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Facilitating Trade  
in Selected Climate Change  
Mitigation Technologies  
in the Energy Supply,  
Buildings, and Industry  
Sectors

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**FACILITATING TRADE IN SELECTED CLIMATE CHANGE MITIGATION TECHNOLOGIES IN  
THE ENERGY SUPPLY, BUILDINGS, AND INDUSTRY SECTORS**

**OECD Trade and Environment Working Paper No. 2009-02**

**by Ronald Steenblik and Joy Aeree Kim**

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## Abstract

It is in every country's interest that the deployment of carbon-change-mitigation technologies (CCMTs) be accomplished at the lowest possible cost to society and that their diffusion be rapid. Reducing barriers to trade is one way to accomplish that, especially given that it is unlikely that every country will become proficient in the production of every CCMT. This study provides a preliminary assessment of the significance of tariff and non-tariff barriers to trade in a representative selection of CCMTs chosen from among those that have been identified by the IPCC and the IEA as having a large economic potential for mitigation, are globally traded, and can be easily adapted to national circumstances. Those examined in the report include: (a) technologies, such as gas-fired reciprocating engines, used in the co-production of both process (or district) heat and electric power (CHP); (b) technologies, such as pipes and meters, used in the production and delivery of heating and cooling at the scale of a city district (DHC); (c) technologies that harness solar energy to heat water or heat or cool the air in buildings (SHC); and (d) relatively energy-efficient electric motors and related systems. The study finds that trade in CCMTs faces higher tariffs in some non-OECD countries than in OECD countries. Judging from information provided by exporters in response to a questionnaire, non-tariff measures are common, and in some countries are acting as barriers to trade. Overcoming some of the general measures that impede trade will take time. However, the problems that lax enforcement of intellectual property rights, cumbersome customs-clearance procedures and non-transparent government procurement create for trade in CCTMs should be regarded as providing additional reasons for importing countries to address these issues urgently. Finally, importers may need, at the same time, to examine their domestic policies in order to address behind-the-border impediments to the diffusion of CCMT technologies.

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- *District heating and cooling systems*: Robert Burzynski (Building Research Establishment Ltd)
- *Solar heating and cooling systems*: David Forward (Building Research Establishment Ltd)
- *Energy-efficient electric motor systems*: Conrad U. Brunner (A+B International)

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## **FACILITATING TRADE IN SELECTED CLIMATE CHANGE MITIGATION TECHNOLOGIES IN THE ENERGY SUPPLY, BUILDINGS, AND INDUSTRY SECTORS**

### **EXECUTIVE SUMMARY**

Various analyses, including those conducted by the Inter-governmental Panel on Climate Change (IPCC) and the International Energy Agency (IEA) have found that the greatest economic potential for global mitigation of gases that contribute to climate change exists in the energy supply, buildings and heavy industry. The large mitigation potential derives from both the enormous amount of fossil energy consumed by these sectors, and the expanding list of technologies that can increase the efficiency of energy use or substitute other, non-fossil energy for fossil fuels. The IEA (2008) finds that in 2050, with moderately optimistic assumptions about the diffusion of technologies, reductions in greenhouse gases of 33% could be achieved in the buildings and appliances sector (compared with a business-as-usual scenario), and somewhat smaller reductions from electricity and heat plants (28%) and industry (19%). Many of these technologies are already sold commercially and enter international trade.

Given the scale of effort that would be required to reduce or stabilize global emissions of greenhouse gases (GHGs), it is in every country's interest that the deployment of climate-change-mitigation technology (CCMT) technologies be accomplished at the lowest possible cost to society. It is unlikely that every country will become proficient in the production of every CCMT, hence keeping costs down means for many countries reducing barriers to trade. The sooner barriers to the diffusion of CCMT technologies are reduced, the better, if the world is to avoid locking in inefficient technologies. In respect if buildings in particular, once investments are made, they determine energy use for decades.

The purpose of this study is to provide a preliminary assessment of the significance of tariff and non-tariff barriers to such trade, considering a representative selection of CCMTs chosen from among those that have been identified as having a large economic potential for mitigation, are globally traded, and can be used in most countries (i.e., easily adapted to national circumstances).

- technologies, such as gas-fired reciprocating engines, used in the co-production of both process (or district) heat and electric power (CHP);
- technologies, such as pipes and meters, used in the production and delivery of heating and cooling at the scale of a city district (DHC);
- technologies that harness solar energy to heat water or heat or cool the air in buildings (SHC);
- relatively energy-efficient electric motors and related systems.

CHP is a mature technology, in the sense that it has been used for decades, though innovations keep improving its thermal efficiency and reliability. With the rise in prices for fossil fuels in recent years, however, CHP has seen a resurgence in popularity. In 2005 CHP plants accounted for less than 7.5% of the world's electric generating capacity, but they accounted for 20% to 25% of its new capacity. Several European countries have already attained CHP shares of 30% or more, suggesting an enormous potential for growth elsewhere in the world.

One of the main uses of the heat generated by CHP plants is district heat, but not all district-heating plants are CHP plants. District heating, like CHP, is also a mature technology, and is also likely to expand in response to rising prices for natural gas, as total system efficiency of district heating is considerably greater than for heating provided by a large number of individual heating units. The advent of district cooling (or combined heating and cooling plants) is a more recent phenomenon, but represents a fast-growing market, particularly in climates with hot summers.

Whereas DHC is generally applied at the multi-building scale, solar heating and cooling (SHC) is typically tailored to the needs of specific buildings. The market for SHC has so far been strongly influenced by government policies, particularly subsidies for the initial installation of SHC equipment. The largest national markets are currently China, Japan, the United States, Germany and Spain. As costs of fossil energy rise, and the costs of manufacturing SHC systems falls, however, the potential global market for SHC systems should expand exponentially.

Electric motors are ubiquitous in industrialized and industrializing countries -- they are, literally, what drives the manufacturing sector. The energy required to power electric motors and connected equipment accounts for some 70% of electricity consumption in industry. Improving the efficiency of electric motors should therefore make a significant dent in the world's electricity demand, and consequently in the primary energy used to generate that electricity. Such improvements have been steady over time, encouraged in many countries by progressively stringent minimum energy performance standards, or MEPS. The most-efficient motors now being manufactured consume 20% less electricity than motors with the same rated output would have required a decade ago.

The study looks at both tariff and non-tariff measures (NTMs) affecting trade in these selected technologies. Information on tariffs is readily available from several public sources. These show that the applied MFN (most-favoured nation) tariffs on goods associated with heating and cooling systems are generally low in OECD countries, but vary considerably among non-OECD countries. Tariffs on solar thermal panels are particularly high in Brazil (20%) and China (35%). Some countries, like Japan and South Africa, apply zero tariffs to a large number of manufactured products.

To assess the nature and importance of NTMs, several experts with specialized knowledge of the sector were engaged to survey a small sample of equipment exporters. These exporters were asked, in the first instance, to respond to a questionnaire on NTMs prepared by the OECD Secretariat. For most of the technology groups, at least three companies responded in detail. Several of these respondents were then contacted by telephone for follow-up interviews.

Because of the small sample size, and the largely qualitative (and unverifiable) nature of the responses, the results of these surveys should be treated only as indicative. Nevertheless, they do suggest that NTMs are hindering trade in some CCMTs, and that the importance of those NTMs are greater for some countries than for others. Among the most common NTMs cited by the respondents were technical regulations applied by the importing country that differed from international standards. Producing to different standards adds to manufacturing costs, but also often requires undertaking additional testing to demonstrate conformity to the standards. In the case of some power-generation technologies, differences in the ways that countries measured thermal efficiency are a particular issue for CHP.

DHC systems are often owned and operated by government entities, and thus the lack of transparency of bidding procedures when government procurement is involved is an issue in some countries. More generally, the impression of some exporters was that preference was being given to domestic suppliers.

These findings are consistent with earlier OECD work on perceived trade barriers to environmental goods more generally, which found that the most important impediments to trade and investment are



technology-specific. Nonetheless, a number of exporters also mentioned NTMs that are not technology-specific. Perhaps the most common complaint was the inadequacy of systems for protecting intellectual property rights (IPRs) in some major importing countries. Where this is the case, counterfeit copies of goods (including computer software) manufactured by the exporter are often tolerated by the national authorities, and enforcement of violations is weak. Their concern over this problem was so great that several companies said that they were refusing to sell certain technologies in the problematic countries.

Border measures that affect the ability of companies to carry out after-sales service quickly and at least cost were mentioned explicitly by manufacturers of CHP systems, but probably apply equally to manufacturers of many other technologies. A common complaint included the high cost of obtaining temporary visas for specialist technicians. Other NTMs that the companies reported encountering, such as lengthy customs-clearance procedures, were considered to be occasionally important but more generally in the nature of a nuisance.

The measures that importing nations could take to address the technology-specific barriers include reducing or eliminating tariffs on CCTMs, and aligning their technical regulations with international standards. The latter action may not always be simple or possible, however, if no dominant international standard exists. Thus there may be a role for international co-operation on harmonizing standards for particular technologies, and negotiating mutual-recognition agreements for testing results.

Overcoming some of the general measures that impede trade will take time. However, the problems that lax IPR enforcement, cumbersome customs-clearance procedures and non-transparent government procurement create for trade in CCTMs should be regarded as providing yet another reason for addressing them urgently.

Finally, importers may need, at the same time, to examine their domestic policies in order to address behind-the-border impediments to the diffusion of the aforementioned technologies. This would include undertaking reforms in electricity markets. Ending rules that discriminate in favour of centralised, large-scale power production is often the most important step necessary to encouraging the spread of CHP, for example. For other technologies, overcoming information barriers may be what is most needed.

## INTRODUCTION

According to the IPCC's *Fourth Assessment Report (2007)*, a large number of technologies already exist with a good economic potential to mitigate the emission of greenhouse gases associated with energy used in buildings, industry and electric power production. For example, greater use of layered insulating glass windows, district heating and cooling, and solar heating and cooling could considerably reduce CO<sub>2</sub> emissions from buildings, and, in addition, save money. Reductions in energy use of up to 70% are possible in new buildings (IEA, 2006). A huge potential to reduce energy demand and CO<sub>2</sub> emissions exists also in the industrial sector through improving the efficiency of motors, pumps, boilers and heating systems; increasing energy recovery in materials-production processes; using materials more efficiently and increasing the rate of recycling of used materials; adopting new and more-advanced processes and materials, and switching to cleaner fuels. The economic potential in the industrial sector is greatest in energy-intensive industries, such as petrochemicals, pulp and paper, metals, and cement manufacturing. Some power-generation technologies, such as combined heat and power (CHP) systems or combined-cycle natural gas turbines, also provide opportunities to achieve substantial reductions in greenhouse-gas emissions through improved thermal efficiency (IEA, 2006; IEA, 2007; IPCC, 2007).

International trade and investment in the aforementioned technologies are hindered by various impediments, however. A fundamental problem in many developing countries is a lack of supporting and legal institutions and frameworks, including standards and procedures for evaluating environmental technologies (USTR, 2006). Trade-related barriers are also common. Among the traditional trade barriers are tariffs and other border charges.<sup>1</sup> Non-tariff measures include excessive and non-transparent state intervention in energy markets, cumbersome trade-documentation systems, product standards that differ from international norms, and complex certification requirements.

Tariffs are, by their nature, technology-specific. In the case of non-agricultural (i.e., industrial) tariffs, which are what are of main importance in respect of climate-change mitigation technologies, applied tariffs are generally low in most OECD countries: often zero, and almost always less than 10%. In the case of some of the major developing countries, tariffs vary considerably. South Africa, for example, applies a zero tariff on most of the climate-change-mitigation technologies (CCMTs) listed in Table 1. Brazil, by contrast, levies tariffs of between 14% and 20%. Both Brazil and China levy an MFN (most-favoured nation) tariff on solar water heaters that is higher than their average industrial tariff. China's, for example, is 35%. Generally, however, it would appear that tariffs on these selected goods are higher than the country's average industrial tariff in Brazil (14%) and lower than the countries' average industrial tariffs in South Africa (8%), China (10%) and India (29%).

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<sup>1</sup> These include *document taxes* (taxes that are paid as a percentage of the value of the transaction engaged in under the document being taxed) and various user fees, cost reimbursements, storage fees, and similar payments ostensibly meant to offset costs incurred by the importing government in order to service importation. Not all countries levy these charges on imports.

Table 1. Applied MFN tariffs levied by selected OECD and non-OECD economies on selected goods relevant to climate-change mitigation

(percentage ad valorem)

HS code	Description	Technologies <sup>2</sup>	Canada	EU	Japan	Korea	USA <sup>1</sup>	Brazil	Russia	India	China	South Africa	Saudi Arabia
<b>3917</b>	Tubes, pipes and hoses, and fittings therefor (for example, joints, elbows, flanges), of plastics	CHP, DHC, SHC	6.5	6.5	4.6–5.8	6.5	3.1–6.5	16	10	10	6.5–10	0–15	5–15
<b>8403</b>	Central heating boilers other than those of heading 8402	CHP, DHC	7	2.7	0	8	0	14–18	15	7.5	10	0	5
<b>8406</b>	Steam turbines and other vapour turbines	CHP, DHC	0–9.5	2.7	0	5	0–6.7	14	15	7.5	5–6	0	5
<b>8407</b>	Spark-ignition reciprocating or rotary internal combustion piston	CHP	0–6	2.7–4.2	0	8	0	18	10	7.5	10	0	5
<b>8408</b>	Compression-ignition internal combustion piston engines (diesel or semi-diesel engines) – [other than for marine or vehicle propulsion]	CHP, DHC	0	4.2	0	4–8	0–2.5	18	5–10	7.5	5–8.4	0–15	5
<b>8419.11 ex</b>	Instantaneous or storage heaters, non-electric [and non-gas]	SHC	6.5	2.6	0	8	0	20	0	7.5–10	35	0–15	5
<b>8419.50</b>	Heat-exchange units	CHP, DHC, SHC	0	1.7	0	8	0–4.2	14	0	7.5	10	0	5
<b>8501</b>	Electric motors and parts	EEM	0–9	2.7	0	0–8	2.4–6.7	14–18	0–15	7.5	5–12	0–20	5

1. Generally, tariffs for the United States are expressed as a percentage of f.o.b. value.

2. CHP= combined heat and power; DHC = district heating and cooling; SHC = solar heating and cooling; EEM = energy-efficient motors.

Note: text in square brackets is not part of the official HS description.

Source: • **EU:** TARIC database; • **all other countries:** European Commission, "Applied Tariffs Database", <http://mkacddb.eu.int/mkacddb2/indexPubli.htm> (data are for beginning of 2008).

The OECD (Tébar Less, 2006) and the World Bank (Mani et al., 2007) have shown that identifying and addressing non-tariff measures (NTMs) affecting trade in specific climate-mitigation technologies could help promote their diffusion as well.<sup>2</sup> These include technical regulations that diverge substantially from international standards, weak intellectual property-rights regimes, and restrictions on foreign investments. Some non-tariff measures, such as production subsidies, can of course stimulate the adoption of particular technologies; but if they discriminate in favour of domestic producers, trade in more-advanced technologies may be hindered (OECD, 2005).

Trade barriers relate not only to the movements of the goods themselves. Technologies are not just bundles of machinery or equipment — i.e., “hardware” — but total systems that also include “software”, in particular the know-how, skills, and services associated with installing and operating them (OECD, 2001). Thus business practices, organisational and institutional arrangements, and policies affecting foreign investment and trade in services, can also profoundly affect the market for particular technologies. Among the non-trade measures that hinder the diffusion of these technologies, therefore, are insufficient domestic regulations (especially environmental regulations) and weak institutional capacity within the importing nations. In short, successful deployment of climate-change-mitigation technologies hinges on addressing both supply-side (technology-specific and general trade barriers), and demand-side (regulations and investment incentives) measures.

### Scope and Methodology

The purpose of this paper is to investigate technology-specific measures that impede trade in selected climate-change-mitigation technologies, and to identify ways to overcome such barriers. Drawing on surveys of actual exporters, the paper examines four technologies in three sectors where some of the greatest economic potential<sup>3</sup> for global mitigation exists: energy supply, buildings and industry. The objectives of the paper are to:

- Analyse market trends of the selected climate-change-mitigation technologies in the energy supply, buildings and industry sectors.
- Identify technology-specific tariff and non-tariff measures.
- Identify measures to facilitate trade in and use of the selected technologies.

<sup>2</sup> A distinction is sometimes made between non-tariff measures (NTMs) and non-tariff barriers (NTBs). NTMs refer to government measures of a regulatory nature that may or may not have trade effects; and, if they do, these effects may or may not be intentional or necessary for achieving the measures’ principal objectives. The term is intended to be neutral by recognising that governments are free to set regulatory policies to serve legitimate social, environmental and other goals. NTBs” refer to specific NTMs that have or are perceived to have trade-restrictive effects. In surveying manufacturers, firms were initially asked to indicate whether, and to what degree, any of 19 listed areas or categories of NTMs posed obstacles to their exports (i.e. could be considered to be NTBs). Such an NTB is thus a specific measure, policy, conduct or procedural aspect thereof, perceived by the interviewee to be a barrier to its exports.

<sup>3</sup> The concept of “mitigation potential” has been developed to assess the scale of reductions in emissions of greenhouse gases that could be made, relative to emission baselines, for a given level of carbon price. A technology that also has “economic potential” is one for which there would be a net positive return from its use (taking into account all social costs and benefits, discounted at a social discount rate). In some cases, realizing a technology’s social potential may require changes in policies, including the removal of barriers to its deployment (IPCC, 2007).

The four technologies with the greatest economic potential for global mitigation were selected for this study based on their being commercially viable<sup>4</sup> and traded globally (Table 2). The implications of liberalising trade in a technology would be limited if it were not yet cost-competitive and largely produced and used domestically. Annex I describes the components of these selected technologies in detail.

**Table 2. Selected Mitigation Technologies Covered by the Study**

<b>Sector</b>	<b>Technology</b>	<b>Leading exporting countries</b>	<b>Projected reduction in 2050 (Gt CO<sub>2</sub>/year)</b>
<b>Energy supply</b>	Combined heat and power (CHP)	Austria, USA, India and Finland	0.3
<b>Buildings</b>	District heating and cooling (DHC)	Austria, Denmark, Finland, Germany, Iceland, Sweden, Switzerland, USA	0.5
	Solar heating and cooling (SHC)	Austria, Greece, China	0.6
<b>Industry</b>	Energy-efficient electric motor systems	Europe, China, Japan, USA	1.5

Source: IEA, *Energy Technology Perspectives* (2008, [p. 113])

Surveys were carried out in each sector by independent consultants in order to gain insights into the trade barriers perceived by exporters, and the types of measures that seem to need to be in place in order to facilitate trade. For each survey, several manufactures<sup>5</sup> from the main exporting countries were approached, and asked to fill out a standardized, 20-page questionnaire. The questionnaire asks details about specific measures, grouped under 15 different generic categories of NTMs (Table 3). Some of the companies were then contacted subsequently and asked to elaborate on their answers. However, no independent check was made to validate the information that they provided. Because the sample size was small, the results of the surveys cannot be considered scientific; they are at most suggestive of areas for further investigation.

<sup>4</sup> The criteria for their commercial viability are largely based on the stage at which the technology is cost-competitive with or without specific CO<sub>2</sub> reduction incentives.

<sup>5</sup> Only one manufacture responded to an interview request in the case of solar heating and cooling systems.

**Table 3. Categories of non-tariff measures (NTMs)**

<b>Category</b>	<b>Type of measure</b>
1	Pre-shipment inspection and customs procedures
2	Quantitative import restrictions (Import licensing, Import quota or prohibitions)
3	Import surcharges or border taxes
4	State-trading monopoly or state monopoly control of imports
5	Cargo handling and port procedures or requirements
6	Technical product regulations, standards and approval procedures
7	Restrictions on investment
8	Restrictions on after-sales services
9	Price controls or administered pricing in destination market
10	Regulations on payment; restrictive foreign exchange allocations to importers
11	High or discriminatory taxes or charges in destination market
12	Subsidies or tax benefits given to competing domestic firms in destination country
13	Violation of intellectual property protection
14	Government procurement procedures in destination market
15	Informal "additional payments" required to effect import of your product

*Source:* OECD Secretariat.

Each of the following chapters: describes the technologies; analyses key market trends; and summarizes the findings of exporter surveys of perceived trade barriers. The final chapter offers possible suggestions for overcoming the perceived barriers and facilitating trade.

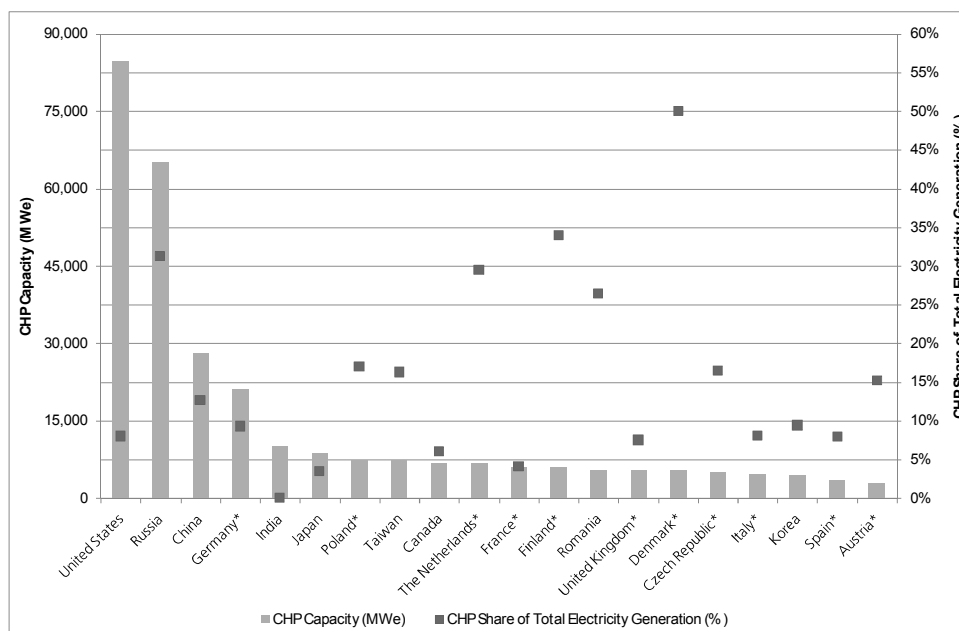
## COMBINED HEAT AND POWER (CHP) SYSTEMS

### Overview

Combined heat and power (CHP) systems, also known as cogeneration systems, are fuel-efficient processes that simultaneously produce electric power and heat. Typically they require 10-25% less fuel than stand-alone systems using the same fuel (IEA, 2008). A growing number of so-called “tri-generation plants” – providing cooling as well as heat and power – are being installed around the world. Box 1 summarises the key current (commercially proven and conventional) and emerging prime-mover CHP technologies. Since almost all trade in CHP prime movers relates to the current commercialised technologies, they are the focus of the trade barriers assessed here.

According to the World Alliance for Decentralized Energy (WADE, 2006), the worldwide share of decentralised energy systems was over 7.2% in 2005, with CHP representing the great majority of such systems. The CHP market share of new power generation output was between 20% and 25% in 2005. Figure 1 shows the electric-generating capacity of CHP plants in the world’s major markets, together with the national share of total power generation provided by CHP plants. The United States has the biggest CHP electricity capacity in the world, followed by Russia and China. As a share of national power generation, Denmark leads the world, followed by Finland, Russia and the Netherlands. Energy experts maintain that most countries can significantly increase their use of CHP (IEA, 2008).

**Figure 1. CHP electricity capacity (MWe) and CHP market shares in selected countries**



Source: International Energy Agency, 2008.

The main market driver for CHP systems is the difference between the price of electricity and the price of fuel normally used for industrial process heat. The greater the difference, the more profitable it will be to cogenerate heat and power. In general, high electricity prices stimulate investment in CHP systems. Where this also takes place in the context of a widely available supply of competitively priced natural gas, conditions will be particularly favourable. At the international level, agreements to address global climate change are slowly stimulating investment in the CHP systems, but the key policy drivers to date have been at the national level.

#### Box 1. Basic CHP plant configurations and technologies

Combined heat and power (also known as co-generation) units provide simultaneous supplies of electricity and heat from one or sometimes several items of generating equipment. Where two generating devices are employed, they are coupled through the heat output from the first device(s) serving as the energy for the input to the second device. When heat production from a CHP unit ceases and it produces only electricity, it becomes an “electricity-only” unit and should be reported as such.

CHP power plants can be divided into five types:

**Backpressure power plant** — The simplest co-generation power plant is the so-called backpressure power plant where CHP electricity is generated in a steam turbine, and backpressure exerted on the steam in the turbine maintains the temperature of the steam exiting the turbine. The steam is then used for process steam or district heat. A steam boiler supplying a backpressure turbine with heat configuration can be designed to fire solid, liquid or gaseous fuels.

**Extraction-condensing power plant** — A condensing power plant often generates only electricity. In an extraction-condensing power plant, however, part of the steam is extracted from the turbine and used as process steam or to provide district heat.

**Gas turbine heat-recovery power plant** — In gas turbine heat-recovery power plants, fossil fuel is combusted in the turbine, and hot flue gases exiting the turbine are directed through a heat-recovery boiler. In most cases, natural gas, oil, or a combination of these fuels is used to fire the turbine. Gas turbines can be fired with gasified solid or liquid fuels, but an appropriate gasification facility needs to be placed in proximity to the turbine.

**Combined-cycle heat recovery power plant** — Recently, natural gas-fired, combined-cycle power plants consisting of one or more gas turbines, heat recovery boilers, and a steam turbine have become quite common.

**Reciprocating engine power plant** — Instead of a gas turbine, a reciprocating engine, such as a natural-gas fired spark-ignition (Otto-cycle) engine, or compression-ignition (Diesel-cycle) engine, can be combined with a heat-recovery boiler, which in some applications supplies steam to a steam turbine to generate both electricity and heat. Many micro-CHP systems are of this sort, typically operated as heating appliances, providing space heating and warm water in residential or commercial buildings, as well as electricity.

**Fuel-cell powered micro-CHP** — In place of a reciprocating engine, a proton-exchange-membrane fuel cell is used to generate heat and power. Fuel-cell-based CHP are still in the demonstration stage.

*Source:* Adapted from IEA (2005) and Cogen Europe (2005).

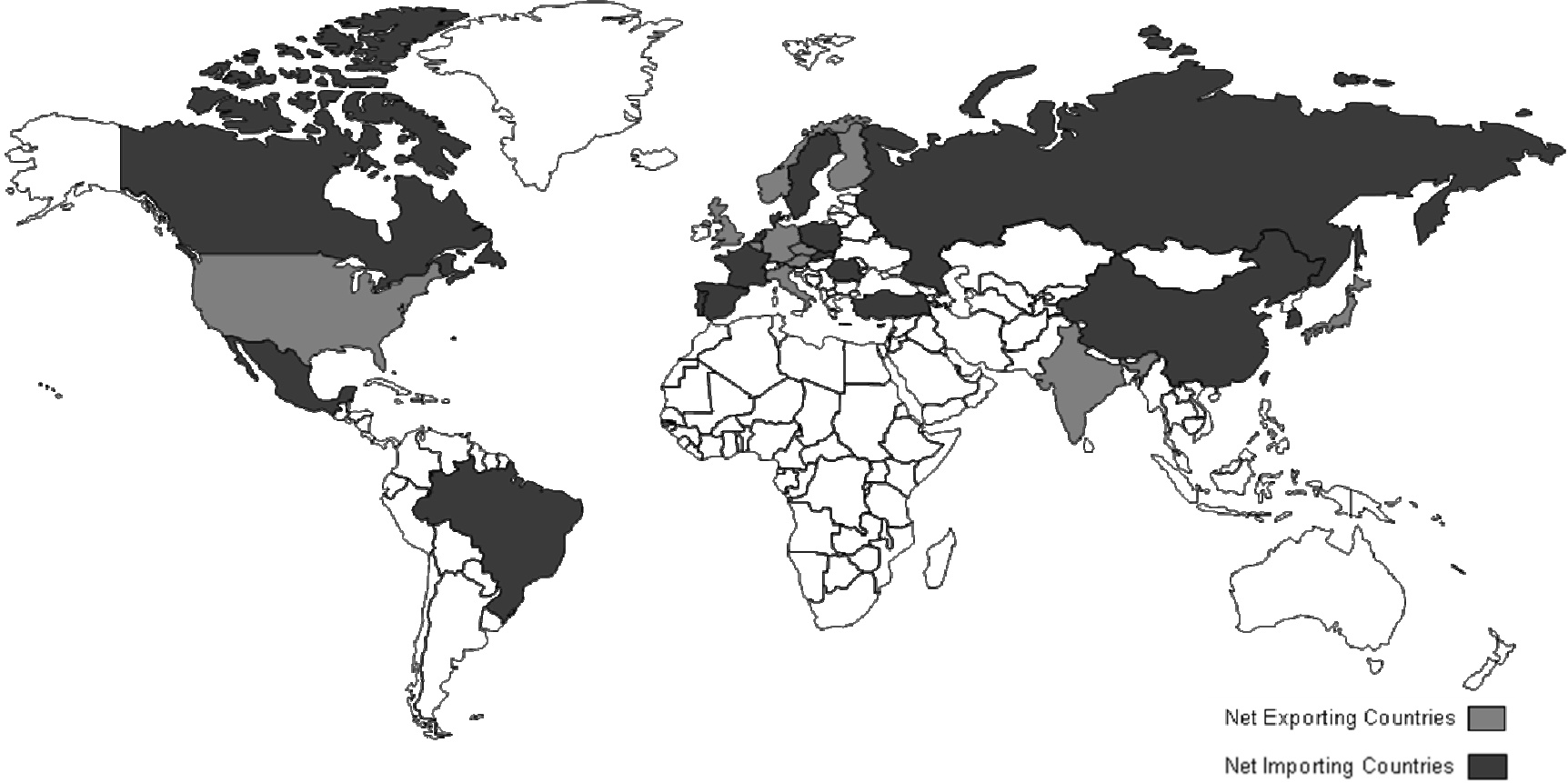
#### Key markets and policy drivers

The leading exporters of CHP technologies are India, Japan and the United States. Austria, Belgium, the Czech Republic, Finland, Germany, Italy, Norway and the UK are also net exporters of CHP technology. The leading importing countries are Brazil, Canada, China, Mexico, Russia and Turkey. Several European countries such as Denmark, France, Poland, Portugal, Spain, Sweden and the Netherlands are net importers of the technology (Figure 2).



The European CHP market has been slowly but steadily re-emerging since 2005 after a major market downturn in the mid-1990s. Growth has been particularly strong in southern European countries. The majority of CHP plants in northern and eastern Europe combine power generation with the production of steam for district heat; CHP plants in western and southern countries mainly produce industrial process heat. The European Commission's non-binding CHP Directive requires that Member States perform an assessment of their CHP potential.

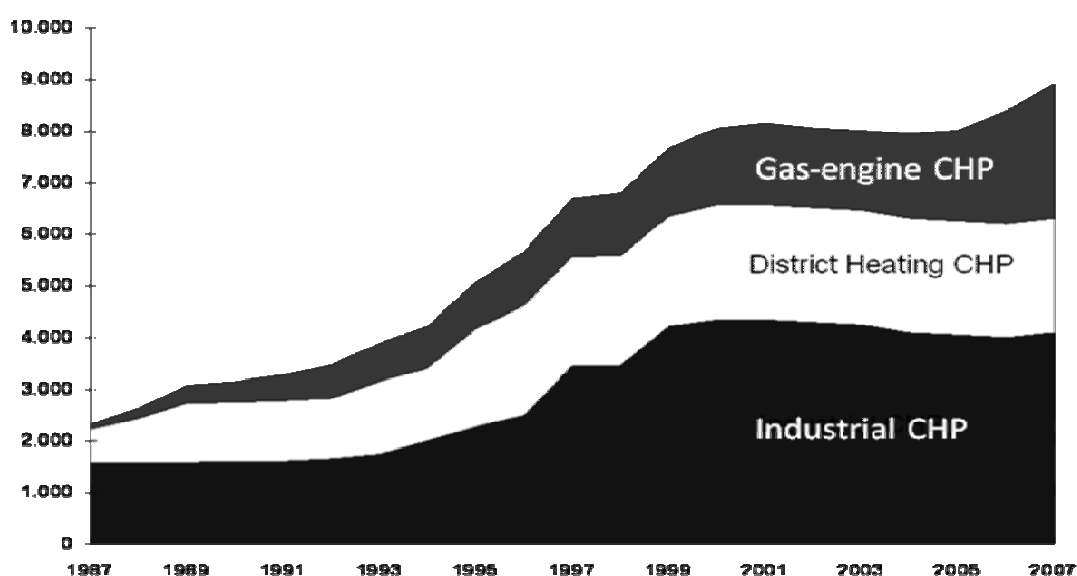
**Figure 2. Key Exporting and Importing Countries of CHP Systems – preliminary assessment**



Source: Delta Energy and Environment, 2007.

**Denmark, Finland, and the Netherlands** have the highest CHP shares of national power production in the world. CHP policy has been particularly supportive for district-heating CHP in Denmark, and for industrial and commercial CHP in the Netherlands. **Denmark** has provided numerous tax incentives to encourage investment in CHP for district heating in towns and cities, and has required that new buildings connect to district-heating systems. **Finland**, by contrast, required only moderate incentives to stimulate market development, thanks in part to the availability of numerous industrial steam loads in the pulp and paper industry and its long heating season, which enables cost-effective investments in district heating. The rise of CHP in the **Netherlands** during the 1990s (Figure 3) was stimulated by regulatory reforms — notably, the unbundling of energy companies. In so doing, energy-supply companies had an incentive to invest heavily in industrial CHP systems in partnership with energy-intensive industries. Favourable gas prices, investment support and good CHP feed-in tariffs also helped.

**Figure 3. CHP growth in the Netherlands (MWe)**



Source: Cogen Netherlands, 2007

In **Germany**, investment in municipal and small-scale CHP systems has been stimulated by government incentives. The federal Co-generation Act guaranteed bonus payments of up to € 0.0511 per kWh for CHP electricity exported to the public grid, in addition to the base price paid for this electricity. These payments were phased out at the end of 2006 but continue for fuel-cell-based plants. Indeed, government support has been one of the reasons for Germany being both an importer and exporter (though overall a net exporter) of various types of CHP systems. The **UK** government has established an exemption from the Climate Change Levy (a tax on fuel and electricity to improve energy efficiency and reduce CO<sub>2</sub> emissions) and supports certified “Good Quality” CHP.

Increasing energy prices and CHP goals set by the **U.S.** federal government are promoting the cogeneration market in that country. CHP capacity stood at 82 GWe in 2006 and the federal government’s target of 92 GWe by 2010 is expected to be surpassed. Several U.S. states, including California, Connecticut, New Jersey and New York, are promoting greater competition in electricity supply and, in the process, removing barriers to the diffusion of CHP. At the federal level, the US Department of Energy and the Environmental Protection Agency have extensive outreach programmes to promote awareness of CHP, as well as a number of CHP R&D programmes.

**Japan** has some industrial and commercial-scale CHP, but the big growth area is in micro-CHP systems for the residential sector. These are units with capacities of only 1 kW and incorporating gas engines or proton-exchange-membrane fuel cells (PEMFCs). More than 30 000 micro gas-engine CHP systems and 1 250 fuel cell CHP systems had been installed in Japan by the end of 2006 (Aki, 2007). Gas-engine micro-CHP systems are already considered to be commercially viable. In order to encourage their penetration in the residential market, the government subsidizes half or two-thirds of the initial cost of residential fuel-cell CHP systems.

CHP, fueled by bagasse (sugar-cane residues), is common in **Brazil's** sugar-ethanol industry, encouraged by Government policies. CHP plants fuelled by natural gas, which help to stabilize seasonal changes in hydro-electric power supply, are also proliferating. Legislation supports these developments. Projects funded by the CDM mechanism is also stimulating equipment imports. The lack of a clear policy on interconnection and sale of surplus energy from CHP continues to constrain the market.

In **Russia** there is already a strong CHP market linked with district heating; however, much of the existing capacity is in old plants with low thermal efficiencies. The growth potential for CHP in Russia is huge, however, as the country has a high demand for both heat and power and an abundant supply of natural gas.

**India's** CHP market is being stimulated by rapid economic growth and changes to its electricity laws that previously hindered the private generation of power. However, India's limited natural-gas network and remaining market barriers in several states continue to constrain the potential for CHP. The Electricity Act 2003 has triggered some significant CHP market developments, but support from State governments has been weak, especially in relation to the selling of surplus CHP energy. In addition, larger CHP plants are taxed at the same rates as conventional plants that do not recover heat.

**China** has a significantly higher CHP share than the global average. During the 1980s and 1990s, a strong energy-efficiency policy stimulated the development of coal-based CHP systems. Most of these operate at a low level of efficiency, however. Increasing electricity prices, rapidly growing industrial and residential demand for process heat, and the wider availability of natural gas may favour further CHP development. Recently, there has been regulatory uncertainty within the electricity sector due to slow liberalisation and high gas prices. Nevertheless, few doubt that China will eventually become a major importer of CHP equipment, the scale of which will depend in part of the extent to which non-Chinese companies establish manufacturing bases in the country.

### **Domestic regulatory issues**

Despite favourable policies encouraging CHP in a number of countries, various local market barriers remain (IEA, 2009). One is high back-up and top-up fees – the fees charged by electricity companies on CHP owners for the supply of electricity in the event of CHP system non-operation (back-up charges; for example to allow maintenance) or where grid supply is required in addition to that provided by the CHP system (top-up charges). Where these fees are set at the discretion of the electricity supply company, they can often be set at punitive levels.

An energy user who wishes to remain linked to the electricity system after establishing a CHP plant must satisfy various technical requirements for interconnection and will need to apply for authorisation to do so. Where the electricity supply companies themselves establish the rules for such interconnections

(which is often the case) this presents an opportunity for high interconnection costs and delays to procedures. These practices are common in many countries, even OECD countries.<sup>6</sup>

The prices paid by an electricity company for the surplus electricity supplied by a CHP plant when it produces more electricity than is needed at the energy user's site – the buyback rate – may be set too low. The price fetched for this electricity is a critical determinant of the overall economic performance of the CHP scheme. However, where these prices are set by the electricity company rather than an independent regulator, they are often set at low or very low levels in order to discourage or prevent investment.

Climate-change commitments in **Europe** have not yet significantly stimulated CHP development, as these commitments tend to favour renewable energies (including biomass-powered CHP) and not improved energy efficiency through gas-fired CHP. The principal European policy initiative to promote CHP, the CHP Directive (EU Directive 2004/8/EC), is one of the very few cross-country policy initiatives that aim to reduce barriers to CHP systems that relate to grid standby rates and access to fuels at competitive prices, grid interconnection issues, and plant licensing and other administrative procedures.

### Trade measures

This section summarizes the responses of the four CHP equipment manufacturers who responded to the OECD questionnaire on trade-related measures that may be impeding trade in CHP. (Two other CHP companies contacted indicated that they had not encountered any trade barriers.) Details of the responses are provided in Annex II.

*Customs procedures* were mentioned by several companies as having been burdensome in Mexico, Turkey<sup>7</sup> and certain African countries. Typical complaints were delays in the export of CHP products with no clear justification and irregular requirements. Definitions and classifications of CHP systems were raised as a common challenge in relation to customs clearance. Several manufacturers cited confusion among customs officials between electrical efficiency, thermal (or heat) efficiency and combined electrical and heat (CHP) efficiency. For example, a boiler with an efficiency of 80% or greater tends not to attract any significant customs attention or duty. Yet a CHP system, with a combined efficiency also of around 80%, faces quite different treatment in some markets based on different classifications of energy-producing systems, with France having been cited by one company as a country wherein delays have arisen as a consequence of this differential treatment.

Differing technical or energy-performance requirements present a related challenge. In Pakistan, for example, imported power systems are required to achieve energy-conversion efficiencies of around 45%. CHP systems typically have fuel-to-electricity conversion efficiencies below this threshold, while providing an overall energy efficiency of up to 90%. The perverse outcome is that the technical requirements favour sub-optimal electric-power-only systems at the expense of high-efficiency CHP systems.

Manufacturers of CHP systems based on reciprocating engines have indicated that emerging CHP efficiency requirements, for example EU Directive 2004/8/EC (the "CHP Directive"), may discriminate

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<sup>6</sup> According to Neal Elliot of the American Council for an Energy-Efficient Economy (quoted in Zumbun, 2008), electric utilities can impose repeated delays on applicants. "Require an interconnection study takes 60 days; present the study, 60 days to do that; the utility takes 90 days to review that, then if they have any questions, you have another 30 days ... When it adds up, it make a year or two or three. And time is money." According to Elliot, gratuitous delays have "killed more CHP projects [in the United States] than anything else."

<sup>7</sup> In respect of Turkey, the 2004-2007 period coincided with a crucial transition stage in the alignment of its technical regulations with EU rules and norms. The situation has improved considerably over the last year.

against such systems at the expense of gas-turbine based systems. This is because systems based on gas-turbines can often achieve higher overall energy efficiencies than engine-based systems even though the electrical efficiencies of the latter are higher.

Restrictions on investment and after-sales service were alleged to be a problem in China, Bangladesh, Pakistan, Russia and India. The establishment of locally incorporated CHP companies or joint ventures is often necessary to overcome certain restrictions (e.g. high taxes).

Three of the four respondents mentioned *violation of intellectual property rights* (in China, India, South Korea and certain other Asian countries), and one major CHP company said it was having a significant impact on its exports. Another company, as a consequence of its concern about IPR violations, has decided not to export high-value CHP technology to China.

## **DISTRICT HEATING AND COOLING (DHC) SYSTEMS**

CO<sub>2</sub> emissions can be significantly reduced by using district heating and cooling in place of individual heating and cooling systems. While district heating is already a mature technology, modern district heating systems utilise pre-insulated pipes and sophisticated moisture surveillance techniques that allow leaks to be located quickly, before they develop into serious problems. The history of the industry suggests that district heating systems have mainly expanded during times when energy prices for end users have been rising. Thus, in several countries new systems are under development or in the feasibility study phase.<sup>8</sup>

At the consumer end, a typical heating installation entails a compact, prefabricated unit (possibly with an insulated casing) to deliver heat and hot water. Depending on the network design (direct or indirect connection) the unit is comprised mainly of a thermostatic valve or pressure-controlled valve, a heat exchanger and a heat meter. Despite the widespread commercial availability of highly automated<sup>9</sup> district-heating technologies, there are many countries operating district heating networks that still use comparatively simple and inefficient technologies.

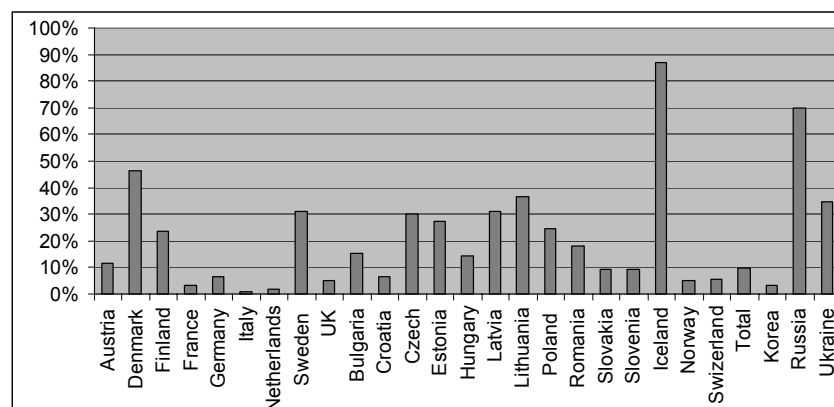
District cooling is an emerging technology for providing comfortable indoor climate during the summer months. Its energy efficiency is five times higher than that of conventional air conditioners. The demand for cooling, already large in Australia, Japan and North America, is steadily increasing in all EU and candidate countries as well. District cooling finds its widest application in densely populated areas, serving service industries, public buildings and, in a few places, apartment buildings and factories. Cooling networks are usually operated by energy utilities and energy-service companies (ESCOs). Among the goods used in district cooling are absorption chillers, compressors, and pipes for drawing cooling water from a lake or other water source.

### **Key markets and policy drivers**

#### ***District heating***

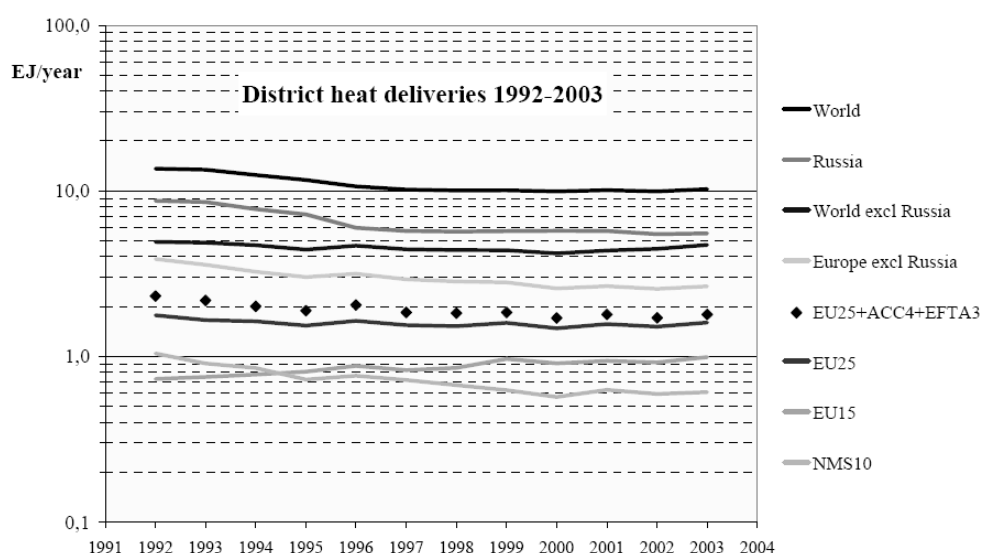
The total net heat demand for the industrial, residential, and service sectors in 32 European countries<sup>10</sup> has been estimated by Euroheat & Power (2007) to have been 20.8 EJ/year in 2003. Most of this demand was concentrated in urban areas. Iceland meets more of its heating demand with district heating (over 80%) than any other country, followed by Russia (70%) and Denmark (45%) (Figure 4).

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8. Research activities are currently focused on optimising transmission and distribution systems for heat and cool delivery to high and low heat density areas, network size, and efficient use of thermal storage.
  9. Modern district heating systems utilise advanced communication and automation technologies to remotely monitor the operation of plants and the network.
  10. The target area for the assessment of heating and cooling markets was the EU27 (15 old and 12 new member countries); plus the EFTA area (Iceland, Norway and Switzerland), and Croatia and Turkey.

**Figure 4. Share of district heating in total heat demand in 2005.**

Source: Euroheat & Power (2007).

Statistics prepared by Euroheat & Power show that total deliveries of district heat for the EU25 countries remained stable over the decade to 2003 (Figure 5). Increased deliveries within the EU15 countries were offset by declines in the 10 new member states. Heat deliveries in all Europe 32 countries decreased on average by 2% per year. High growth rates were noticed in Netherlands (16%) which can be explained by more industrial heat deliveries from CHP plants. Lower growth rates in Sweden and Denmark (2% each) are a consequence of the fact that district heating already has a high market share in these countries. In Germany and France -- countries with old, but immature district-heating systems -- heat sales have remained essentially flat over the last 11 years. The greatest declines appeared in Romania (-11%), Bulgaria (-10%), Estonia (-9%), Latvia (-7%), Lithuania (-6%), and Poland (-6%). The main explanation for these declines is the loss in deliveries to industrial heat consumers, which is typical for countries in transition.

**Figure 5. District heating deliveries 1992 – 2003**

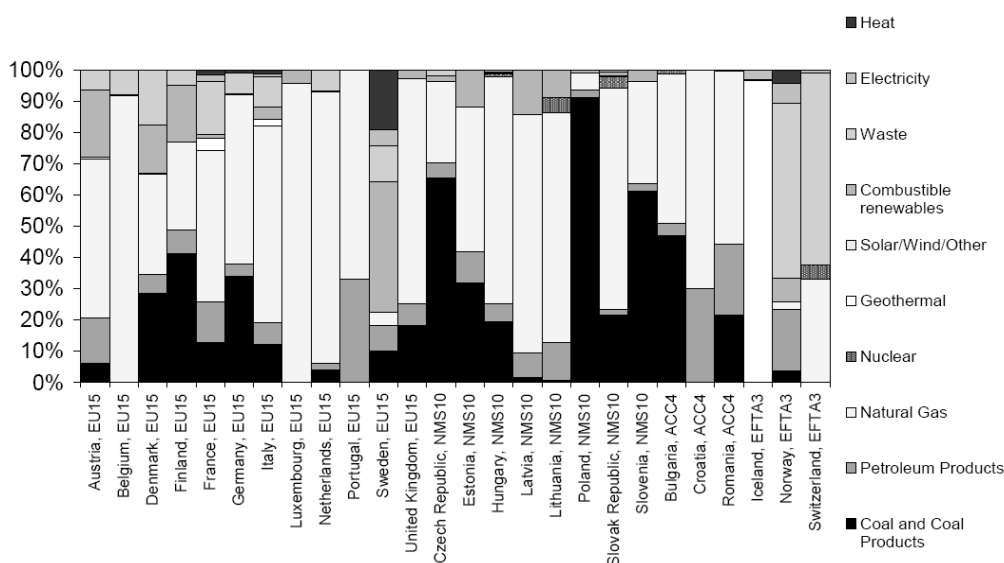
Source: Building Research Establishment Ltd.



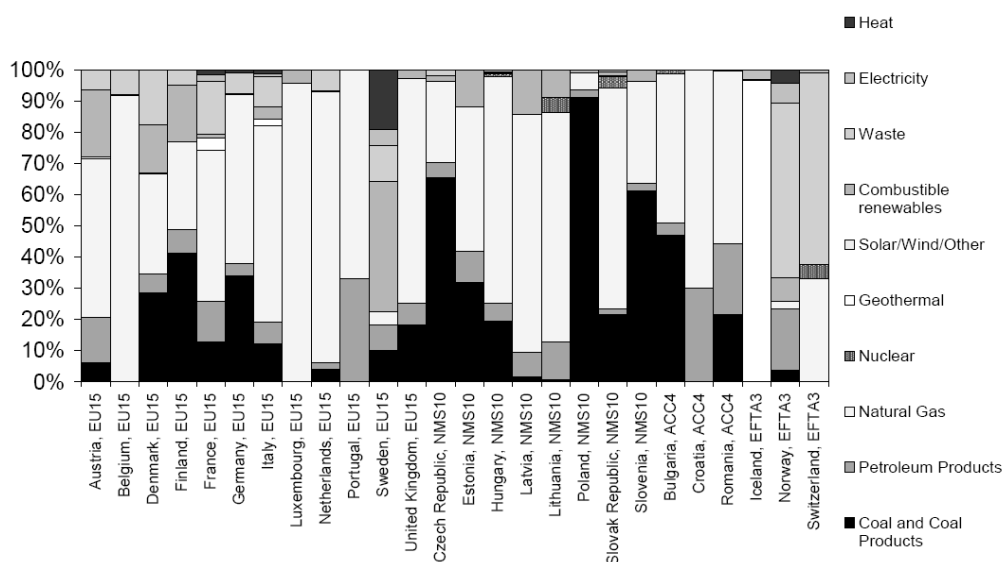
Outside of Europe and Russia, sales of district heat are experiencing growth rates of about 5% annually. This is due mainly to the strong expansion of district heating in China (7%) and Korea (24%). The IEA *Energy Balances* report a slight decrease for district heat deliveries in the United States.

According to Euroheat & Power (ECOHEATCOOL project in 2005), fossil fuels such as coal, oil and natural gas dominate the energy supply for district heat with a combined 83% share in 2005. Although there are variations among the 26 European countries, it appears that district heating systems in Europe generally have the same dependency on fossil fuels as the rest of the European energy system (Figures 6 and 7).

**Figure 6. National compositions of energy supply in Europe.**



**Figure 7. Composition for the energy supply in district heat generation during 2003 in Europe**



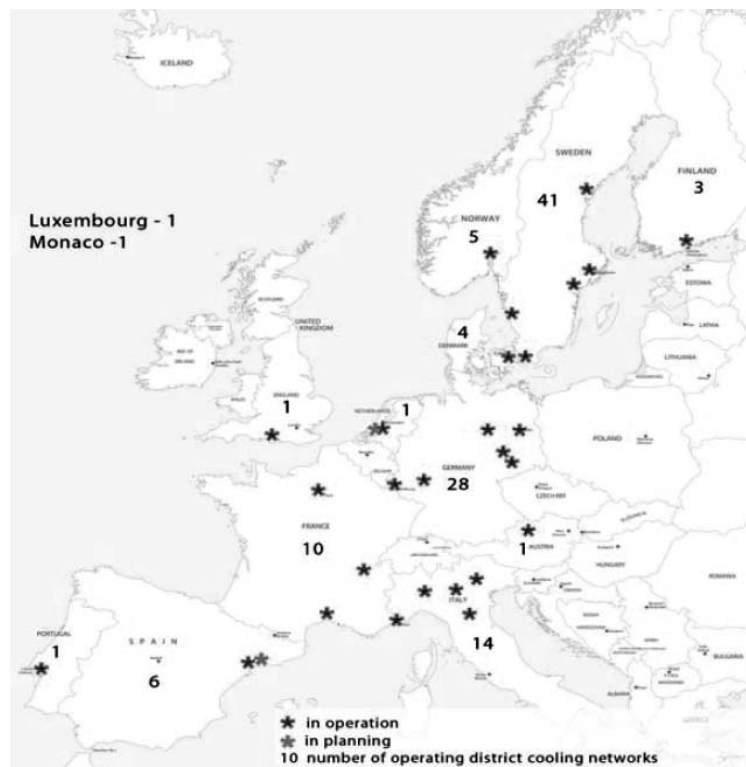
Source: Building Research Establishment Ltd.

The future development of district-heating networks looks promising as there is a tremendous potential for improving the efficiencies of existing, aging systems in China, Korea, Russia and Northern Europe. But because of its considerable potential to reduce carbon emissions, significant expansion of existing district-heating networks and the construction of new networks can also be expected even in regions such as Western Europe, which already have modern DH networks.

### ***District cooling***

Total cooling demand in the EU-15<sup>11</sup> in 2000 has been estimated to have been around 150 TWh<sub>c</sub> (corresponding to 80 TWh<sub>e</sub> or 3% of annual electricity generation).<sup>12</sup> The share of the total cooling market met by district-cooling networks is about 1-2%, or between 2 and 3 TWh<sub>c</sub>. Currently, there are around 100 district cooling systems in Europe, mainly in high-density city centres and commercial areas (Figure 8). In 2003, France had the greatest amount of installed district cooling plant capacity and sales of district cooling, followed by Sweden and Germany (Figure 9). Although Europe's demand for cooling is still small compared with North America's, its recent growth has been substantial, driven by the demand for space cooling. Future cooling demand for the EU-15 alone is expected to reach 500 TWh<sub>c</sub> by 2020.

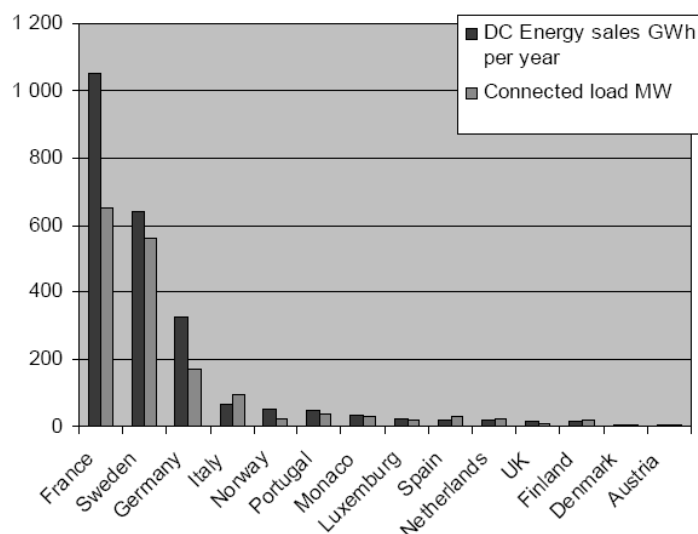
**Figure 8. Indicative mapping of cooling networks and on-site cooling installations in Europe**



Source: Building Research Establishment Ltd.

<sup>11</sup> Of the countries with district-heating plants, it is those in the EU-15 countries that have been integrating district cooling.

<sup>12</sup> At present, no data are available on cooling demand in other regions except for the EU 15 countries. In many of the existing networks in Russia, for example, the most urgent need is to repair existing district-heating networks. In new cities in China, the Middle East and rapidly developing Asian markets, there are numerous opportunities for installing new district-cooling networks, often integrated with other services.

**Figure 9. District cooling Energy Sales per year in Europe (2003)**

Source: Building Research Establishment Ltd.

Manufacturers of equipment for district heating (especially of pre-insulated pipes, sub-stations, heating controls and heat meters) are usually located in countries that established a highly developed district heating infrastructure at an early stage.<sup>13</sup> Denmark in particular is home to a large number of companies manufacturing equipment for district heating.

In Europe, pre-insulated district heating network pipes are manufactured and used mainly in Denmark and Finland. These types of pipes are also manufactured by a company in Russia, which exports about 20% of its production to the rest of Europe. Prefabricated district-heating pipes are manufactured also in Austria, Germany, Iceland, Sweden, and Switzerland.

Many manufacturers have established local assembly plants outside their home countries. According to Euroheat & Power, the total annual sales value of prefabricated district heating pipes is around € 400-470 million per year. This sales value corresponds to a total pipe length of 10 000-11 000 km. Some of these pipes replaced existing pipes; much of the rest was exported to the EU's ten New Member States and four Accession Countries. In these countries several small-scale, locally owned manufacturers have appeared during recent years.

Only a few companies produce prefabricated consumer substations, and the main European manufacturers are from Denmark and Finland. The total sales of customer substations and corresponding equipment is around € 250-350 million per year.

According to Euroheat & Power, control equipment nowadays forms part of the expanding building-automation industry, which has an annual turnover of about € 6 billion in Europe. The market for hardware and equipment has been shrinking in line with increasing expenditure on services and software associated

<sup>13</sup> In the absence of national statistics of international trade in goods associated with district heating and cooling, it is difficult to assess the export and import market trends of these technologies. However, it is possible to make a qualitative assessment of international trade trends in this sector based on current district heating and cooling market trends (heat demand).

with building automation. The major exporters of heating controls are located in Germany, Denmark and the United States.

Net importers of district-heating technologies include countries such as Poland, Bulgaria, Romania, Estonia, Latvia and Lithuania that are trying to significantly modernise and optimise their antiquated district-heating systems. The Netherlands, which has experienced steady growth in deliveries of district heat in recent years, and the United Kingdom, which imposed new planning obligations favourable to DHC systems, are both also important importers.

Outside of Europe, the largest potential markets include Russia, Ukraine, Korea and China. The IEA recently estimated that about USD 70 billion would be needed by 2020 to upgrade the district heating infrastructure in the Russian Federation alone (IEA, 2004). In one recent project in the Russian Federation, the European Bank for Reconstruction and Development (EBRD) is financing the rehabilitation and modernisation of the existing district heating distribution network and the introduction of new, compact individual heating sub-stations equipped with meters in residential apartment buildings in the city of Cherepovets. China, which needs both to upgrade existing district-heating systems and install new ones, would be a potentially very large market as well.

### **Domestic regulatory issues**

Public policy towards district heating and cooling differs considerably from country to country. Even in Europe, the market conditions are not harmonized. The national conditions are so different, in fact, that some market actors avoid entering a heat market in another country.

Modernising or developing new DHC schemes is capital-intensive. Large-scale demand for district heating generally depends on governmental support through obligations imposed on developers or property owners to at least prepare a feasibility study of district heating or cooling before any significant refurbishment of existing or development of new buildings is approved.

A general overview of various measures preventing, or mechanisms supporting, the expansion of district heating in Europe was done for the ECOHEATCOOL project prepared by Euroheat & Power. Those highlighted by the study are illustrative of the types of barriers that remain in some countries.

- **Low fuel and electricity prices.** The main advantage with district heating is the low input of primary energy, which reduces the expense of heating. This advantage has a considerable market value when the international market prices of oil, natural gas, and electricity are high. Clearly, therefore, regulations that blunt the transmission of world energy-price movements into domestic markets discourage investment in DHC.
- **Short-term investments.** District heating is a long-term commitment comparable with investments in roads, bridges, railways, and buildings. This commitment is made in each local urban heat market. A deregulated and privatised energy market prioritises investments with short pay-back periods. If during the planning stage of new urban developments public authorities do not ensure that the options of district heating and cooling are carefully taken into consideration, conventional heating will become the default.
- **Price regulation.** In most of the EU's 10 new Member States (NMS10) and the four accession countries (ACC4), extensive price regulation is applied to protect the poorest part of the population. This cuts into the revenue stream of DHC systems and leaves insufficient funds available for rehabilitation and expansion of the networks. This situation prevents many private investors from entering the district-heating sector.

- **Distorted market prices.** A related problem in some NMS10 and ACC4 countries is that regulated prices for energy commodities are not efficient. For example, natural gas has been sold to final customers at the same prices paid by large industries and power plants — i.e., at a price that does not cover the additional costs of building and maintaining distribution networks. This has not tipped the playing field away from district heating. Liberalization of energy markets should lead to differentiation of fuel prices for different classes of users.
- **Cost allocation.** The major driving force for many district-heating systems is the benefit of combined heat and power. This CHP benefit must be shared between the electrical and heat side. Sometimes the whole CHP benefit is allocated to the electrical side, giving the district heat side no market advantage at all. This situation appears both in price regulation schemes and when a power company owns the CHP plant, and when waste incineration and industrial surplus heat are used. District heating systems cannot expand without having a significant advantage compared with market alternatives. The solution is not to harmonise rules for cost allocation, but to deregulate the market, so that the cost allocation between heat and electricity can be decided in each project, based on the prevailing local conditions.
- **Emissions trading.** Potential customers for district heating using fuel oil or natural gas are not normally included in the European emissions trading system.<sup>14</sup> When they connect to a district-heating system, however, the district-heating operator must buy more emissions quotas in order to compensate for the additional fuel consumed to supply the greater heat load. This barrier could be removed by accepting all new district heating customers as new entrants to the trading system and entitled to additional allocations of emission quotas.

## Trade measures

Three exporters of DHC equipment, all based in Denmark, provided responses to a questionnaire on NTMs (see Annex III for details). The results of the interviews show that the measures affecting trade in district heating equipment are similar to those affecting trade in other products. The most common problem identified, though not mentioned as constituting a serious impediment to trade, was *differences in technical regulations and standards* in export markets, and between the export markets and the home market of the exporter. This results in the need for additional testing according to national standards of importing countries. Although a directive standardizing metering has helped inside the EU, outside the EU there can be very detailed demands to satisfy approval procedures. Some companies mentioned delays in testing and certification, especially in Russia and some countries in the Far East.

Some exporters reported encountering problems with obtaining *import licences* where the company had to be approved by government and pay an import licence in addition. Many companies have avoided such problems by establishing co-operation with a local partner well acquainted with local market conditions and regulations. Some mentioned difficulties in obtaining advance information about licensing requirements because either the requirements are dispersed in different regulations or they are not available in other languages than the language of the importing country (e.g. Russian or Chinese). Access to

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<sup>14</sup> In the next phase (following the proposed revised directive), however, things may change. The draft text states, “In order to encourage a more efficient generation of electricity, electricity generators could, however, also receive free allowances for heat delivered to district heating or industrial installations.” Moreover, “Free allocation may be given to electricity generators through Community-wide rules in respect of the production of heat for delivery to district heating networks or to industrial installations. In each year subsequent to 2013, the total allocation to such installations in respect of the production of heat for delivery to district heating networks or to industrial installations shall be adjusted by the linear factor in Article 9a.”

*information about tenders*, and unclear rules and regulations in the export market, were cited as a problem in many countries from Eastern and Southern EU to Russia and China.

In some cases, *visa requirements* for staff needed to perform maintenance duties or repairs has made *after sales service* more difficult when utilisation of local labour is not possible. Use of local labour is sometimes demanded in international tenders, e.g. in Russia.

In Russia, new rules require *foreign private investors* to seek permission from a committee chaired by the Russian prime minister to take more than a 50% interest in companies in strategic sectors, including energy supply. Foreign state-controlled companies will be barred from taking a controlling stake in strategic companies, and will have to seek permission for a stake of more than 25% (Buckley, 2008).

Some exporters reported encountering problems related to lack of enforcement of *intellectual property rights* – specifically, the distribution of pirated copies of their products. Sometimes local producers utilising their own brand were selling exact copies of foreign products and marketing them as such.

Several of the respondents considered requirements for qualifying for bids somewhat arbitrary, especially in Russia and China. This problem was often compounded by a *lack of independent appeal procedures* in the same countries. The decision-making process is not always transparent. In the Middle East, for example, companies alleged that arbitrary enforcement of the requirements and procedures occurs.

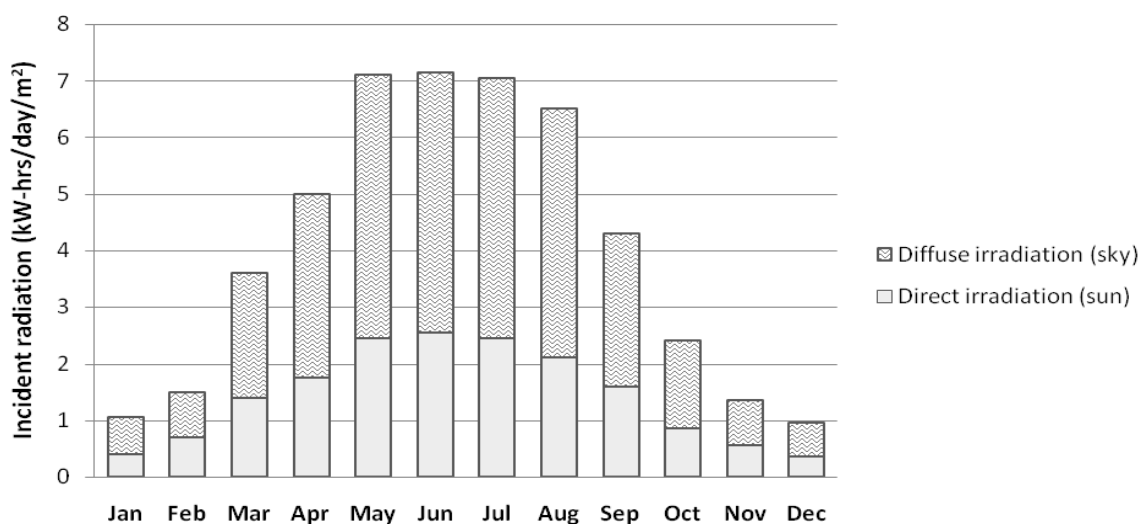
## SOLAR HEATING AND COOLING (SHC) SYSTEMS<sup>15</sup>

### Introduction

Solar heating and cooling systems harness the sun's power to heat or cool buildings by absorbing solar radiation through collectors and transferring the heat energy to space- or water-heating units, or air-conditioning systems. SHC systems are already sold commercially, but their deployment still lags far below their economic potential (IEA, 2008a).

There is a common misconception that solar thermal systems do not operate under cloudy conditions. In the UK there is a relatively high percentage of cloudy days compared with clear days (Figure 10). When the sun's radiation passes through clouds, it is dispersed and is known as diffuse radiation. On clear days, with no dispersion effect, it is known as direct radiation. Solar thermal systems are able to operate in both conditions, though generally more efficiently on sunny days.

**Figure 10. Average daily light energy for London**



Data source: World Radiation Data Centre Database (<http://wrdc-mgo.nrel.gov>)

Solar thermal systems provide more hot water during the summer than during the winter. This means that an auxiliary heat source will still be required to heat the water during the winter months. Nevertheless, solar thermal systems can still save between 40% and 60% of the energy that would have been required to heat up the hot water using conventional energy sources, such as natural gas.<sup>16</sup> Actual savings for any household will, of course, depend on its water-usage pattern.

<sup>15</sup> Data presented in this section are derived from manufactures of solar collectors, and statistics on imports and exports of hot-water systems, combi systems, and cooling systems.

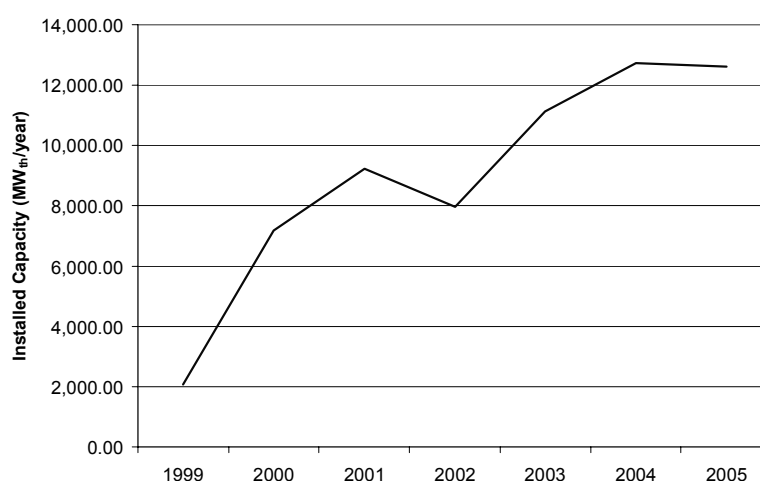
<sup>16</sup> CIBSE (2007) Solar Heating Design & Installation Guide.

The importance of government policy in driving the market for solar energy equipment (including photovoltaic and concentrated solar power systems) cannot be over-stated. According to a survey of 61 solar companies performed by *Climate Change Business Journal* in March 2008 (EBI, 2008), 70% of respondents rated government (financial) incentives as the “most important” or a “very important” market driver for their products; government requirements for renewable energy ranked second, attracting a 29% vote for “most important”, and a 26% vote for “very important”. The cost of oil ranked third among the factors, with 43% of respondents considering it “very important”, but only 13% identifying it as the “most important” factor. Annex IV describes in detail the government support policies for SHC systems in a number of OECD and non-OECD countries.

### Key markets and policy drivers

Overall, the market for SHC systems increased rapidly between 1999 and 2005 (Figure 10). Among the countries for which data are available, a majority of them showed a steady increase in the number of collectors installed annually between 1999 and 2006. In 2005 and 2006, however, growth in the numbers of units installed slowed in some countries, owing to the expiration of government incentives.

**Figure 11. Global Annual Installed capacity of solar-thermal collectors (MWth)**



Note: Data were collected from the following countries: Albania, Australia, Austria, Barbados, Belgium, Brazil, Canada, China, Cyprus<sup>17, 18</sup>, Czech Rep, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, India, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Mexico, Namibia, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Rep, Slovenia, South Africa, Spain, Sweden, Switzerland, Taiwan, Tunisia, Turkey, the United Kingdom, and the United States.

Source: Weiss et al., 2008.

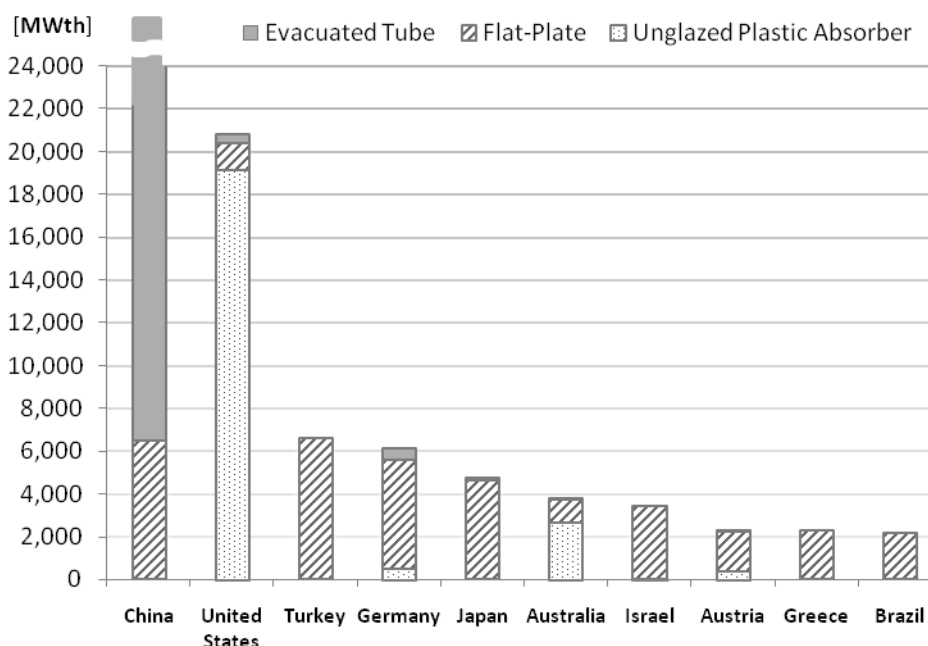
<sup>17</sup> Footnote by Turkey: The information in this document with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the “Cyprus issue”.

<sup>18</sup> Footnote by all the European Union Member States of the OECD and the European Commission: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.



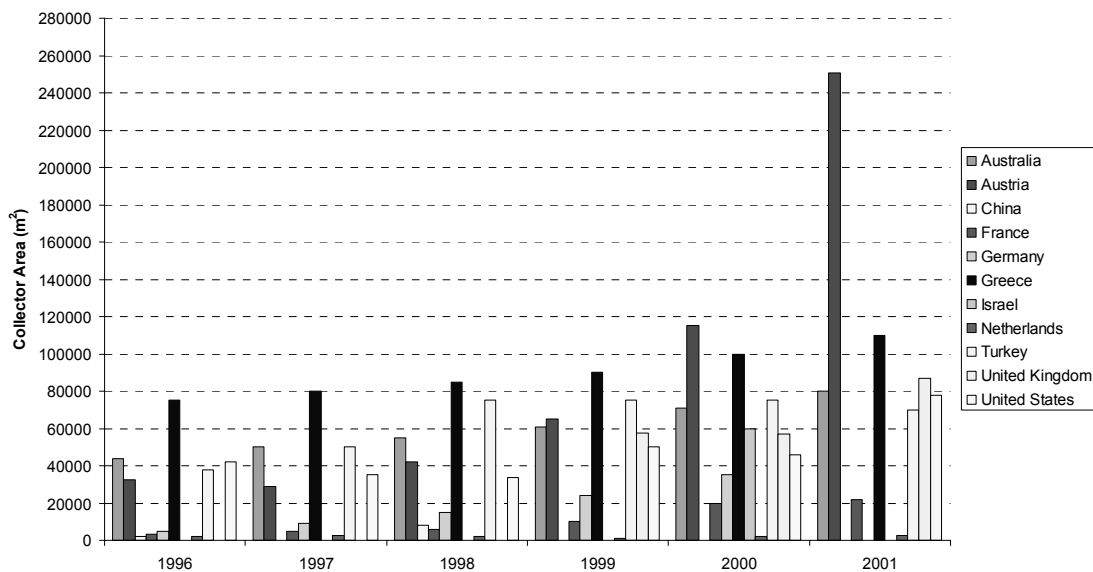
Globally, sales of SHC systems (weighted by installed collector capacity) increased 13% between 2005 and 2006, led by a 24% increase in China, the country which by far makes the greatest use of solar thermal collectors to heat water (Figure 11). China mainly manufactures and uses evacuated-tube collectors; elsewhere, glazed (flat-plate) collectors. Sales in Japan declined by 41% between 2001 and 2005, owing to the withdrawal of subsidies by the Japanese Government. *Climate Change Business Journal* (EBI, 2008) estimates that the global market for solar hot-water systems was worth around USD 2.80 billion in 2007; the journal reckons that the heat generated by these systems was worth an additional USD 2.81 billion.

**Figure 12. Total capacity of water-heating solar collectors in leading countries, end of 2006**



Source: Weiss et al. (2008).

China is the world's leading user of solar-thermal systems. The country receives in excess of 2 200 hours per year of sunshine over 66% of the country. That equates to an average of more than 5 GJ/m<sup>2</sup>, or approximately 1 400 kWh/m<sup>2</sup>, of solar energy (Brechlin et al., 2003). By the end of 2006, the country's accumulated installed area of domestic solar water heating systems had reached approximately 93 million m<sup>2</sup>, or almost 100 square kilometres (Weiss et al., 2008). Access to natural gas and electricity is not fully developed outside the major conurbations and therefore solar energy is regarded as the most economic and viable energy source for heating water. The government's industrial strategy, which strives for international scale and high levels of technology, has also assisted in the development of the solar thermal industry in China. Nonetheless, China exports only a small percentage of its collectors (0.3%). Greece was the largest exporter until 2000, when it was surpassed by Austria (Figure 13).

**Figure 13. Exports of solar-thermal collectors by country**

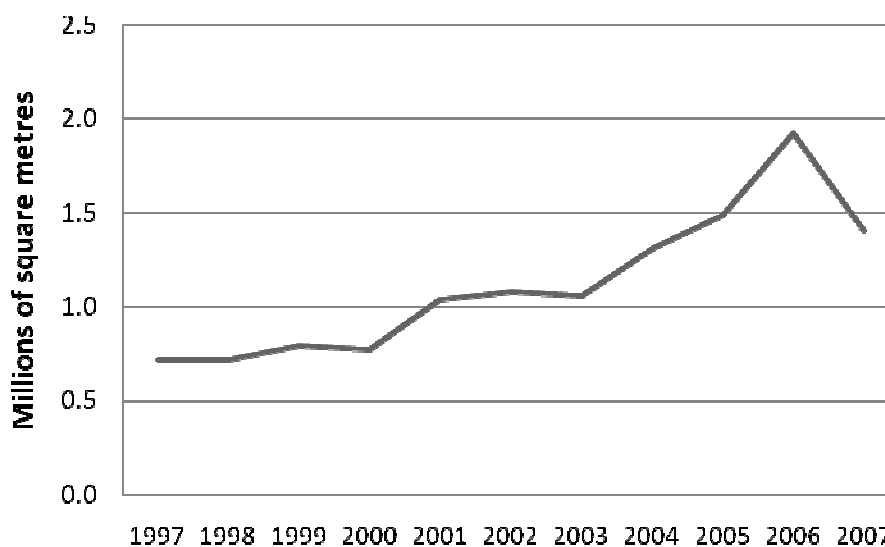
Source: Building Research Establishment Ltd.

At least one in eight family homes in Austria have solar heating systems installed on their roofs, and since 1998 half of the new installations have been so-called “combi systems”, which provide space heating as well as domestic hot water, enabled by advances in technology that achieve higher solar yields. Austria has also pioneered solar-assisted, biomass-fuelled district-heating systems.

There is a large internal market for solar systems in Austria that has been stimulated by high energy costs and its citizens’ high level of environmental awareness. The Austrian government has also introduced financial incentives for the installation of solar-thermal systems. This has resulted in a large manufacturing base and created a competitive local market, which in turn has led to the production of quality products and an increase in sales to other countries.

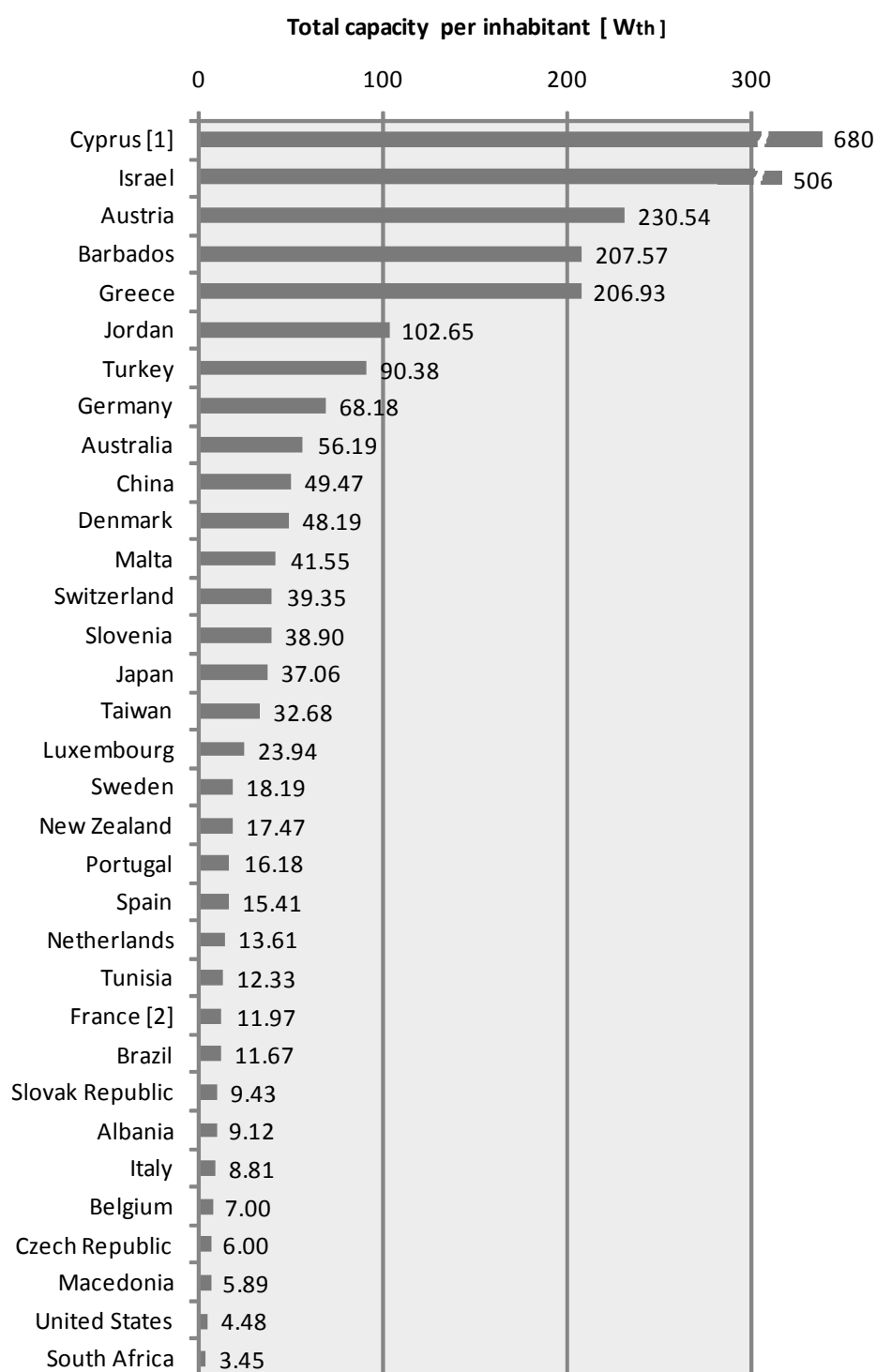
Germany is the world’s second leading importer of solar collectors. Several German states (*Länder*) offer subsidies for solar collectors. These range from around € 125 to € 200 per square metre of installed collector space (Annex IV).

The US solar water-heating and solar space-heating market showed moderate growth between 1997 and 2003, due to funding for solar-thermal equipment being reduced each year, and competition from the photovoltaic initiative (PV:BONUS). Between 2003 and 2006, however, domestic shipments almost doubled (Figure 15). In 2006 the US Federal Government introduced financial incentives for residential solar water-heating systems. That, together with the rising cost of conventional energy, is expected to have spurred growth in demand of around 50% in 2007. For products to qualify for the federal financial incentive, solar collectors are required to be certified by the Solar Rating and Certification Corporation (SRCC). Since the introduction of the financial incentive, SRCC has seen an increase in products being certified and an increase in the number of products entering the US market. However, US manufacturers have stated that with a limited time for the incentive, they are unlikely to be able to increase production substantially. Three-quarters of all domestic shipments are to Florida, California or Nevada. Hawaii and the Commonwealth of Puerto Rico also have a large number of installations (SEIA, 2006).

**Figure 14. Annual domestic shipments of solar thermal collectors in the United States, 1997-2006**

*Data source:* Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

The potential for developments beyond these markets is huge. Figure 16 shows that two countries, Cyprus and Israel, have solar-heating capacities in excess of 500 Watts per inhabitant. Even relatively northern Austria has achieved 230 Watts per inhabitant. By contrast, countries with abundant solar insolation, like Portugal, Spain, Brazil and South Africa still have less than 25 Watts per habitant. Growth in these former two countries has been fast, with increases of, respectively 25% and 50% in Portugal and Spain in 2007 (ESTIF, 2008).

**Figure 15. Total capacity of solar collectors per capita, by country as of the end of 2006**

1. See footnotes 17 and 18 in the text.

2. Includes Overseas Departments.

Data source: Weiss et al. (2008).

### **Domestic regulatory issues**

The IEA (2006) mentions that information available to builders and home-owners about total costs is often inadequate, and high initial costs can be a barrier. Consumers often doubt that the heating system will operate as effectively as what it replaces. In many countries, service, distribution and installation are poor, retarding the uptake of SHC technologies.

To overcome some of these barriers, the IEA (2006) suggests revising building codes in a way that is more favourable to the use of solar heating and cooling. Improving information and technical advice for consumers, and supporting training and accreditation programmes for installers, can help increase consumer confidence in the performance of the technology over its lifetime. Demonstration projects have been shown to be useful in countries that have a low rate of market penetration, especially for commercial (e.g., hotel operators) and public (e.g., hospitals) sectors.

### **Trade measures**

A UK-based exporter of evacuated heating pipes has indicated that different certification processes pose the biggest challenge to their exports to the European market. Even in the EU, their products are required to be tested by different certification bodies for different countries. For instance, even if their products have obtained the Solar Keymark certification, the pan-European voluntary third-party certification mark that demonstrates to users and consumers that a product is in conformity with the relevant European Standards, some European countries still require a specific certification process. As a result, the cost for certification can be significant. Obtaining Solar Keymark certification alone costs them € 15 000–20 000 per product, plus annual maintenance fees. The exporter estimates that it incurs additional costs of approximately € 45 000 in conforming to multiple certification procedures. Moreover, having to meet the requirements for different certification processes slows down their sales and hampers their ability to penetrate the market with new products. The respondent felt that countries, at least in Europe, should automatically recognise certification by the Solar Keymark Scheme, as proof of conformity with a recognized international standard.

Another manufacturer of solar panels contacted for this study, a German company that has been trading and manufacturing solar thermal products for around 30 years, mainly addressed technical product regulations and approval procedures. The respondent stated that, even though there is a common test standard for European countries, some individual countries, such as France, require that their own standards be applied. Showing conformity with these standards results in delays in products being exported to these countries, and also increases costs.

## ENERGY-EFFICIENT MOTOR SYSTEMS

Electric motor-driven equipment consumes around 70% of electricity used in the industrial sector and 40% of total electricity worldwide (Brunner, 2007). Electric motor systems<sup>19</sup> comprise a range of components centred on a motor-driven drive. According to the IEA (2007), advanced electric motor systems typically deliver 20-25% more horsepower per kWh consumed than the motors they replace.

If all existing electric motors in the world were to operate at such efficiencies, global demand for electricity would fall by 7%. The efficiency of electric motors and systems is typically improved by precision manufacturing, and improvements in design and operating characteristics.<sup>20</sup> The efficiency of any motor can be further improved through proper maintenance (regular inspection and care of mechanical and electric parts); ensuring a high-quality power supply (which assures a continuous supply, small variations in voltage, balanced phases, etc.); and eliminating unnecessary operation and loads.

Electric motors and core motor systems (electric motor plus integrated or combined pump, fans and compressor, adjustable speed drive, gears, etc.) are standard products that are globally traded.

### Key markets and policy drivers

The total global stock of electric motors has been estimated to be around 300 million pieces of equipment, with Europe (88 million) accounting for the biggest share (De Almeida et al., 2007) followed by Japan (64 million), China<sup>21</sup> (57 million), and the USA (35 million) (Boteler, 2007). Brazil has around 9 million (Schaeffer, 2005).

The leading manufacturers of large motors include the United States, the EU (Germany, Finland, France, Italy, Poland, Sweden, and the UK), Switzerland, Brazil, India, Japan and China (De Almeida et al., 2007). Annual sales of electric motors are estimated at around 30 million pieces, worth some USD 20 billion per year (Brunner, 2000). Europe accounts for almost half of all sales (Table 4).

Trade flows of motor systems between different regions are not well documented. It can be estimated from available data that between 7 and 10 million electric motors with an end-user value of from USD 5-8

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<sup>19</sup> The study covers 0.7 to 500 kW electric motors powered directly from the regular electric grid at between 100 to 1000 volts, and run in continuous duty (between 2 000 and 8 000 hours per year) and used in industry (energy-intensive sectors such as steel, chemicals or aluminium), public works and large buildings. It does not cover smaller (fractional — i.e., below 0.7 kW), 1-phase electric motors that are used in household appliances or in office equipment, etc. And it does not cover motors used in vehicles. Nor does the study cover the total drive system (complete heating or ventilating systems and their associated piping, ducting, etc.) that is installed locally according to specific design requirements.

<sup>20</sup> Some of the design features include: electronic controls that enable the motor output to adjust itself more closely to varying loads during operation and start-up; adjustable speed drives; state-of-the-art transmissions, using gears and fluids that minimize friction losses; precision manufacturing and the incorporation of more active materials (copper, aluminium, steel) into the motor.

<sup>21</sup> Database from A+B International, 2007.

billion are traded internationally every year. Among the five leading motor-producing countries and regions, Europe (the EU and EFTA) is the biggest exporter, followed by Japan and China.

**Table 4. Global sales of electric motors**

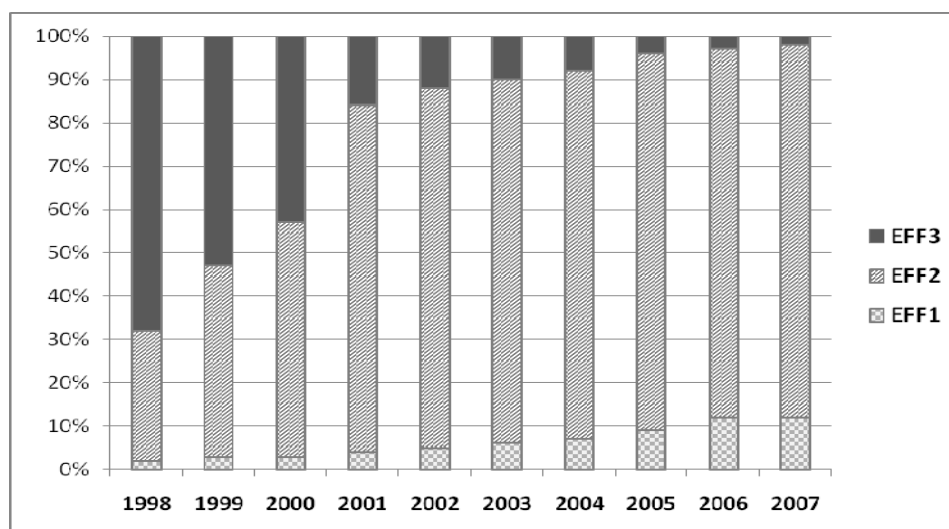
(thousands of pieces per year)

Countries	Production	Exports	Imports	Net domestic sales	Year
Europe	8 100	4 100	5 100	9 100	2005
Japan	6 400	1 200	2 800	8 100	2005
China	5 700	800	700	5 600	2003
USA	1 600	n.d.	n.d.	1 600	2006
Brazil	n.d.	n.d.	n.d.	1 300	2006
India	n.d.	n.d.	n.d.	1 000	2005
Thailand	454	103	441	792	2004
South Korea	n.d.	n.d.	n.d.	400	2006
Australia	16	19	310	310	2004
Malaysia	49	68	35	64	2004

Sources: ● **Europe:** De Almeida (2007); ● **Japan:** JEMA (2006) ; ● **China :** CNIS (2006) ; ● **USA:** Boteler (2007) ; ● **other countries:** AGO (2005) .

In Europe, the market share of EFF 3 (below standard efficiency) motors of between 1.1 and 90 kW declined substantially between 1998 und 2001, those of EFF 1 (high efficiency) and EFF 2 (standard efficiency) motors increased over the same period (Figure 16). This can be largely attributable to the introduction of a voluntary agreement between the European Commission and the CEMEP<sup>22</sup> on an efficiency classification scheme (EFF 1, EFF 2 and EFF 3) in 1999 with the goal of reducing the market share of the lowest-grade motors by 50%. This classification scheme has been superseded by a new international motor-efficiency classification nomenclature, created by the International Electrotechnical Commission, which uses IE 2 (high efficiency) and IE 1 (standard efficiency) in place of EFF 1 and EFF 2.

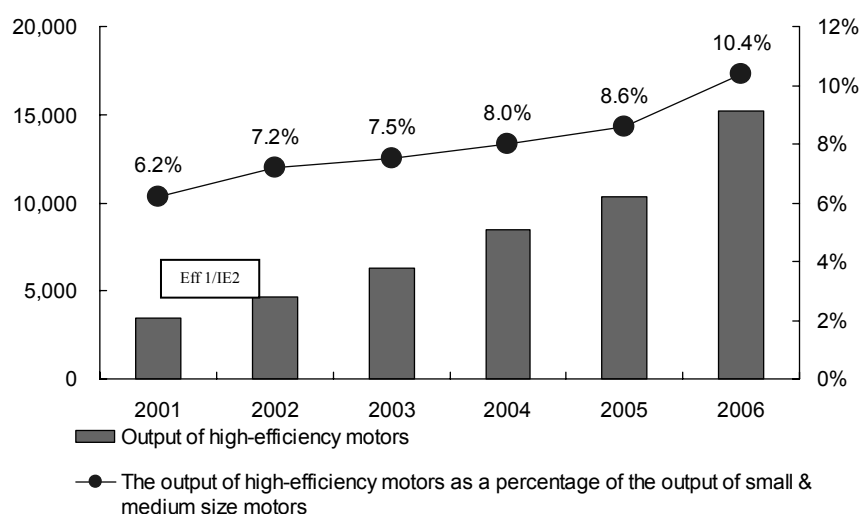
<sup>22</sup> Comité Européen de Constructeurs de Machines Electriques et d'Electronique de Puissance.

**Figure 16. Market share of EFF-motors under the scope of the Voluntary Agreement of CEMEP**

Note: Motors covered by CEMEP's Voluntary Agreement are defined as totally enclosed fan ventilated (IP 54 or IP 55) 3-phase A.C. squirrel-cage induction motors of 1.1 to 90 kW, with 2 or 4 poles, rated for 400 V-line, 50 Hz, S1, Duty Class, in standard design. Standard design can be interpreted as type N as per EN 600 34-12 and according to HD 231.

Source: CEMEP: [http://www.cemep.org/fileadmin/downloads/agreement\\_1998-2007.pdf](http://www.cemep.org/fileadmin/downloads/agreement_1998-2007.pdf)

The development of China's market for electric motors shows a slow increase in the market share of IE 2 motors, from 6.2% in 2001 to 10.4% in 2006 (Figure 17). China adopted a minimum energy performance standard (MEPS) for electric motors in 2002, and improved it in 2006, but has yet to enforce it.

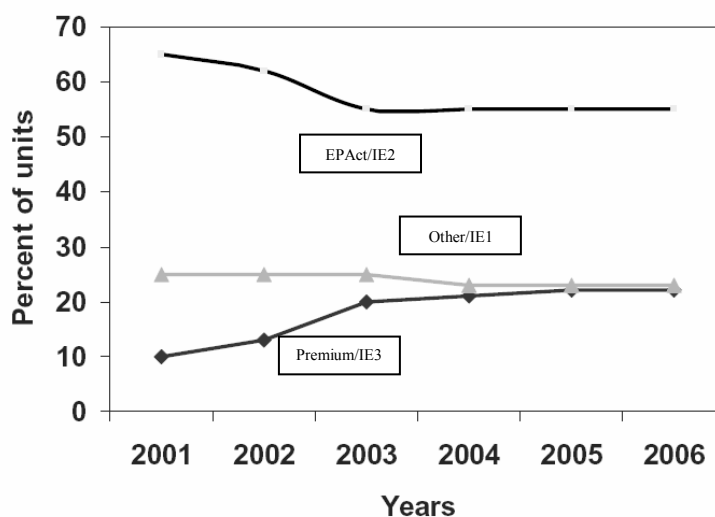
**Figure 17. Evolution of market shares for new high efficient (IE2) electric motors in China**

Source: ICA (2007).



Thanks to the introduction of mandatory MEPS on IE 2 in 1992<sup>23</sup>, the market share for highly efficient electric motors the United States reached 20% for IE 3 and 55% for IE 2 in 2006 (Figure 18), compared with 9% in Europe and 10.4% in China (10.4%). In the last three years, federal government-procurement programs have also boosted the market share of IE 3. At present, the US Congress is discussing legislation that would apply MEPS to IE 3 motors by year 2011, which would provide a further boost to the market for energy-efficient motors.

**Figure 18. Market development for new electric motors in the USA (NEMA members)**



Source: Boteler (2007).

The combination of technological advances and mandatory MEPS has caused a sea change in the global market for electric motors. Manufacturers have responded by redesigning their products, and rising electricity prices and growing awareness among buyers of the energy-saving potential of the latest motor designs have also increased the range of high-efficiency motors. Studies have shown that countries that have adopted mandatory MEPS, such as the Australia, Canada, New Zealand, and the United States, have achieved much greater market-penetration rates for high-efficiency motors than countries that have not.

The adoption of MEPS in China and Europe, together with new universal (IEC) testing standards for electric motors and four efficiency classes will lead shortly to a more transparent market situation and eventually to a larger share for highly efficient motors, particularly those in the IE 3 and IE 2 classes (Table 5). In February 2009, Boteler et al. (2009) published a “Motor MEPS Guide” which provides a checklist for engineers, motor users, manufacturers and regulators developing MEPS in harmony with existing national and international standards.

<sup>23</sup> Its enforcement only began in 1997.

**Table 5. Motor efficiency classes, testing standards and implemented and announced MEPS in 2008**

Efficiency Levels	Efficiency Classes	Testing Standard	Performance Standard
	IEC 60034-30	IEC 60034-2-1	Mandatory
	Global 2008	incl. stray load losses 2008	Policy goal
Super Premium efficiency	IE4		
Premium efficiency	IE3		USA 2011
High efficiency	IE2		USA
			Canada
			Mexico
			Australia
			New Zealand
			Korea 2008
			Brazil 2009
	China 2011		
	Europe 2011?		
Standard	IE1	China	
		Brazil	
		Costa Rica	
		Israel	
		Taiwan	
		India	

Source: Brunner (2007).

### Domestic regulatory issues and information barriers

According to the IEA (2008a), electricity costs are normally a secondary consideration for all but the most energy-intensive industries. Industrial plants focus on production, not energy efficiency, and production managers tend to be reluctant to change systems with which they are familiar and which work satisfactorily. Especially among small and medium-sized enterprises, lack of awareness of potential energy-saving opportunities may be an issue. Often the budgets for energy efficiency investments and for paying energy bills are kept separate, so the potential for efficiency savings may not be obvious. A related problem is that the market tends to focus on components, not systems. Production managers generally do not have the expertise to provide solutions, even if they were to recognise the potential for energy savings.

### Trade measures

Annex V lists the responses to a questionnaire on NTMs sent out by a consultant engaged by the OECD to five major motor manufacturers (1 from China, 2 from USA and 2 from Europe). This section summarizes these responses. An important caveat to the interpretation of these responses is that the terminology and the definition of a non-tariff trade measure was not always clear to the respondents. The boundary between what was considered an NTM, and what was considered merely a nuisance, or a time-consuming and costly obstacle, was often a judgment call. For that reason, the accurateness, completeness, and importance of their answers cannot be vouchsafed.

Table 6 summarizes the “yes” or “no” responses given to whether the companies encountered NTMs.

**Table 6. NTMs encountered by the 5 surveyed motor and motor system manufacturers**

	<b>Trade Barriers International</b>	A	B	C	D	E	total
1	Pre-shipment inspection and customs procedures	(yes)	yes	yes	yes	yes	4
2	Quantitative import restrictions (Import licensing, Import quota or prohibitions)	no	yes	no	no	no	1
3	Import surcharges or border taxes	(yes)	no	yes	no	yes	2
4	State-trading monopoly or state monopoly control of imports	no	yes	no	no	no	1
5	Cargo handling and port procedures or requirements	no	yes	no	yes	yes	3
6	Technical product regulations, standards and approval procedures	yes	yes	yes	yes	yes	5
7	Restrictions on investment	no	yes	no	no	no	1
8	Restrictions on after-sales services	no	yes	no	no	yes	2
9	Price controls or administered pricing in destination market	no	yes	no	no	no	1
10	Regulations on payment; restrictive foreign exchange allocations to importers	no	no	yes	no	no	1
11	High or discriminatory taxes or charges in destination market	(yes)	yes	yes	yes	no	3
12	Subsidies or tax benefits given to competing domestic firms in destination country	no	yes	no	no	no	1
13	Violation of intellectual property protection	no	yes	yes	yes	no	3
14	Government procurement procedures in destination market	no	no	no	no	no	0
15	Informal "additional payments" required to effect import of your product	no	no	no	yes	no	1
	total	1	11	6	6	5	29

1. The answer (yes) above means that, after second thoughts, manufacturer A considered these barriers as "only tiring and cumbersome procedures that could not be clearly called trade barriers."

Respondents identified 13 countries by name as having NTBs that they considered to be problematic: Argentina, Belarus, Brazil, Chile, China, Ecuador, Norway, Mexico, Philippines, Russia, Turkey, Ukraine, and Venezuela. The NTMs of Brazil and Mexico were mentioned by several manufacturers. For example, a Europe-based global manufacturer of motors and generators (Case Study No. EEM-1) indicated that Brazil's national standards (NBR) seem to favour domestic suppliers since the NBR requires testing and certification additional to that required to be certified to the International Electrotechnical Commission (IEC) standards. The NBR requirement has increased the manufacture's export costs into the Brazilian market by 10%, as the standards require changes in the manufacturing process. Motors exported to Brazil also face high import tariffs.

Another Europe-based global manufacturer indicated that meeting the requirements for the Saudi Arabian Standards Organisation (SASO) standards applying to ventilators impose additional costs on exports to that country. Under SASO standards, products such as automotive parts, chemicals and electrical and electronics must meet essential standards relating to safety, national security and the Islamic religion. Most of the SASO standards are based upon the safety testing of IEC standards and where no applicable Saudi standards exist, an acceptable international standard may have been approved by SASO. However, SASO has its own national differences because of climatic and geographical conditions.

## CONCLUDING OBSERVATIONS

This study provides an initial, qualitative, examination of tariff and perceived non-tariff barriers to trade in several important climate-change mitigation technologies (CCMTs). Because of the small sample size, and the largely qualitative nature of the responses, the results of these surveys should be treated as only indicative. Nevertheless, they do suggest that NTMs are hindering trade in some CCMTs, and that the importance of those NTMs are greater in the case of some countries than others.

Among the most common NTMs cited by the respondents were technical regulations applied by the importing country that differed from international standards. These were mentioned by companies involved in all of the CCMT segments surveyed. Producing to different standards can add to manufacturing costs, but also often requires undertaking additional testing to demonstrate conformity with the standards. Even where technical regulations are similar or unified, exporters may be required to undertake separate testing. In the case of solar heating and cooling (SHC) systems sold in the EU, where there is a pan-European voluntary third-party certification mark, some importing countries still require their own certification of products in addition. In the case of some power-generation technologies, differences in the ways that countries measure thermal efficiency are a particular issue for CHP.

DHC systems are typically owned and operated by government entities, and exporters sometimes encounter bidding procedures that are non-transparent. Some exporters also expressed a sense that preference was being given to domestic over foreign suppliers.

These findings are consistent with earlier work on trade barriers to environmental goods more generally, which found that the most important barriers to trade and investment are technology-specific.

A number of exporters also mentioned NTMs that are not technology-specific, indeed not targeted at any sector in particular. Perhaps the most common complaint was the *inadequacy of systems for protecting intellectual property rights* (IPRs) in some major importing countries, particularly China. Where this is the case, counterfeit copies of goods (including computer software) manufactured by the exporter are often tolerated by the national authorities, and enforcement of violations is weak. Their concern over this problem was so great that several companies said that they were refusing to sell certain technologies in the problematic countries.

Border measures that affect the ability of companies to carry out *after-sales service* quickly and at least cost were mentioned explicitly by manufacturers of CHP systems, but probably apply equally to manufacturers of many other technologies. A common complaint included the high cost of obtaining temporary visas for specialist technicians. Use of local labour is still sometimes demanded in international tenders.

Other NTMs that the companies reported having encountered, such as lengthy *customs-clearance procedures*, were considered to be occasionally important but generally more of the nature of a nuisance.

Where trade barriers added to costs, many exporters said that they were able to pass on those costs to their foreign customers. But increasing costs is not the only inefficiency created by trade barriers. Some are less apparent because the company concerned will simply avoid exporting to countries with high trade barriers. Indeed, as with the exporters of environmental goods and associated services (Fliess and Kim,

2007a), it would appear that what firms mostly do in response to NTMs is to devise ways to cope with the difficulties that they encounter, rather than seek help from their home governments.

The measures that importing nations could take to address the technology-specific barriers include reducing or eliminating tariffs on CCTMs, and aligning their technical regulations with international standards. The latter action may not always be simple or possible, however, if no dominant international standard exists. Thus there may be a role for international co-operation on harmonizing standards for particular technologies, and negotiating bilateral or multilateral agreements on recognizing testing results. The Standards for Energy Efficiency of Electric Motor Systems (SEEEM) project to harmonize MEPS for motors is one such example. The fruits of that effort, plus the continuous work on global testing and classification standards in the IEC and the new IEA Implementing Agreement 4E, should start to be seen in the next one to three years when full compliance with the agreed new IEC testing standard and with the new IEC energy classification standard (to be finalized by 2008) becomes widely accepted.

Overcoming some of the general barriers is going to take time. However, the problems that lax IPR enforcement, cumbersome customs-clearance procedures and non-transparent government procurement create for trade in CCTMs should provide yet another reason for addressing them urgently.

Finally, importers may need, at the same time, to examine their domestic policies in order to address behind-the-border measures that impede the diffusion of the aforementioned technologies. It is a commonly held view among the CHP companies interviewed, for example, that trade barriers are less important constraints in the CHP market and export development than the specific national policy and regulatory barriers that face CHP in most countries. Thus the reform of these domestic measures will probably have a greater impact on promoting CHP trade than the removal of trade barriers. Ending rules that discriminate in favour of centralised, large-scale power production is often the most important step necessary to encouraging the spread of CHP, for example. For other technologies, overcoming information barriers may be what is most needed.

This survey sheds some light on the effects that NTMs are having at the level of individual exporters of certain CCTMs. Further research both to expand the sample size and on additional sectors would lend more confidence to the results.

## BIBLIOGRAPHY

- Aki, Hirohisa (2007), “The penetration of micro CHP in residential dwellings in Japan”, Power Engineering Society General Meeting, 2007, 24-28 June 2007, pp:1 – 4. Digital Object Identifier 10.1109/PES.2007.385625.
- Bate, Roger and W. David Montgomery (2004), *Beyond Kyoto: Real Solutions to Greenhouse Emissions from Developing Countries*, American Enterprise Institute for Policy Research, Washington, D.C.
- Benkhart, B. (2006), “Overview of NEMA premium motors in the USA”, in *Proceedings: IEA Electric Motor Systems Workshop*, Paris, France.
- Boteler, R. (2007), “NEMA Premium Update”, in Proceedings EEMODS’07, Beijing, China.
- Boteler, R, C.U. Brunner, A. de Almeida, M. Doppelbauer and W. Hoyt (2009), *Electric Motor MEPS Guide*, Zurich, Switzerland.
- Brechlin et al. (2003), *Sun in Action II: A Solar Thermal Strategy for Europe*, Vol.2, Brussels, European Solar Thermal Industry Federation.
- Brunner, C.U. et al. (2007), Standards for efficient electric motor systems - SEEEM, building a worldwide community of practice, in *Proceedings: EEMODS’07*, Beijing.
- Buckley, Neil (2008), “Russia curbs foreign investment in key sectors”, *Financial Times*, 5 May 2008.
- CEMEP, (2007), The proactive role of the motor industry in the field of energy efficient motor driven systems, in *Proceedings: EEMODS’07*, Beijing.
- CNIS (2006), Technical Supporting Report for National Standard Revision for Electric Motors in China, Beijing.
- COGEN Europe (2005), *Micro-CHP Fact Sheet: Germany*, The European Association for the Promotion of Cogeneration, Brussels.
- De Almeida, A. (2007), Generic economic data of low voltage AC motors in the EU 15, personal communication, 2007.
- De Almeida, A., et al. (2007), Energy-using Products Lot 11 Motors, Coimbra, Portugal.
- EBI (2008), *Climate Change Business Journal* (Environmental Business International), San Diego, California, March/April, pp. 1 & 20-21.
- ESTIF: European Solar Thermal Industry Federation (2008), *Solar Thermal Markets in Europe: Trends and Market Statistics 2007*, European Solar Thermal Industry Federation, Brussels, Belgium.

Euroheat & Power (2007), *District Heating and Cooling: Country by Country Survey 2007*, The International Association for District Heating, District Cooling and Combined Heat and Power, Brussels.

Fliess, Barbara and Joy Kim (2007a), *Business Perceptions of Non-Tariff Barriers (NTBs) Facing Trade in Selected Environmental Goods and Associated Services—Part I: Survey Results*, OECD Trade and Environment Working Paper No. 2007-02. Paris; OECD.

Fliess, Barbara and Joy Kim (2007b), *Business Perceptions of Non-Tariff Barriers (NTBs) Facing Trade in Selected Environmental Goods and Associated Services—Part II: Findings of Ten Country Studies*, OECD Trade and Environment Working Paper No. 2007-02. Paris; OECD.

Han, P.-W. et al. (2007), “Minimum energy performance standards for three-phase induction motors in Korea”, in *Proceedings: EEMODS’07*, Beijing.

ICA (2007), Current Market Situation of Chinese Energy efficient Motors, in *Proceedings EEMODS’07*, Beijing.

IEC 60034-2-1 (2007), *International Standard - Rotating Electrical Machines - Part 2-1: Standard Methods for Determining Losses from Test*, International Electrical C, Geneva, Switzerland.

IEC 60034-30 (2007), *International Standard - Rotating Electrical Machines - Part 30: Efficiency Classes of Single Speed, Three-Phase, Cage-Induction Motors (IE-code)*, second draft, Geneva, Switzerland.

IEEE 112 (2004), US Standard Test Procedure for Polyphase Induction Motors and Generators, New York.

IEA: International Energy Agency (2005), *Energy Statistics Manual*, IEA/OECD, Paris.

IEA (2006), *Industrial Motor Systems Energy Efficiency: Towards a Plan of Action*, IEA/OECD, Paris.

IEA (2007), *Tacking Industrial Energy Efficiency and CO<sub>2</sub> Emissions*, IEA/OECD, Paris.

IEA (2008a), *Energy Technology Perspectives 2008*, IEA/OECD, Paris.

IEA (2008b), *Combined Heat and Power: Evaluating the Benefits of Greater Global Investment*, Paris; IEA/OECD.

IEA (2009), *Cogeneration and District Energy: Sustainable Energy Technologies for Today...and Tomorrow*, IEA/OECD, Paris.

IPCC: Intergovernmental Panel on Climate Change (2007), *IPCC Fourth Assessment Report*, Working Group III. Available at: [http://www.mnp.nl/ipcc/pages\\_media/AR4-chapters.html](http://www.mnp.nl/ipcc/pages_media/AR4-chapters.html)

JEMA (2006), *Electrical Industries in Japan, power & industrial apparatus*, Tokyo, Japan.

Kiel, E. (2005), “Energy saving potential in motor driven systems”, in *Proceedings: EEMODS’05*, ZVEI, Heidelberg, Germany.

Konishi, K. (2007), Electric motor production and export in Japan 2005, personal communication).

- Mani, Muthukumara, Chandrasekar Govindarajalu, Hiau Looi Kee, Sunanda Kishore, Eri Tatsui, Cizuka Seki, Sachiko Morita, and Mahesh Sugathan (2007), *Warming Up to Trade? Harnessing International Trade to Support Climate Change Objectives*, The World Bank, Washington, D.C.
- USITC: United States International Trade Commission (2005), *Renewable Energy Services: An Examination of U.S. and Foreign Markets*, USITC Publication 3805, USITC, Washington, D.C.
- USTR: Office of the United States Trade Representative (2006), “Report by the Office of the United States Trade Representative on trade-related barriers to the export of greenhouse gas intensity reducing technologies”, USTR, Washington, D.C.
- Ryan, P. (2005), *Benchmarking of Electric Motors in Five Asian Countries*, Australian Greenhouse Office, Canberra, Australia.
- Schaeffer, R., et al. (2005), *Assessment of Energy efficiency Performance Standards for Three-Phase Induction Motors*, Rio de Janeiro Brazil.
- SEIA (2006), *US Solar Industry Year in Review*, Washington DC; Solar Energy Industries Association.
- Seo, H. (2007), “Korea’s MEPS Plan for High Efficiency 3-Phase Induction Motors”, in *Proceedings: Motor Summit 2007*, Zurich Switzerland
- Soares, G. A. (2007), “Brazilian Industrial Energy Efficiency Program, focus on motor driven systems”, in: *Proceedings EEMODS’07*, Beijing China.
- Tébar Less, Cristina (2005), *Achieving the Successful Transfer of Environmentally Sound Technologies: Trade-Related Aspects*, OECD Trade and Environment Working Paper No. 2005-02. Paris; OECD.
- Weiss, Werner, Irene Bergmann and Gergard Faninger (2008), *Solar Heat Worldwide: Market and Contribution to the Energy Supply 2006*, AEE-Intech for the Solar Heating & Cooling Programme of the International Energy Agency, Gleisdorf, Austria.
- Wikström, Per (2008), “Impact of motor drives on energy efficiency”, Zurich (unpublished).
- World Alliance for Decentralised Energy (2006), *World Survey of Decentralised Energy*.
- WRI: World Resources Institute (2006), “Government Incentives for Renewable Energy in Europe”, Washington, D.C.
- Zhou, V. et al. (2007), “Current market situation of Chinese energy-efficient motors”, in *Proceedings: EEMODS’07*, Beijing China.
- Zumbrun, Joshua (2008), “The most efficient power plants”, *Forbes*, 7 July 2008.



## ANNEX I. SELECTED MITIGATION TECHNOLOGIES BY SECTOR

Sectors	Technology	Components
Energy supply	Combined heat and power (CHP) systems	<ul style="list-style-type: none"> <li>• Prime movers (steam turbines, gas turbines, combined-cycle systems, reciprocating engines)</li> <li>• Generators</li> <li>• Gearboxes</li> <li>• Boilers</li> </ul>
Buildings	District heating and cooling (DHC) systems	<ul style="list-style-type: none"> <li>• Heat distribution pipes (pre-insulated pipes, steel and plastic pipes)</li> <li>• Heat meters</li> <li>• Joints</li> <li>• Sophisticated moisture surveillance techniques</li> <li>• Water-quality equipment</li> <li>• Sub-stations</li> <li>• Customer connections (secondary pipes and hydraulic interface units)</li> </ul>
	Solar heating and cooling (SHC) systems	<ul style="list-style-type: none"> <li>• Solar collector (unglazed, glazed flat plate, standard flat plate, evacuated tubes)</li> <li>• Combi systems</li> <li>• Solar systems and components (i.e. direct domestic hot water (DHW), twin coil, preheat DHW, drainback and pressurised systems)</li> <li>• Cooling technologies (single-and double-effect absorption chillers, absorption chillers, solid or liquid desiccant systems)</li> </ul>
Industry	Energy efficient motor systems	<ul style="list-style-type: none"> <li>• High-efficiency motors for compressor, pump, fan and traction such as Premium AC induction motors, permanent magnet motors, copper rotor motors, switched reluctance drives and written pole motors</li> <li>• Speed control devices for varying loads such as adjustable speed drives (ASDs)</li> <li>• High-efficiency transmission systems like gears and belts</li> <li>• Equipment that is driven by the motor (pumps, fans, compressors, conveyor belts, etc.)</li> </ul>

## **ANNEX II. DETAILS OF RESPONSES FROM EXPORTERS OF CHP EQUIPMENT**

### **Survey procedure**

For the purpose of this study, four large international manufacturers and exporters of prime movers for CHP (natural gas or oil-fueled reciprocating engines or gas turbines) were selected and invited to answer (by the end of February 2008) a questionnaire on trade barriers that had been prepared by the OECD Secretariat.

### **Case Study No. CHP-1**

This mid-sized company has been exporting gas engines, including for CHP application, since 1958; its home market represents just 1% of its turnover. According to this company, 15% of its total turnover is affected by trade barriers, mainly in Asian countries. These trade barriers have not prevented export sales, but they have increased the exporter's costs.

The company has encountered, for example, restrictions on after-sales services in Bangladesh and Pakistan (and to a lesser extent Singapore). These affected the overhaul of gas engines for CHP, of which there are 600 units in Pakistan and 200 in Bangladesh. For the maintenance of these gas engines this company has to provide a local service because high export taxes make it unfeasible to send the engines back to the company's headquarters. Therefore, service partners have to be trained, creating additional costs. They are also sometimes required to use local labour and inputs.

Another barrier has been onerous visa requirements. Visas for company staff are expensive (approximately € 200 per person in most countries). With 100 units installed per year in Asia, this amounts to an added expense of around € 20,000 per year. The company mentioned Singapore as having particularly costly visa requirements.

In China, and to a lesser extent India, the company has had to deal with violations of protection of intellectual property. Pirate copies of software and spare parts are produced or circulate in many export markets, a practice that is tolerated by some governments. It is a particularly significant problem in China and to some extent in India. Often there are no procedures for penalizing deliberate acts of counterfeiting, or sanctions against counterfeiting are inadequate.

### **Case Study No. CHP-2**

This company, a producer of diesel, oil and gas engines for CHP applications, has been selling its products in the international market since the early 1970s and gas engines since the late 1980s. The company has no specific internal measures for dealing with trade barriers: each problem is dealt with on a case-by-case basis and all necessary procedures are checked meticulously. Trade-barrier costs and issues tend to be transferred, as far as possible, to the customer.

The company asserts that delays related to preshipment inspection and customs procedures have in the past slowed down the delivery of exported equipment to Turkey and, to a lesser extent, to African countries such as Sudan, Tanzania and Kenya. These delays have improved over the last few years, however. In India, high import tariffs, combined with additional customs-clearance costs, convinced the company to establish a factory in India for serving that country's domestic market.

Technical regulations and standards in the company's export markets often differ from those in its home-market. Each country tends to have different regulations for fire-fighting systems, for example. Within the EU, regulations are typically standardised. In the United States, by contrast, its regulations differ from one state to another. In the company's opinion, these differences slow down the spread of CHP systems across the United States, as each system has to be adapted to the local situation. Another example is pressure-vessel regulations linked to heat recovery. Because labelling and packing requirements are not standardised worldwide, the company sometimes encounters delays in customs clearance.

The company has encountered restrictions on investment in India and certain Middle Eastern countries for oil and gas engines for CHP, including parts. These pertained to local establishment and ownership restrictions. Some Middle Eastern countries, such as Yemen and Saudi Arabia, give preference to locally established companies.

### **Case Study No. CHP-3**

This company has been active in international markets for over a decade, exporting fuel cells and micro-turbines for CHP applications. Generally, the company exports only to countries wherein it is the sole owner of the product. It is wary of partnerships with local firms and takes a careful, step-by-step approach to exporting its unique products.

Violations of property rights in China (and to lesser extent in India and South Korea) were mentioned by the company as a serious concern. Pirate copies are produced or circulate in the export market, and counterfeit trademarks exist; both are tolerated by some governments. Protection of the exclusive rights conferred by patents or industrial designs is often weak or non-existent. Because the company has decided not to sell certain advanced or innovative products to these markets, there is limited scope to partner fully with local companies.

### **Case Study No. CHP-4**

This company has been exporting CHP gas turbines and parts (e.g., for gas compressor overhaul and replacement) for more than 30 years, and sells in all continents. Generally, trade barriers are an issue for the company, though it considers the cost impacts of the barriers to be fairly low. Customs and other related procedures are assessed internally and discussed with the client and relevant government agencies. All custom surcharges and trade barrier costs are then passed on to the client.

The company complained about pre-shipment inspection and customs procedures in Mexico, Turkey and Nigeria and, to a lesser extent, other African countries. These include the misclassification of products or origin of products by customs officials, and difficulties in obtaining information on the rules and regulations of the export market, both of which can lead to delays in customs clearance. The company claims that, in Mexico, tariffs are sometimes determined only by reference to the brand name.

Restrictions on investment have been an issue for the company in Russia, Indonesia and Malaysia. To enter the Russian market, the company had to be established locally through a joint-venture to overcome legislation and other market constraints that favour domestic companies. In Indonesia, the company has had to establish a joint venture for the same reasons.

Violation of protection of intellectual property in export markets has been a comparatively minor issue for this company, and mainly affects its exports to emerging markets, such as China and, to a lesser degree, Brazil, Indonesia, Malaysia, Mexico and Nigeria. Typically in these countries, according to the company, sanctions against deliberate counterfeiting acts are weak.

### ANNEX III. DETAILS OF RESPONSES FROM EXPORTERS OF DHC EQUIPMENT

#### Survey procedure

For the purpose of this study, thirteen Danish manufacturers and exporters of equipment for district heating and cooling (DHC) equipment were contacted and asked to complete a comprehensive questionnaire regarding barriers to international trade that had been prepared by the OECD Secretariat. The questionnaire was e-mailed to senior management within these organisations, and given until February 2008 to complete the surveys. In the event, only three companies responded. Follow-up telephone calls were then made to the respective individuals to check on progress and assist with the completion of the form.

#### Case Study No. DHC-1

This company has been exporting equipment for DHC for 25 years. One of the barriers it encounters frequently is different technical regulations for meters and other instrumentation. The markings on the meters are usually prescribed, with the type and size of the lettering and numbers often specified. This adds to costs by necessitating the modification of its instruments to serve specific markets. When exporting to Russia and CIS countries, the company has sometimes had its products misclassified. Delays related to a lack of automated customs clearance is a problem in China. China was also identified by the exporter as a country where pirated copies are produced or circulate and are tolerated by the government. An added barrier to exporting to China are subsidies provided to local producers. Finally, the company mentioned a concern about non-transparent bidding procedures in Eastern Europe and some of the Balkan countries.

#### Case Study No. DHC-2

This company has been operating for more than 100 years, producing various products. The company has encountered NTBs from time to time, but the effects of these on its costs are not especially large. Its main complaint is that EU technical standards are not recognized in China and Russia, which necessitates retesting of its products.

#### Case Study No. DHC-3

This company has been selling DHC equipment internationally for around 80 years, and has been exporting heat exchangers and complete sub-stations for around 40 years. It markets its equipment all over the world.

Among the NTBs it has faced are *delays related to lack of automated customs clearance* in countries such as Kazakhstan and Uzbekistan, and *lack of alignment with international standards* in Kazakhstan and Russia. Like several other exporters, it mentioned tolerance of counterfeit trademarks in China and Korea, and lack of enforcement of procedures to penalize said counterfeiters.

## ANNEX IV. GOVERNMENT INCENTIVES AND REGULATIONS FOR PROMOTING SOLAR HEATING AND COOLING IN SELECTED OECD AND NON-OECD COUNTRIES<sup>24</sup>

### Australia

Sales of solar water heaters have increased dramatically in Australia since 2001 when the federal government instituted a Mandatory Renewable Energy Target (MRET). Some States also provide support for solar water heaters by offering a subsidy for their installation. The IEA estimates that the value of the MRET and the state subsidies provide support worth a total of approximately AU\$30 million per annum. Electricity retailers, which had previously subsidized sales of solar water heaters, have cut back on these programs due to their ability to buy renewable energy certificates (RECs) at lower prices. This contributed to the reduction in the rate of increase in new installations in 2004 and 2005.

### Austria

The market penetration of renewables in buildings was supported by subsidies worth about € 50 million in 2004. Of that amount, about half was provided by local governments for the installation of **solar thermal systems** in homes. These subsidies covered 10%–40% of the investment costs. Federal grants, typically worth 30% of eligible costs, are provided to entrepreneurs investing in a wide range of renewable energy systems, including **solar thermal collectors** with a surface area greater than 10 m<sup>2</sup>.

Some 72% of the solar collector area for hot water preparation and residential space heating (11 328 m<sup>2</sup>, in 10 571 solar systems) installed in Austria in 2004 was subsidized. Additionally, about 11 210 m<sup>2</sup> of collector areas (255 solar systems) were financial supported in commercial and industrial buildings.

### Brazil

Several cities in Brazil are actively promoting solar hot water and cooling. Brazil's largest city, São Paulo, adopted a law in 2007 requiring in the installation of solar hot-water systems in all new buildings larger than 800 square meters. The city of Betim is installing solar hot water in all new public housing.

### Canada

The Province of Ontario provides up to CAD 5 000 in zero-interest loans to homeowners who retrofit solar-energy systems, including systems for solar hot water, on their homes. Ontario has set a target of having 100,000 solar water heaters installed on rooftops in the province by the early 2020s.

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<sup>24</sup> Based on Pamela Murphy, ed., *Solar Energy Activities in IEA Countries: A Report of the Solar Heating and Cooling Programme* (International Energy Agency, Paris, October 2006) and Renewable Energy Policy Network for the 21st Century, *Renewables 2007: Global Status Report* (REN21 Secretariat, Paris, 2008).

## China

China has a long-term national goal of having 150 million square meters of solar thermal panels installed in the country by 2010 and 300 million square meters by 2020 (compared with 100 million square meters in 2006). Achieving these targets would likely mean that over one-quarter of all Chinese households, as well as a significant share of commercial and public buildings, would be heating their water with solar energy by 2020. In addition, the Chinese city of Rizhao mandates solar hot water in all new buildings, and Shenzhen mandates solar hot water in new residential buildings below 12 stories in height.

## Denmark

Until the programme was ended in 2002 (after 25 years), Denmark subsidized up to a maximum of 30% of the cost of installing SHC systems. The government now feels that, after such a long period of government support, and with prices of oil and gas now much higher than they were prior to 2002, the technology is mature enough to compete commercially without government inducements.

## France

France's Plan Soleil (Solar Plan), created in 1999, emphasizes the development of partnerships between industry and installers, and between national and local public authorities. Plan Soleil has targeted three different applications: single-dwelling units for hot-water production (CESI), collective hot-water production (centralized plants) and space heating combined with hot-water production (solar combi-systems, or COMBI), applied mainly to detached houses. Plan Soleil provides financial incentives for installing systems and monitoring them, as well as professional training, communication campaigns, technical audits, on-site measurement programs, and tools for undertaking feasibility studies.

To be eligible for subsidies, ADEME (the French Agency for Environment and Energy Management) requires that the solar collector or system be certified (by French or European Solar-Keymark or an equivalent certifier), and installed by plumbers with specified professional skills (e.g., those from enterprises that had signed a "Qualisol" commitment). The national incentives through 2004 varied with the size of the SDHW unit; a system with 4 m<sup>2</sup> collector area and 200 litres of water storage would qualify for a subsidy of around € 900. In 2005 the national subsidies ("prime CESI" and "prime COMBI") from ADEME were replaced by a national tax-credit scheme. This scheme — which will run at least through 2009 — is open only to owners of principal residences. The rate of reimbursement of the net solar equipment purchase was 40% in 2005, and then raised to 50% in 2006 — again under the condition that the solar collectors benefit from an official certification. The scheme allows for total public financial support of up to € 8 000 (€ 6 400 in 2005) for a two-person family.

Demonstration projects have been carried out in France for several years to test and promote **solar combined space and water-heating systems with solar-heated floors** in single-family houses. (For many years this type of solar combi-system was called "Plancher Solaire Direct" or "PSD," after the sole French manufacturer of factory-made solar heating systems.) Public subsidies of up to € 2 000 per recipient were made available to individual buyers of standardized SCS systems, depending on the type of roof integration of the solar collector and on the availability of tested performance and global solar fraction of the SCS (determined through in-situ measurements. Other types of SCS, manufactured in Austria and Germany, began to become available in France from 2002.

ADEME has set up partnerships with Regional Authorities and some lower-level ones (Departments and municipalities) with the aim of providing additional incentives to buyers of SCS. Most Regional Authorities have agreed to give about € 1 000 per installation.

Subsidies covering up to 70% of costs (with a limit of € 2 300 or € 3 800, depending on the complexity of the study) are also provided by ADEME and regional authorities for technical studies of medium or large-scale hot-water plants. A large number of these studies have been performed, and a relatively high proportion of them has led already, or will probably lead, to investments to invest in solar plants.

## **Germany**

On 1 February 2002, the Energy Saving Regulation (EnEV) went into effect, tightening the upper limit of the total primary energy demand of new buildings by 30% compared with the previous building code (WSVO 1995), which had set a standard of 50-100 kWh/m<sup>2</sup>, depending on the surface/volume ratio of the building. The new regulation encourages both efficient heat generation and energy conservation. Energy supplied by solar collectors is not counted as part of total primary energy demand.

Germany's Renewable Energies Heating Law requires that, starting in 2009, all new residential buildings obtain at least 14% of their household heating and hot-water energy from renewable sources, which can include solar energy, biomass, or geothermal energy. Existing buildings will need to be retrofitted to meet 10% of their heating energy from renewable sources.

To support compliance with the new law, the Federal Government allocated € 350 million (\$490 million) in 2008 for capital grants to homeowners. Low-interest loans and 30% capital-cost subsidies are also available for solar-based systems designed for heating, cooling, or industrial process heat that involve collectors that are larger than 40 square meters in extent.

Previously, under its "Market Program on Deployment of renewable energies and rational use of energy" programme, a total of € 200 million a year was available for subsidies to private investors in renewable energy installations — including, in particular, solar thermal domestic hot water and heating systems and low-energy buildings. The subsidies for solar thermal collectors are € 105 per m<sup>2</sup> for single-dwelling hot-water systems, and € 130 per m<sup>2</sup> for solar combi-systems (SDHW+space heating).

Solar heating and cooling is also encouraged through an "eco-tax", introduced on 1 April 1999. The tax on fossil fuels and electricity currently stands at € 0.0205 per litre of light fuel oil and € 0.00164 per kWh of natural gas.

## **Italy**

Italy's tax system allows for subsidies for the application of renewable technologies, funded at the regional level. The regions of Trento and Bolzano alone account for 30% of the nation's installed solar-collector surface. This high percentage has been attributed to a combination of generous local subsidies and proximity to Austria, which has a well-established network of vendors. A tax credit is also provided at the national level for investing in the purchase of a domestic hot solar system (among other building-related energy-saving investments). National and local incentives together typically cover between 25% and 30% of the cost of a solar heating or cooling system.

Italy has about 30 national producers of solar collectors and many specialized companies that supply complete thermal solar systems and the necessary technical assistance. About half of the market is supplied by branches of foreign producers that import solar-thermal systems, mainly from Austria, Australia, Germany, Greece, and Israel.

## **Korea**

Korea requires that at least 5% percent of the cost of new public buildings larger than 3 000 square meters be spent on renewable energy sources, which can include SHC systems.

## **Netherlands**

The main incentive available for promoting SHC systems is a tax credit available to businesses investing in energy-efficient technologies (including those based on renewable energy). The tax credit is worth about 15% of the investment. Sales of solar water heaters for retrofitting on existing houses has declined slightly since 2003, following the discontinuance of a specific subsidy at the end of that year.

## **Norway**

Enova SF, the body responsible for achieving the national energy targets by 2010, provides project financing from the Energy Fund to finance energy savings and investments to reduce the use of electricity for heating purposes and in new environmentally friendly forms of energy production. The Energy Fund obtains its revenues from a levy on electricity (NOK 0.01 per kWh). In 2005 the Fund received about NOK 660 million from this levy.

Enova and the Research Council of Norway have jointly established a program for introducing new technologies for producing heat from the sun or biomass. Public support can amount to maximum 30 % of documented project cost.

Solar heating and cooling is also encouraged indirectly through fuel taxes. These are a specific tax of NOK 0.0414 per litre of heating oil, a CO<sub>2</sub> tax of NOK 0.052 per liter of mineral oil, and a sulfur tax of NOK 17 per kilogram of SO<sub>2</sub> in fuel.

## **Portugal**

At the national level, private purchasers of certified solar collectors installed by certified installers are eligible for a subsidy of 20%. Public entities can benefit from a subsidy of 40%. Both schemes are subject to an upper limit of € 300 000 per installation. In addition, specific equipment for solar systems (mainly solar collectors) benefits from a reduced VAT rate of 12% (compared with the VAT rate of 21% normally applied to manufactured goods). Companies investing in solar equipment can amortize their investment over four years in their corporate income tax filings. Householders are allowed to deduct one-third of the cost of a solar thermal system from the annual income taxes (up to a maximum of € 728).

## **Spain**

In 2006 Spain established a national building code that requires solar hot water to meet 30–70% of hot water energy needs. The requirement for any given building depends on the climatic zone in which it is located, expected consumption levels, and type of back-up fuel. The national mandate was preceded by ordinances enacted by over 70 municipalities throughout Spain. Barcelona's dates back to 2000 and requires that 60% of the energy for water heating come from solar energy.

Regional governments throughout Spain provide subsidies for the installation of SHC systems. Uptake of subsidies by the PROCASOL (Canaries) and PROSOL (Andalusia) programmes has been so great that in the early 2000s applications for grants quickly exceeded the the available budgets.

Any installation benefitting from a national or local subsidy must use thermal solar collectors that had previously been qualified in a recognized national laboratory. Before the foundation of the Renewable



Energy National Centre (CENER), Spain had only two recognized laboratories that could certify solar-thermal equipment: INTA-Arenosillo in Andalusia and ITC in Canary Island. Having a third qualifying centre has facilitated greater access to the Spanish market of solar thermal collectors from non-Spanish manufacturers, mainly those producing in northern European countries.

### **United States**

Until recently, the U.S. Federal government offered a tax credit on federal income tax worth 30% of the investment cost of a solar hot-water or cooling system. The credits were available for systems "placed in service" between 1 January 2006 and 31 December 2008, up to USD 2 000 in any given tax year. To qualify, residential systems must be certified for performance by the Solar Rating Certification Corporation (SRCC) or a comparable entity endorsed by the state government in which the system is located.<sup>25</sup> The credit was not available for expenses relating to water for swimming pools or hot tubs.

Tax credits are also available in some states, and rebates are provided by a number of electric and gas utilities for the purchase and installation of solar energy systems in buildings. The largest state subsidy program is that enacted by California in late 2007. It will provide USD 250 million in rebates over 10 years to encourage the installation of some 200 000 residential and commercial systems.

For many years, the U.S. Department of Energy has awarded State Energy Program (SEP) grants to State Energy Offices (SEOs) for Home Energy Rating Systems (HERS) programmes. These grants were intended to establish a link between HERS and the Energy Efficiency Mortgage (EEM) programme. HERS is a standardized system for rating the energy efficiency of residential buildings and can be used to qualify a buyer for an EEM. By taking into account the reduced utility bills associated with buildings that incorporate solar or other energy-efficiency features, consumers who purchase homes that qualify for an EEM are able to obtain larger loans than their income levels would normally permit. The principle is that buyers' total outlays remain the same or less because higher monthly mortgage payments are balanced by lower monthly utility bills. HERS are available in 47 states and the District of Columbia, and EEMs are offered nationwide by several national lenders.

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<sup>25</sup> The SRCC is an organisation established by the U.S. solar industry to test and certify equipment (see [www.solar-rating.org](http://www.solar-rating.org)).

## ANNEX V. DETAILS OF RESPONSES FROM EXPORTERS OF ENERGY-EFFICIENT MOTORS

### Survey procedure

For the purpose of this study, five large international manufacturers and exporters of motors, pumps and fans in various regions were selected in mid October 2007 and invited to answer (by the end of February 2008) a questionnaire on trade barriers that had been prepared by the OECD Secretariat. The selection process focused on manufacturers specializing in high-efficiency products. The country of origin (company headquarters) was considered to be of subordinate importance, because many companies run their own production facilities in their own subsidiaries and joint ventures, which have been acquired in order for the parent companies to obtain a better regional market reach. Large motors are heavy: a 110 kW motor weighs 700 kg (not including the weight if packaging), and cannot be transported easily and quickly to a customer on the other side of the world.

The five manufacturers (1 from China, 2 from USA and 2 from Europe) finally chosen were selected at random from a larger pool. Their identity and the identification of their answers have been kept confidential.

The inquiry was based on a questionnaire on NTBs relating to 15 types of trade barriers. This involved the following four steps:

1. Contact was made with the company headquarters through a liaison person, to identify a representative who could answer the questions.
2. The company identified key persons within the company in global sales that would be able and willing to answer the questionnaire.
3. The individuals were first asked which of the 15 types of trade barriers apply. Considerable time transpired before all the responses came back, in many cases because several qualified individuals within a company had to become involved.
4. Subsequent telephone and mail contact was made to expand and elaborate on one specific experience and on strategies to overcome barriers. The feedback by phone was in many cases very difficult because one person could not answer for all regions and for all types of questions. In two cases no substantive telephone conversation was possible, in one of the cases because of language barriers.

The procedure to find a total of five manufacturers willing to respond and to identify key personnel that were able and willing to answer the OECD questionnaire was very lengthy and complicated. Most companies have located sales staff in different sales regions who handle import questions directly. Therefore the headquarters had to motivate and question multiple representatives. Their eventual answers then had to be compiled and relayed to the consultant. Language proved to be also an issue that made lengthy translations necessary.

The terminology and the definition of what a trade barrier “NTB” really is, proved to be not clear to many of the respondents. The boundary between NTBs and merely nuisances and time-consuming and costly obstacles seemed to be indistinct. Several of the manufacturers expressed a general sentiment of

being discriminated against vis-à-vis national manufacturers, and wondered whether that qualified as an NTB.

### **Case Study No. EEM-1: Europe-based global manufacturer of motors, generators and drives**

This company, through its predecessors, have been trading internationally for more than 100 years. At the beginning of the 1990s, the company started offering a range of high-efficiency motors (corresponding to the current EFF 1 definition) as its main product line for large motors.

In answer to the question, “What kind of Tariff or Non-Tariff barriers has your company encountered lately?”, the company indicated the following:

- Nr. 1 Pre-shipment inspection and customs procedures
- Nr. 3 Import surcharges or border taxes
- Nr. 6 Technical product regulations, standards and approval procedures
- Nr. 11 High or discriminatory taxes or charges in destination market

Additionally, it alleged that the **Brazilian national standards** (NBR) for motors were being applied in a way that favors a domestic supplier. According to the company, the Brazilian national standards (NBR) differ clearly from IEC standards (necessitating different or additional testing procedures and certification) and thus seems to favour domestic suppliers. Satisfying NBR requirements adds about 10% to the cost of the company’s motors, simply because their difference from the international standards requires special attention in the manufacturing process. This increase in the manufacturing cost, added to the high import tax, effectively protects domestic suppliers. The main impact is not only lost market share in the Brazilian market, but also lost market-share on the worldwide market due to the Brazilian companies’ strengthened position, according to the supplier. A very well-protected home base makes Brazilian company stronger when exporting to other countries.

This issue was raised bilaterally by the European Union in discussions with Brazil during 2005. European motor manufacturers and their association CEMEP were giving comments about the situation at that time. To date, however, there has been no change in the situation, and the company has not found a way to overcome the barriers. Meanwhile, it keeps supporting international standards and trusts someday that national standards like the NBR will be harmonized with the international standards.

Finally, the respondent noted that, otherwise, “there are not so many clearly discriminatory practices concerning energy-efficient motors.” For instance, “pre-shipment inspection is a very common practice and not really related to discriminatory customs procedures but simply related to [the requirements of] the Engineering Procurement and Contracting-company (the company that builds complete production lines or plants on behalf of the final customer, which is typically an oil- and gas or mining business) or Original Equipment Manufacturer (OEM).”

In a follow-up telephone interview with the OECD’s consultant, conducted in March 2008, a company representative claimed that it was experiencing problems only with Brazil, and only in respect of highly efficient EFF 1 motors. The Brazil NBR standards are different from others and require special products with small volume. This affects cost that increase according to market studies by some 10%. With this additional cost the market competitiveness with local manufacturers is lost. The company nevertheless wants to stay in that market with Eff1 products and hopes the situation will change within 5 to 10 years. We work closely with CEMEP in order to have international standards accepted.

**Case Study No. EEM-2: Europe-based manufacturer of motors and ventilators**

This company has been in the international business since 1963 (i.e., 45 years), and starting with exporting Direct Current (DC) Electronically Commutated (EC) motors; more recently it has been supplying the computer and Information Technology (IT) industry. In its written responses to the questionnaire it mentioned the following tariff and non-tariff barriers:

- 1 Pre-shipment inspection and customs procedures in *Mexico, Russia, Ukraine, and Belarus*
- 3 Import surcharges or border taxes in *Brazil & South America in general; Russia, Belarus, Ukraine, and all certain non-EU countries* (e.g., Turkey and Norway).
- 4 State-trading monopoly or state monopoly controls of imports in *Mexico*.
- 5 Cargo handling and port procedures or requirements in *Brazil*, as well as *Central and South America* generally.
- 6 Technical product regulations, standards and approval procedures (Underwriter Laboratory (UL) test procedures, unclear/not applicable requirements for integrated products, CCC in China and GHOST in Russia needs to be specified separately).
- 7 Restrictions on investment in *Argentina* and some other countries in South America.
- 8 Restrictions on after-sales services in *Brazil* and some other countries in South America.
- 9 Price controls or administered pricing in *Argentina* and some other countries in *South America, Belarus* (where companies are only allowed to have a margin of 20 %), and *Russia* (which starts with an assumed market price for imported goods as a base price for taxes).
- 11 High or discriminatory taxes or charges in *Brazil* and *Mexico*.
- 12 Subsidies or tax benefits given to competing domestic firms in *China* and *Mexico*.
- 13 Violation of intellectual property protection in *China*

In a telephone interview with the OECD's consultant, conducted in March 2008, a company representative described explicit negative experiences in exporting to Brazil:

- Rules for taxes, fees and licenses are changed frequently. New import requirements with complex exemption rules: Non-compliance with Import License means 10-fold fees.
- New regulations are often retroactive.
- Fees that sometimes change when the required information (often requested with only a short period to respond) is not provided in time.
- Having to engage local representatives, tax consultants, lawyers can add up to 40% to costs.
- Variations exist in VAT rates, social insurance contributions, etc., in different regions.
- Explicit privileges benefit domestic producers and MERCOSUL members.

**Case Study No. EEM-3: US-based global manufacturer of motors and drives**

This company has been in business since the 1920s, and started exporting premium efficient motors in the late 1980s. Some years ago it acquired a European manufacturer in order to facilitate its market access to both Europe and eventually Asia. In its written responses to the questionnaire it mentioned the following tariff and non-tariff barriers:

1	Pre-shipment inspection and customs procedures	Philippines, Ecuador, SGS	CE marking EU only	EU only
3	Import surcharges or border taxes	Yes	Brazil 19% duty	
6	Technical product regulations, standards and approval procedures	Argentine IRIM lab test	Brazil lab test similar to NOM	Mexico NOM sim to NEMAN FIDE gov regulation
10	Regulations on payment; restrictive foreign exchange allocations to importers	Venezuela paperwork to deal in USD		
11	High or discriminatory taxes or charges in destination market		Brazil 19% duty	Mexico with China
13	Violation of intellectual property protection	China		

In a telephone interview with the OECD's consultant, conducted in February 2008, a company representative mentioned a case in Chile, in which US products tested under IEEE 112B had to be re-specified and retested under IEC. The hassle with customs people and bureaucrats is delaying and costly. For goods with a relatively small sales value, something like 30% additional costs had to be spent for lawyers, engineers and experts. Help from US trade association NEMA is not expected to bring rapid relief. The source of the complication seems to be difficult to pinpoint. The company speculated that a large South American manufacturer may have been influential in setting standards in various other countries.

**Case Study No. EEM-4: US-based global motor manufacturer**

This company has been exporting high efficiency motors for over 25 years (since it established offices in south-east Asia). In its written responses to the questionnaire it mentioned encountering the following tariff and non-tariff barriers:

- 1 Pre-shipment inspection and customs procedures
- 5 Cargo handling and port procedures or requirements
- 6 Technical product regulations, standards and approval procedures
- 11 High or discriminatory taxes or charges in destination market
- 13 Violation of intellectual property protection
- 15 Informal "additional payments" required to effect import of your product

A successful telephone interview was not possible in the available time frame.

**Case Study No. EEM-5: China-based motor manufacturer**

This company has been trading internationally for 24 years, and has been selling NEMA normal efficiency motor since 1998, and EFF 1 motors since 2002, sale of NEMA normal efficiency motor since 1998. In its written responses to the questionnaire it mentioned encountering the following tariff and non-tariff barriers:

- 1 Pre-shipment inspection and customs procedures
- 3 Import surcharges or border taxes
- 5 Cargo handling and port procedures or requirements
- 6 Technical product regulations, standards and approval procedures
- 8 Restrictions on after-sales services

A successful telephone interview was not possible due to language problems.