Insulation of school buildings: Windows and doors

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Doors and windows are weak parts regarding buildings ability to retain heat. Typically around 40 % of the heat losses are through windows and doors. In many school buildings these figures can be even higher. Constructions of poor quality have big gaps and cracks. Years without maintenance make the situation even more critical.

Sealing of cracks, replacement of broken glass and installation of double glazing will improve the heating situation substantially. To heat buildings with substantial air leakages require often much more fuel than available. This results in cold and unhealthy learning environment in schools. Indoor temperature often drops down to +10°C or below. Simple sealing of cracks can raise the indoor temperature by 3-10°C without consuming any extra fuel. Our work in Central Asia has focused on window restoration as the fastest, cheapest and simplest way to improve energy efficiency in school buildings.

GENERAL INTRODUCTION

After the collapse of the Soviet Union, Countries of Central Asia faced serious difficulties to provide the population with energy for heating, cooking and lighting. This new energy crisis has hit Tajikistan and Kyrgyzstan particularly hard. These two countries, unlike the other three (Kazakhstan, Uzbekistan and Turkmenistan) do not have their own oil and gas resources. The inefficient and heavily subsidized centralized system for fuel supply was too expensive and impossible to keep for the new independent states. Lack of access to affordable energy services and regular power supply affects all vital activities of local communities and reduces their ability and capacity for further development. Village residents use firewood, scrubs, dry dung and other biomass for space heating and cooking. Of late, an increasing degradation of rare forest resources has been observed around many mountain settlements as a result of repetitive cutting of trees.

Especially remote mountain villages are heavily hit by the cut of energy supply from outside. The severe shortage of energy sources in mountain villages deprives the population of the most basic means of subsistence and community development. Moreover, the use of oil or paraffin lamps and candles for lighting negatively affects the village residents' health and also becomes a major factor of poverty aggravation: the families spend a significant part of their resources on such lighting devices and fuels. Therefore availability of lighting would have a positive effect on improving comfort and health, children's performance at school, small business development and activation of the communities in general.

In the same way, access to communications (no telephones) in remote mountain villages is difficult. Access routes (usually dirt roads) are often blocked and transportation is extremely difficult in winter period.

During Soviet period the emphasis was on ever expanding big production facilities. Building quality and small scale energy production was neglected. Energy was greatly subsidized and looked upon as a more or less free commodity. No wonder then that people’s attention and knowledge on energy efficiency and small scale utilization of renewable resources was low. Still government and academic institutions do not significantly involve in demand-side management nor improved efficiency and quality in traditional energy and building techniques. They focus on the modern western life style, but have no ideas how to bring this to the majority of the population.

WINTERIZATION (HEAT INSULATION) OF SCHOOLS

Because of low temperature in classrooms in wintertime, it has unfortunately has become quite common that many children have to wear overcoats even during classes. The problem of heating schools during the cold season is among the most urgent ones. In cities, district heating systems have stopped working due to high fuel prices. In Tajikistan and Kyrgyzstan, electricity has to a certain level substituted for district heating in towns. Nevertheless heating is insufficient and expensive.

The most difficult situation exists in schools of remote mountain villages. Electricity supply in such areas is severely limited during the winter period to 3-4 hours per day and some villages are not connected at all to the centralized electricity distribution network. This results in many schools using firewood, coal and dry dung for heating in wintertime.

During the cold season, heating has to be used on a continuous basis to maintain proper temperature and comfort. In mountain villages, schools are usually heated by burning coal and firewood. This results in depletion of natural and fossil resources, as well as atmospheric pollution. Moreover, if the winter is cold the heating season (normally from late October up to late March or early April) has to be extended. Some schools have to close down temporarily during the lowest winter temperatures.

The environmental organization Little Earth, working with support and assistance from the Norwegian Society for the Conservation of Nature under the SPARE Project (School Project for Application of Energy and Resources), has identified the areas of highest concern with regard to energy conservation in schools.

School buildings lose vast amounts of energy due to a number of reasons. This is largely associated with the structure of school buildings and materials used to construct them. Many schools are constructed based on a standard design of bricks or concrete slabs from the Soviet time. In the past, all schools in cities and larger towns were connected to a centralized heating supply network. For schools in remote mountain villages, there used to exist a centralized system of fuel supply. This system worked more or less fine for several decades. In the situation when energy sources and heating were in constant supply, the issue of thermal insulation of school buildings was not regarded as an urgent one.

Now that the centralized system has collapsed, we are facing all the consequences of its irrationality: the problem of heat conservation and shortage of energy sources has emerged to prominence. Nevertheless, even now local authorities and school administrations do not pay sufficient attention to energy efficiency, and new buildings are constructed without paying due attention to energy conservation possibilities. It is no wonder that most energy in schools during the cold period is used for heating.

HEAT LOSSES IN SCHOOL BUILDINGS

The most common reasons for heat losses in classrooms are as follows:

- Poorly insulated and hermetic windows and doors
- Outer walls (particularly in buildings made of pre-cast panels)
- Ceilings and floors to the ground

In many schools, single window frames, cracked and broken panes or complete lack of glass in some rooms constitute a major problem. On the other hand, slits in windows, doors and junction areas of the building structure are other significant sources of heat losses. All of this results in the fact that schools use up much more energy than they really need. Losses of heat in schools of the republic exceed the standards by several times.

When heat leakages from a building are high, one has to spend a lot of energy to maintain comfortable indoor temperature. This is why it is essential to reduce energy losses as much as possible. In this case we can save energy without sacrificing the comfort.

WINDOWS RESTAURATION

Windows are normally the week part of building thermal insulation. In average about 40 % of the heat leaks trough the windows. In many buildings this figure is considerably higher do to big air leakages. The leakages can occur between the wall and the frame, between frame and windows and around the glass.

The situation can result from bad window design, poor quality of the construction work or lack of maintenance. Often we find bad design, built with poor quality and seriously damaged through years without maintenance.

In schools without any maintenance budget, it is also common to find cracks in glasses or broken glass. Too often broken glass was not replaced properly.

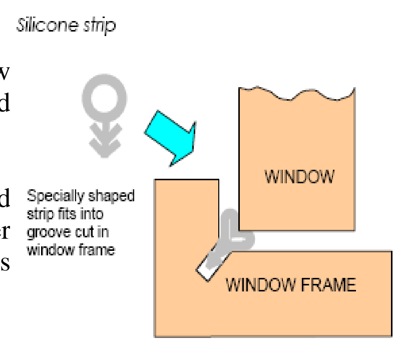
Working method depends on window quality. Anyway, the work is relatively simple and can be achieved by volunteers, teachers, older pupils and parents, after demonstration and some training.

1) Sealing of possible gaps between wall and frame can be done with expanding foam or clay mix.
2) Window glasses are taken out, frame cleaned and glass put back, sealed with silicone and fixed
3) Sealing of gaps between window and frame by adjustment and strips

The technique for sealing windows by strips depends much on the type and quality of the windows. Often tapes are used in preparation for the winter. This is effective, if previous points 1) and 2) have already been implemented. Nevertheless tape has some drawbacks: it will not be possible to open the window and tape glue often doesn’t last for the whole winter.

The Energy brigades launched by environmental NGOs in Central and Eastern Europe in the 90’s have introduced a high quality method. This method has also successfully been used in Central Asia. It results in durable solution (10 + years), it looks good and allows for opening of the windows.

INSTALLATION OF PERMANENT SILICON STRIPS



By using an electrical hand tool, it is possible to cut a groove in the window frame. This is made all around the window. A silicone strip with adapted profile (see illustration) is then fitted into the groove.

Silicone strips are available in different sizes in order to fit the gap (6-8 and 10 mm). The air filled tube shape of the strip makes it very flexible in order to adjust to and fill the actual gap between the window and the frame. Doors can be sealed in the same way.

The method is suitable for most timber, although sometimes the quality of windows is to low for any sensible restoration.

The drawback of the method is mainly that the electrical hand tool and the silicon strips can be difficult to find on the local market and experienced trainer should be available to oversee the work.

FINANCING
Financing of the activities has mostly been shared between donors (equipment and materials) and the local community (work). After demonstration in one classroom or one school, it is possible for the Municipality to try to find financing for continuation. This is sometimes found in local school budget or collected from the parents.

RESULTS
All schools in the region face problems of insufficient fuel, draft and low indoor temperature during the winter season. Within the last 2-3 years Norges Naturvernforbund and partners in the six Central Asian countries have improved the windows in nearly 100 schools. Sealing of doors and windows will results in improved indoor climate in the winter season. All schools report positive results. Comfort heat has been reached during winter time and fuel consumption reduced. Experience shows that the sealing alone increases the temperature with 4-10 C. For schools connected to district heating, the main results are increased temperature in classrooms. Schools using wood for heating also report fuel savings between 30% and 50%.

Improved comfort is important for the quality of the education. The teachers also pointed out that pupil's absence because of cold-related diseases decreases.

Energy efficiency measures in the schools are always implemented together with education activities on energy efficiency, renewable energy and climate change mitigation. The educational program includes practical tasks as monitoring and simple practical efficiency tasks. In this way, improvement's results combined with children's knowledge and experience with improved efficiency standard can result in increased awareness and new activities at in schools and homes. More on the educational activities at www.spareworld.org

EXSAMPLE: SCHOOL IN LABIJAI VILLAGE, TAJIKISTAN
The secondary school of general education #95 in the Western part of mountain village of Labijai in Karatag gorge (100 km from the city of Dushanbe) was selected after several fact-finding trips to the area. The school was constructed in 2000. The school building is a one-storey structure, rectangular in plan view which consists of two classrooms and a staff-room. Walls are 40 cm thick made of adobe bricks and quarry stone. The total area of the building in plan is 54 $m^{2.}$ Floors are wooden made of edged tongue-and-groove boards. The deck is wooden. Ceilings are made of wood-fiber board.

The school does not have funds for reconstruction and purchasing of additional fuel. The school used to spend about 15 cubic meters of firewood during the heating season. There were droughts in the classrooms; window frames had slits and window panes were broken in several places. Besides, there was no water drain (trough) to evacuate water from the roof. In absence of a platform, the back wall of the school building would get wet up to 1.5 from the ground.

Neither the school nor the entire Labijai villages are connected to the centralized power supply network. The school had 36 primary school children in grades 1 through 4. It is envisaged that in the future the school will have school children of grades 1 through 9. The school works in two shifts. The staff consists of five teachers.

Implemented activities

Prior to starting heat insulation of the school per se, "Little Earth" conducted several meetings with the school headmaster and chairman of the jamoat. In July, 2007, based on the understanding that had been reached, an agreement on implementation of the project was made with local authorities and school administration. The agreement stipulated that "Little Earth" was to provide the necessary materials for thermal renovation of the building (installation of windows and doors) and the local authorities and the school administration were to make available workers to implement water-proofing, drainage, removal of water from the roof and to monitor correctness of work.

Replacement of windows

Based on the results of building assessment it was decided to replace single-pane windows with double glazed ones. In August 2007, three school windows sized 1.17 x 0.75m was replaced by double-glazed ones with wooden frames. Although windows were new from the carpentry, total renovation was in order to meet insulation standards. The windows were also insulated using silicon sealer.

Replacement and winterization of doors

All three doors of the school building were winterized using heat insulating padding. One of the doors was completely replaced with a new one and then winterized. Door openings were also winterized using silicon tube to improve thermal insulation and prevent droughts.

Drain installation.

A channel system was installed on the roof of the school building. Melt rain and storm water is now collected in troughs and evacuated through water pipes mounted on corners of the building. This helped to avoid wetting of walls and foundation of the building which affected the temperature inside the classrooms.

Hydro-insulation of the back wall

Since the back wall of the school kept getting wet on account of melting snow and rain water, it was decided to waterproof it. Waterproofing was done by affixing rubberoid to the wall from 1.5 meters high to bottom using asphalt mastic. After that, a drainage system was constructed.

Solar panels for lighting

In wintertime when the weather is cloudy, it becomes dark in classrooms on account of a rather small area of window openings. This often happens in the afternoon during the second shift. On such days paraffin lamps get used in school, which results in additional emission of soot, carbon monoxide and unpleasant smell of paraffin oil.

With this in mind, "Little Earth" decided to provide the school with electric energy by installing solar panels (with the total capacity of 100 watts) and equipment for transforming the low voltage direct current (12v) into alternating 220 volt current and to equip the classrooms with daylight lamps. This equipment is used for lighting of the classrooms and could be used to run one desktop computer with LCD monitor (school doesn't have any) for 5-6 hours.

Results of the intervention

After the above activities were implemented, the temperature inside the school rose on the average by 7 degrees in wintertime. Temperature readings taken in late December 2007 and January 2008 showed that temperature in the winterized classrooms were about 18-20°C while the outside temperature was around 4-5°C.

A more comfortable temperature resulted in improvement of the education process and academic progress of the pupils. This is demonstrated by interviews with the school teachers. According to the school teachers and their headmaster, they have been using much less firewood ever since the school was winterized and the temperature in classrooms has risen considerably. The heat insulation has led to reduced pollution inside the classrooms and, consequently, decreased the risk of diseases children used to develop from the smoke generated by stoves heating the classrooms. The teachers also pointed out that pupils went less often down with cold-related diseases this winter. Thermal insulation of the school also helped reduce consumption of firewood. At present we are trying to obtain more accurate data on the amount of saved fuel.