

# Modernizing Refrigeration Equipment with the Kyoto Protocol's Clean Development Mechanism

During 2007, 12 bn Euros were invested worldwide in reducing climate changing emissions via the Clean Development Mechanism (CDM). This is a four-fold increase over 2006 and this trend in expanding CDM continues in 2008. Around one-fifth of these CDM projects concerned energy efficiency improvements and among these energy efficiency CDM, a few comprised the modernization of refrigeration equipment. The most prominent example is a CDM project to replace 531 chillers in India.

The following article proceeds in three steps. First, the basic aspects of energy efficiency CDM for refrigeration are presented. To illustrate such CDM projects, the chiller CDM is then described, outlining the major operational and financial features which influence the multiplication of such CDM. In the third part, a broad outlook on the near future for refrigeration CDM is attempted.

## **Energy efficiency CDM for refrigeration**

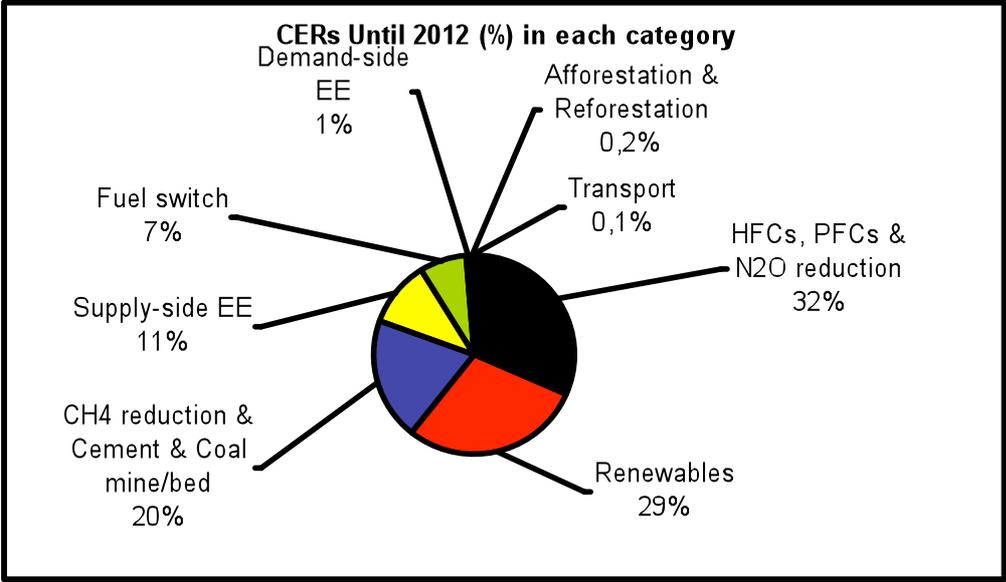
CDM is a creation of the Kyoto Protocol and the U.N. Framework Convention for Climate Change. It is thus a set of rules produced by a multilateral organisation defining how private entities can engage in emission reduction efforts and trade the emission reduction achieved on the global market. All CDM rules, information, decisions and negotiations are public and subject to intense scrutiny. The U.N.-FCCC website is the only official source, [www.unfccc.int](http://www.unfccc.int) and it contains all relevant documents in standardised and rigid formats.

Any company, NGO or other organisation can elaborate a CDM project and submit it to the U.N.-FCCC. After validation, verification and monitoring the CDM, the U.N.-FCCC issues emission reduction credits called Certified Emission Reductions (CER) to the CDM project owner. Each CER corresponds to one tonne of CO<sub>2</sub>. In 2007, 350 mio. CERs were sold in the global market. This market for CERs is rapidly expanding and diversifying, however its dependence on the U.N.-FCCC as its regulator, gives this market a unique type of uncertainty.

As any emerging market, the CDM market proceeds in the order of specific costs. Specialised companies are active in each country, analysing CDM opportunities and mass-producing CDM project documents for submission to the U.N.-FCCC. Some of these companies are publicly listed and their competition is intense. The cheapest investments in emission reductions have been in the production of refrigerant HCFC-22. All of these opportunities are already realised. At present, the highest number of CDM projects coming to the market are hydropower, windpower and N<sub>2</sub>O in nitrogen fertilizer plants. As the CDM market expands, the type of CDM projects change in the order of their rising specific costs. Once all nitrogen fertilizer plants are submitted for example, other CDM projects with higher costs per CER will appear in order to satisfy the demand. Currently the demand comes from European utility companies such as Endesa, Enel, RWE, E-ON, Vattenfall and so on.

Energy efficiency CDM projects on the demand-side have lower investment costs than windpower or hydropower, however at present, their return on investment is also lower. Correspondingly most CERs traded currently are from windpower and hydropower, see figure below.

**Figure 1: Types of CDM Projects developed so far, by volume of CER**



Source: <http://cdmpipeline.org> accessed 1 February 2008

The World Bank's chiller CDM project in India is the first large energy efficiency CDM in refrigeration with 2.4 mio CERs over its 7 year lifetime. It will demonstrate the specific costs of such refrigeration CDM. The principle reason why energy efficiency CDM have not been undertaken faster is that energy efficiency gains (kWh saved) are distributed over many small sites. For a

single refrigeration unit, the administration costs to realise a CDM are relatively high and therefore other CDM in larger units (such as windpower) are cheaper. The overall specific cost of refrigeration CDM reflects the cost of aggregating many refrigeration units in one CDM project.

Overall, refrigeration CDM have not been pursued because the expanding CDM market still has cheaper emission reductions in the pipeline. CDM projects comprising several hundred small refrigeration units are likely to become competitive in 2008. The point in time when this happens depends on the demand for the emission reductions, the CERs. For example, when the governments of the USA and Australia join the EU in obliging industry to purchase CERs (legislating cap-and-trade emission reductions), the demand for CERs increases and with disappearing hydropower and windpower opportunities, energy efficiency CDM projects expand.

### **India - Accelerated Chiller Replacement Programme**

On 30 November 2007, the U.N.-FCCC approved a Chiller CDM in India. This CDM is a cooperation between one of the largest banks in India, ICICI, and the World Bank. In setting this precedent, a special CDM methodology for chillers was created, called AM0060, which is now available for anybody to use. The CDM project will replace 531 chillers across India. The CDM project owner is the Indian bank and as a financial service company it is a suitable project owner allowing the aggregation of a number of refrigeration units. Besides the financial results, this CDM will illustrate that this aggregation role of the project owner is important.

The total financing volume of the CDM project is 91.3 mio US\$. Approximately 90% of the cost is provided by the chiller owners. The remaining 9.1 mio US\$ is the contribution by ICICI. The CER revenues are estimated at 14 mio US\$. These figures are given in the official CDM documents submitted to the U.N.-FCCC, on

<http://cdm.unfccc.int/UserManagement/FileStorage/GQSORSEWQTEWAYDBBZ7ECL6ILO5DOV>.

ICICI offers a credit to the chiller owner, who is responsible for the chiller purchase, installation and operation. ICICI's credit comprises the total chiller investment or only the part of the investment financed with the expected CER income. A chiller owner can choose a difference source of financing for the part not covered from CDM. In other words, ICICI administers the CDM project giving the chiller owners maximum freedom to proceed as it wishes, while ICICI assumes the risk for the CDM registration and the CER trading.

The CERs achieved in the implementation of the CDM project become tradable when they are issued by the U.N.-FCCC (the secondary market is also well established). Every year, an independent auditor has to control whether the power savings in kWh correspond to the expected savings (340,000 CERs p.a. over 7 years). The auditor submits a "CDM Monitoring Report" to the U.N.-FCCC for approval. ICICI estimates that the new chillers financed in this CDM project are 40 - 50 % more energy efficient than the old ones. ICICI can receive more CERs than projected and these CERs can bring a higher income when the prices for CERs in the global markets are higher than projected. ICICI assumes the financial risk of this CDM project comprising the monitoring accuracy and the CER trading conditions. At 14 mio US\$ CER income from 2.4 mio CERs, ICICI uses 5.8 US\$/CER in its financial planning. During 2007, the price actually fluctuated around 20 US\$/CER and so ICICI used an average price estimate at a quarter of the current level. The future price of a CER depends mainly on the political will of OECD countries to allow its industry to invest in emission reductions in developing countries.

Many international banks have recently established their capacity to provide such CDM financing services, ABN Amro, Barclays, BNP, Morgan Stanley, UBS, to name only the most prominent ones. As a prominent Indian bank, ICICI is well suited to implement the CDM project in India, but there are no restrictions on who assumes this CDM project owner role. In place of ICICI it could also be a financial service provider from any other country. Evidently a refrigeration equipment manufacturer could also assume this CDM project owner role. At present, large manufacturers such as Trane and Carrier are changing their financing services to integrate CDM finance.

ICICI decided to exclude the choice of chiller technology from the conditions it offers to the chiller owners, posing only one condition. Any chiller can be part of this CDM project, as long as the Global Warming Potential (GWP) of the refrigerant in the new chiller is lower than the GWP of the old one. This implies that a CFC-11 chiller or a CFC-12 chiller can be replaced with a HCFC-123, a HFC-134a, an Ammonia or a Hydrocarbon chiller. The chiller owner chooses the technology. ICICI anticipates that most chillers replaced in this CDM project will be CFC-11 and CFC-12 ones, but a smaller number of HCFC-123 and HFC-134a will be replaced as well.

The CDM methodology AM0060 contains the rules for the calculation of the emission reduction. It stipulates that each old chiller must be tested at different load conditions prior to dismantling. Such a test can be realised within one day and allows to establish a numerical power consumption function for the

old chiller. The new chillers are fitted with continuous data loggers, recording the actual load. This data logger transmits the load data to a computer every day. The power consumption function of the old chiller allows to calculate the power the old chiller would have used and the difference to the new chiller power is the power saving in kWh. Finally, the old chiller's compressor unit must be cut with a blow-torch when it is dismantled.

These rules in AM0060 might seem rather stringent, but the Kyoto Protocol regulations for CDM require that the emission reduction must be measured with accuracy and a certain level of conservativeness in the calculations has to be assured. The environmental integrity of the CDM projects rests on this accuracy. While the U.N.-FCCC is sometimes criticised for being bureaucratic and for imposing unnecessary costs to CDM projects it must be stressed that the accuracy of the emission reduction results is required to assure that all technologies and all sectors are treated equally. Creating CERs by manipulating measurements in a CDM project is equivalent to printing money. The U.N.-FCCC acts like a central bank protecting its currency. Careful engineering of the technology in a CDM project, demonstrated transparently to the public, has often lead to quick CDM approval and implementation.

## **Outlook for refrigeration CDM**

Five major factors will determine when CDM projects will be realised on a large scale to finance refrigeration investments.

### **1. New methodologies for large-scale demand-side energy efficiency**

Aggregating many appliance units poses a number of specific conditions for their approval by the U.N.-FCCC. The cost of monitoring the electricity savings is reduced when only a sample of the appliances has to be monitored. For each type of appliance this sampling is different. For lightbulbs, the sample must comprise representative lighting use behaviour and such a sample can be only 50 - 100 households out of a CDM project for millions of lightbulbs (methodology AM0046). There, the distribution of the new energy efficient lightbulbs (CFL) is the major cost item. For refrigerators and for Air-conditioners, the user behaviour is different and suitable sampling procedures must be developed. For industrial refrigeration, solutions akin to the power consumption function for

chillers (methodology AM0060) can be used. Three new methodologies for refrigeration have been submitted and await approval.

2. Besides finance institutions, utilities, ESCOs and manufacturers are potential CDM project owners

Because monitoring costs are a significant part of CDM project costs, utilities, ESCOs and manufacturers can reduce these costs and function as CDM project owners. Utility companies produce a monthly electricity bill to their customers and can offer customers rebates when they purchase more efficient refrigeration equipment. The utility can monitor a sample of appliance users with little extra costs. Likewise, equipment manufacturers can offer their clients to participate in a CDM project and target this offer to those clients using particularly inefficient old refrigeration equipment. Manufacturers can prepare different CDM projects for different groups of their clients.

3. Refrigeration with HFC-134a offers a particular incentive

Among the six gases in the Annex 1 of the Kyoto Protocol, HFC gases are the only refrigerants eligible as contributing to global warming and thus as CDM emission reductions. All refrigeration equipment with HFC-134a that is replaced with non-HFC refrigerants effectively eliminates emissions of HFC-134a. With its GWP of 1300 (in other words 1 ton of HFC-134a emissions avoided yields 1,300 CERs), such CDM projects should be very profitable.

4. New CDM regulations for Programme of Activities CDM are well suited for refrigeration (<http://cdm.unfccc.int/ProgrammeOfActivities/index.html>)

Taking into account the aggregation problem for demand-side energy efficiency projects, the U.N.-FCCC has recently created a new type of CDM with conditions that allow to start a small CDM project and expand it over time. For the above described chiller CDM in India, this would have allowed to start it with only a smaller number of chillers, for example only CFC-12 chillers of a certain size, and later on expand it with different conditions for other sizes and refrigerants. Thereby the CDM project owner can offer more advantageous conditions to each equipment owner. Programme of Activities (PoA) CDM are currently being prepared for household refrigerators and Air-conditioners.

5. Energy prices can reach a level where the additional income from CDM projects is sufficient to cover the higher investments of higher efficiency refrigeration equipment

The most important parts of refrigeration equipment, the compressors, are not price-sensitive for higher efficiency. Higher efficiency refrigerator compressors for example cost only 10 - 20 % more the standard compressors. When energy prices translate into typical Payback periods of 3 or 5 years for investments in higher efficiency refrigeration equipment, the additional income from CDM above the benefit of lower energy costs can shorten the typical Payback by 1 or 2 years.