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# NORWEGIAN CONSUMPTION, CHINESE POLLUTION

## 消费在挪威， 污染在中国

HOW OECD IMPORTS  
GENERATE CO<sub>2</sub>  
EMISSIONS IN  
DEVELOPING COUNTRIES  
- AND THE NEED FOR  
NEW LOW-CARBON  
PARTNERSHIPS

经合组织国家的进口是怎样导致  
发展中国家CO<sub>2</sub>排放的  
- 以及建立新的低碳伙伴关系的  
必要性

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# TRACES OF NORWAY

## 挪威的足迹

Goods for consumption in OECD countries are increasingly produced in developing countries and particularly in China, effecting increased pollution: Norway's carbon footprint in China almost tripled between 2001 and 2006. Norway and other OECD countries are part of the problem of rising CO<sub>2</sub> emissions in China and the developing world – and should also be part of the solution.

经合组织国家的消费产品越来越多地生产于发展中国家，特别是中国，造成了以下这个污染上升的事实：挪威在中国的碳足迹从2001年到2006年增加了将近两倍。挪威和其它经合组织国家是中国和第三世界CO<sub>2</sub>排放量增加的根源之一，因此也应该是解决这个问题的答案之一。



# INTRODUCTION: THE NEED FOR NEW LOW-CARBON PARTNERSHIPS

## 前言：建立新的低碳伙 伴关系的必要性

### NORWEGIAN CO<sub>2</sub> EMISSIONS TRIPLED – IN CHINA

#### 挪威在中国的CO<sub>2</sub> 排放增长了两倍

Using Norway as an example, this study investigates to what extent OECD consumption generates increased CO<sub>2</sub> emissions in developing countries, especially China. The numbers and trends presented in the study are clear:

- Production of Norwegian consumer goods is increasingly outsourced to developing countries which are countries without emission constraints under the Kyoto Protocol.
- Norway's carbon footprint in China almost tripled in the period 2001-2006. In developing countries it rose by 65% (vs. 16.5% in developed countries).
- In 2006 Norway "saved" 357 million € by importing from developing countries, a cost of CO<sub>2</sub> that would be imposed on the imports if they were produced in the EU.

本项研究将以挪威为例，探讨经合组织国家的消费在多大程度上导致了发展中国家，尤其是中国的CO<sub>2</sub>排放量的上升。本项研究中所展示的数据及趋势十分明了：

- 挪威消费品的生产越来越多地外包给碳排放不受京都议定书限制的发展中国家。
- 从2001年到2006年，挪威在中国的碳足迹增长了将近两倍，在发展中国家的碳足迹增长了65%（而在发达国家增长了16.5%）。
- 2006年，挪威由于从发展中国家进口而“节省”了3.57亿欧元，而如果这些进口产品是在欧盟国家生产的话，就会在进口挪威时被征收这一笔额外的碳费。

The findings illustrate that, in a globalized economy, restrictions on CO<sub>2</sub> emissions must be applied globally. If not, we will see examples such as this of so called “carbon leakage”. Secondly, they show that high income OECD countries such as Norway are a part of the problem of the rapidly increasing CO<sub>2</sub> emissions in developing countries. The consumption of a typical Norwegian household causes almost as much CO<sub>2</sub> emissions in China annually as does the average Chinese citizen (3.3 vs. 3.8 tons). It is therefore not only China that needs to transform in order to curb Chinese CO<sub>2</sub> emissions: Norway – and the West – must also change. Finally, the findings indicate the substantial economic benefit that Western consumers derive from outsourcing production (and pollution) to developing countries.

研究结果表明，在一个全球化经济中，CO<sub>2</sub>排放限制必须在全球推广实行。否则，我们会目睹这一类的所谓“碳泄漏”的现象。第二，研究结果还显示了像挪威这样的高收入的经合组织国家，是发展中国家CO<sub>2</sub>排放急剧上升的缘由之一。一个典型的挪威家庭的消费，在中国所导致的年度CO<sub>2</sub>排放量，几乎等于一个普通中国公民消费所产生的年度排放量（前者为3.3吨，后者为3.8吨）。因此，要控制中国的CO<sub>2</sub>排放，不仅中国需要改变，挪威和其他西方国家也必须改变。最后，研究结果还彰显了西方消费者通过将生产（和污染）外包转移给发展中国家而获取的巨大的经济效益。

## CAN WE CHANGE TOGETHER?

### 我们能携手促成 变化吗？

If a global warming with severe detrimental impacts is to be avoided, developed and developing nations need to forge new partnerships that stimulate a joint transition to sustainable low carbon societies. The speed and scale of development in China - with low production costs combined with huge investment flows in R&D and infrastructure - provides an unprecedented opportunity for mass market production and implementation of low-carbon technologies, which also are in demand in developed countries. China's ferocious development can wreck the world, but it can also be made to play a crucial role in saving it.

要避免全球变暖所带来的严重危害，发达国家和发展中国家需要构筑新的伙伴关系，来相互促进向可持续的低碳社会的共同转化。中国发展的速度和规模，加上低廉的生产成本与巨额资金流入研发和基础设施领域的的这种结合，都为低碳技术的大量生产和推广使用提供了前所未有的契机。对这些技术发达国家也有需求。中国迅猛的发展可能会震垮世界，但也能被用来在拯救世界的过程中发挥关键作用。

OECD countries such as Norway are in a position to invest resources and know-how in developing nations facing the climate change challenge – and to gain by doing so. But the potential gain here has more important aspects to it than just exports. It is about linking financial resources and the best knowledge milieus in the West, with efforts to tackle the immense challenge of sustainable and equitable low-carbon development in developing countries. Such a linkage has the potential to spur development of a whole new global clean-tech industry, driving innovation and bringing down costs whilst helping to ensure a low-carbon transition also in OECD countries.

象挪威这样的经合组织国家，有能力在面临气候变化挑战的发展中国家里投入资源和知识专长，并通过这样的投入获取自身利益。但这些潜在的利益蕴涵着比出口商机更为重要的方面，即怎样将西方的财力资源和最佳专业知识，与应对发展中国家可持续和公平的低碳发展中所面临的巨大挑战结合起来。这种结合有潜力来刺激一个崭新的全球清洁技术工业的生成，催化创新、降低成本，同时也有助于保障经合组织国家自身的低碳转化。

Today, however, the Norway-China trade relationship promotes increased consumption based on unsustainable models of production. If incentives are developed to make the Norwegian-Sino relationship a driver for mutual low carbon development, chances will increase for both Norwegian and Chinese stakeholders to become winners in a future low carbon economy.

但是，当今的挪中贸易关系却助长着建筑在不可持续的生产模式上的消费。如果能够建立起有关激励机制，使挪中关系成为两国低碳化互动发展的推动力，那么，挪威和中国的利益相关方就更有可能成为未来低碳经济中的佼佼者。

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# 1. BACKGROUND

## CONSUMPTION AND POLLUTION

When we think of daily activities that cause pollution we tend to think of driving to work, heating the house or washing the clothes. But the biggest impact of individuals is through the products that they buy. Ultimately, it is consumers (including companies and government) buying products, that triggers the chain of events that leads to most pollution.

If you buy a television set, you share responsibility for the energy used by the shop and for the transport of the TV set from its country of assembly. But it does not stop there. Components are typically produced in numerous other countries. Each component is produced in a factory, which requires electricity, chemicals, plastic or metals. If one traces the production system back to its origin it will end in areas such as a coal mine in China, an iron-ore mine in Australia, a bauxite mine in Brazil, and an oil well in Canada. The pollution from these mining activities in distant lands to the purchase of a TV set in a Norwegian shopping centre generates considerable pollution. This pollution lies behind most of our personal footprints.

Our livelihoods depend on consumption, however, we must evaluate *how* and *what* we consume.

## ESTIMATING CARBON FOOTPRINTS IN A GLOBAL ECONOMY

The most common way to evaluate a country's CO<sub>2</sub> emissions is to produce an inventory of emissions within the country. Considered in this manner, Norway emitted 54 million tonnes (Mt) of CO<sub>2</sub> in 2003. This is about 11.9 tonnes per Norwegian, a slightly higher average than countries (2003 numbers) such as Germany (10.7 t/cap) and UK (10.3 t/cap), significantly higher than neighbouring Sweden (6.9 t/cap), and much higher than the average per capita emissions of developing nations such as China (3.4 t/cap) or India (1.1 t/cap).<sup>i</sup>

估算一个国家CO<sub>2</sub>排放的最常见的方法是，制作一张这个国家内的排放清单。以这种方法核算，那么挪威在2003年总共排放了5400万吨CO<sub>2</sub>。平均每个挪威人排放了11.9吨，略微高出德国(10.7吨/人)和英国(10.3吨/人)，但显著高于邻国瑞典(6.9吨/人)，而且远远高出中国(3.4吨/人)或印度(1.1吨/人)等发展中国家的人均排放。(以上均为2003年数据。)

Calculated in this way, the CO<sub>2</sub> emissions do not take into account that a country's consumption also instigates production and hence pollution outside of the country. The global CO<sub>2</sub> emissions from consumption within a country are known as a country's carbon footprint. The carbon footprint is essentially the emissions within a country plus imports minus exports.

以这种方式计算CO<sub>2</sub>的排放量时，并没有考虑到这个国家的消费也促成了国外的生产，因而造成了国外的污染。一个国家内的消费所引起的全球性CO<sub>2</sub>排放被称为那个国家的碳足迹。碳足迹实际上就是一个国家内的排放加上进口所包含的、并减去出口所包含的碳排放。



## ENSURING DEVELOPMENT WITHIN ENVIRONMENTAL LIMITS

In 2001 – the most recent year with detailed available analysis – the production of Norwegian imports generated 29 Mt CO<sub>2</sub> outside of Norway. The same year the production of Norwegian exports – generated largely by exports of oil and gas and international shipping – entailed emissions of 36 Mt CO<sub>2</sub>. Thus in 2001, Norway's total carbon footprint was 47 Mt CO<sub>2</sub> (54+29-36) which is lower than the territorial emissions due to Norway's CO<sub>2</sub> intensive exports.<sup>ii</sup>

**Carbon footprint = the global CO<sub>2</sub> emissions from consumption of a person or country.** 碳足迹=一个人或一个国家的消费所引起的全球性CO<sub>2</sub>排放

Greenhouse gas emissions cause the same climate effects wherever they are emitted. If one tonne of CO<sub>2</sub> is emitted in China, it causes exactly the same climatic effect as if it was emitted in Argentina, Botswana, Canada or Norway itself. Taking account of CO<sub>2</sub> emitted elsewhere but caused by Norwegian consumption is therefore both an ethical duty and in the self-interest of Norwegians.

Developing countries need to develop their economies to alleviate poverty and reach higher standards of living. Yet, it is a key fact that there are not enough natural resources on the planet for the developing countries to emulate Western living standards with current forms of production and consumption. In a longer term perspective, it is actually physically impossible for every Chinese and Indian to over time consume like the average Norwegian does.<sup>iv</sup>

发展中国家需要发展经济，以达到减贫和提高人民生活水准的目的。但其间一个关键性的事实是，以目前的生产和消费形式，地球上没有足够的自然资源使发展中国家能够效仿西方国家的生活方式。从长远看，使每个中国人和印度人都逐渐地能够象一个普通的挪威人那样消费，其物质基础是根本不存在的。

**There are not enough resources in the world for every Chinese and Indian to consume like Norwegians do.**

*In the Living Planet Report by WWF, Global Footprint Network, and the Zoological Society of London (2006) the total bio-capacity of the world was estimated to 11.2 billion global hectares (2003). On average, that translates into 1.8 global hectares per person if consumption is to be in line with the carrying capacity of the world's ecosystems and thereby sustainable long-term.*

*In 2003, every Norwegian consumed 5.8 global hectares. If the +2 billion people living in China and India were to consume like Norwegians did in 2003, we would therefore need biological resources of more than 11.6 billion global hectares per year to serve that consumption. That overshoots the 11.2 billion hectares available for the total world population in 2003.*

In addition, developing countries trying to raise living standards using current modes of production will lead to CO<sub>2</sub> emissions over the next decades that, according to the projections of *World Energy Outlook 2007* and the scenarios of the UN Intergovernmental Panel on Climate Change (IPCC), will provoke global warming of far more than an average +2° Celsius, the accepted threshold for dangerous interference with the climate system. The effects of such warming are predicted to be extremely detrimental, first and foremost for the populations in the developing world.

另外，根据《世界能源展望2007年》的预测和联合国政府间气候变化小组的推断，未来几十年中，发展中国家在努力提高生活水平时，其使用目前的生产方式所造成的CO<sub>2</sub>排放，将引起地球气温平均升幅远远高于2° C这个对气候系统危害性干预的公认的阈值。这种程度的气候变暖预计将会造成灾难性的后果，首先是对发展中国家的居民而言。

New solutions will be necessary to raise living standards globally whilst still ensuring the ecological and climatic integrity humankind ultimately depends upon for livelihoods. Transfer of resources and know-how from developed nations to developing nations is an important step in developing new solutions that can ensure global sustainability, as recognised by the UN Framework Convention on Climate Change.

为了在全球普遍提高人民的生活水准，同时保障人类生存所最终依赖的生态与气候系统的完整性，采用新的对策将成为一种必要。发达国家向发展中国家的资源和知识转让，正如联合国气候变化框架公约所确认的那样，是制定保障全球可持续发展新对策过程中的重要一步。

## NORWAY AND CHINA IN FOCUS

This study focuses on CO<sub>2</sub> in Norway's trade-relationship with developing countries, primarily China. There are several reasons for this being a relationship of general interest. Most basically, Norway and China are increasingly interlinked in the global economy and both need to change radically – from very different starting points.

这项研究着重于挪威与发展中国家的，其中主要是与中国的贸易关系中的CO<sub>2</sub>排放。有多重原因使这种贸易关系引起人们的普遍关注。最基本的原因是，挪威和中国在当前的全球经济中关系日益紧密，而且两国都需要进行重大变革，尽管各自的出发点大不相同。

## KEY FACTS ABOUT NORWAY AND CHINA

Source: Human Development Report 2007-08	Norway	China
Population	4.6 mill.	1.3 bill.
Size in km <sup>2</sup>	323,802	9,596,960
Population density	1/14 km <sup>2</sup>	135/1 km <sup>2</sup>
Gini* (year 2000/2004)	25.8 (6th lowest)	46.9 (medium)
GDP (2005) US\$	295.5 bill. US\$	2,234.3bill.
Purchasing Power Parity (2005) US\$	191.5 bill. US\$	8,814.9 bill.
GDP / capita (2005)	72,306 \$ (2 <sup>nd</sup> )	1,713 US\$
Purchasing Power Parity / capita (2005)	46,300 \$ (3 <sup>rd</sup> )	6,757 US\$
Annual growth rate 1975 – 2005 (%)	2.6	8.4
CO <sub>2</sub> emissions (2003/2004)	54 Mt	5,007.1 Mt
CO <sub>2</sub> emissions per capita (2003/2004)	11.5 Mt	3.8 Mt
Human Development Index (2005)	2	81

Table 1: Key facts about Norway and China. (The CIA World Fact Book is the source of population, size and Gini. The Gini coefficient is a measure of statistical dispersion used as a measure of inequality of income distribution or inequality of wealth distribution.)

## NORWAY: A RICH, SMALL OECD-COUNTRY IN A GLOBAL ECONOMY

With 4.7 million people on an area of 323,802 km<sup>2</sup>, Norway is one of the wealthiest countries in the world. The wealth is equally distributed to an extent rarely seen, the education level is high, the population density is low, and climatic conditions are stable and generally benevolent. Norway is rated the most peaceful country in the Global Peace Index (2007). Norway has since 2001 consistently been rated the top country on the UN Human Development Index, in 2007/2008 being adjusted to second place after Iceland. Norway is the country providing the largest percentage of its GDP – 0.92% – to overseas development aid. In many ways Norway is a model country, representing a welfare level many countries aspire to.

挪威在其323 802平方公里的土地上有着470万人口，是世界上最富裕的国家之一。社会财富分配的平等程度举世罕见，国民教育水平高，人口密集度低，气候条件稳定而且总体良好。挪威被全球和平指数榜评为世界上最和平的国家(2007年)。自2001年以来，挪威连续多年被列于联合国人类发展指数榜之榜首，仅在2007/2008年度被冰岛取代而退居第二位。挪威将其GDP的0.92 %用于对外发展援助，这项比例在世界上是最高的。挪威从很多方面都被视为是一个典范，它所代表的福利水平是许多其它国家所孜孜以求的。

The Norwegian way of life is heavily dependent on imported products, from staple food products, “luxury” items such as televisions and cars, and specialized machinery used in industry. With Norway’s heavy dependence on imports, it is reasonable to consider whether reductions of greenhouse gas emissions in Norway will come at the expense of increased emissions outside of Norway through increased imports. Especially since continued economic growth is expected.

Norway’s economic progress is caused in part by the exploitation of oil and gas reserves in the North Sea. Oil revenues constitute 25% of Norway’s GDP and 24% of total investments (2007). As a commodity exporter Norway is projected to see a significant net increase in GDP during the next decades, driven by increased demand caused to a large extent by the economic expansion in China and India. At the same time Norwegian consumer products will remain cheap due to increased production of such imports in low cost countries such as China. This secures Norway a very profitable position in the current world economy.

未来几十年中，由于中国和印度的经济扩张将在相当大的程度上驱动需求的增长，作为商品出口国的挪威的GDP预计也将获得显著的净增长。同时，由于挪威消费的进口产品越来越多地是在中国这样的低成本国家生产的，挪威国内的消费品将仍然保持低廉的价格。这就确保了挪威在目前世界经济中的十分有利的地位。

Norway is a signatory to the Kyoto Protocol. Norway has, nevertheless, seen a growth in CO<sub>2</sub> emissions since signing the protocol. In 2006, Norway’s emissions of CO<sub>2</sub> were 6.8% above its Kyoto commitments (7.8% above 1990-level, as Norway is allowed to increase its emissions to 1% above 1990 levels). Norway is therefore dependent on offsetting emissions through using mechanisms such as the Clean Development Mechanism (CDM) of the Kyoto Protocol. China is considered to be a main country for future Norwegian CDM-investments. The Norwegian Government winter 2007/2008 launched new climate policy goals, stating that Norway will become carbon neutral by 2030 through “significant” domestic reductions and offsetting.

挪威是京都议定书的签约国，但自议定书签署以来，挪威的CO<sub>2</sub>排放却仍然有所提升。2006年的CO<sub>2</sub>排放量比其在京都议定书中的承诺高出6.8个百分点(比1990年提高了7.8%，而挪威的排放量允许在1990年的水平上提升1%)。挪威因而就依赖于利用京都议定书中所规定的清洁发展机制(CDM)等手段来补偿其碳排放。中国被视为挪威未来CDM投资的主要对象国。挪威政府于2007到2008年年间这个冬季出台了新的气候变化应对政策，声明挪威将通过“显著”的国内减排和补偿，在2030年成为一个碳中和国家。

Norway may be a top nation on the UN Human Development Index. Nevertheless, the Norwegian model is fundamentally unsustainable. If every person on the planet is to consume as many natural resources as the average Norwegian does, we will need 3.4 planets like the earth to serve that need. If every country is to emit as much CO<sub>2</sub> per person as Norwegians, global warming will lead to devastating impacts globally – primarily in developing countries.

## CHINA: A HUGE DEVELOPING COUNTRY IN A GLOBAL ECONOMY

The People's Republic of China is the largest country in East Asia and one of the largest countries in the world. With a population of over 1.3 billion, roughly a fifth of the earth's total population, it is the most populous country in the world. It has the world's fourth largest economy and second largest measured using purchasing power parity.

China is a developing country ranking 81 on the UN Human Development Index. The rate of economic development over the last thirty years is unparalleled globally (also historically). Since 1978, China's market-based economic reforms have helped to lift over 400 million Chinese out of poverty, bringing down the poverty rate from 53% of population in 1981 to 8% by 2001 (World Bank 2006). China provides an example for other developing countries.

Because of its vast population, rapidly growing economy, huge research and infrastructure development investments,<sup>vi</sup> the world's growing dependence on low cost Chinese products, and its huge spending on military, China is considered an emerging super-power. However, the Chinese model is faced with challenges, one of the most important being environmental degradation of a severity and scale that possibly is unparalleled globally (also historically). The environmental crisis threatens to undermine the development towards higher welfare levels for the Chinese population.<sup>vii</sup>

With current trends, China's primary energy demand is projected to more than double from 2005 to 2030. The International Energy Agency (IEA) projects that China will become the world's largest energy consumer in 2010. The use of CO<sub>2</sub> intensive coal is expected to grow rapidly and its share of total primary energy demand will, with current trends, stay high - at over 60 % in 2030. China's per-capita emissions will reach current European levels by 2030. China and India alone will account for 56% of the projected global increase of CO<sub>2</sub> emissions 2005-2030, from 27 gigatonnes (Gt) to 42 Gt.

Projected cumulative investments in China's energy-supply infrastructure are estimated to 3.7 trillion year-2006 dollars over the period 2006-2030. This effectively means that how China invests and provides its energy needs over the next decades will to an overwhelming extent determine how mankind will be able to reduce global CO<sub>2</sub> emissions and prevent global warming from triggering the worst future scenarios of the IPCC.

According to the IEA, China overtook the USA as the biggest emitter of CO<sub>2</sub> in 2007. China has ratified the Kyoto Protocol but is not required to reduce carbon emissions because of its status as a developing country and since it historically is the developed nations that have mainly been responsible for the current CO<sub>2</sub> atmospheric concentrations and have the financial and technical ability to mitigate.

Measured on a per-capita basis, CO<sub>2</sub> emissions in China were 3.8-3.9 tonnes in 2005, approximately one third (35%) of those of the OECD (11 tonnes per capita). A recent study estimates that net exports in 2004 accounted for 24% of China's total CO<sub>2</sub> emissions. The IEA estimates that 34% of China's CO<sub>2</sub> emissions stem from production of exports. In 2007, the Chinese government made the point that "countries importing energy-intensive Chinese exports should assume some responsibility for the emissions their manufacture generated".<sup>x</sup>

以人均计算，中国2005年的CO<sub>2</sub>排放量为3.8到3.9吨，大约为经合组织国家（人均11吨）的三分之一（35%）。据近来的一项研究的估算，2004年的净出口造成的CO<sub>2</sub>排放占了中国总排放量的24%。国际能源署估计，中国CO<sub>2</sub>总排放量的34%来自出口制造。2007年中国政府明确指出，“进口中国高能耗产品的国家，应当对这些产品所引起的排放承担一些责任”。

In June of 2007, China unveiled a 62-page climate change plan reiterating China's aim to reduce energy use per unit GDP by 20% in the period 2006-2010 and increase the amount of renewable energy it produces. The Chinese Government promised to put climate change at the heart of its energy policies but also insisted that developed countries had an "unshirkable responsibility" to take the lead on cutting greenhouse gas emissions, referring to the "common but differentiated responsibility" principle agreed on in the UN agreements on climate change. The Chinese government also called for transfer of technology to developing nations, in accordance with Kyoto Protocol commitments commenting that "We have heard a lot of thunder but have yet to see the rain".<sup>xi</sup>

China's predicament illustrates the fact that developing countries will not be able to emulate Western welfare levels using the same development model as the West has. To reach high living standards China must develop and implement more resource and energy effective solutions than OECD-countries currently apply. It is of global interest that China succeeds in this. For one, China has the potential for mass market production of low cost low-carbon technologies that can help OECD countries to reach their CO<sub>2</sub> reduction targets – for instance the production of compact fluorescent lamps, electric cars, or wind turbines. Secondly, the effect of China not succeeding in implementing new low-carbon solutions will be felt globally in the form of escalating global warming.

中国所处的困境说明了，发展中国家如果照搬西方的发展模式，是不可能达到西方国家的福利水平的。为了提高生活水准，中国必须开拓和实施比经合组织国家当前所应用的更具有资源与能源效益的解决方法。中国在这方面的成败与否关系到整个地球。首先是因为，中国具有大量生产低成本低碳技术的潜力，而这些技术可以帮助经合组织国家达到他们自己的CO<sub>2</sub>减排目标，例如节能灯、电动车或风力发电机的生产制造。其次，中国实施新型低碳技术方案如果失败，其效应将加快全球气候变暖而触及整个地球的居民

## 2. NORWEGIAN IMPORTS = CHINESE CO<sub>2</sub> EMISSIONS

### 挪威的进口=中国的碳排放

**NORWAY'S  
CARBON  
FOOTPRINT IS  
GROWING**  
挪威的碳足迹在  
增长

In 2001, Norwegian imports generated 29 million tonnes of CO<sub>2</sub> emissions abroad. Projections for 2006 suggest that the emissions embodied in Norwegian imports increased up to one-third over the next five years, to 39 million tonnes.<sup>xii</sup> Thus, in 2006 more than 8 tonnes of CO<sub>2</sub> was emitted per Norwegian in production of their imports.

2001年，挪威的进口造成了在国外的2900万吨的CO<sub>2</sub>排放。对2006年的预测显示，挪威进口所包含的碳排放在未来五年中的增幅会高达1/3，达到3900万吨。如此计算，则2006年每个挪威人因其所消费的进口产品的制造而排放了8余吨CO<sub>2</sub>。

Norway's domestic CO<sub>2</sub> emissions have remained relatively static from 2001 to 2006, indicating that the emissions embodied in export (36 Mt in 2001) are also relatively static. But Norway's carbon footprint abroad is growing steadily. With current trends, Norway's CO<sub>2</sub> emissions abroad will most likely surpass domestic CO<sub>2</sub> emissions in the near future.

挪威国内的CO<sub>2</sub>排放在2001至2006年这段时间里保持在一个相对稳定的水平上。这也就说明了出口所包含的排放也相对比较稳定(2001年为3600万吨)。但挪威在国外的碳足迹却在稳步增长。如果目前的这种趋势继续下去，则未来几年中挪威在国外的CO<sub>2</sub>排放很有可能超过其国内的CO<sub>2</sub>排放。

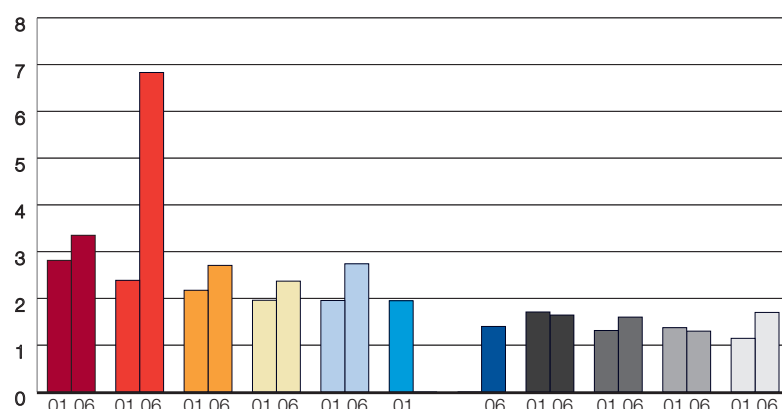
The mass of imports into Norway has grown 10% from 2001 to 2006, while the emissions occurring abroad have grown almost 35%. This is because Norway is increasingly importing products and from countries with comparatively large CO<sub>2</sub> footprints for the production processes in question. Therefore the growth in the CO<sub>2</sub> emissions embodied in imports is greater than the growth in the mass of imports.

从2001年到2006年，挪威的进口量提升了10%，而在国外的排放却增加了35%。这是因为挪威不断扩大进口，并且进口产品越来越多地是来自采用碳足迹相对较大的生产过程的国家。因而，进口所包含的CO<sub>2</sub>排放的增幅要高于进口量本身的增幅。



# TOP TEN COUNTRIES OF NORWAY'S CARBON FOOT-PRINT ABROAD

挪威在国外碳足迹数额最大的十个国家



2001		2006	
俄罗斯	(280万吨, 10%)	俄罗斯	(340万吨, 9%)
中国	(240万吨, 8%)	中国	(680万吨, 17%)
美国	(220万吨, 7%)	美国	(270万吨, 7%)
瑞典	(195万吨, 7%)	瑞典	(240万吨, 6%)
德国	(195万吨, 7%)	德国	(280万吨, 7%)
加拿大	(195万吨, 7%)	波兰	(140万吨, 4%)
英国	(170万吨, 6%)	英国	(160万吨, 4%)
丹麦	(131万吨, 5%)	丹麦	(160万吨, 4%)
芬兰	(140万吨, 4%)	芬兰	(130万吨, 3%)
其它前苏联国家	(110万吨, 3%)	其它前苏联国家	(170万吨, 4%)

Fig. 1: The ten countries where Norwegian imports generate most CO<sub>2</sub> emissions, in 2001 and 2006. Total for 2001 = 29 mt. Total for 2006 = 39 Mt.  
图一：挪威进口产品的生产导致CO<sub>2</sub>排放最多的十个国家，2001年和2006年。2001年排放总量=2900万吨，2006年排放总量=3900万吨。

Figure 1 shows the top 10 countries emitting CO<sub>2</sub> in the production of imports to Norway. Several countries have had a large change in their emissions from 2001 to 2006. What really stands out is that China's contribution almost tripled (increased 180%), from 2.4 to 6.8 Mt CO<sub>2</sub> - 17% of Norway's CO<sub>2</sub> footprint abroad, making it the biggest emitter of CO<sub>2</sub> emissions for imports into Norway. On average every Norwegian has a CO<sub>2</sub> footprint of 1.5 tonnes in China. In contrast, the mass of imports from China to Norway increased only 90% in the same period. This indicates that not only is the volume of imports from China growing, but the import mix is shifting to more CO<sub>2</sub> intensive products (see also below).

图一显示了为挪威生产其进口产品而排放CO<sub>2</sub>最多的十个国家。从2001年到2006年，不少国家的排放量都发生了较大的变化。但真正值得注意的是，中国2006年的排放几乎是2001年的三倍（增幅达180%），即从240万吨攀升到了680万吨。这是挪威在国外碳足迹总额的17%，以此，中国就成了为挪威生产其进口产品而排放CO<sub>2</sub>最多的国家。在中国的挪威人均碳足迹为1.5吨。相比之下，挪威从中国的进口同期增幅仅为90%。这就不仅说明了挪威在扩大从中国的进口，而且进口产品的构成也更倾向于CO<sub>2</sub>高排放产品（见下）。

The CO<sub>2</sub> emissions occurring in the Rest of the Former Soviet Union increased 67%, with Ukraine being the main country. Most other countries in the top 10 increased around 20%: Russia (19%), Germany (40%), USA (25%), Sweden (21%), Denmark (25%), UK (7% decrease).



## NORWAY'S CO<sub>2</sub> FOOTPRINT IN DEVELOPING COUNTRIES AND EMERGING ECONOMIES

挪威在发展中国家和新兴经济体中的碳足迹

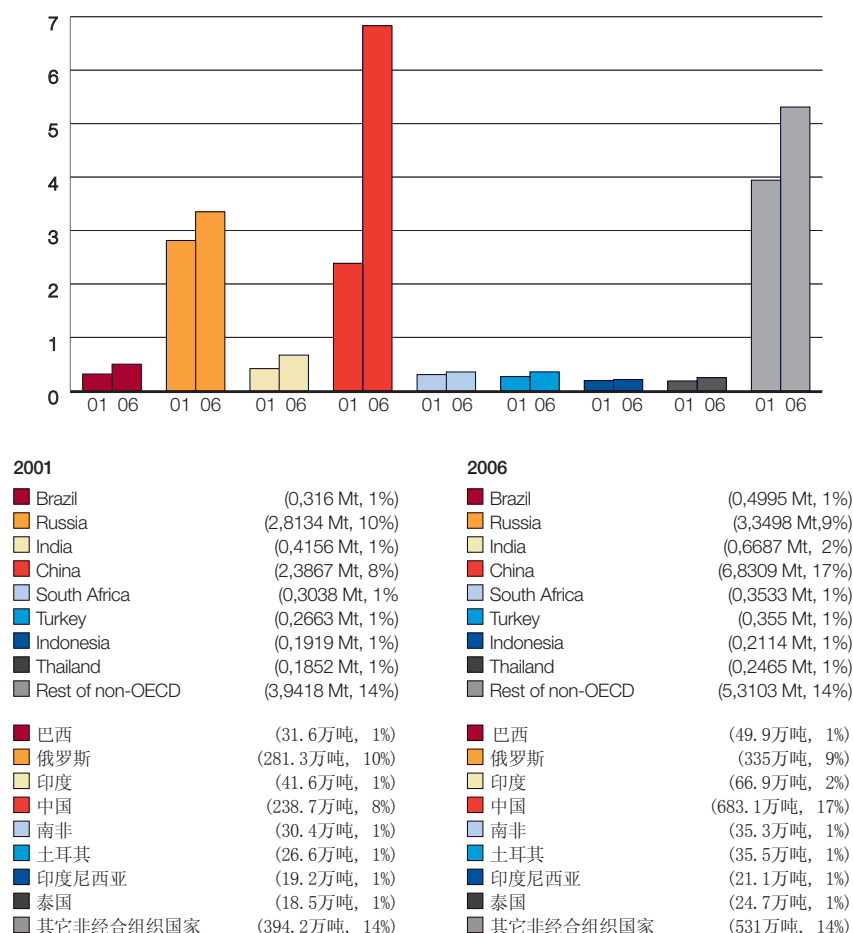


Fig. 2: The developing countries where Norwegian imports generate the most CO<sub>2</sub> emissions, in 2001 and 2006. Total for 2001 = 29 mt. Total for 2006 = 39 Mt.

图二：挪威进口产品的生产导致CO<sub>2</sub>排放最多的发展中国家，2001年和2006年。2001年排放总量=2900万吨，2006年排放总量=3900万吨。

In 2001 about 37% (10.8 million tonnes) of Norway's carbon footprint abroad was in developing countries. By 2006 this had increased to 45% (17.8 million tonnes), equalling one third of Norway's total domestic emissions (54 Mt in 2003) – or almost 4.5 tonnes of CO<sub>2</sub> per Norwegian. This suggests that “carbon leakage” is occurring in Norway, with Norwegians increasingly causing emissions in countries without emission constraints.

2001年，挪威在国外的碳足迹总额的大约37%(1080万吨)是在发展中国家。2006年这个百分比上升到了45%(1780万吨)，而这部分的碳足迹就相当于挪威国内总排放的三分之一(2003年为5400万吨)，平分到每个挪威人身上就几乎是4.5吨CO<sub>2</sub>。这就意味着，由于越来越多地在没有排放限制的国家引起排放，挪威正在发生“碳泄漏”现象。

With current trends Norway will soon have a larger CO<sub>2</sub> footprint in developing countries than in developed ones. Moreover, the trade data shows a shift in trade patterns towards countries and types of products that are more pollution intensive.<sup>xiii</sup> A similar trend has been reported for UK, indicating that this might be a general phenomenon for OECD countries.<sup>xiv</sup>

按目前的这种趋势发展下去，挪威在发展中国家的碳足迹将很快超过在发达国家的碳足迹。不仅如此，有关贸易数据还显示了贸易格局的一种转化，即趋向于污染更为严重的国家和产品种类。据报告，英国也有类似的趋势。这就说明了这种趋势可能是经合组织国家中的一种普遍现象。

## COAL - THE MAIN CULPRIT BEHIND THE SCENES 煤-幕后主凶

The production of products leads to CO<sub>2</sub> emissions, but usually most of the emissions do not occur directly in the factory of production, but further along the supply chain. For instance, sewing together textiles to produce clothing is not necessarily pollution intensive; rather, it is the purchases and production of chemicals, electricity, and so on used in the clothing factory that causes the emissions.

产品制造固然导致CO<sub>2</sub>排放，但大部分的排放并不是在工厂里直接产生的，而是在供应链的其它环节上。例如，将纺织品缝制成服装并不一定会产生很多污染，反而是化学物品、电力等服装厂所需原料和资源的购买及生产造成了排放。

The following figure shows which Chinese industries that emit most CO<sub>2</sub> to produce Norway's imports for 2001.

以下示意图显示了中国的哪些行业在2001年生产出口挪威的产品中CO<sub>2</sub>排放最多。

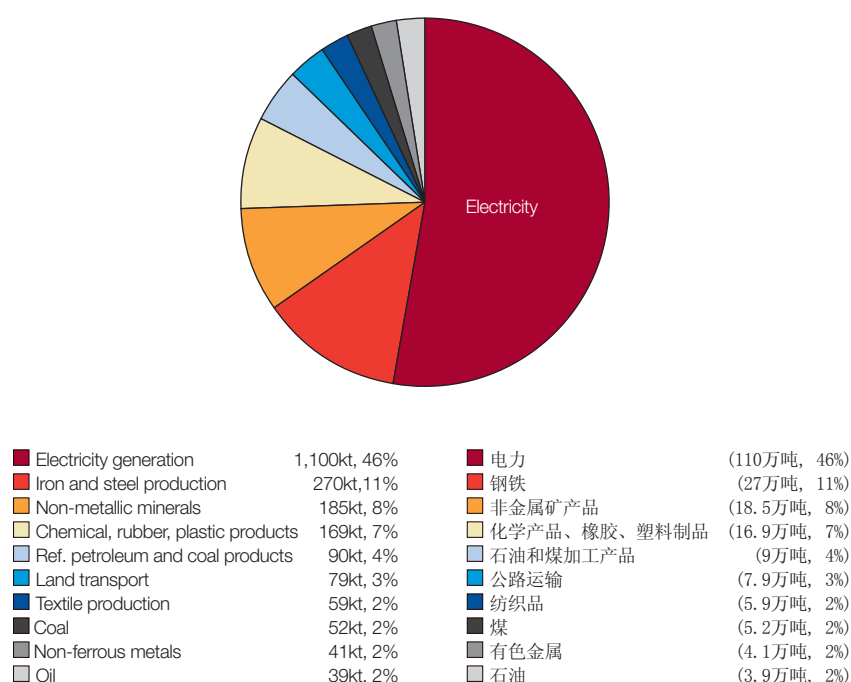


Figure 3: The sectors in China which emit the most CO<sub>2</sub> emissions to produce Norwegian imports (2001).  
图三：中国生产出口挪威的产品中CO<sub>2</sub>排放最多的产业部门（2001年）

Not surprisingly, the inputs of electricity into factories and other industries in the supply chain is the largest cause of CO<sub>2</sub> emissions. Currently, 69% of the energy production in China comes from CO<sub>2</sub>-intensive coal-burning. Presuming that Norway's carbon footprint in China is distributed in a similar manner among sectors in 2006, this effectively means that Norwegian consumption leads to more than 2 million tonnes of CO<sub>2</sub> emissions from coal plants in China annually (6.8 Mt x 0.46 x 0.69 = 2.16 Mt). Following electricity suppliers, we find the various energy intensive industries providing products or materials which have a significant carbon footprint from their own production process.

无需感到惊奇的是，向工厂和供应链上的其它行业输送的电力，是导致CO<sub>2</sub>排放的首要根源。目前，中国69%的能源生产是释放大量CO<sub>2</sub>的燃煤发电。假设2006年挪威在中国各产业部门的碳足迹分布状况基本不变，则挪威的消费每年就造成了中国火电厂的200多万吨的CO<sub>2</sub>排放（680万吨 x 0.46 x 0.69=216万吨）。排在供电行业之后的是提供其它产品或材料的各种高能耗产业，而这些产品或材料在制造过程中也会产生显著的碳足迹。

Thus, while the import of manufactured products drives the emissions in China, it is the electricity and energy intensive industries in China that actually emit the CO<sub>2</sub>. Norway can therefore make a difference by investing in raising environmental standards and

**PUTTING A  
PRICE ON CO<sub>2</sub>  
EMISSIONS  
EMBODIED IN  
IMPORTS**  
为进口所包含的  
CO<sub>2</sub>排放定价

energy-efficiency in Chinese energy intensive industries. Most urgent, is for developed countries to assist China in shifting its electricity mix to a lower carbon intensity.

因此，在挪威进口产品驱动中国CO<sub>2</sub>排放的同时，实际上排放CO<sub>2</sub>的是中国的电力生产和高能耗产业。所以，挪威能够通过在中国的高能耗产业里投资提高环保标准和能效来改变这种局势。头等紧要的是，发达国家能够协助中国实现电力构成向低碳型的转化。

If Norway is to get to the heart of the problem of its CO<sub>2</sub> footprint in China, Norway must invest to help develop “clean coal” technologies and scale-up application of renewable energy solutions that gradually can substitute the use of fossil fuels.

如果挪威要在实质上解决其在中国的碳足迹的问题，则必须投资去帮助中国开发“清洁煤”技术，并推广使用能够逐步替代化石燃料的可再生能源。

As the Chinese Government has pointed out, if OECD imports are responsible for a certain amount of CO<sub>2</sub> emissions in China, then one could argue that the OECD countries in question – such as Norway – has a responsibility for those emissions.

正如中国政府指出的那样，如果经合组织国家的进口对中国CO<sub>2</sub>排放中的一部分负有责任，那么我们就可以推论说，象挪威这样的经合组织国家就对这部分排放负有责任。

One way to develop a systematic approach for Norway to address its carbon footprint in developing countries is to use the average price put on CO<sub>2</sub> emissions in OECD countries to calculate the cost.<sup>xvi</sup> In this way, we obtain a price on the CO<sub>2</sub> emissions an OECD country generates via its imports. In Europe it would be natural to use an estimate of the price for a CO<sub>2</sub>-quota in the EU carbon trading scheme. The Norwegian Pollution Control Authority and the European Commission estimates the CO<sub>2</sub> quota price for 2008 to be approximately 20 Euros (160 NOK), a price that is estimated to rise to 37 Euros by 2020.

挪威要系统性地解决其在发展中国家的碳足迹问题，有一种途径就是，使用经合组织国家里给CO<sub>2</sub>排放所定的平均价格来计算碳费。这样，我们就能获得某个经合组织国家的进口所引起的CO<sub>2</sub>排放的价格。在欧洲，用欧盟碳排放交易机制中的排放配额单位估计价格来计算是很自然的。据挪威污染控制管理局和欧盟委员会的估计，2008年的CO<sub>2</sub>排放配额价格大约为20欧元/吨(160挪威克朗)，而这个价格到2020年预计将上升到37欧元。

Putting a price on Norway's CO<sub>2</sub> footprint in developing countries 2006  
为挪威2006年在发展中国家的碳足迹定价

Country	Amount of CO <sub>2</sub> CO <sub>2</sub> 排放量	Price of Norway's footprint 挪威碳足迹的价格
China 中国	6.8 Mt / 680 万吨	136 Million € / 1.36 亿欧元
Russia 俄罗斯	3.4 Mt / 340 万吨	68 Million € / 6800 万
India 印度	0.7 Mt / 70 万吨	13 Million € / 1300 万
Brazil 巴西	0.5 Mt / 50 万吨	10 Million € / 1000 万
South Africa 南非	0.4 Mt / 40 万吨	7 Million € / 700 万
Turkey 土耳其	0.4 Mt / 40 万吨	7 Million € / 700 万
Thailand 泰国	0.2 Mt / 20 万吨	4 Million € / 400 万
Indonesia 印度尼西亚	0.2 Mt / 20 万吨	4 Million € / 400 万
Developing countries (total) 发展中国家(累计)	17.8 Mt / 1780 万吨	357 Million € / 3.57 亿

Table 2: Putting a price on Norway's CO<sub>2</sub> footprint in developing countries (estimation for 2006).  
表二：为挪威在发展中国家的碳足迹定价(2006年估算)

With this methodology the price of Norway's CO<sub>2</sub> footprint in developing countries was €357 million (ca. 2.9 billion NOK), which is equal to the Norwegian Government's daily revenue from petroleum extraction in 2006 (ca. 2.8 billion NOK).

使用这种方法计算，挪威在发展中国家的碳足迹价格就达到了3.57亿欧元(约29亿挪威克朗)，相当于挪威政府2006年每天的石油开采收入(约28亿挪威克朗)。

More over, such a principle could be applied in all OECD countries' CO<sub>2</sub> footprints in the developing world. In 2001 the CO<sub>2</sub> emissions embodied in all imports into developing countries (Annex B including USA) from developing countries (non-Annex B) was 1585.3 Mt.<sup>xvii</sup> With €20 per tonne this amounts to €31.7 billion euros.

此外，这样的原则也能运用于所有经合组织国家在发展中国家的碳足迹的估算。2001年，发达国家(附录B国家包括美国)从发展中国家(非附录B国家)进口的所有产品所包含的CO<sub>2</sub>排放量为15.853亿吨。以每吨20欧元计算，累计价格就达到了317亿欧元。

A very rough current estimate can be made by extrapolating from the fact Norway's GDP is 0.7% of the OECD total (2006 estimate).<sup>xviii</sup> Presuming that Norway is a typical OECD country, the 2008 price for the OECD CO<sub>2</sub> footprints in the developing countries can very roughly be estimated to lie around €51 billion (357 million = 0.7%, then 51 000 million = 100%).<sup>xix</sup>

以挪威的GDP是经合组织国家GDP总量的0.7% (2006年估计)这一事实为基础，我们就可以做一个非常粗略的现行估算。假设挪威是一个典型的经合组织国家，则经合组织国家2008年在发展中国家的碳足迹价格，可以非常粗略地估算为510亿欧元左右(3.57亿= 0.7%，则510亿=100%)。

The numbers above for Norway's footprint should not be considered fixed, they rather indicate the financial scale of the issue of Norway's (and OECD's) carbon footprint if we apply EU carbon market principles. The estimations of CO<sub>2</sub> embodied in Norwegian imports in 2006 clearly need further refinement. Moreover, a general consensus and well-considered methodology must be developed for how to estimate the CO<sub>2</sub> emissions embodied in imports. Nevertheless, the numbers are interesting as they, in financial terms, indicate the possible scale of the issue of CO<sub>2</sub> embodied in imports.

以上的挪威碳足迹的价格数据不应被当成一个既定的数据，而是给了我们这样一个概念，即如果运用欧盟碳排放交易市场的原则来计算，那么挪威的(和经合组织国家的)碳足迹问题具有多大的经济内涵。对2006年挪威进口中所包含的CO<sub>2</sub>排放的估计数据显然需要调整。不仅如此，就怎样估算进口中所包含的CO<sub>2</sub>排放，还必须达成普遍共识并制定恰当周密的估算方法。即使如此，这些数据仍然值得关注，因为它们从经济角度展示了进口所包含的CO<sub>2</sub>排放这个问题的深度和广度。

# 3. PERSPECTIVES

## 观点

### THE NEED FOR NEW PARTNERSHIPS 建立新的伙伴关系 的必要性

Huge developing nations such as China and India, with one third of the global population, provide not just a challenge for global sustainable development but also an immense opportunity if it is handled correctly. The speed and scale of development, with low production costs combined with enormous investment flows in new infrastructure as well as research and development over the next twenty years, provides an unprecedented opportunity for mass market production and implementation of low-carbon technologies and other sustainable solutions. The very scale could, in fact, transform the global economy, as countries jostle to gain a leading competitive position in the race to be the ones to provide the low carbon, sustainable solutions of the future. It would be a win-win opportunity of enormous magnitude, if the future growth of a country like China could come from developing the solutions that will save the planet.<sup>xx</sup>

中国和印度这样的发展中大国，有着地球上三分之一的人口，这不仅向全球可持续发展提出了挑战，如果予以恰当处理的话，同时也会为此提供巨大的契机。这些国家发展的速度和规模，加上低廉的生产成本与未来二十年中新型基础设施和研发领域的庞大资金的流入，都为低碳技术和其它可持续技术方案的大量生产与采用，提供了前所未有的契机。事实上，仅其规模就足以能促成全球经济的转化，因为世界各国都在为能够率先提供未来的低碳的可持续技术方案而进行角逐。如果象中国这样的国家能够在未来以开拓拯救地球的技术方案为其发展基础，从中获得双赢效应的可能性就是巨大无比的。

With increasing innovation and the incentives of an environmental crisis and climate change vulnerability, China may well become the provider of new solutions and low carbon development paths which, possibly more complacent, OECD countries such as Norway can learn from in their transition towards low carbon development. In the gradual global transition to a low carbon civilisation all economies are transition economies. Norway's and China's starting points are different – but connected.

创新的深入拓宽和环境危机与气候变化危害性所带来的忧患，都会使中国成为新技术方案的供应者，并踏出一条低碳发展的新路径。可能更令人鼓舞的是，这些方案和途径甚至能向挪威这样的经合组织国家在实现其自身的低碳转化中提供借鉴。在向低碳社会的全球性逐步转化中，所有的经济体都是转型经济。尽管挪威和中国的起点不同，却也紧密相关。

### THE CLEAN DEVELOPMENT MECHANISM AND LOW CARBON INNOVATION

The Kyoto Protocol acknowledges that OECD nations have benefited from emitting CO<sub>2</sub> and therefore also must take the lead in reducing emissions. In the developing world CO<sub>2</sub> emissions will likely increase in the short term. Until an agreement can be reached on a global caps for CO<sub>2</sub> emissions, there will be different mechanisms channelling resources from OECD countries to developing countries.

The Clean Development Mechanism (CDM) of the Kyoto Protocol allows Annex B countries (countries with emission obligations under the Kyoto Protocol) to offset CO<sub>2</sub> emissions through investing in CO<sub>2</sub> reducing activities in developing countries. The

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Norwegian Government is relying on this mechanism to reach its goals for reducing CO<sub>2</sub> emissions, with China as a main market. The CDM mechanism typically helps developing countries approach current Western standards in energy efficiency and pollution control. But whilst beneficial, the CDM is not enough to solve the climate change problem. Offsetting through CDM should therefore be accompanied by active promotion of new sustainable low carbon solutions in developing countries.

Current modes of production are too resource and pollution intensive for current levels of global (predominantly Western) consumption to be sustained. It is not, however, necessarily consumption itself that is the problem, but rather what we consume. Norway should work to eliminate trade barriers to environment-friendly goods and services, in national policies and in international frameworks for trade such as EU and the WTO.<sup>xxii</sup> Consumption and trade can be part of the solution, a driver for sustainability, if the right framework is provided.

Trade generally requires transport. Air and road transport are very CO<sub>2</sub> intensive.<sup>xxiii</sup> Life-cycle assessment has shown that this may be an important factor in the overall global warming impact of a traded product, but that it depends on a number of variables, in particular the mode of transport. In fact, (long) transport is in itself not necessarily a good variable for determining a product's carbon footprint. For instance, studies show that New Zealand lamb that is transported to the United Kingdom can actually generate 70% less CO<sub>2</sub> than lamb produced in the UK.<sup>xxiv</sup>

That Norwegian trade embodies large amounts of CO<sub>2</sub> is not an argument against trade. It is primarily an argument for Norwegians to consume less embodied CO<sub>2</sub> (whether in imports or domestic products) and to encourage trade in certain products more than in other products.

即使挪威与他国间的贸易包含着大量的CO<sub>2</sub>排放，这也不能成为反对贸易的理由。这首先证明的是，挪威应当降低包含CO<sub>2</sub>排放的消费（无论是进口产品还是本国产品），并优先鼓励开展某些产品的贸易。

## INVESTING IN LOW CARBON SUSTAINABLE DEVELOPMENT

Investments can perpetuate current practices or it can stimulate innovation. OECD countries like Norway should actively stimulate application of best practises and innovation, particularly in those countries that will be the largest economic powers of the next decades.

The Norwegian Government *Pension Fund – Global* manages about 250 billion €. Managers of large pension funds or similar assets, should generally make low-risk, strategic investments in drivers for sustainable development; the companies and sectors that are aiming to serve the needs of the global population in a low-carbon, sustainable manner. In the 21<sup>st</sup> century it is not enough that so called ethical guidelines for investments (which the Norwegian pension fund has pioneered) helps avoiding or improving the worst of companies in terms of environmental and social standards.



## A CLIMATE VENTURE FUND? 气候风险基金?

The real ethical challenge for OECD countries is to instigate systemic change that can make welfare also in developing countries possible within the limits of the one planet we share and spare billions of people in the third world from the most devastating of the global warming scenarios of the IPCC. Sound and systematic investment in sectors and companies promoting sustainable low carbon development is to invest in long term stability and security that may ensure return on investments for many generations to come.

经合组织国家所面临的实质性的道德挑战，是怎样驱动系统性的变化，在我们所共有的这一个地球的限度内，使福利在发展中国家里也成为现实，并使第三世界的几十亿人民不至于遭受政府间气候变化小组所预测的全球变暖可能造成的最严重的危害。在各个行业和企业进行充分而系统的投资，促进可持续低碳发展，是对长期稳定和安全的一种投资，一种能为未来几代人保障回报的投资。

Without innovation, it will not be possible to reach the UN Millennium Development Goals of ending poverty and securing ecological integrity on the planet. Current modes of production are simply too resource and pollution intensive to be able to provide sustainable welfare and security to mankind as a whole. A country like Norway could annually place an amount equal to the price of its CO<sub>2</sub> footprint in developing countries in a pilot “climate venture capital fund”.

不进行创新，我们就不可能实现联合国千年发展计划中消除贫困和保障地球生态完整性的目标。挪威这样的国家可以设立一项试点性“气候风险基金”，每年拨给相当于其在发展中国家的碳足迹价格的一笔资金。

Like venture capital funds, a climate venture fund will provide capital to high-risk, new, growth businesses, but in this case for companies focussing on scaling up use of existing renewable energy solutions or developing new solutions with potential to transform current non-sustainable practises with sustainable, low carbon ones. The fund could invest globally in what is considered the most promising possibilities, based on the principle that breakthroughs will have a global impact irrespective of where they are made commercially or technologically viable. Return on investments could be reinvested or go to financing the global policy process aimed at developing and upholding a joint, global and equitable approach to climate change.

科研上的突破，无论是在世界上哪个地方得到商业性或技术性应用，都会产生全球性影响。基于这个原则，这项基金可以在全球范围内对最有发展前途的领域或项目进行投资。投资的回报可用于再投资，或用来资助全球性的政策调整，以在应对气候变化的努力中，达到开拓和坚持共同的、全球性的和公平的发展途径的目的。



## 4. FIVE RECOMMENDATIONS TO THE NORWEGIAN GOVERNMENT

WWF encourages the Norwegian Government to take the lead in all fields related to ensuring low carbon development. In particular, the Norway-China relationship should become a driver for mutual low carbon development. If that potential can be released, chances increase for Norway as well as China to become winner's in the future low carbon economy.

1. Norway should collaborate in developing an internationally applicable methodology for measuring its CO<sub>2</sub> footprint in developing countries and methods for putting a cost on such a footprint.
2. Norway should mainstream promotion of low carbon development in aid and trade policies, actively exploring "climate smart" relationships that can ensure increased welfare as well as low carbon development in developing countries.
3. Norway should introduce "ethical guidelines of the 21st century" for the Norwegian Pension Fund – Global, introducing positive filtration ensuring systematic and strategic low-risk investment in companies and sectors aiming to serve the needs of the global population in a low-carbon, sustainable manner, particularly in emerging economies. Such guidelines can be presented to the Norwegian Parliament spring 2009, as an outcome of the evaluation of existing guidelines to take place in 2008.
4. Norway should over the state budget annually place an amount equal to the cost of its CO<sub>2</sub> footprint in developing countries – for 2006 an estimated €357 million – in a pilot climate venture capital fund providing risk capital to new companies focussing on providing low carbon solutions, in order to stimulate the innovation needed to reach Millennium Development Goals of securing ecological integrity and ending poverty.
5. Norway should encourage all developed countries to estimate their CO<sub>2</sub> footprints in developing countries and their cost and annually place an equal amount – for 2006 roughly estimated to €51 billion – in mechanisms aimed at developing low carbon and high efficiency technologies in these countries.

The quantification in this report should also contribute to a more factual debate about the responsibility of different countries in a post-2012 global climate regime.

## 5. SUMMARY OF FINDINGS

### 研究结论摘要

- Trade data indicate a shift in trade towards countries and types of products that are more pollution intensive. Norway's increasing emissions associated with imports from countries without emission constraints is an example of unchecked carbon leakage.

有关数据显示，国际贸易的重心正在倾向污染程度较高的国家和产品种类。挪威从没有排放限制国家进口的产品所包含的排放量的增加，是一个碳泄漏失控的具体例证。

- While Norway's CO<sub>2</sub> emissions remain fairly stable at 55-57 Mt per year, Norway's carbon footprint abroad is growing fast (33% 2001-2006, to 39 Mt) and will in the near future likely surpass domestic emissions. Promised future reductions of CO<sub>2</sub> emissions in Norway may thus be outweighed by increased emissions abroad through increased imports - especially since increased growth is expected.

挪威本土的CO<sub>2</sub>排放每年都均稳地保持在5500-5700万吨，但在国外的碳足迹却在迅速增加(2001-2006年间增幅为33%，达到3900万吨)，并将在不远的未来超过国内排放。由此，挪威政府承诺的未来减排量可能会被扩大进口而提高的国外排放所抵消，尤其是因为进口预计还会扩大。

- Norway's CO<sub>2</sub> footprint in developing countries increased 65% from 2001 to 2006: In 2001 about 37% (11 million tonnes) of Norway's carbon footprint was in developing countries. By 2006 this had increased to 45% (18 Mt) of the total footprint abroad.

从2001年到2006年，挪威在发展中国家的碳足迹增加了65%。2001年，挪威碳足迹总数额的37%(1100万吨)是在发展中国家，而2006年，这个比份已经攀升到了45%(1800万吨)。

- Norway's carbon footprint in countries receiving direct Norwegian development aid doubled 2001-2006, reaching 10 Mt. This is more than Norwegian CO<sub>2</sub> emissions from domestic road traffic (9.6 Mt in 2005). Norway's CO<sub>2</sub> footprint in India is equal to the CO<sub>2</sub> emissions for non-electric heating of Norwegian households (0.7 Mt 2005).

从2001年到2006年，在直接接受挪威发展援助的国家里，挪威的碳足迹总额翻了一翻，达到了1000万吨，超出了挪威国内道路交通的CO<sub>2</sub>排放量(2005年为960万吨)。挪威在印度的碳足迹相当于所有挪威家庭非电热取暖所排放的CO<sub>2</sub>的总量(2005年为70万吨)。

- China is the developing country where Norway's carbon footprint is largest and increasing most rapidly, almost tripling from 2.4 Mt in 2001 to 6.8 Mt in 2006. On average every Norwegian causes emissions of ca. 1.5 tonnes of CO<sub>2</sub> in China.

挪威在中国的碳足迹是其在所有发展中国家数额最大、增速最快的，已从2001年的240万吨攀升到2006年的690万吨，增幅达到将近两倍。平均每个挪威人在中国造成了约1.5吨的CO<sub>2</sub>排放。

- The mass of imports from China to Norway increased 90% 2001-2006 with the import mix of products shifting to more CO<sub>2</sub> intensive products. (The import of products such as machinery, electric appliances, computers and office equipment increased more than the import of less CO<sub>2</sub> intensive products such as clothing.)

从2001年到2006年，挪威从中国进口的总量提高了90%，而且进口产品构成逐步趋向于高排放产品（机械、电器、电脑和办公设备的进口增幅大于排放较低的产品，如服装的进口增幅。）

- Norwegian consumption is leading to more than 2 million tonnes of annual CO<sub>2</sub> emissions from coal fired power plants in China: In China almost half (46%) of the CO<sub>2</sub> emissions from producing Norwegian imports came from electricity generation of which about 70% stems from coal fired power plants.

挪威的消费引起了中国火电站每年200多万吨的CO<sub>2</sub>排放：中国生产出口挪威的产品所造成的CO<sub>2</sub>排放近乎有一半（46%）来自电力生产，而70%的电力来自火电站。

- By putting a price on Norway's carbon footprint in developing countries using an estimated EU carbon market price of €20 per ton, the price of Norway's footprint in 2006 can be estimated to €357 million. (The Norwegian Government's daily revenue from petroleum extraction in 2006 was ca. €350 million.)

用欧盟碳排放交易市场的估计价格20欧元/吨为基准来为挪威在发展中国家的碳足迹定价的话，则挪威2006年的碳足迹价格可被估算为3.57亿欧元。（2006年挪威政府每天的石油开采收入约为3.5亿欧元。）

- The price of Norway's carbon footprint in main developing countries: China (€136 million), India (€13 million), Brazil (€10 million), South Africa (€7 million), and Indonesia (€4 million).

挪威在主要发展中国家的碳足迹的价格：中国1.36亿欧元，印度1300万欧元，巴西1000万欧元，南非700万欧元，印度尼西亚400万欧元。

- Presuming that Norway is an average OECD-country, the price of the OECD CO<sub>2</sub> footprints in developing countries is very roughly estimated to €51 billion (extrapolating from the fact that Norwegian GDP is 0.7% of OECD GDP).

假设挪威是一个普通的经合组织国家，则经合组织国家在发展中国家的碳足迹价格可以非常粗略地估算为510亿欧元（根据挪威的GDP是经合组织国家GDP总量的0.7%这一事实进行推算）。

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<sup>i</sup> Source: European data from Eurostat Environmental Accounts (NAMEA data). China and India from Climate Analysis Indicators Tool (CAIT) Version 5.0. (Washington, DC: World Resources Institute, 2008, [cait.wri.org](http://cait.wri.org)).

<sup>ii</sup> As for monetary trade data, it is tempting to consider a CO<sub>2</sub> balance of exports minus imports. As an example, the CO<sub>2</sub> balance for Norway in 2001 is 36-29=7 Mt, that is, Norway has net CO<sub>2</sub> "exports" of 7 Mt CO<sub>2</sub>. In this study we have not focused on the CO<sub>2</sub> trade balance as it can be misleading since it may in certain cases cloud the issue of addressing "carbon leakage" - that a country's national CO<sub>2</sub> emission reductions are accompanied by increased emissions in other countries. A large exporter of CO<sub>2</sub> intensive products could import lots of CO<sub>2</sub> and still end up as a net exporter of CO<sub>2</sub>. Norway is, in fact, precisely such a country. The CO<sub>2</sub> embodied in Norwegian exports stem largely from CO<sub>2</sub> intensive production of oil and gas and international shipping. As we have seen, Norway's net export of CO<sub>2</sub> in 2001 was 7 Mt. This does not, however, mean that Norway does not have a problem with carbon leakage in its efforts to reduce CO<sub>2</sub> emissions. Rather, it illustrates that Norway in addition faces a challenge in its export sectors when adapting to a future low carbon economy. Likewise, it would be natural for small countries with small resource bases, such as Japan, to be net importers of pollution.

<sup>iv</sup> Living Planet Report 2006 (WWF, Global Footprint Network, Zoological Society of London). In 2003 the bio capacity of the world is estimated to be 11.2 billion global hectares. This year, Norwegians consumed 5.8 per person, far above the 1.8 global hectares per person that would be sustainable globally. For the +2 billion people living in China and India consuming like Norwegians we would need more than 11.6 billion global hectares.

<sup>v</sup> China provided approximately 1.3 % of GDP for R&D, €102 billion. (Overtaking Japan, being third after USA (ca. €248 billion) and EU-25 (1.9% of GDP, some €195 billion, in 2004). (Source: OECD 2006). Projected cumulative investments in China's energy-supply infrastructure is estimated to 3.7 trillion year-2006 dollars over the period 2006-2030, three quarters of which goes to the power sector (World Energy Outlook 2007).

<sup>vi</sup> Pan Yue, number one deputy director of the State Environmental Protection Agency (SEPA) became world famous for his statement "The [economic] miracle will end soon because the environment can not keep pace." (New Statesman, December 2006). See also Elizabeth Economy's analysis in Foreign Affairs Sept/Oct 2007: "The Great Leap Backward?".

<sup>vii</sup> All numbers in these paragraphs are from the International Energy Agency: World Energy Outlook 2007.

<sup>ix</sup> Peters, G.P. & Hertwich, E.G., CO<sub>2</sub> Embodied in International Trade with Implications for Global Climate Policy, Environmental Science and Technology, 2008. Forthcoming.

<sup>x</sup> Quoting Mr. Ma, chairman of the National Development and Reform Commission (the chief economic planning agency that also handles climate change). Financial Times (2007): "China puts growth ahead of climate change <<http://www.ft.com/cms/s/34ef96a2-1258-11dc-a475-000b5df10621.html>> ", June 4, 2007.

<sup>xi</sup> Quoting Mr. Ma, chairman of the National Development and Reform Commission. Source: "China urges rich nations to lead on climate <<http://www.ft.com/cms/s/34ef96a2-1258-11dc-a475-000b5df10621.html>> ", Financial Times <[http://en.wikipedia.org/wiki/Financial\\_Times](http://en.wikipedia.org/wiki/Financial_Times)> ", June 4, 2007. (The same quote also figures in the article above.)

<sup>xii</sup> Caution should be exercised with the projections for 2006 (ref. appendix with methodology). The projections assume that the production technologies and efficiencies have not improved between 2001 and 2006. This is a strong assumption; however, put in context, there are some advantages of using this assumption. The sector and region specific emission intensities are essentially used to weight the trade data to determine the emissions embodied in trade. Our assumption, essentially assumes that the emission intensity in each country and industry improves at the same rate, which is much weaker assumption. As a consequence of our assumption, when we consider the pie charts in the report, the percentages (location of import) are more reliable than the absolute emissions for 2006.

<sup>xiii</sup> The projections from 2001 to 2006 are based on the trade flows weighted by the region and sector specific emission intensities. The projections assume that the emission intensities are constant at 2001 values. When considering the distribution of emissions between countries this assumption allows the emission intensities to change as long as the changes are uniform in each sector and region. For instance, if the difference between the emission intensity was a factor 2 between clothes and manufacturing in 2001, then we assume that it is still 2 in 2006. Likewise, if production in China is 5 times as emission intensive than Japan in 2001, then we assume the same in 2006. Thus, if the total imports from China increased by 10%, but the emissions embodied in imports increased 50%, then this would mean that relatively more pollution intensive products were imported. Likewise, if the total imports into Norway increase 10%, but in the projections the emissions increase by 40%, then this shows that the import mix is more pollution intensive either by changes in the product mix or the country that produced the imports.

<sup>xiv</sup> In their study "Too Good To Be True. The UK's Climate Change Record", Dieter Helm, Robin Smale and Jonathan Phillips note that "The UK has an increasing propensity to import from more greenhouse gas-intensive economies. In 1992, 15% of imports to the UK (in value terms) came from countries with higher than the world average greenhouse gas intensity, and these imports accounted for 45% of greenhouse gas imports. In 2006, 25% of imports came from countries with higher than the world average greenhouse gas intensity, accounting for 64% of greenhouse gas imports." (2007: p. 21).

<sup>xv</sup> On the other side, one could argue that CO<sub>2</sub> embodied in Norwegian exports to the developing country in question should be subtracted from this. That would be reasonable on a level playing field. In this case, however, developed nations such as Norway are committed to caps on national emissions under the Kyoto Protocol, while developing nations are not since they have urgent development needs and historically have a small share in creating the global warming problem. In Kyoto Norway acknowledged responsibility and targets for reducing its national emissions, while recognizing the need of developing countries for support in tackling the climate change challenge. In line with this, we don't subtract emissions embodied in Norwegian exports to developing countries. (Ref. also footnote 2 above.)

<sup>xvi</sup> Peters, G.P. & Hertwich, E.G., CO<sub>2</sub> Embodied in International Trade with Implications for Global Climate Policy, Environmental Science and Technology, 2008. Forthcoming.

<sup>xvii</sup> Ref. "OECD in figures 2007".

<sup>xviii</sup> The carbon footprint estimates for OECD in developing countries may be seen in context with the Stern Review's estimates of the need for increased public spending on technology policies (from research and development to demonstration and early deployment). The Stern Review argues that the scale of existing deployment incentives worldwide, particularly to support the market for early-stage technologies in electricity generation, should increase two to five times, from the current level of around \$34 billion per annum, in order to effectively counter climate change. Stern, N. (2006): "Stern Review: The Economics of Climate Change", HM Treasury, UK.

<sup>xix</sup> The two last sentences are paraphrasing James Martin, founder of the James Martin 21st-Century School at the University of Oxford: "The Meaning of the 21st Century", Transworld Publishers 2007.

<sup>xx</sup> For a good overview of EU-China interdependencies and opportunities in the field of trade, energy and climate policy, see Chatham House (2007): "EU-China Interdependencies, Energy and Climate Security. Roundtable 1 December 2006."

<sup>xxi</sup> Note that the GTAP database does not allocate emissions occurring in transport to sectors and countries in a consistent manner. While the study includes CO<sub>2</sub> emissions from all forms of transportation, there is no guarantee that the emissions are correctly allocated to products or countries.

<sup>xxii</sup> Caroline Saunders, Andrew Barber, Greg Taylor: "Food miles – Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry, AERU Research Report 285/July 2006, Lincoln University.



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