

Keeping it cool.

## Cooling - growth - climate change

On behalf of

**BMZ**



Federal Ministry  
for Economic Cooperation  
and Development



Federal Ministry for the  
Environment, Nature Conservation  
and Nuclear Safety

**giz** Deutsche Gesellschaft  
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# Content



## **Rising energy consumption and the right to cooling?**

Should there be such a thing as the right to a refrigerator and an air conditioning unit – similarly to the right to heating?

Page 3



## **Cold chains for healthy supply**

According to the estimates of the World Health Organisation (WHO) on average 30% of all foodstuffs go to waste due to a lack of proper cold storage – in tropical countries the figure is 50%.

Page 4



## **Green technology and value creation**

The magic word is resource efficiency. In refrigeration the key to this lies in natural gases.

Page 7



## **Added value for both climate and economy**

Companies in developing countries have become more competitive with their environmentally friendly cooling appliances. New jobs are created.

Page 10



## **Energy efficiency in the fight against poverty**

Electricity alone is not enough: the operation of a fridge must be affordable in order to be of benefit economically and socially.

Page 12



## **Cool buildings: local action with global impact**

The conversion to natural refrigerants among the largest Asian export companies has a global impact on air conditioning systems.

Page 14



## **Sustainable policy making**

Sustainable cooling and air conditioning need allies in industry and policy.

Page 16

# Rising energy consumption and a right to cooling?



Refrigerators and air conditioning units feature high on the wish lists in hot countries. Whoever is connected to the grid does not just want to have light and a television but also wants to cool their apartment, the office and the food.

Is there such a thing as the right to air conditioning and a refrigerator – in the same way as the right to heating? Particularly in the tropics and sub-tropics the development of refrigeration and air conditioning nowadays has the same status as heating in the north. Air conditioning units and refrigerators already consume 20% of the electrical energy world-wide – and this is on the up. The energy requirement for air conditioning alone is going to grow at an average of 7% annually until the year 2050 in developing countries.<sup>1</sup>


Old and badly-equipped appliances waste valuable energy. Their loss of refrigerant increases the greenhouse effect and contributes to the depletion of the ozone layer. Nevertheless, in many developing countries refrigeration and air conditioning are a prerequisite in supplying food to a growing population. Cooling and refrigeration are also necessary for the development of competitive industry and services. In many countries the electrical appliance industry and the cooling business have gained a considerable standing with respect to the economic and employment policy.

## The Proklima approach

The rapidly increasing demand for refrigeration and cooling and the associated problems of gas emissions, which damage the ozone layer and the climate, as well as the consumption of energy and resources may only be solved

sustainably with a change-over to natural refrigerants together with a decoupling of the energy and resource consumption. The Proklima programme starts here and promotes the transition to ozone and climate friendly technology for refrigeration, air conditioning and insulation in developing countries and emerging nations. On behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) and the International Climate Initiative (ICI) of the Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH with the Proklima programme supports technically and strategically partner countries in the implementation of the regulations from the Montreal Protocol\* and other international conventions. The programme is also supported by allies and progressive thinkers in industry and policy who wish to tackle the goals of sustainability together with Proklima and its projects.

\* The Montreal Protocol was signed by 24 governments and the Commission of the European Economic Community in 1987. This treaty banned the use of chemicals containing chlorine and bromine such as chlorofluorocarbons (CFCs) world-wide. They lead to chemical reactions in the atmosphere which break down the ozone layer. To date 196 signatory states have ratified the Montreal Protocol.



# Cold chains for healthy supply

**According to the estimates of the World Health Organisation (WHO) on average 30% of all foodstuffs go to waste due to a lack of proper cold storage – in tropical countries the figure is 50%.**

Thanks to urbanisation fewer and fewer people are self-sufficient and all the more people are dependent on well-functioning cold chains for their food. More than half of the world's population already lives in cities and by the year 2030 it is supposed to be already three in five people.<sup>2</sup> The majority buys its food.

According to the estimates of the WHO, on average 30%<sup>3</sup>, in tropical countries as much as 50%<sup>4</sup>, of all edible produce goes to waste due to a lack of proper storage and refrigeration. In the same way essential medicines and vaccines have to be constantly cooled before they

reach people. The use of reliable refrigerators in industry and households is therefore necessary to guarantee health and the provision of food.

Nevertheless, developing countries still lack reliable cold chains even for processing and transportation. With proper refrigeration fishermen and farmers could achieve a better distribution and income for their produce. Even in remote areas without a connection to the grid it would be possible to store produce economically using solar-powered systems and thereby increase the earnings.





*Distribution centres for supermarkets: one stop-off point for food on its way to the consumer.*

On its way from the producer to the consumer fresh produce requires:

- **at the producer end:** refrigeration for foodstuffs such as fish, dairy produce, meat, fruit and vegetables
- **in the producer cooperatives:** cold stores, ice machines for common collection, processing and packaging
- **during transport:** refrigeration equipment for transport in lorries and on ships
- **at the wholesaler:** central refrigeration in the distribution centres
- **at the retailer:** retail refrigeration at markets, in shops or supermarkets
- **at the consumer end:** refrigerators in households and catering

#### Real life example

### South Africa:

**Conversion of refrigerators in supermarkets: natural refrigerants instead of fluorinated gases (F-gases)\***  
(2008 to 2011)

#### Innovation:

Ammonia/CO<sub>2</sub> refrigeration plants, central cooling

#### Financing:

ICI/BMU: ca. 1.6 million Euro

#### Partner:

Ministry of Environmental Affairs, South Africa

#### Companies involved:

Pick n Pay (South African supermarket chain)

#### Impact:

- savings of 2,000 t CO<sub>2</sub> equivalent per annum (in two supermarkets)
- more highly qualified technicians in the private servicing sector.
- efficiency: energy and cost savings thanks to the use of more efficient refrigeration units with natural refrigerants.
- knock-on effect: a further supermarket chain has started with the conversion to natural refrigerants.

\* Fluorinated gases (F-gases) are highly volatile chemicals. They include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs). F-gases remain in the atmosphere for a duration of one year to several hundred years and exacerbate the greenhouse effect. Consumption of HFCs, due to their function as replacement substances for CFCs and HCFCs, is growing dramatically world-wide.

<sup>2</sup> UN World Urbanization Prospects 2007

<sup>3</sup> WHO 2000

<sup>4</sup> FAO 1989, Aworth 2008



## Example: fish

Fish should be fresh when served in order to feed people and not end up in the bin. However, a catch will often go off during processing due to a lack of cold chains and bad hygiene. The loss, which is avoidable, of valuable animal protein is estimated at 40% of the annual global catch.

Being able to buy a fish of consistently high quality in a supermarket, for example, may be taken for granted by the customer. Nevertheless, in the background a comprehensive network of infrastructure, maintenance and supply services is required before the produce finally arrives at the consumer. Such a network can have weak points. If the cold chain is interrupted, the produce loses its quality. It is hard to sell and reduces the income of the producers and traders.

## The cold chain – an obstacle course



### TRANSPORT

The refrigeration of the cargo during transport is energy intensive and expensive since the containers in some countries are not well insulated and are run inefficiently on diesel. In spite of high temperatures and humidity, fresh produce is transported badly refrigerated over long stretches to the central markets.



### LOGISTICS

It is often the case that large distribution centres take over the job of processing, packaging and the storage of produce for local distribution or export. These centres are run with central refrigeration plants which leak large amounts of gases that are harmful to the climate.



### SUPERMARKET

For supermarkets reliable refrigeration is the highest priority – but it is not always guaranteed. To add to this, there are the high costs for energy, maintenance and refrigerant: 70% of the energy costs in an average supermarket are caused by air conditioning and refrigeration.

# Green technology and value creation



**The magic word is resource efficiency. In refrigeration the key to this lies in natural gases.**

In the developing countries there is still too little refrigeration capacity for the production, transport, refinement and retail. Many plants are old, inefficient and run with refrigerants which are highly damaging to the climate. Even for new units, manufacturers in developing countries use refrigerants which damage the climate like the chemicals HCFCs and HFCs. In Europe the use of these are banned or restricted respectively.

From the point of view of climate protection the following aspects are important in refrigeration:

- the prevention of loss of cold (insulation) as well as the efficiency in the cooling process and thermal transfer
- the impact on the climate from emissions of refrigerants and blowing agents depending on the unit
- the proportion of fossil energies in the electrical supply to the units
- the quality of maintenance, repair and installation of appliances and installations

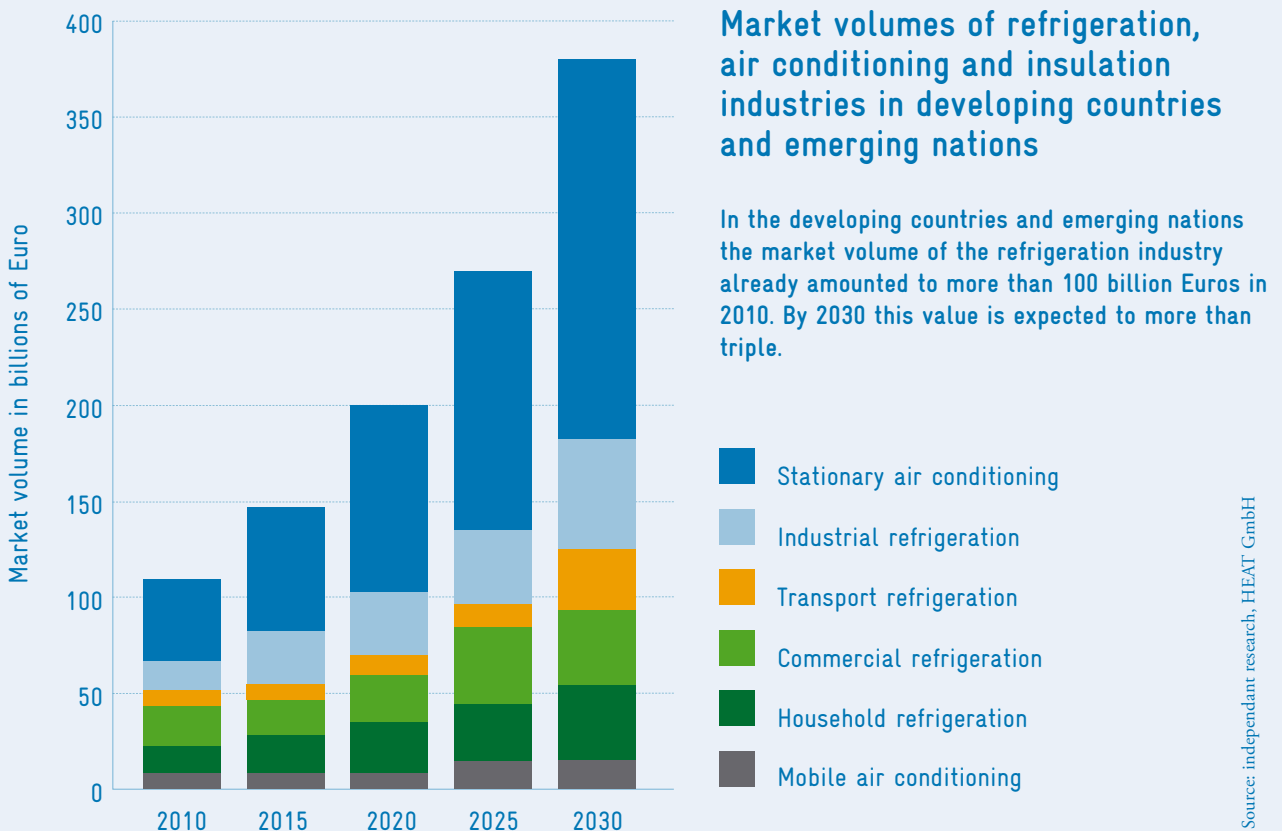
Emissions also occur during the production and above all during the disposal of refrigeration units. Proklima therefore supports the development of units which consider the idea of closed-loop recycling management in their design.

### Green growth and resource efficiency

One sustainable alternative is the immediate conversion of appliances and installations to natural cooling gases such as hydrocarbons, ammonia or CO<sub>2</sub>. This prevents leakage, the escape of F-gases into the environment, which is highly damaging to the climate\*. The alternative use of natural gases also avoids the exploitation of the world's fluorine deposits, which are rare, for the manufacture of F-gases.

The energy efficiency of appliances saves electricity and increases the cost-effectiveness for the user. At the same time, the use of recycled degradable material preserves the environment since recycling uses less energy than the extraction of new raw materials. In the case of appliances for refrigeration this applies both to the use of natural gases as well as the use of plastics and metals from recycled materials. This requires the appliances to be designed in such a way that they may be recycled under the conditions in developing countries without the release of substances which are toxic or damaging to the climate.

Furthermore these appliances support the transition to a renewable energy industry and a gradual decoupling from energy from fossil fuels. New techniques in insulation reduce the loss of cold. In connection with cold storage accumulators a flexible power supply corresponding to availability is possible.





Such a transition to green technologies requires companies to invest. Nevertheless, it also opens up opportunities for the manufacturers in the sense of the green growth concept. This concept connects sustainable economy with growth if industry sees itself as addressed and responsible for the development and manufacture of the necessary technical components as well as the setting of higher standards.

### Modifying technology

With a view to introducing ozone and climate friendly refrigerating units in Swaziland, Proklima carried out a project together with the company “The Fridge Factory”, formerly Palfridge. It was funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) in the course of the International Climate Initiative (ICI). During the project the company first of all converted their production plant for refrigerators. The line is now able to take the use of natural gases like isobutane and propane in the cooling cycle instead of the ozone and climate damaging F-gases used to date. The use of natural gases such as pentane in insulation was encouraged in accordance with the Montreal Protocol.

The company “The Fridge Factory” converted four models of their household refrigeration units to natural refrigerants as well as one bottle cooler and one commercial freezer for use in supermarkets. Since the natural substances isobutane and propane are flammable, the design engineers together with experts from Germany modified the design of the units regarding their safety. The units use nearly a quarter less energy than conventional models. Moreover, in the course of the project the company established a quality control system for each appliance in accordance with the European standards IEC 60335-2-89 and EN 378.

\* F-gases contribute heavily to climate change. Their impact is up to 15,000 times higher than that of CO<sub>2</sub>. On the contrary, CO<sub>2</sub> is suitable as a natural refrigerant since with the use of the right refrigeration technology no more CO<sub>2</sub> is emitted to the environment than was previously extracted. Ammonia and hydrocarbons like isobutane also count among the natural refrigerants. They are highly efficient and climate friendly.

#### Real life example

### Swaziland:

**Climate and ozone protection with refrigerators: natural refrigerants instead of F-gases in production (2008 to 2011)**

#### Innovation:

Use of natural refrigerants like isobutane (R600a) and propane (R290)

#### Funding:

ICI/BMU: 1.4 million Euro

#### Partner:

Ministry of Tourism & Environmental Affairs, Swaziland

#### Companies involved:

Fridge manufacturer “The Fridge Factory”, formerly Palfridge, Swaziland

#### Impact:

- 1.5 million t CO<sub>2</sub> equivalent will be saved in 10 years (directly and indirectly)
- 500 more qualified employees and service technicians at “The Fridge Factory”
- efficiency: cost reductions for the manufacturers as well as energy savings for the consumer from the use of more efficient fridges

### Adapting to the climate change

The rising average and peak temperatures in subtropical and tropical regions mean that the performance of cooling and refrigeration appliances has to be adjusted. Furthermore, the latter are indispensable for controlled conditions during industrial processing and packaging. Their use directly supports a country's productivity and standard of living – if the refrigeration units and their design are adapted to the local conditions. The knowledge for the maintenance and repair of the appliances and installations must also be available.



# Added value for both climate and economy

**Companies in developing countries have become more competitive using environmentally friendly cooling appliances. New jobs are created.**

The components, technologies and patents for this sort of conversion of products and production lines come from Germany and other industrial countries. After the conversion of the fridge manufacture in the company “The Fridge Factory” in Swaziland, which Proklima, commissioned by ICI/BMU, carried out from 2008 to 2011, the rights to build the units, nonetheless, lie with the African manufacturer: the company does not have

to pay any licensing fees. This shows that it is possible to surmount obstacles like the deliberate reconciliation of interests, which require protecting, between the suppliers of technology and the manufacturers. Using existing regulations, it is possible to solve them to the advantage of the manufacturers. With environmentally friendly cooling appliances, companies in developing countries are able to open up on the international market.

#### Real life example

### Southern and Eastern Africa:

Regional training in 16 African countries of 5,000 refrigeration technicians in the maintenance sector (1998 to 2010)

#### Innovation:

Recycling units for refrigerants (Best Practice)

#### Funding:

BMZ: ca. 7 million Euro

#### Partner:

Environment Ministries

#### Companies involved:

Micro and small enterprises, informal sector

#### Impact:

- emission reductions during maintenance and handling
- recovery of refrigerants
- sealing of installations
- improved energy efficiency of cooling installations



*Refrigeration technicians learn how to service old units and deal with natural refrigerants.*

### Creation and preservation of qualified jobs in the service sector

Through the measures of Proklima new jobs for the maintenance and installation of the appliances as well as for the recovery of refrigerants have been created in thousands of companies in Africa, Asia and Latin America. At the same time, the suppliers in Germany and Europe get new orders for their components and an incentive to develop modified products for their clients in the southern countries as well as to provide initial and further training for skilled workers.

Over the last 15 years, Proklima has implemented, with BMZ funded programmes, qualification and certification measures in the refrigeration sector in more than 30 countries. By the year 2010, around 30,000 and around 5,000 refrigeration technicians were trained in Latin America and Africa respectively. In the meantime, the maintenance technicians in the partner countries earn stable incomes for their families.

Skilled workers provide a better maintenance service. This reduces the leakage of refrigerants by up to 50%, makes the appliances safer and prolongs their lifespan. The energy efficiency of the installations and appliances is also markedly improved. This improvement is still above the 15% which is achieved by good maintenance practices in the EU.<sup>5</sup> The cost savings get used for improving the pay of the technicians. Their specialist knowledge is in demand since a green economy requires a local infrastructure for qualified maintenance and repair.

<sup>5</sup> EU Preparatory study for the new edition of the Ecodesign directive, 2009



# Energy efficiency in the fight against poverty

**Electricity alone is not enough: the operation of a fridge must be affordable in order to be of benefit economically and socially.**

Around 90% of the households in Latin America have a refrigerator. A fridge is not just used to store food. In the same way as air conditioning it is also a symbol of a modern standard of living. Possession alone, however, is not enough: the electricity to run the unit has to be generated and made available. A total of 1.6 billion people world-wide do not have access to electricity and a further billion only for a few hours per day<sup>6</sup>. This fact makes the supply of electricity one of the key indicators for poverty.<sup>7</sup>

Furthermore, inefficient fridges consume up to 80% of the precious energy in households and are the ruin of families with little income. Old appliances really put up the prices of their electricity bills and cause some customers to change to illegal electricity tapping.

For example in Brazil: there are around 30 million old appliances in the country.<sup>8</sup> Many are 16 years old or more. Their refrigeration capacity is poor. The majority of these old appliances still use CFCs as refrigerants and leak due to many repairs so that gases, which are

damaging to the climate, can continually escape. The greenhouse effect of the CFCs contained in one old unit equal the annual CO<sub>2</sub> emissions of a small car driving an average number of kilometres.

## **Development of the energy supply**

In order to counteract an inflated electricity consumption the Brazilian electricity suppliers have, by law, had to invest a half percent of their net revenue into energy efficiency since 1999: Half of it has to benefit their customers in the poorer classes of the population. Since then the electricity suppliers have been buying them energy saving fridges run on isobutane which only require 188 kWh per annum – in contrast to the ca. 800 kWh of the old units. With a view to setting up financial incentives for the exchange Proklima, on behalf of BMZ, established a development partnership with Bosch and Siemens Household Appliances in Brazil. The electricity suppliers' customers in poor households were provided with the savings model, for the most part, free of charge – in exchange for their old appliances. To date, around 620,000 households have

benefited. In comparison, the new units barely consume a quarter of the electricity of their predecessors. This also pays off both in the midterm and in the long run for the user: the electricity bill is reduced and becomes affordable. There is a further advantage for poor people – they become credit-worthy. In Brazil, if you can pay your electricity bill, and prove it, you can get credit at supermarkets and petrol stations.

## Recovery and recycling

In order to create a favourable environmental balance from the exchange, the old appliances with CFCs have to be properly disposed of in Brazil. Up to now, waste and metal collectors have picked up the appliances from the streets and stripped them down into their individual components. However, the improper disassembly releases the greenhouse gases from the cooling system and the insulation into the atmosphere. There are no recycling plants where the old fridges can be destroyed, after yielding the maximum of quality and quantity of recyclables.

For this reason the ICI/BMU project funded one of the first environmentally safe, automatic recycling plants in Latin America at the company Revert in the Brazilian state of Minas Gerais. Up to 400,000 fridges can be completely recycled in the plant and the escape of CFCs and HFCs prevented. Each appliance exchanged and recycled prevents a release of greenhouse gases which would correspond to two to three tonnes of CO<sub>2</sub>.

Instead, the plant recovers the refrigerants, sucks off the greenhouse gases used in the insulation foam and stores them for incineration. The fridge bodies are shredded and the metal and plastics recovered sold to industry. Their recycling helps the progress to a modern recycling economy in Brazil. With this in mind, the state introduced a system of manufacturer's liability and established standards for recycling.

Moreover, measures have been carried out for the qualification of personnel on the operation and maintenance of the plant. New jobs are also created with the exchange of old appliances and a local infrastructure for waste management built up. In this way the project helps the Brazilian state in training former street collectors. They learn how to collect old fridges from households, take them back and store them properly.



*The recycling plant for fridges in the national colours of Brazil*

### Real life example

#### Brazil:

**Training of 30,000 refrigerator technicians**  
(2004 to 2011)

#### Innovation:

Training for recycling, best practice and the use of new refrigerants

#### Funding:

BMZ: ca. 4 million Euro

#### Partner:

Brazilian Ministry of the Environment

#### Companies involved:

Technicians and mechanics of the vocational training institute SENAI

#### Impact:

- prevention of release of CFCs during maintenance, repair and recycling of old fridges
- qualified technicians trained in dealing with modern F-gas free fridges
- technicians and companies alike safeguard their incomes through qualification and certification





# Cool buildings: local action with global impact

**The conversion to natural refrigerants among the largest Asian export companies has a global impact on air conditioning systems.**

In many warm countries, air conditioning and refrigeration are prerequisites for the development of a competitive industry. Without air conditioning, the growing industrial nations of south-east Asia and Latin America, for example, cannot cope with their growth rates. This does, however, give rise to problems such as very high energy costs and overloading of energy suppliers. The waste heat from air conditioning systems leads to changes in the climate in metropolitan areas, the so-called heat-islands.

On top of this, the need for office, residential and hotel buildings is continually growing in developing countries and emerging nations. The sales of air conditioning systems are increasing at rates with double figures and will continue to increase. Then there is also the growing need for air conditioning in industrial production and in the service sector. One often overstates the critical role it plays in achieving economic success. Above all for employees: people who work in buildings with a comfortable room temperature are more productive.<sup>9</sup>

## Building efficiency: example China

Sensible investments in the architecture, construction materials and insulation of a building provide for a comfortable room temperature despite high temperatures outside. Nevertheless, the insulation of buildings can also have its hidden dangers: for example in China per cubic metre of plastic foam insulation emissions are released which correspond to five tonnes of CO<sub>2</sub>. This almost equals the annual discharge of a modern German one family household when heating. For the proofing of a multi-storey office block with insulation foam, emissions through foam production often arise which are comparable to the annual discharge of a small German town.

Moreover, a lot of office, school and apartment blocks are built as cheaply as possible with the result that their inhabitants or users have to fall back on the air conditioning. This has a dramatic effect on the electricity consumption and the emissions of HCFCs in China. At the same time, the country is the world's largest exporter of air conditioning systems using HCFC technology: Global manufacturers, mostly from China, sell some 105 million units per annum.

More than a billion of these units have already been installed world-wide and have to be serviced and refilled regularly.

## Equipped for the phase out

Commissioned by the ICI/BMU, Proklima helped the largest Chinese air conditioning manufacturer, the company Gree Electric Appliances, to replace a production line using HCFC technology with natural refrigerants thereby demonstrating its feasibility. The prototype was certified by the German technical monitoring association TÜV in the year 2011. It can now go into mass production and be launched on the global market. The unit reduces the emissions of refrigerant damaging to the climate by 98% and saves up to 15% of the energy in comparison to current conventional models. The production of 100,000 units is planned as a start.

### Real life example

#### China:

**Climate friendly insulating material for buildings: conversion of foam production to natural refrigerants (2008 to 2012)**

#### Innovation:

CO<sub>2</sub>-blown, extruded polystyrene foams (XPS)

#### Funding:

ICI/BMU: ca. 3 million Euro

#### Partner:

Chinese Ministry of Environmental Protection

#### Companies involved:

Beijing Beipeng New Building Materials Co. Ltd.; other manufactures of XPS insulation foam; associations, technical colleges, standards committees

#### Impact:

- savings of around 5 million t CO<sub>2</sub> equivalent (direct)
- improved safety at work
- lower running costs
- less waste

In the meantime other large air conditioning manufacturers in China are following this technological progress and want to remodel 18 production lines correspondingly. The conversion of the production of their air conditioning systems helps China to comply with the requirements in accordance with the modified Montreal Protocol and is part of the national strategy to phase out HCFCs. Since many air conditioning units from Chinese suppliers are meant for export, the use of natural refrigerants has a global impact.



# Sustainable policy making

## Sustainable cooling and air conditioning need allies in industry and policy.

Common to the aims of environmentally friendly refrigeration and air conditioning is the fact that they need global allies in both industry and policy. Only together can they ensure that mankind resorts to using renewable energies as well as natural gases in the cooling industry. How international cooperation can solve such environmental issues is shown by the Montreal Protocol: to date the 196 signatory states have reduced the potential for

ozone depletion by more than 90% in comparison to the year 1987.<sup>10</sup> Ozone damaging substances like CFCs, halons and methyl bromide have been replaced by natural substances. In this respect the average cost efficiency amounts to about 1 Euro per tonne of CO<sub>2</sub> equivalent – this means that, on average, it costs about 1 Euro to cut down on greenhouse gases which have the same impact as one tonne of CO<sub>2</sub>. This is unbeatably cheap.

#### Real life example

**Afghanistan, Brazil, Bolivia, China, Iran, Liberia, Lesotho, Mauritius, Namibia, Papua-New Guinea, the Seychelles, Zimbabwe:**

**The development of national strategies for phasing out HCFCs**

(2012 to 2020)

#### **Innovation:**

National registers, systems of documentation within industry, policy counselling, best practice training

#### **Funding:**

BMZ: around 20 million Euro

#### **Partner:**

Environment ministries of the partner countries

#### **Impact:**

- savings of up to 10 million t CO<sub>2</sub> equivalent by 2020
- more climate friendly production of plastics and cooling appliances
- leak-proof installations
- lower running costs

This success requires measures and laws on a state level which protect the climate and the environment and promote the advancement of green technologies. This starts with regulations on the use of raw materials in production and continues with standards for product quality through to provisions for dealing with old appliances and wastes. The best example of this on a national level: the disposal branch. If the manufacturers are not made liable for their products the latter are not taken back by the retailers.

A lot of developing countries are also prepared to adopt such policy as is shown by the introduction of minimum standards for the energy efficiency of cooling and refrigeration appliances in many countries. One of the keys to a better environmental safety is therefore the development of more specialist knowledge world-wide on the subjects of cooling and sustainability in policy, administration and industry.

In accordance with the Montreal Protocol, Proklima has advised more than 40 governments and promoted discussions on how a long-term sustainable policy on technology in the cooling sector can be implemented. Equally the programme has supported companies and executives who desired to have a hand in the progress: the basis for all projects was that public administration and the private sector had already taken the initiative and invested independently. In the midterm, the funding of sustainable cooling and refrigeration technology has created new jobs in the partner countries and contributed to the development of specialist knowledge. In Germany it has stimulated foreign trade with production technologies, components and services. At the same time, these instances of cooperation in trade and technology strengthen international cooperation in accordance with multilateral agreements and their funding mechanisms.

To accelerate the propagation of green cooling technologies nevertheless requires still more examples for a successful exchange between the suppliers and users of technologies like those in Swaziland, China or Brazil. The development of innovation networks through which progressive thinkers from industry, finance and policy can realise their ideas quickly is gaining in importance. Commissioned by ICI/BMU, Proklima therefore set up the international “Green Cooling Initiative”. This is designed to accelerate the sustainable development of refrigeration and cooling appliances and well as air conditioning systems in partner countries: thereby bringing together “ecologically compatible”, “economically profitable” and “socially conducive” – and realising the goals of Rio+20.

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