, emissions from vehicles showed a reduction of only 3%.

This background shows: NOx is still an emission of national priority, as there do occur EQS exceeding at monitoring stations across the country. On the other hand, total pollution control has been enacted by the prefectures facing the most severe situation. It is therefore reasonable to define a national target flow based on the structure of EQS exceeding concentration levels and the adopted prefectural target flows.

The following approach has been developed for JEPIX: As the amount of reduction of automobile NOx is defined in six prefectures, it is possible to construct a link between the reduction ratio necessary in other prefectures: the annual average at roadside monitoring stations of the designated areas is exceeding the EQS of 0.04 ppm by 213% in average. According to the principle of precautiosness, the lower 0.04 ppm was taken for calculation. If we look at the average concentration exceeding EQS at roadside monitoring stations, it is 153% compared to EQS of 0.04 ppm. The designated areas hence need a reduction of flow, which is 139% bigger than the non-designated areas. The reduction of NOx flow from mobile sources in the designated areas is set as 31% in the amended Automobile NOx Law. This is considered as sufficient to reach the EQS by the government. Hence it is convincing, that the non-designated areas should reach their EQS by reducing 31% / 1.39 leading to a 22% reduction of mobile flow.

Calculation of Ecofactor

The national total flow can be divided into fix and mobile sources. From the total 1’996’000 tons in 1999 some 856000 tons were from fixed sources. The rest comes from mobile sources and is divided into flow of designated areas and flow of non-designated area. By summing up the flow from fixed sources with the 78% of non-designated area mobile emissions and the 69% designated area mobile emissions the total target flow results in 1’718’437’282 kg NOx.

F target	F actual	EIP / kg NOx
1’718’437’282	1’996’000’000	676

As the concentrations of NOx are regionally very different, the Ecofactor can be scaled to the local conditions. This has been achieved by multiplying the Ecofactor by the ration between the annual average concentration and the national average of annual average concentration. As a result the NOx Ecofactor varies from a minimum of 273 EIP kg in Wakayama to 1579 as the maximum in Tokyo. The average of designated areas is 1179 (25% of total national NOx EIP load) compared to the average of non-designated areas of 602 (75% of total national NOx EIP load). This can be recognized as a reasonable and consistent result.

4.7 Clean Air Law: SPM 10

Small Particulate Matter SPM 10 is the name of the fraction of particulate matter or dust, which is smaller than 10 micrometers Because these particles are so small, they can enter the respiratory system of humans and carry toxic or irritating substances. SPM 10 mainly consists of elementary carbon (soot), organic matter such as abrasion from tires or particles that form in the air from other pollutants or, finally, natural pollen.

Whereas the environmental technology installed during the last years has led to reduced emissions of particulate matter as a whole, the amount of SPM 10 is still considered to be responsible for respiratory health problems. Japan has defined EQS concentration levels for SPM 10 at 0.1 to 0.2 mg/m3.

Actual Flow of SPM 10

In Japan there are no official statistics on the total flow of SPM 10, but for 1999 some 75'000 tons of PM from stationary sources are reported[46]. From other literature[47], a representative composition of PM can be used for estimating the SPM 10 emissions (55% of total particulate matter of stationary sources) and the amount of SPM by mobile or stationary (16% of total SPM10) sources. Hence the annual flow of SPM 10 can be estimated at approx. 257'813 tons.

Target Flow SPM 10

Japan has enacted EQS for SPM and is monitoring the situation. There are no explicit targets for flows of SPM10 in Japan, yet. But amendment of the Automobile NOx Law foresees tighter measures against SPM10 which may probably lead to a similar regime as with NOx emissions. As long as there are no such target flows for designated prefectures, the target flow must be derived from the concentration levels as measured by the government. The compliance rates have been at 84% in 2000 and 66% in 2001 at general monitoring stations and at 66% and 47% at roadside monitoring stations.

Whereas in 27 prefectures the compliance rate reaches 100% at general monitoring stations, the

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[46] The Survey of Fixed Emission Sources Relating to the Air Quality by the Ministry of Environment, 1999.

[47] Dockery, D.W., Pope, C.A.: "Acute respiratory effects of particulate air pollution," *Annual Review of Public Health* 15: p. 107-132, 1994.

rate for some prefectures lies at low 23% in Chiba, 53% in Ibaraki and 75% in Tokyo.

To establish a link between the annual flow and the EQS, all data from the monitoring stations had been compiled. As there is no clear pattern that would link average of concentrations and days exceeding EQS in a consistent way, the estimation of a target flow must rely on a conservative criteria. The fact that no average is exceeding the EQS (0.1 mg/m3 - 0.2 mg/m3), that some compliant prefectures show high numbers of days not meeting the EQS and non-compliant prefectures showing low number of such days, it is difficult to establish a consistent linkage between the trend of situation and the annual flow. Unlike with Photochemical Oxidants, for SPM the peaks are not considered as the key problem. It is rather the average concentration which leads to accumulation of SPM 10 in the respiratory system and therefore a rise in adverse health effects.

A remaining clear criteria addressing the daily level of concentration is the concentration levels of the compliant prefectures. The average concentration level of all monitoring stations (0.026593287 mg/m3) divided by the average concentration level of the compliant prefectures (0.023662 mg/m3) we calculate a reduction ratio of 12% of the actual flow. Comparing the average of each category (annual average, hourly maximum, average of hourly maximum 98%), the ration of non-compliant prefectures to the average of all prefectures is in accordance with this (112%, 108%, 113%).

The fact, that in Japan EQS for SPM10 (0.1 mg/m3 - 0.2 mg/m3) is 5 times higher compared e.g. to Switzerland (0.02 mg/m3) and that there are compliant prefectures, which do not meet the standards during a high number of days indicates, that SPM10 may not yet reflect a high priority in Japan, yet. The target flow estimated is therefore seen as at the low end of reduction needed.

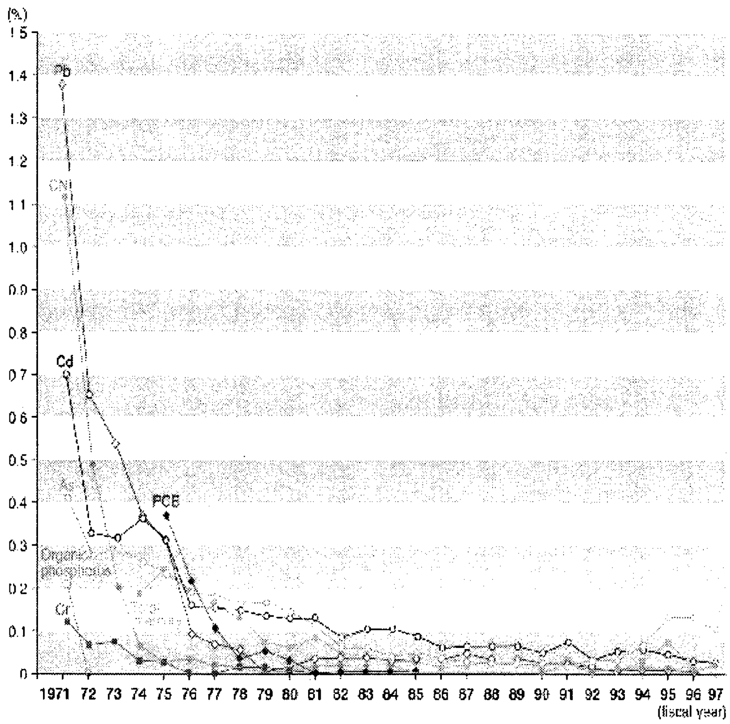
Calculation of Ecofactor

As there are large differences in the SPM10 situation, the Ecofactor can be scaled using the average concentration of each prefecture compared to the national annual average. These prefectural Ecofactors (see excel sheet for details) reflect a high range of results - from 3'104 in Tottori to 8'184 in Tokyo with an average of 4'473 in compliant prefectures and 5'771 in non-compliant prefectures.

F target	F actual	EIP / kg SPM10
225871208	257812500	5'053

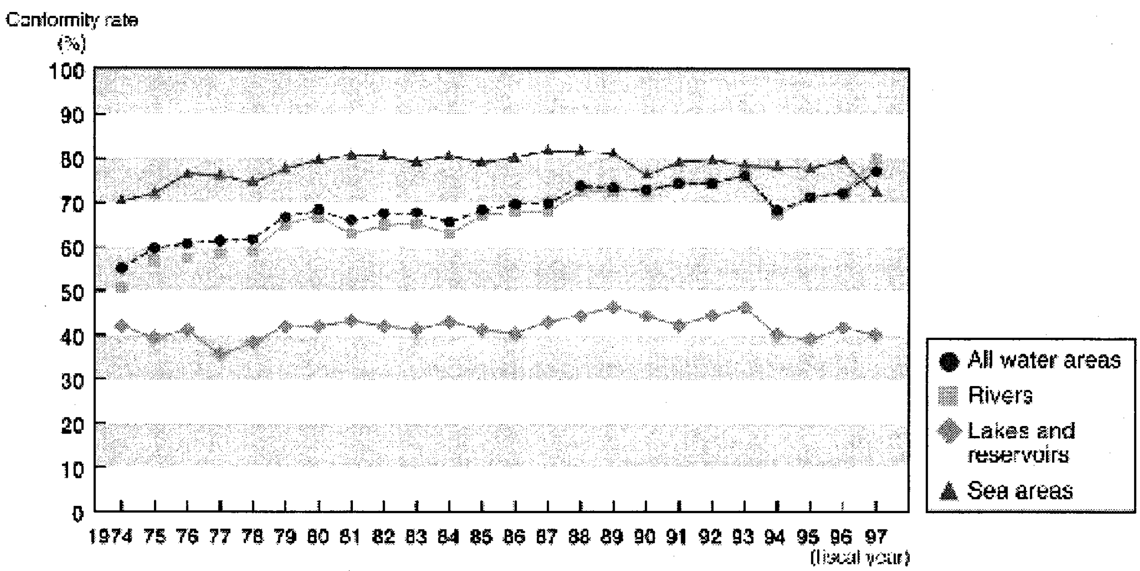
Clean Water

In recent years, remarkable improvements in water quality have been achieved in Japan. For most hazardous chemicals covered by law, including heavy metals significant reductions of pollution resulted from regulations on industrial wastewater. On the other hand, EQS for organic pollution are still not being met at about 30% of Japan's total water area. In particular, there has been little improvement in urban rivers and enclosed water areas such as inland seas, inlets, lakes, and reservoirs.



The EQS are bound to quality classes for specified water areas from the viewpoint of use and environmental conservation. Usually sum parameters such as Biochemical Oxygen Demand BOD or Chemical Oxygen Demand COD are used to characterize the water quality. Beyond these, substance groups such as Nitrogen N or Phosphorous P or specific chemicals such as selected Heavy Metals or Pesticides are applied to define water quality. EQS are furthermore set for SS Supended Solids, pH, Dissolved Organic Carbon DOC and total coliform bacterias. For a total of 26 substances EQS are set nationwide and for some more 22 substances precautionary monitoring is carried out.

Rates of conformity to water environmental quality standards
(BOD or COD) (according to water area)



The national compliance of many chemicals is high and on a satisfying level around 99%, except Tetrachloroethylen, Trichloroethylen and Arsenic [48]. But the priority water issue are substances relevant for Eutrophication.[49] This adverse ecological phenomena causes Algae bloom (e.g. red tide) that have toxic effects on fish and other sea-life. Water quality monitoring stations in lakes, closed seas and rivers show a stagnant compliance rate at 82% for BOD, 45% for COD in lakes and 75% in coastal waters. For the nutrient classification N and P the respective value is 79%. For these indicators COD, BOD, N and P this report provides Ecofactors.

It is relevant to have in mind, that more specific water pollution by toxic substances is covered by the Ecofactors for Toxicity. There specific Ecofactors for a number of 170 emissions into fresh or maritime water are provided.

4.8 Water Quality for Rivers as BOD

Actual Flow of BOD

No regularly published data could be found for the actual flow of BOD from emitting sources such as households or industry. According to the Environmental White Book 2000 of the Ministry of Environment [50] an estimation was made based on the households discharge of BOD and taking into account the different levels of waste water treatment. As for other sources of BOD there are no official flow data available, we used our estimation for households for 1999 in combination with the structure of total emissions from other sources estimated by Japanese experts for 1996 [51]. A total flow of some 10'150'000 tons BOD per year from various sources was estimated.

On the other hand, the concentration levels for BOD are monitored by the government. Because of the complex and local chemistry controlling the Oxygen within the river, it is not possible to estimate the annual flow into these rivers by looking at the BOD concentration. Therefore this concentration can only be used as an indirect - trend compatible - indicator instead of a real inflow of substances. Accepting the unknown function between emissions into the river and the resulting concentration, a linear relation can be constructed as a virtual flow of BOD. This indicator can be used to aggregate the situation of rivers and provide an Ecofactor that allows to provide area specific values, which do

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[48] OECD: *Environmental Performance Reviews - Japan, 2002*, p. 92

[49] An up to date discussion of Eutrophication in Japan can be found in: Hirosaki, J., Itsubo, N., Furota, T., Inaba, A.: "Estimation of the Damage by Eutrophication," in: *Proceedings of the 5th Intornational Ecobalance Conference, Tsukuba 2002*, p. 45 - 48.

[50] Environmental White Book 2002 of the Ministry of Environment, accessible as www.env.go.jp/policy/hakusyo/hakusyo.php3?kid=215

[51] Norihiro Itsubo: *Development of Impact Assessment Methodology for Manufacturing Metals*, Thesis for a doctorate in University of Tokyo (1997), page 191.

reflect the level of pollution and it's trend.

There is statistical data available on the flow rate of major rivers and their concentration of BOD. For most important rivers, this data is collected. For missing flow rates, the average water flow per km2 catchment area can be used for estimating these missing values. This is used to calculate a virtual BOD flow per year. For 1999 the data for 109 rivers has been compiled. For 26 of these rivers, mainly non-compliant rivers, BOD concentration values have been available. The others have been classified as compliant by assuming 1 mg / l BOD which is the drinking water class A level. An annual virtual flow of BOD for 1999 is estimated as 213'193 tons. The average concentration is 1.30 mg/l.

The comparison of these two estimations - the emission flow of BOD and the concentration based virtual flow show a ratio of 47 to 1 (BOD emission flow is 47 times higher than virtual concentration based flow).

Target Flow of BOD

The same procedure is used to define a target level for the virtual flow of BOD in rivers. This is done by the same principle. Based on the water flow of the non-compliant rivers, their BOD flow is calculated (average of non-compliant is 2.6 mg/l). In a second step, an estimation is based on the EQS Class A level of 1 mg/l, which is drinking water. The total flow of non-compliant rivers is 108'178 tons is reduced by some 50'462 tons. The annual actual flow will then be reduced by this reduction target and the target concentration based virtual BOD flow results at 162'730 tons.

When estimating the actual emission flow of BOD, it was found to be 47 times bigger than the concentration based virtual flow. By multiplying the target concentration based virtual flow by this factor, the target flow of emissions is estimated. The result is 7'747'000 tons per year.

Calculation of Ecofactor

The Ecofactor is calculated for the emission flow. This factor can be adjusted to specific rivers based on the relation between EQS concentration of BOD and actual concentration in a specific river. The average Ecofactor for compliant rivers (water class A; 1 mg BOD /liter or less) is 165 EIP per kg BOD emission and for the non-compliant the average is 440 EIP per kg. As there do occur extreme concentration levels for some rivers, the maximum Ecofactor is 1'420 per kg BOD emission for the Tsurumi river.

F target	F actual	EIP / kg BOD emission
7'747'307'454	10'149'742'537	169

4.9 Water Quality for Lakes and closed Sea as COD

As for rivers the most important indicator is BOD, lakes and closed sea water quality is assessed using EQS and monitoring for COD. Here the compliance rate for lakes is at low 45% only, which indicates, that COD is a severe issue for Japan's Environmental Policy.

Actual Flow of COD

Again, there are no periodically updated governmental statistics available for the total emission flow of COD in Japan. There do exist statistics only for designated areas such as Tokyo bay, Ise bay and Setonaikai. Compared to some estimation by Japanese experts for 1994, these areas made up for some 4% of the annual flow at that time.

The law does specify, that EQS are only applicable to bay areas where adverse effects such as algae bloom occurs, most of COD is emitted into areas not covered by the legislation. This makes it difficult to asses the actual flow of COD for the entire scope of Japan. But as EQS for COD are not met by many areas and lakes, it is important to calculate some indicator for COD. Therefore a similar approach for COD is followed as for BOD: a virtual concentration is calculated for lakes and bays as the data on EQS is available. So only the regions data accessible is taken into account.

For the Tokyo bay, Ise bay and Setonaikai the total flow of emission per year is known. Furthermore, the concentration average of COD for these closed seas is also available on a regular basis. The annual flow in 1999 was 416'100 tons for these designated areas.

For the biggest 15 lakes, only concentration levels of COD and water capacity are officially published. For these lakes, a virtual concentration based flow is calculated. It is 129'000 tons as for 1999.

Target Flow of COD

For the lakes the EQS can be used to estimate a virtual target flow based on the concentration levels. It is assumed that the quality class AA and A for lakes and A class for coastal water are the target level of water quality (drinking water). The respective EQS is 2 mg COD / litre. The target flow for lakes can now again be estimated using the water capacity and be compared to the actual flow exceeding this level. The result is a reduction for lakes of 43'000 tons.

Concerning the closed sea areas, there do exist emission flow target values under the total pollution load regime [52]. These are set for a period of 5 years and continually adjusted as long as adverse effects are observed, these steps usually foresee reductions of 7-8% of COD emission flow. To derive a concentration based virtual target flow for these areas, the current flow is divided by the actual

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[52] Based on the Water Pollution Control Law

concentration level. The result is a virtual water capacity, which in a second step is used to estimate the target flow based on the EQS of 2 mg / litre. The result is now based on a similar basis as for the lakes and can be added. The result is a total target flow of 394'000 tons.

Calculation of Ecofactor

This Ecofactor is not really bound to the whole area of Japan as it is calculated from 15 biggest lakes and three designated closed seas only. Second, the Ecofactor is only a very rough indicator as the relationship to emissions of COD into lakes covered are not available. So the indicator is a mixture derived from concentration level based virtual flow and emission flow for closed sea. But it allows to evaluate take into account regional differences in the actual pollution level. It is plausible, that the relation between emissions into lakes and the concentration in the lakes is smaller than the ration between emissions into hugh water bodies and their concentration.

Therefore the Ecofactor for COD is scaled by using the ratio between the actual concentration level in a lake or closed sea and the average concentration of exceeding water bodies. The minimum Ecofactor is calculated for lake Inawashiro at 606 EIP and the highest for lake Teganuma at 21'379 EIP. The average for closed sea is 3'772 EIP versus 5'052 for lakes.

F target	F actual	EIP/kg COD
409'398'049	548'374'285	3'272

4.10 Water Quality for Lakes and closed Sea as N and P

To tackle the Eutrophication issue the Japanese Water Management has enacted EQS for nutrient substances Nitrogen and Phosphorous. For selected areas, where certain adverse effects such as algae bloom is observed, this EQS apply. In 1999 the compliance rate is at 41% for lakes and 79% for coastal waters. Therefore some total pollutant load designated areas have been installed and target flows for N and P have been imposed.

Actual Flow of N and P

The procedure followed for COD is again applied for N and P (see above), which means that target and actual flow are separately estimate for lakes and for closed seas and then added.

For the Tokyo bay, Ise bay and Setonaikai the total flow of emission per year is known. Furthermore, the concentration average of P and N for these closed seas is also available on a regular basis. The annual flow in 1999 was 363'175 tons of N and 27'996 tons for these designated areas.

For 10 lakes, only concentration levels of P and N as well as water capacity are officially published. For these lakes, a virtual concentration based flow is calculated. It is 11'197 tons of N and 277 tons of P as for 1999.

By summing up these two indicators, a virtual annual flow of 374'372 tons N and 28'272 tons P are calculated.

Target Flow for N and P

Again, there are target flows for the three bays set by the government. By using these to calculate virtual capacity and then apply the EQS standard the target flow for closed sea can be estimated. For closed sea water as well as lakes the average concentration of the EQS of class I and II were chosen: 0.25 mg / litre N and 0.025 mg/l for P. Directly from the water capacity and the EQS, the concentration based virtual target flow is calculated.

Again this calculation is a mixture of emission based and concentration based values and therefore not precise, but an indication of the current situation compatible with the trends of the available data. As the percentage of the lakes within the flows of the closed seas are low, it is considered as a feasible procedure. If N and P emission flows into lakes would be available, the indicator could be revised and made more precise.

Calculation of Ecofactor

The procedure for N and P is same as the procedure for COD. Beyond the Ecofactor for the biggest lakes and designated closed sea, specific Ecofactors are provided for each water body using the ratio between actual concentration level and the average concentration level of the exceeding lakes.

For N the minimal Ecofactor was calculated at 2'512 EIP / kg for lake Nojiri, the highest Ecofactor resulted at 77'462 EIP / kg for lake Teganuma. The closes seas differing situation is taken into account by scaling the Ecofactor by the ratio of average bay concentration divided by the average concentration of all bays. Using this adjustment factor, EIP for the specific bays results at 23'171 EIP for Tokyo bay, 2'180 for Setonaikai and 3'492 for Ise Bay.

F target	F actual	EIP / kg N
216'688'759	374'372'191	7'973

The same procedure is carried out for P. Here the Ecofactor for Tokyo bay is 211'588 EIP / kg, 29'278 EIP for Setonaikai and 53'375 EIP for Ise bay. Looking at the lakes, the minimal Ecofactor is calculated for lake Biwa with 4'330 EIP and the largest again for lake Tagenuma with 368'316 EIP.

F target	F actual	EIP / kg P
18'299'597	18'301'084	84'428

4.12 Waste Management: Landfill Capacity

Waste disposal is recognized as an important environmental issue by the public: there do occur emissions of dioxins and other harmful substances at incineration plants and on the other hand, waste disposal by landfill is limited by the high density of population in many areas.

Japan is moving towards the creation of a recycling based society and trying to reduce the stream of waste especially towards landfill disposal.

Actual Flow of Waste to Landfill

The total flow of waste is published by the Ministry of Environment on a yearly basis. In 1999 some 51'450'000 metric tons of municipal waste have been discharged, 23% of this flow was sent to landfill. For non-municipal waste some 399'799'000 metric tons were collected and 16% of this fraction was sent to landfill. In total approx. 76 mio tons of waste was sent to landfill in 1999.

Target flow of Waste to Landfill

There do exist several quantitative target for waste flows addressing collection rates and recycling rates. In 2001 the Ministry of Environment set a target for wastes into landfill [53]. There is a short term (2005) and a long term (2010) target for each of the two categories.

Waste Category [54]	1999	Target 2005	Target 2010
Municipal Waste	11.8 Mio. tons	8.0 Mio. tons	6.0 Mio. tons
Non-Municipal Waste	64.3 Mio. tons	36 Mio. tons	30 Mio. tons
Total	76.1 Mio. tons	44 Mio. tons	36 Mio. tons

Calculation of Ecofactor

Ecofactors shall express the current political pressure of an issue and therefore calculations should always be based on the most strict target available, which means 2010 in this case. There is no obvious difference between a capacity for municipal waste or non-municipal waste, the total target for landfill is used for calculation of the Ecofactor. This results in 58.7 EIP per kg of waste disposed in landfill.

Ftarget	Factual	EIP / kg landfill	EIP / kg waste generated
36'000'000'000	76'035'456'500	58.67	9.9

Taking into account the disposal rate, the Ecofactor for waste generated (before recovery and reduction) is 9.9 EIP per kg. This factor should be used, when calculating EIP for a corporate

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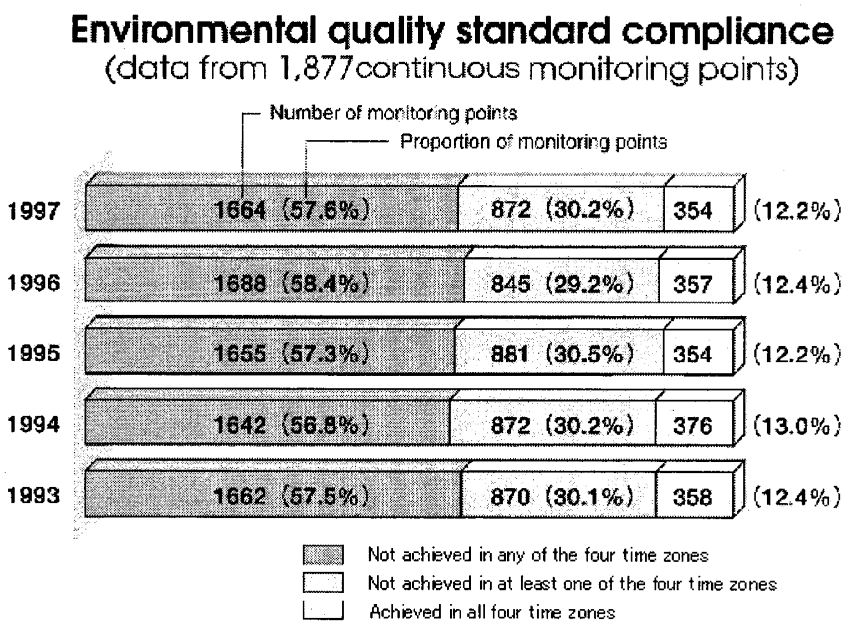
[53] *OECD Environmental Performance Reviews: Japan, 2002*, p.108.

[54] *OECD Environmental Performance Reviews: Japan, 2002*, p.107 and data for 1999 from Ministry of Environment, Waste Management Division, January 2003, verbal communication.

Ecobalance. The landfill Ecofactor is used when waste is directly sent to landfill.

4.13 Road Traffic Noise

In Japan, one of the serious issues in environmental policy is noise [55]: there are more than 15'000 complaints filed from citizens every year due to annoyance from noise exposure. There do exist specific EQS for noise, but the monitoring station show low compliance rates for road traffic noise so far: only 12% of all stations do achieve the EQS. And some 58% of stations are non-compliant around the clock.



Road traffic noise levels can be influenced by reducing the transportation of people and freight, by using modern equipment and sophisticated route planning. Therefore an Ecofactor for road traffic is calculated based on the traffic volume and the noise characteristics of vehicles. It is expressed in EIP per km.

Annual Flow of road traffic in Noise Kilometre

The road traffic noise is monitored by the government to assess compliance with the EQS at some 1900 monitoring stations. There are detailed reports available on the type of road, where noise is monitored and statistics on the level of exceeding of the EQS is available. To establish a link to the traffic volume, the virtual unit of noise kilometres is defined. According to BUWAL SRU 329 [56], a pragmatic estimate says, that the noise caused by 10 passenger cars equals 1 truck. So noise

[55] Environmental Quality Standards for Noise.

[56] BUWAL: *Larmbekampfung in der Schweiz*, SRU 329, p. 51, Bern, 2002.

kilometres are defined as the kilometres driven by passenger cars per year in Japan, plus 10 times the kilometres driven by truck or other heavy vehicles. The total traffic volume in Japan is covered by statistics of the Ministry of Land, Infrastructure and Transport on a regular basis. For 1999 the total is 952'019'191'000 km [57] covering passenger cars and heavy vehicles. Solely passenger cars made up for 630'000'000'000 km or 66%.[58]

By multiplying the kilometres of heavy vehicles by the factor 10, total annual noise kilometres are obtained (3'843'396'910'000 N km).

Target Flow of road traffic in Noise Kilometre

Based on the virtual unit of noise kilometres the target flow can be derived as follows: by principle road traffic needs to be reduced to an extent, that all monitoring stations meet the EQS. The statistics [59] show for compliance levels: first, the number of monitoring stations compliant to the EQS. Second, the number of stations, which exceed the EQS by 1 to 5 db. Third, the number of stations exceeding 5 - 10 db and finally exceeding more than 11 db:

	Compliant	1-5 db exceeding	5-10 db exceeding	>11 db exceeding
Day	46.20%	37.10%	14.30%	2.40%
Night	51.40%	28.10%	15.30%	5.20%
Average	48.80%	32.60%	14.80%	3.80%

It is assumed, how much the traffic volume at current technology needs to be reduced to meet the EQS. As the unit db to express noise levels has a logarithmic scale, the reduction required grows exponentially for each category. Recent research [60] shows, that a reduction at the levels relevant here of 50% of traffic will result in a noise reduction of 3 db. By applying this reduction ratio, for each compliance category the required reduction in % is calculated. Then the total annual flow of noise kilometres is allocated to the four compliance categories - indicating the amount of traffic occurring in each category. Then the amount of reduction is calculated and summed up over all categories. As a result, the target flow of noise kilometres is estimated and an Ecofactor for noise can be calculated.

Calculation of Ecofactor

The Ecofactor is calculated for the virtual unit of Noise Kilometers by comparing the actual

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[57] Verbal Communication, Ministry of Land, Infrastructure and Transport, February 2003.

[58] *Environmental White Book 2002 of the Ministry of Environment*, accessible as www.env.go.jp/policy/hakusyo/hakusyo.php3?kid=215.

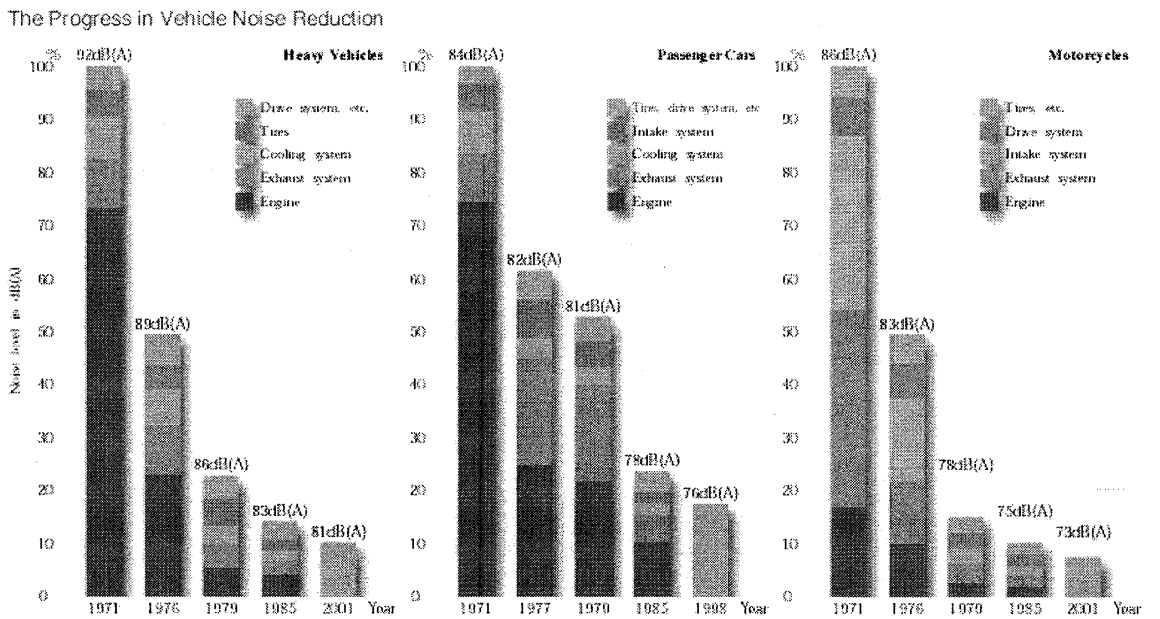
[59] www.env.go.jp./air/car/noise/noise_h11.html.

[60] BUWAL: *Larmbekampfung in der Schweiz*, SRU 329, p. 94, Bern, 2002.

amount of road traffic with the target flow of Noise Kilometers. This Ecofactor can be directly used to assess passenger cars. For trucks, the Ecofactor needs to multiplied by 10 to break down noise kilometre into real kilometres again. The result is an Ecofactor for trucks of 5.6 EIP / km.

Ftarget	Factual	EIP / Noise km
2’618’929’088’443.10	3’843’396’910’000.000	0.56

To differentiate the noise characteristics of different trucks or cars, it is important to take into account the following fact: test conditions in the lab to measure noise are not comparable to the real in situ noise characteristics. In test labs usually this aspect is not taken into account, but the test is assessing the engine, exhaust system, cooling system, etc. noise. According to modern standards, most noise sources within the vehicles have been reduced substantially. But on the real road, speed and surface of the road turn out to be the dominant parameters for noise pollution. So the technical specification of official car documents can be used to adjust the Ecofactor, but it can not be fully accounting the reduction differences between vehicles. This is why here we stipulate a pragmatic and linear differentiation between different types of technologies:



[61]

It is assumed, that current noise levels are caused by an average fleet meeting the standards of 1985. As a rule of thumb, a vehicles Ecofactor can be adjusted by the difference of the next lower of higher category.

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[61] http://www.jama.or.jp/eco/eco_car/en/en_1_10_01.html

Vehicle	1979 level	1985 level	2001 level
Heavy vehicle	+ 50% = 8.4 EIP	100% = 5.6 EIP	- 35% = 3.64 EIP
Passenger car	+ 75% = 0.98 EIP	100% = 0.56 EIP	- 25% = 0.42 EIP

This means, that the total EIP from noise kilometre would be reduced by approx 35% if vehicles, which comply with the actual technical standards, would carry out all traffic. Of course, there are cars or even truck, which are better than the standards. For these, the above procedure can be used to calculate a specific Ecofactor.

5 Ecobalance for Japan 1999 based on JEPIX 2005 draft

Following the detailed description of how to calculate Ecofactors for Japan within the 11 selected policy focus subjects, this chapter shall give a brief view on the results of the calculation and apply the Ecofactors to the national Ecobalance of Japan for the base year 1999.

National Ecobalance for Japan 1999

The following table summarizes the results of this technical report as for each policy focus the actual flow, the target flow, the Ecofactor and the total national score for 1999 is listed. The total score stands for the total national Ecobalance for 1999.

1999	Actual Flow in kg	Target Flow in kg	National Score
GHG CO2-Eq.	1'147'945'000'000	299'449'662'921	18'011'527'441'043
ODP	3'617'180	2'902'777	1'552'790'555'421
Photochemical Oxidant	1'097'247'394	711'447'591	2'378'610'273'297
Nox	1'996'000'000	1'717'227'299	1'351'031'597'205
SPM	257'812'500	225'871'208	1'302'825'328'407
Toxics incl. Dioxin	16'454'961'482	7'986'677'545	4'244'841'113'388
COD (designated area)	548'374'285	409'398'049	1'794'166'014'238
N (designated area)	374'372'191	216'685'232	2'985'028'857'629
P (designated area)	28'272'854	28'272'854	2'386'633'114'585
BOD (biggest rivers)	213'193'584	162'730'851	1'716'360'333'086
Landfill	76'035'456'500	36'000'000'000	4'460'949'571'885
Road Noise	3'843'396'910'000	2'618'929'088'443	2'153'689'022'882
Total			44'338'453'223'065

For a proper interpretation of these results, it is important to have in mind, that these are tentative results based on JEPIX2005draft. The total score itself is an isolated result without much meaning. When we can draw a time series e.g. the national Ecobalance from 1995 till 2000, then the trend in the total score becomes meaningful. At current stage, the structure of the score is much more interesting than the total score itself:

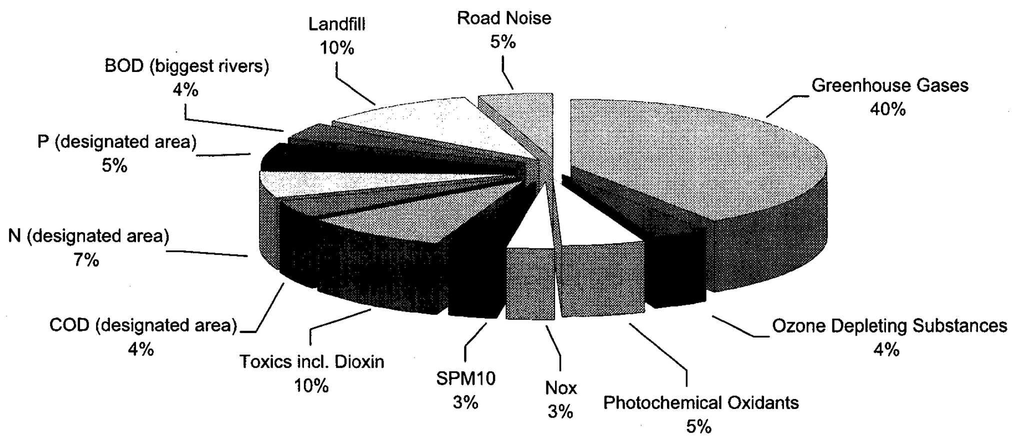
As can be seen from the pie chart of the national Ecobalance for 1999, there are policy subjects that gain higher priority than others. The challenge of climate change policy is reflected in the result as GHG account for 40% of the total Ecobalance. Landfill and toxic substances including Dioxins are next important subjects accounting each for 10%.

Closed water pollutant nutrients Phosphorous and Nitrogen rank third. This priority should be carefully read at current stage of JEPIX: water pollutants data was not yet covering all of Japan, but only limited to 15 biggest lakes and three closed sea areas. Therefore, the current result is probably overestimating the score for these water pollutants (P, N, COD). Next fiscal year, more adequate water data will be available and will allow a redesign of these Ecofactors.

Other high priority areas include Road Noise and Photochemical Oxidants, whereas ODP, SPM10 and NOx show less urgency when applying the distance to target principle.

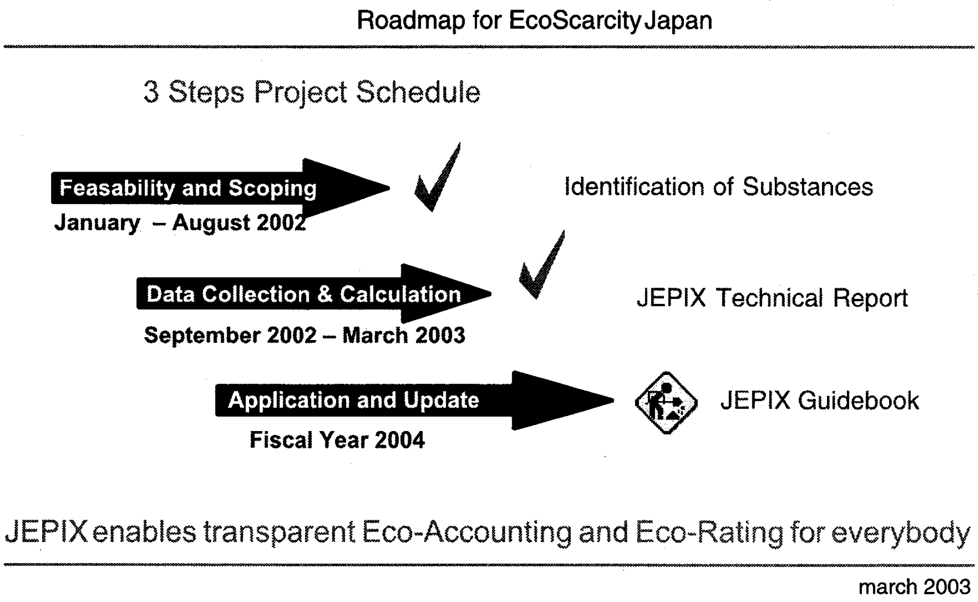
There are a few subjects to keep in mind when doing interpretation of this national Ecobalance: First of all, it is based on the data available for 1999. The data availability for toxics and for water pollutants such as P, N, and COD are not yet on a sufficient quality level, but will soon be improved. Second, the national total score includes all national data and not just industry specific data. This means, that in the total national score the emissions from private households as well as public bodies are included. Furthermore, there are very specific emissions, such as Dioxins, which are emitted by waste treatment facilities and contributing to the total national score of toxics. When applying the Ecofactors to a companies Ecobalance, the result will look quite different, e.g. putting more emphasis on GHG, NOx, SPM and Photochemical Oxidants.

National Ecobalance for Japan 1999
(based on actual national flows from official national statistics)



Summary and Outlook

This report is just a starting point for the application of JEPIX. It provides the results of an extensive search for national environmental statistics and national environmental laws. For 11 policy focus subjects, the calculation of an Ecofactor is described in detail and some 1050 Ecofactors are provided in the attached Excel Sheet for free usage by interested people and organizations. For several substances, regionalized Ecofactors are available for an appropriate application of JEPIX across the country of Japan. Finally, the report provides an extensive discussion of the data quality and the basic principles of the JEPIX method.



Now, it is up to the prospective users of such methods to start evaluation and application of Japanese Ecofactors within their context. The JEPIX project team is looking forward to share experience and strive for continual improvement of the method.