FORSCHUNGSFORUM
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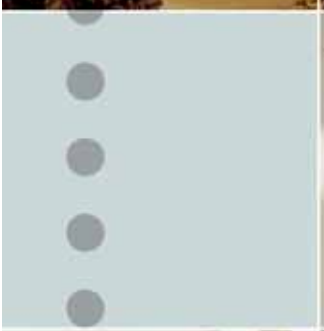
ENERGY

INNOVATIVE USE OF AUSTRIAN STOVE FITTING TECHNOLOGY FOR A SUSTAINABLE DEVELOPMENT

TILE STOVES IN AUSTRIA
CLAY STOVE FOR ZIMBABWE



bmvit

P R O J E C T

TILE STOVES IN A SUSTAINABLE CONCEPT OF ENERGY USE

Simple Technological Solutions with a High Potential for Energy Efficiency

■ In the context of a sustainable development there are certain simple and well-established technological concepts which also yield good results and therefore show future-oriented aspects.
As far as sustainable concepts of energy use are concerned it is crucial, first, to analyze such approaches, if necessary; to improve the technology involved and, if the results are positive to develop strategies for diffusion. Austrian stove fitting technology is leading even on a global scale and offers future-oriented perspectives in this field. The development of new applications for this high-grade technology and its integration in sustainable concepts for the future constitutes an important research-political approach. The Austrian Federal Ministry of Transport, Innovation and Technology commissioned two studies investigating the implementation and diffusion of Austrian stove fitting technology and its adaptation for new applications.

A project conducted by the Interdisciplinary Research Institute for Development Cooperation (IEZ) aimed at adapting Austrian stove fitting technology to suit the concrete needs of the population in a developing country and to make it available for on-site implementation. On the basis of a preliminary study realized in Zimbabwe, which describes the special living conditions of the people in this country, a cooperation of the Austrian Tile Stove Organisation and the Vienna University of Technology designed a clay stove for the use in developing countries.
A second project supported by the BMVIT investigated a type of biomass heating system, which is rather widespread in Austria: the tile stove. A study by the Austrian Institute of Ecology examined the potential of this technology within the scope of sustainable concepts of energy use. If the great number of existing stoves were adequately used and if a greater number of stoves were newly installed (also as ***main heating system***), this form of heating could substitute a great amount of fossil energy and, thus, contribute considerably to a sustainable development. An essential factor in this context consists in the emission behavior of existing tile stoves, and in the conditions and technological prerequisites for an ecologically sound operation of newly installed stoves.

The project was realized by the Institute of Ecology and yielded rather interesting results. The principal questions involved were:

- What is the possible role of tile stoves as part of a sustainable concept of energy use?
- What are the prerequisites for an environmentally sound operation of tile stoves?
- What strategic measures for the promotion of tile stoves have to be implemented?

The number of existing tile stoves in Austria has been estimated to be 400,000 – 500,000; this means that approx. 13 percent of households in this country are equipped with a tile stove. In contrast to the original assumption of the study maintaining that the existing stoves are only rarely used, an analysis based on a telephone poll involving 1,000 households has shown that the majority of owners do operate their tile stoves rather frequently. (166 owners of tile stoves participated in interviews based on a questionnaire; 54 percent operate their stove every day, and 15 percent several times per week). Consequently, the research project concentrated on the potential for the new installation of tile stoves and their use as main heating system.

16 energy experts (stove fitters, architects, energy advisors, and experts in the timber market) and 10 users of tile stoves participated in qualitative in-depth interviews and were asked about user behavior, motives for purchase, requirements and possible improvements of the tile stove, as well as about the prerequisites and barriers for the further diffusion of the technology. The main interest focused on the following issues:

Impact on the environment

Comparison of emission data of tile stoves with those of other heating systems and identification of the conditions for an environment-friendly operation.

Potential for development

Scenarios for a moderate and an ambitious increase, respectively, evaluation of the possible effects of an increased use of tile stoves in the framework of a sustainable energy concept with a view to overall energy consumption, emission of CO_2 and effects on employment.

Strategies

Definition and description of possible spheres of strategy such as information, communication, customer advisory service, after-sales service, as well as subsidies.

*The present study defines a tile stove as **main heating system** if it had been integrated in a comprehensive concept at the planning stage of the building, already, and if it had been adequately dimensioned to provide heating for the greater part of the building.*

PROMOTION OF THE USE OF TILE STOVES IN AUSTRIA

The results of the study conducted by the Institute of Ecology clearly show that the tile stove may assume an important role in a sustainable energy concept. Outside urban centers the pronounced use of tile stoves has to be considered beneficial from an ecological point of view. The proportion of biogenic fuel for space heating and hot water preparation could be increased considerably, which would be an important contribution to a reduction of CO_2 emissions.

MOTIVES AND OBSTACLES

The interviews with experts and users resulted in largely concurrent statements. Consumer satisfaction with tile stoves for space heating is great; tile stoves are usually purchased as an additional heating system for in-between season heating, in practice, however, they are used much more frequently. Important motives for the purchase of a tile stove include comfortable radiant heat, direct access to the flickering flames, the great leeway for creative design, as well as ecological and financial reasons (wood is considered an ecologically acceptable and relatively cheap fuel). Users found the initial costs (starting from ATS 150,000) acceptable and demanded subsidies as incentive rather than as a substantial financial support. A negative aspect often mentioned in the interviews consisted in the troublesome operation – in particular the time consuming and work-intensive procedure of starting the fire; however, a lack of information concerning ease of operation has been noted in this context. Potential improvements have been suggested in the field of services provided by firewood dealers and with implements.

EMISSIONS

Experts differ over the ecological quality of tile stoves; some of them referred in particular to wrong dimensioning of older stoves and to frequently inadequate operation. They all agree, however, on the high quality of the computer program (developed by the Austrian Tile Stove Organisation) for the calculation of the dimensioning of tile stoves, which has improved the emission data of new tile stoves considerably.

The emission behavior of tile stoves as compared to other heating systems was assessed on the basis of the emission factors of the various heating systems as published in Austria. The comparison has shown that tile stoves emit less CO_2, SO_2 and NOx than comparable heating systems. However, as far as CO, CxHy and dust are concerned, they show worse results than oil or gas heating systems. A comparison between older tile stoves and newly installed ones has shown a substantial reduction of carbon monoxide emissions (2,500 mg/MJ for older stoves vs. 1,351 mg/MJ for new installations). Therefore, the increased use of new tile stoves has to be recommended from the point of view of emission behavior, at least outside urban centers.

The following prerequisites have to be met for low-emission operation:

- Integration of the tile stove, at an early planning stage, as an important part of the building design
- Supervision of the design of newly installed tile stoves
- Regular maintenance
- Adequate operation

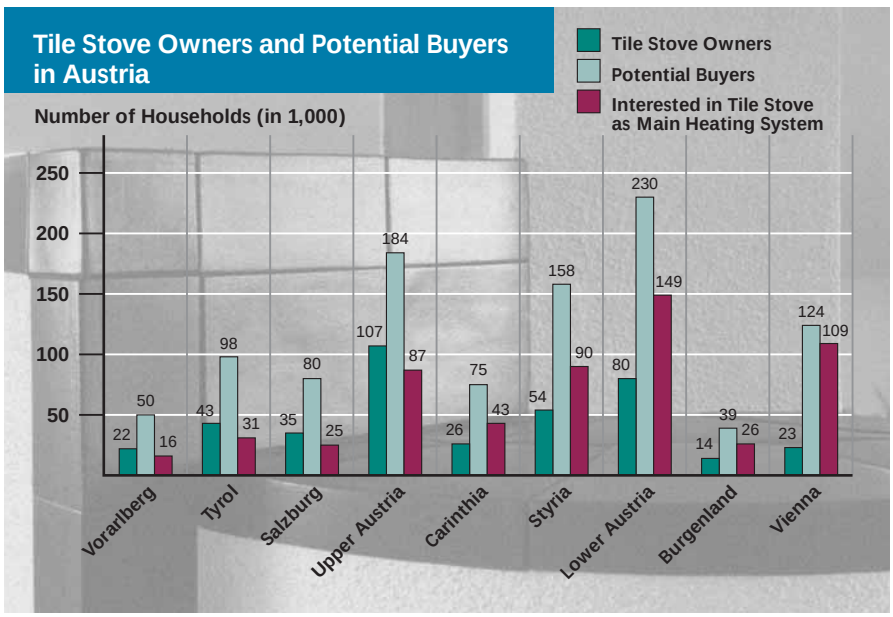
DIFFUSION

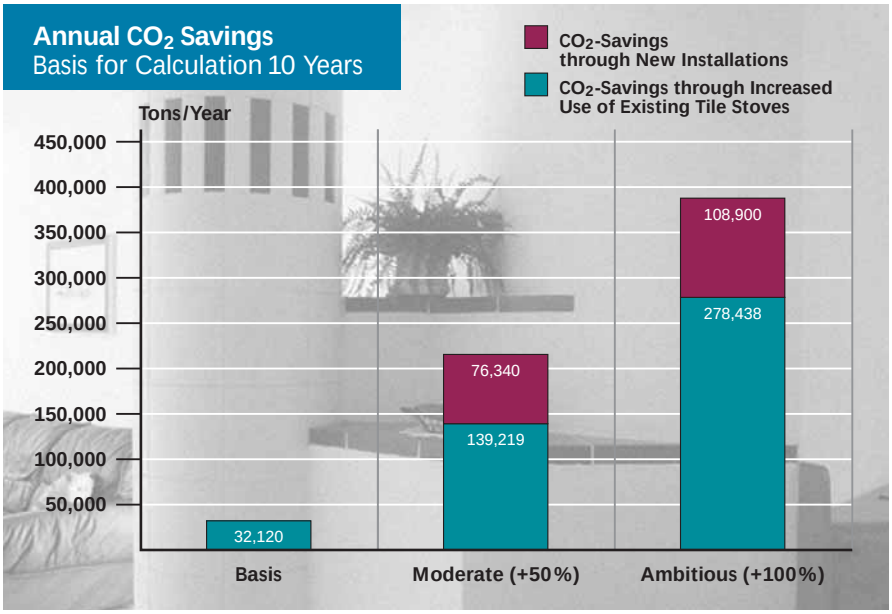
Three approaches may contribute to an increased use of tile stoves in Austria:

- Intensified use of existing tile stoves
- Installation of tile stoves in new and reconstructed buildings
- Tile stoves as main heating system in low-energy houses

The most important prerequisite for the use of tile stoves as main space heating is a maximum heating capacity of 8 kW. Low-energy houses are particularly suited on account of their low energy consumption, which, in turn, also reduces the work-intensive handling of firewood. A compact, open ground plan of the building facilitates the integration of a tile stove; the position of the chimney in the building and its dimensioning are of essential importance.

Source: Austrian Institute of Ecology





Source: Austrian Institute of Ecology

From a technical point of view, the simplest and cheapest solution consists in a design where the tile stove is installed in a central position of the building and, thus, provides radiant heat for all rooms. In this set-up, hot water preparation and antifreeze detection have to be taken over by a supplementary heating system. In buildings where the arrangement of rooms requires a more targeted heat distribution heat can be transferred either to the medium water or air (hypocausts) and then be transported to distant rooms by means of pipes or air ducts. In any case, an essential factor for implementation consists in the close cooperation of the different professions involved: architect/contractor, stove fitter, and plumber.

In order to be able to assess the effects of an increased use of tile stoves with a view to energy consumption, potential CO_2 savings and possible effects on employment, the study broke up the basic scenario and defined a moderate and an ambitious scenario. The moderate scenario starts out from an increase of newly installed tile stoves of 50 percent while the ambitious scenario assumes an increase of 100 percent, which means that the proportion of rarely used stoves will be reduced accordingly by 50 percent and 100 percent, respectively.

In the moderate scenario the proportion of firewood in the total end-energy consumption used for space heating and hot water preparation in Austrian households could be increased by 1 percent, the potential increase in the ambitious scenario is 2 percent. This would result in a reduction of CO_2 emissions by 184,000 to 355,000 tons per year as compared to the present situation (i.e. between 2.5 and 4.5 percent of the country-to-country emission targets agreed upon within the EU in compliance with the Kyoto protocol). As to the reduction of CO_2, costs per saved ton, and effects on employment, the increased use of tile stoves shows results comparable to other measures aiming at a reduction of CO_2.

STRATEGIES

The study defines the essential strategic fields for a pronounced promotion of tile stoves:

Communication

Deficits have been discerned in the sphere of information and communication between stove fitters and customers and other important actors such as architects, chimney sweeps, and energy advisors. Potentials for improvement in this area consist in targeted advertising and PR campaigns.

Service and Customer Advisory Service

Proactive customer service in the form of maintenance reminders, information about firewood, and the correct operation of the stove, as well as counseling during the first heating period are of great importance for an environment-friendly operation of the stove. In addition, special service (such as measuring firewood humidity, firewood delivery) will also be conducive to customer satisfaction.

Subsidies

Subsidies should serve as incentives only and, as conditional grants, be linked to adequate maintenance of the stove in order to ensure positive effects for the environment. In addition, promotion programs for the continuous training of the professions involved, as well as for the transfer of information should be supported.

Research

There is a need for further research, in particular on the use of the tile stove as main heating system with a view to technical systems for implementation, optimal combination with supplementary heating systems, and to building physics. In addition, research projects and competitions are to contribute to innovations in product development and result in cheaper tile stoves, new technologies, and standardized products.

CLAY STOVE FOR USE IN DEVELOPING COUNTRIES

Transferability of Austrian Technology for Use in Developing Areas – Zimbabwe as an example

Austria plays a leading role in research and development in the field of stove setting technology. One important research-political objective consists in the accelerated development of new applications and in the adaptation of the technology for new tasks in order to contribute globally to the solution of problems within the scope of a sustainable development.

This motive also inspired the project realized by the Interdisciplinary Research Institute for Development Cooperation (IEZ). The starting point consisted in a research report based on studies and interviews conducted on the site, which yielded an analysis of the living conditions of the population in Zimbabwe. The study proposed to examine the potential for soft technologies in Africa, using Zimbabwe as a model.

This study has shown, among others, that there is an essential potential for improvement in the construction of stoves. Traditionally, the local population has burned great amounts of firewood in rather inefficient stoves or open fireplaces. This results in increasing deforestation there (the extraction of firewood is a major factor in the destruction of forests in the area) and, as a consequence, endangers the food production of the local population.

In addition, smoke emissions from the open fireplaces in the kitchen houses constitute a serious health hazard.

The development and diffusion of an efficient stove with simple design would result in a decisive improvement (not only in Zimbabwe but also in other countries with a similar situation). Two prototypes of such a kitchen stove have been developed within the scope of a project supported by the BMVIT and involving a cooperation of the Institute for Development Cooperation, the Austrian Tile Stove Organisation, and the Institute for Process, Fuel, and Environment Technology at the Vienna University of Technology. The stove meets the particular requirements of the population (as reflected in the interviews) and constitutes an important contribution to a sustainable development on account of an environmentally acceptable use of resources.

Usually, the kitchen is situated in a separate building, in most cases round, with a diameter of 5 meters and a cone-shaped thatched roof (without central column). Cooking is usually done on an open fireplace. At the same time, the kitchen house serves as assembly room for the whole family, and the fireplace also provides for lighting and heating during cold nights.

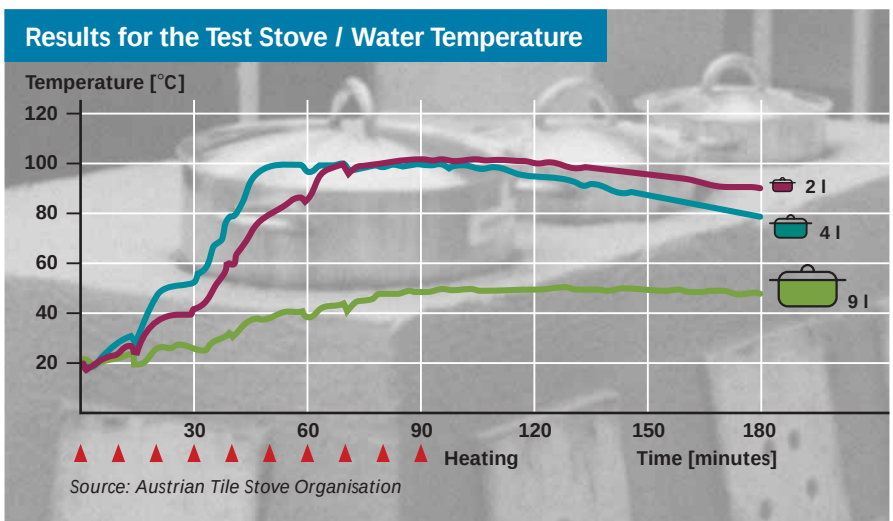
The stove has to meet the following prerequisites:

- Kitchen stove made of clay bricks for firewood, dried corn cobs, or manure
- 2 – 3 cooking plates
- Heat storage
- All day storage of hot water for domestic use
- Facility for bread baking
- Facility to heat an ironing iron
- Simple design, easy to build for local craftswomen (time approx. one week)
- Low material costs, few iron parts

The prototype developed in Austria features simple design and safe operation. After completion, the first prototype was tested and the results have been taken into account in the design of the second model. The clay stove now meets the technical prerequisites and is adapted to the typical daily routine of the population and the resulting special needs.

Taking into account all these factors the participants in the project developed a highly efficient (84 %) low-emission stove. Testing of the prototype yielded very good results. When only one cooking plate was used 2 liters of water were brought to a boil with only 300 grams of firewood.

Full use of the stove showed the following results:



Three differently sized pots (2, 4, and 9 liters) were filled with water. During 90 minutes, the stove was fired with 350 g wood bundles (as they are typically used in Zimbabwe) in intervals of 10 minutes. Then, the stove was closed and the temperature curve of the water was measured during 3 hours. The measurements of the cooking and heating performance of the stove yielded very satisfactory results. The emission data were satisfactory, too.

INNOVATION THROUGH ADAPTED TECHNOLOGY

The development of adapted technologies for other cultures in order to improve the quality of life there involves a long process: Each technology transfer has to be preceded by comprehensive research on the site; preparatory studies should identify and document the needs of the population, the framework conditions, as well as the existing infrastructure. The analysis of these results will show the requirements for the adapted solution.

The process of adaptation yields positive aspects not only for the area where the technology is used; such projects may also trigger off processes that initiate innovations in Austria. A different perspective and modified positions, as well as a critical analysis of habitual standards resulting from the special conditions prevailing in another culture can raise awareness for the potential for increased efficiency of established technologies in one's own country. In addition, this also opens the possibility for the export of excellent technology into markets that could not be accessed because the technology had not been adequately adapted.

Thus, researchers developed, within the scope of the above-mentioned project a clay stove, which is much more efficient than conventional Austrian tile stoves. It boasts a thermal efficiency of 84%, a rate that had been inconceivable until recently. What is more, the total output and, thus, the fuel wood consumption can be reduced considerably. Savings amount to approx. 75% as compared to an open fireplace fulfilling all functions for a household. Until recently, "energy-saving stoves" designed for developing countries yielded savings of only 20%, on an average, because they did not have heat storage.

Austria has a leading position in stove fitting even on a global scale and offers excellent technologies. The project could be the starting point for further development, which could yield a potential for novel applications and, thus open up new markets. Activities for the implementation of the technology and the diffusion of the stove in Africa and Asia have already been initiated and are currently at the planning stage. In addition, the project has also thrown a light on the potential for the development of more efficient stoves for Austrian households, an effort that would offer a future-oriented perspective.

PROJECT SPONSORS

The studies below were commissioned by the Federal Ministry for Transport, Innovation, and Technology (BMVIT):

"Kachelöfen im nachhaltigen Energiekonzept"
Austrian Institute for Ecology (in cooperation with the Austrian Tile Stove Organisation and the Inter-University Research Center, Authors: H. Adensam, H. Rohracher, J. Suschek-Berger, T. Schiffert), Vienna, January 2000.

"Angepasste österreichische Ofentechnologie für semi-aride Gebiete des subsaharischen Afrika"
IEZ / University of Linz (Dr. Andreas J. Obrecht, Project Director: Gerhard Kunze), in cooperation with the Institute of Process, Fuel, and Environment Technologies of the Vienna University of Technology, and the Austrian Tile Stove Organisation (Thomas Schiffert).

PUBLICATIONS

The final reports on the above-mentioned studies have been published in the series ***"Berichte aus Energie- und Umweltforschung"*** (Reports on Energy and Environment Research) by the BMVIT Federal Ministry of Transport, Innovation, and Technology and are available from:
PROJEKTFABRIK,
Nedergasse 23, A-1190 Vienna, Austria.
A complete list of the series can be found on the FORSCHUNGSFORUM HOMEPAGE.

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