United Nations Development Programme – Global Environmental Facility

Commercialization of Super-Insulated Buildings in Mongolia - UNDP-GEF Project

Project of Government of Mongolia

Project Number: MON/99/G35

Final Independent Evaluation Report

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February 2007

Commercialization of Super-Insulated Buildings in Mongolia
Final Independent Evaluation Report

Table of Contents

Feb 2007

1. Executive Summary

This report presents the findings of the independent project evaluation for the **"Commercialization of Super-Insulated Buildings in Mongolia"** (the **EEH** project). It was prepared with considerable input from and assistance from the EEH PIU (Project Implementation Unit). However, the responsibility for the evaluation findings is solely those of the evaluation team authors.

The project goal was large-scale unsubsidized replication of super-insulated straw bale buildings (SBBs) in Mongolia. This was initially to be achieved through technical support, training, awareness raising and full funding of demonstration super-insulated SB (straw bale) primarily social service and institutional buildings (schools, kindergartens, health clinics, local government offices, etc). By project inception, this had been updated to include the promotion of other means of building super-insulation, and with a majority of the funding for building construction coming from beneficiary households, and demonstrating super-insulation directly in private housing - and not in social or institutional buildings.

The EEH project followed the UNDP/GEF PEESS (Provision of Energy Efficiency for Social Services) project implemented during 1997 – 2001. PEESS built 40 fully funded SBB. The PEESS project arose from work carried out by ADRA (Adventist Development and Relief Agency) from 1995 – 1999. ADRA built the first 15 SBB in Mongolia by full funding of their construction costs, as well as demonstrating the wider benefits of (non-SBB) insulation through fully funded retrofits of 40 buildings. There were also two significant local government SBB initiatives in Mongolia, but with mixed results, and some individual donor and private SBB successfully constructed.

The project was supported by a GEF grant of US$ 0.725 million and planned (in the ProDoc) co-funding of US$ 1.084 million. The earlier MSP Brief showed planned co-funding of US$3.3M. Thus, the total project budget halved in the two years between the MSP Brief and ProDoc stages, while maintaining similar outputs.

The rationale for the project was that Mongolia has an extremely harsh winter climate. Ulaanbaatar is the coldest capital city in the world. Building space heating is therefore the largest single energy end use. Winter air pollution in Ulaanbaatar and other urban areas from excessive heating demand in ger areas is a major cause of rising serious respiratory problems amongst urban inhabitants.

The EEH project was approved by GEF in August 1999, based on the original project MSP (Medium Sized Project) GEF brief of 07 June 1999[1]. The MSP Brief was then updated by UNDP, with additional project implementation, management and monitoring details added, to a UNDP ProDoc (Project Document) signed in October 2001 between UNDP and GOM (Government of Mongolia). The EEH project was formally launched in February 2002, and project implementation followed.

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[1] The MSP is still available on the GEF website.

There are significant differences between the MSP Brief and subsequent ProDoc. The ProDoc leaves out the MSP Brief's Annex with its description of SBB technology and development history, nearly all details of the project's barriers and barrier removal activities, as well as the assumptions, context and incremental cost analysis. This material probably was omitted to avoid its updating in the ProDoc. This created serious difficulties as the EEH PIU and UNDP Mongolia tried to implement the specific project activities without their full rationale and background[2].

Straw has been used worldwide as a part of various traditional building systems for Millennia. Modern SBB were first developed in the 1890's in the US State of Nebraska due to the availability of compressed straw and hay bales from horse drawn baling machines coupled with a lack of wood for construction and very cold winters. SBB building technology was revived in the USA from the 1970's. SBB buildings use agricultural grain production waste materials which are traditionally burnt with major smoke emissions. Straw has minimal animal feed value. SBB can be built at similar or slightly lower cost to conventional buildings with high levels of insulation (super-insulation). SBBs are a promising small buildings[3] super-insulation solution for areas with limited local wood supplies for construction, local waste straw availability, cold winters, and low rain and snowfall per year, such as Mongolia.

In the US and most other developed countries, SBB are primarily a self/community-build construction option. Most SBB builders have only built a handful of SBB. SBB are also closely associated with wider green, environmental and sustainable lifestyle movements. This was not recognized in the ProDoc, nor in the prior MSP brief - where SBB was assumed to be a commercial and fully accepted mainstream building technology. This confusion between prior small-scale niche market applications, and widespread and proven commercial uptake, is prevalent throughout both the ProDoc and the earlier MSP Brief.

The direct GHG reduction objective in the UNDP ProDoc was to build 84 SBB, retrofit 50 houses with insulation and efficient stoves[4], and build 6 provincial ECCs. The earlier MSP Brief's objectives were to build 70 social services SBB, 12 private demonstration houses (SB construction not specified, but implied), and retrofit 20 existing institutional buildings (SB construction also not specified).

The actual tangible EEH project-end results will be 72 new SBB constructed, 95 new conventional insulated houses constructed, 53 existing houses retrofitted with insulation, three SBB ECC's built and 440 ger insulated. So the EEH project will achieve direct GHG savings far greater than those specified in the EEH project's UNDP ProDoc and original MSP Brief.

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[2] However, the ProDoc made numerous specific references to the MSP Brief, and the MSP Brief was freely available on the GEF website if the EEH PIU or UNDP Mongolia had wanted to obtain it.

[3] SBBs are most appropriate for buildings with less than a 3 storey construction.

[4] Efficient ger area stoves development and dissemination in Mongolia were provided by another project, which has faced significant difficulties.

The number of training courses, trained builders and attendees exceeded the project's targets. The evaluation of the training courses undertaken shows that they were of a high quality and relevant to the wider dissemination of super-insulated buildings in Mongolia. The project also achieved its target of proving the effectiveness of insulation and super-insulation in SBB and refurbished houses.

A key project output that not specified in the project design was the development, deployment and establishment of the effectiveness of ger insulation blankets. This was an additional and highly significant project output designed and implemented on the initiative of the EEH PIU. Ger insulation blankets are directly applicable to around 50,000 under-insulated ger in Ulaanbaatar alone.

The expected replication outcome, derived from ADRA estimates, was that 15,000 super-insulated (implicitly SB) buildings will have been built four years after project completion. This was stated to be a conservative estimate. In fact, this was a completely unrealistic estimate, as no mechanism(s) were identified in the project design as to how this huge number of super-insulated (SB) buildings' replications (15,000) was to be achieved. In the ProDoc and MSP Brief it was further stated that 25,000 SBB buildings could be built in Mongolia in the next seven years, presumably from the project start. This figure seems to have also been completely unrealistic (as were the related CO_2 reductions of 115,000 tons/year). Mongolia's 15,000 – 25,000 SBB replication target need to be compared against an actual (current) worldwide total of SBB of probably around 2,000. When the project was being formulated, the number of SBB in the world would have been probably 500-1000.

SBB is not yet a mainstream construction technology anywhere in the world. Mongolia already has the highest per capita number of SBB in the world. China has the highest absolute number of SBB in the world, but critically, this is being driven by 60% subsidies. In contrast, EEH has been very successful in building 72 new SBB in Mongolia with a more sustainability focused 20% subsidy level.

The housing construction sector in all countries is understandably very conservative as houses represent one of the largest investments that people typically make in their lifetime. Further, it is hard for an entrepreneur to capture the benefits of SBB compared to other innovative building structural or insulation products. So if SBB are to become a mass-market construction technology of choice in Mongolia, then they are likely to need continued technical, training, materials, and marketing support.

The EEH output of exploring, investigating and designing recommendations for sustainable financing mechanisms was achieved. However, the establishment of a sustainable financing mechanism encountered practical implementation difficulties that could not have been anticipated. However, mortgage markets are independently developing in Mongolia with interest rates falling, strict collateral requirements being relaxed, development of micro-credit underway etc.

The EEH project's ECC financial sustainability outcome sought was useful as a general long term operating principle to maximize financial revenue possibilities within ECC activities. In practice, the three "shop front" ECC's built by EEH will require ongoing "public good" funding by the Mongolian government and/or international donors to continue to provide "public good" building insulation and energy conservation information and support. It is unrealistic to expect the ECCs to cross-subsidize their expected "public good" energy conservation information provision from commercial appropriable (where the service provided can be charged for) activities. Without "public good" funding, whichever NGO operates the ECCs will inevitably focus only on appropriable activities and the particular interests of the NGO provided by their membership or other funding bases.

The EEH project design confused development of a technology, demonstration of the technology's effectiveness, and communication of the results of using the technology - with commercialization. The baling in the autumn harvesting season, the winter storage, and the availability of construction quality SB in urban areas in the following spring (beginning of construction period) was a key missing design for wider SBB commercialization. In Mongolia, the mature insulation technology that SBB competes against is timber walled houses using widely available and accepted EPS insulation. In other countries, the competitor for SBB is (timber) framed houses using bulk insulation, generally fiberglass or mineral wool. The huge gap between demonstration of SBB and its mass market deployment was not recognized in either the MSP Brief or ProDoc.

The EEH project has now proven SBB technology in Mongolia. The necessary technical conditions are now in place, the public and decision makers have a high awareness of SBB and the wider benefits of building insulation, and appropriate SBB designs for Mongolian conditions have been developed and disseminated. The negative perceptions of SBB, including from previous SBB projects, have been overcome. However, in Mongolia, as in the rest of the world, SBB (along with other natural building technologies) is likely to be of greatest interest to home builders and those retrofitting houses who are particularly interested in the environment and nature, rather than low and middle income people at large.

There is a growing awareness, fostered by the EEH project, that insulation is the first priority for housing, followed by improved and high efficiency heating systems, followed by smokeless/improved fuels.

The EEH project has successfully operated within its GEF budget. A home owner contribution of $521,000 was achieved, comfortably exceeding the parallel financing input of $210,000 from home builders specified in the ProDoc[5].

EEH has provided a solid basis for UNDP and other donors to commercialize super-insulated building construction in Mongolia. Specifically, the EEH project has laid the groundwork for the proposed BEEP MSP activities in ger areas in Mongolia. EEH has also provided an excellent basis for the wider uptake of ger insulation blankets through a mix of ger owner, CDM and donor

[5] Noting that the original MSP Brief did not specify <u>any</u> level of building owner contribution, which was a design deficiency for post-project sustainability - that was corrected in the ProDoc.

activities. Ger insulation blankets, as developed by the EEH project, are now a proven and rapidly deployable technology that could reduce Ulaanbaatar's winter air pollution by around 30% at a cost of less than US$15 Million. CDM and ger owner co-funding of ger insulation blanket deployment looks to be a very promising option.

2. Introduction.

This report presents the findings of the independent evaluation for the "Commercialization of Super-Insulated Buildings in Mongolia" project number MON/99/G35 (the EEH project). It was prepared with the considerable and very helpful input from the EEH PIU (Project Implementation Unit), however the responsibility for the evaluation findings and conclusions reached are solely those of the evaluation team authors.

The overall purpose of this final evaluation is to provide an independent review of the EEH project's design, achievements, innovations, adjustments, results and legacy for future super-insulated buildings' commercialization in Mongolia.

A key evaluation element is the issue of project sustainability - that is whether the project is on track to provide a rich legacy of results, products, technical capacity, approaches and institutions that are likely to persist and continue to provide positive results after the EEH project's formal completion. The primary focus of this evaluation is on the impact of the EEH project on GHG emissions (for GEF purposes), as well as on local air pollution, fuel poverty, deforestation, social and other impacts for Mongolia.

The rationale for the project was that Mongolia has an extremely harsh winter climate. Ulaanbaatar, where nearly half of all Mongolians live, is the coldest capital city in the world. Building space heating is therefore the largest single energy end-use, and most heating in urban areas is provided by use of Mongolia's abundant, widely dispersed and low cost coal. There is also the wide use of firewood for starting fires in the stoves in ger and private houses, and wood is also the main heating fuel in the northern urban areas of Mongolia. This use of wood as a fuel and for construction is unsustainable as it is well in excess of forestry regrowth rates and thus causes deforestation in Mongolia. Mongolia's CO_2 emissions per capita are therefore amongst the highest of any country in Asia, and were the highest in Asia in 1990 according to ALGAS (Asian Least Cost Greenhouse Gas Abatement Study). The winter air pollution in Ulaanbaatar and other urban areas from excessive heating demand and the inefficient stoves used in ger areas (ger area heating causes around 90% of urban pollution) has become an extremely serious problem and is a major cause of the rising serious respiratory problems amongst urban inhabitants.

The EEH project was established to remove the barriers to the adoption of enhanced levels of building insulation in Mongolia. The very low insulation levels in detached individual housing (and hence high heating demand) is the root cause of the high GHG emissions and excessive winter air pollution in urban areas in Mongolia. Ger area housing (both small private houses and ger) generally has insulation levels of R 0.5 to 1.0, whereas optimal insulation levels for the Mongolian climate are at least R3.5. SBB is a type of building construction that can provide high insulation levels in walls and ceilings in houses. SBB use a waste agricultural product (straw) that is available in northern areas of Mongolia, can provide good levels of fire resistance if properly constructed, SB plastered walls can provide R values of around 5.3 (super-insulation), SBB can be less expensive than super-insulated solid timber or timber framed houses, and SB can also be used to retrofit existing houses.

For the EEH project, UNDP was the International Implementing Agency and MCUD (Ministry of Construction and Urban Development was the domestic Executing Agency, on behalf of the GOM.

3. The Project and its Development Context

Mongolia was a centrally planned economy in the socialist period from 1923 until 1990. Since 1990, Mongolia has embraced market economic principles and the national GDP has now grown back to a level similar to that of 1989. Despite this, income disparities are now wider and there is greater fuel poverty in winter for the urban poor.

In the socialist period, there were government restrictions on people moving into urban areas, and it was official policy to provide housing for all urban dwellers in apartment buildings and completely phase out *ger* and private houses in urban areas (although this was not achieved in practice). There was therefore a lack of focus on urban private houses before 1990, and so their construction quality and insulation levels were generally very poor. With the end of the socialist era, the apartment-only, and control of population movement to urban areas policies lapsed. There has been a major movement of families into the sprawling urban *ger* areas that have sprung up around urban areas, where around 60% of urban families now live in a combination of small traditional nomadic *ger* (typically $25m^2$) and small houses (typically $24\text{-}32m^2$) that are mostly informally constructed with no formal design input and are which in practice are not covered by any enforced building regulations due to the government's weak controls in these areas. Since 1990, urban dwellers that were living in socialist period existing apartments have generally been given the title of their apartments. The urban dwellers living in ger areas before 1990, and the new urban residents that have come from the countryside, are generally living in very poorly insulated *ger* and private houses.

Mongolia has an eight-month heating season, and winter temperatures that are -10^0C to -30^0C in the daytime in mid-winter (late December and early January) and that can drop to as low as -40^0C at night. Therefore, heating is the primary Mongolian building energy demand. In *ger* areas buildings are heated with highly inefficient stoves that, coupled with minimal levels of insulation, cause around 90% of the severe urban winter air pollution. Ger area housing is generally under-heated in winter, with *ger* generally being even more under heated than small private houses. Mongolia has large and widely dispersed reserves of accessible coal and hence coal is the main heating fuel in urban areas. Mongolia currently has no domestic gas or oil supplies. In the countryside the main heating fuels are dung and firewood.

A commercial mortgage market is now slowly developing for financing private house construction and for the purchase of apartments. Accessing mortgage financing is difficult for most poor urban households due to their irregular or informal income and a common lack of formal title for the land they occupy for their *ger* or their small private houses.

Both urban *ger* and small private houses are estimated to use on average around 5 tons of coal and 1.5 tons of (unsustainable) fuel wood per year, most in the winter and mostly for space heating. Calculations, and the results of some studies, suggest that the energy use of *ger* and small private houses could be halved with optimal levels of insulation and halved again with high efficiency stoves (although less savings would be achieved with the current improved *ger* area stoves technology as they are built down to a price and aimed at retrofitting to existing stoves). In practice, some of the insulation and stove energy efficiency savings would be taken as improved and more consistent internal temperatures. However, coal use of under 2 tons/year for *ger* and small private houses, along with greatly reduced fuel wood use, would seem to be achievable from the results from previous projects and studies.

In the countryside, nomadic families mostly continue to live in traditional *ger*, although they often move with their *ger* to Soum centers in winter for social, education and evening electricity supply reasons. In the countryside, heating fuels used are mainly dung and wood.

Ger were traditionally insulated with only one layer of felt in summer and two layers in winter. In the socialist period, most ger were insulated with either two layers of felt or one layer of felt and a winter insulation blanket of cotton from Soviet Central Asia. However, since the 1990 post-Soviet Union economic contraction in Central Asia, and the adoption of market pricing for Central Asian cotton, this form of insulation is now no longer cost effective. The existing cotton insulation blankets are now worn out and mostly ineffective. It is estimated that only 70% of urban ger are now insulated in winter with two insulating layers (for an R value of around 1.0, and an R-value of 0.5 for one layer of felt). Ger are generally occupied by the lowest income families with no savings and often limited winter income levels. Therefore, affording the necessary 5 tons of coal and 1.5 tons of fuel wood for adequate heating throughout the long harsh Mongolian winter is a major drain on urban poor household finances (fuel poverty).

The EEH project's originally goal was mainstream and large-scale unsubsidized market development replication of super-insulated straw bale buildings (SBBs). In the original project design, this was to be achieved through the provision of technical support, training, awareness raising and full funding of demonstration super-insulated SB (straw bale) primarily social service and institutional buildings (schools, kindergartens, health clinics, local government offices, etc). However, such social service and institutional buildings are much larger that ger area private houses, thus reducing the value of the demonstration effect sought. There was also no explicit mention of improving the insulation of ger. It is likely that the institutional bias against ger was also a factor in the EEH design, with the reality of large numbers of ger occupied by poor households in urban areas being wished away because they were not supposed to exist.

By the EEH project's inception, the SBB social service and institutional buildings goal had been expanded to also promote other types of building super-insulation, with a majority of the funding for building construction coming from beneficiary households, and demonstrating super-insulation directly in private houses and not in social or institutional buildings. This change in the project's goal was a major improvement in producing project results that were more likely to be applicable and replicated post-project. However, the implications of these major changes in emphasis between the MSP Brief and ProDoc stages appears to not have been apparent to UNDP-Mongolia nor to the EEH PIU, nor was there any recognition that this would impact on the means that would be needed to achieve the specific project output targets.

4. Findings and Conclusions

4.1 Project Formulation

The EEH project followed on from the UNDP/GEF PEESS (Provision of Energy Efficiency for Social Services) MON/97/301 project implemented during 1997 – 2001. PEESS built 40 fully funded SBB (Straw Bale Buildings), with Government of Norway support. The PEESS project, in turn, arose from work carried out under the ADRA (Adventist Development and Relief Agency) SBB project from 1995 - 1999 which introduced modern SBB construction to Mongolia. The ADRA project built the first 15 SBB in Mongolia by fully funding their construction costs, and demonstrated the wider benefits of (non-SBB) insulation through fully funded retrofits of 40 buildings.

Following the ADRA project, and concurrently with the PEESS project, there were two significant local government SBB initiatives in Mongolia. The Tuv Aimag (province) government fully funded and built 16 SBB for the use of local government employees. These buildings were constructed by a trained SBB construction company, were built with good construction supervision, and were successful. There were also 12 SBB fully funded and built with the apparent best of intentions by the UB City Government for homeless people. These buildings had weak SBB builder training and construction supervision. Unfortunately, the UB SBB occupant households were not trained or motivated to maintain their (free) buildings. Coupled with these SBB's poor construction quality, three of the UB City Government SBB's burnt down from accidents. There were also some individual donor and private SBB houses independently constructed, apparently successfully.

Thus the EEH project had a very useful technical legacy of successful prior SBB in Mongolia to build on. However, the EEH project also had to overcome some major negative perceptions of SBB as being prone to burning down (perception of poor intrinsic fire protection) and being of poor construction quality. There was also a serious constraint in that there was no focus, including in the original EEH MSP Brief project design, on longer term SBB sustainability through the promotion of public-private partnerships. Nearly all SBB and other insulated buildings in Mongolia had previously been fully funded by donors and government, and not by the homeowners or building users themselves. Thus the pre-EEH project public perception was that SBB were a type of building that was provided to the users at no cost, and hence that SBB were not a type of building that people had to even partly pay for. It is important to note that the EEH

Project Design, as approved and funded by GEF, continued this approach of full funding by donors, and hence the use of public-private partnerships to enhance post-project sustainability was not included in the original project design.

The EEH project was approved by GEF in August 1999, presumably based on the MSP (Medium Sized Project) GEF brief of 07 June 1999 that is still available on the GEF website. The MSP Brief was then presumably updated by UNDP, with additional project implementation, management and monitoring details added, to a UNDP ProDoc (Project Document). The EEH project was then implemented based on the Prodoc, which was signed in October 2001 by UNDP and GOM (Government of Mongolia). The EEH project was formally launched in February 2002 and work then promptly commenced on project implementation. The EEH project, as defined in the ProDoc, had an ambitious planned 30 month implementation period from 1 Oct 2001 to 31 March 2003. However, the project duration was originally even more ambitious with only 24 months duration given in the MSP Brief, and this was also for a project design with a more than two times larger budget as well (although, as stated elsewhere, UNDP-Mongolia and the EEH PIU seems to have been unaware of this change, or its significance).

The EEH project as defined in the ProDoc was supported by a GEF grant of US$ 0.725 million and planned (in the ProDoc) co-funding of US$ 1.084 million from the Government of Norway, Raleigh International and home builders in Mongolia. However, the original MSP Brief showed a planned co-funding level of US$3.3M - including planned funding from the Netherlands, UNDP and ADRA that was not included in the subsequent ProDoc. It is important to note that while the budget was nearly halved in the two years between the original MSP Brief being approved by GEF and the ProDoc (that guided the EEH project's implementation) being agreed between UNDP and GOM, the project's outputs were kept broadly the same (ie the project was altered between 1999-2001 to produce essentially similar outputs with half the budget).

The EEH ProDoc states that the project would facilitate the uptake of energy efficient SBB and other new and retrofit house insulation means in Mongolia. This is a significant widening of the project in the ProDoc to include insulation materials other than SB. The MSP Brief uses the terms SBB and super-insulated buildings almost completely interchangeably and was nearly completely focused on SBB. This widening of the EEH project scope in the subsequent ProDoc to cover more than just SBB has enabled the project to be far more successful than it would otherwise have been (as per the original MSP Brief design). However, the ProDoc retains much of the legacy of the earlier EEH MSP Brief in its primary focus on SBB and not on wider and more internationally commercially proven and mainstream super-insulated building insulation technologies. This focus on SB in the ProDoc project design then consequently limits the possible project results in post-project replication terms.

There are significant differences between the GEF website's MSP Brief (dated 07 June 1999) and the project's ProDoc as signed in October 2001 by UNDP and GOM. In particular, the ProDoc leaves out the MSP Brief's supporting Annex with its description of SBB technology and development history, nearly all of the detail of the barriers and barrier removal activities that the project was designed to achieve, as well as the project assumptions, context and incremental cost analysis. It may be that this material was left out to avoid the necessary work to update it that would have been needed to include it in the ProDoc as signed - two years after the MSP Brief was considered and approved for funding by GEF.

UNDP Mongolia and the project PIU (Project Implementation Unit) were unaware of this deleted material from the MSP Brief that had not been included in the ProDoc. The omission of this material left the project implementation (by UNDP-Mongolia and the PIU) in the dark as to the fundamental project context and rationale. During the EEH project's implementation, it seems that UNDP Mongolia and the PIU were unaware of, and therefore did not refer to, the original MSP Brief that provided the basis for GEF funding of EEH. The MSP Brief is available from the GEF website, and presumably has been available there since late 1999.

So the underlying conceptualization and design of the EEH project was sound. Successfully removing barriers to super-insulation of private housing was, and still is, a highly relevant development and environment issue for Mongolia. Super-insulation of buildings in Mongolia would also without question be effective in reducing global GHG emissions. SBB is clearly a useful super-insulated housing technology. However, the almost exclusive focus on SBB compared to other conventional and accepted means of housing super-insulation limited the GHG and local environmental gains possible from the EEH project and its immediate replication legacy.

The project had five major deficiencies that did not appear to have been fully identified and considered in the project design:

1. At the time of project design, modern SBB construction was not a mainstream commercial technology anywhere in the world, in spite of over 20 years of development, technical support and publicity. Only around 500 SBB had been built in the USA after more than 20 years effort. So expecting 15,000- 25,000 SBB to be built in Mongolia as a result of the project was a very high project risk, and this was not addressed in the project design.

2. Bulk insulation materials such as EPS, fiberglass and mineral wool are more mainstream insulation products in Mongolia and support for these materials would have clearly produced greater global GHG and local environmental and social results (urban air pollution, indoor air quality, improved heating levels, and reduced fuel poverty) during the project and following the project in its replication phase.

3. At the time of project design, the baseline building that SBB were competing against was similar cost informal timber housing and not the much more expensive socialist period traditional formal construction sector solid brick walled buildings. However, brick buildings were referred to as the baseline construction technique in the MSP Brief.

4. The project design made two major assumptions, in that demonstration of SBB technology in fully

funded social and institutional SBB buildings would lead to commercialization of homeowner fully-funded SBB private houses. These are high project risks, but were partly addressed during the project implementation by ProDoc changes to focus on private housing and limit project financial support to 20% of construction costs.

5. Mongolia has no tradition of baling straw, let alone SBB quality SB, so expecting construction quality and quantity SB to be baled in autumn, stored over the winter and transported and supplied to SBB construction companies in urban areas in the following summer construction period was a high project risk. This was mentioned in the MSP Brief as an activity that was assumed to occur as a natural result of project activities, but it was not mentioned at all in the ProDoc.

In terms of Country-ownership/Driveness, the project addressed a significant national need for improved building insulation. However, it would appear that the former socialist period's focus on the formal construction sector was still prevalent in the project's design, as shown also from urban ger and their insulation not being mentioned in the project design, and the baseline building being assumed to be solid brick construction. There also seems to be a focus in Mongolia on "quick-fix" urban air pollution reduction strategies (such as coal briquettes) rather than a fundamental focus on what is driving the need to heating, namely the prevalent under-insulation of private housing for the severe Mongolian winter climate. So the country ownership/driveness was not focused on insulation of the lightweight private houses that were in fact being built.

The focus on not promoting the most widely used insulation material in Mongolia (EPS) seems to come from GEF and not from the Mongolian side. EPS is widely used in the Mongolian formal construction sector as well as in private housing. So the lack of focus on EPS seems to be an example where GEF has not followed Mongolian country ownership/driveness, thereby reducing the project's national effectiveness, impact and replication potential.

In terms of stakeholder participation, the degree to which key stakeholders were involved in the project design stages is not clear. However, it was apparent during the evaluation and during the previous BEEP design that many or most Mongolians regard solid wood or brick as "proper" building materials, and this was reinforced by the number of SBB that were clad with expensive bricks on the outside, rather than just plastered as is the case in many other countries where SBB are used (plastering of SBB is an appropriate and low cost cladding solution for Mongolia's dry climate). This homeowner desire to clad houses in wood or brick did not seem to be considered in the project design. This raises questions as to the real level of stakeholder participation in the project's design.

In addition, the fact that it was necessary to develop ger insulation blankets during the project implementation, and that this was not included in the design, seems to suggest that the project design was strongly driven by an external desire to develop SBB, and perhaps not from a Mongolian stakeholder driven focus on improving ger area housing insulation by the most relevant and promising means possible.

4.2 Implementation

The EEH project aimed to remove key technical and financial barriers to SBB (and other energy efficient building technologies as added in the ProDoc) to become viable on a large scale in Mongolia. The focus on ger area housing was, and continues to be, highly relevant, because ger and small private houses are generally extremely poorly insulated. Under-insulated housing is the major cause of the excessive fuel use that greatly contributes towards Mongolia's high GHG (Greenhouse Gas) emissions per capita, as well as fuel poverty in ger areas and wider major urban air pollution problems.

The housing in the large sprawling informal ger housing areas surrounding major urban areas in Mongolia is of roughly equal numbers of traditional ger nomadic felt tents and minimally insulated mostly wooden and inexpensive (similar cost to SBB) small private houses. These post-socialist period changes regarding the ger areas were already well underway by 1998-99.

When the project was designed (as detailed in the MSP brief), the alternative to SBB was seen to be the much more expensive traditional and formal housing sector solid brick structures of the socialist period to 1990. However, this would already have been a questionable baseline assumption in 1998-99 when the EEH concept note and PDF-A (Project Design Facility – Type A - to US$25,000 budget) design exercise were presumably undertaken. The primary small house construction material by this time would have been either solid timber or timber frame with mud plaster on lath for insulation, or using modest levels of EPS insulation. In the two years between the MSP Brief and the ProDoc, this baseline assumption was changed, and the claims of huge reductions in building costs by using SBB technologies was no longer mentioned, this was a positive project implementation factor.

An external constraint on the EEH project's implementation was that the detail of the LFA approach to the project design was not updated and included in the ProDoc. Not surprisingly perhaps, UNDP Mongolia and the EEH PIU based their project implementation and M&E activities on the ProDoc. Unfortunately, with most of the LFA rationale missing from the ProDoc, this meant that UNDP Mongolia and the EEH PIU knew what they were implementing, but not why, nor the critical assumptions of the project design. Within this context, the project seems to have been implemented in a suitably logical and adaptive fashion.

The project seems to have had a strong and appropriate focus on developing and disseminating suitable material relating to super-insulation and SBB and disseminating this widely by electronic means, print media, meetings, and one-on-one meetings. It also seems to have had a strong and appropriate focus on developing technical capacities of homeowners, construction companies, building designers and specifiers, building regulation officials, government officials and academics.

The project seems to have been appropriately monitored by UNDP and local stakeholders, and their views and suggestions seem to have been suitably and promptly responded to.

In terms of project sustainability, the positioning of SBB as a mainstream and reliable super-insulated technology has been established. It seems that, in the absence of further donor-led activities, there is likely to be a steady construction of SBB at a level comparable with SBB construction levels in other countries without strong government SBB support and incentive projects underway. With continued SBB support, as envisaged in the successor BEEP project, then a stronger uptake of SBB in Mongolia can be expected. A key innovation developed by the PIU and undertaken within the project was ger insulation blankets, and this would seem to be highly promising to be replicated using some mixture of CDM, donor support, ger owner funding, and partial credit guarantee financing (as detailed in the successor BEEP project design).

The project execution seems to have been undertaken very professionally and pro-actively, with suitable staff, national and international staff utilized, and a strong focus on achieving project outputs and being responsive to changing project operational circumstances.

4.3 Results

The evaluators' overall assessment is that the EEH project has been very successfully implemented to date.

Direct project GHG savings of 5380 tons/yr of CO_2 have been achieved [CO_2 emissions generated by the insulated 390 gers was reduced by 1462.5 tons in a year according to the survey made by the team from the Mongolian University of Sciences and Technology]. However, it is important to note that both the original MSP Brief and the subsequent ProDoc were not explicit as to the direct project GHG/coal savings results expected by the EEH project's end.

The project's direct GHG related reduction objective in the EEH ProDoc was to build 84 SBB, retrofit 50 houses with insulation and efficient stoves (noting that efficient stoves are provided by another project which has faced significant commercialization and market uptake difficulties), and build 6 provincial ECCs. These objectives were a very relevant and useful update of the original MSP Brief's specific GHG reduction objectives (Activity 1, Construction of Demonstration Buildings) to build 70 social services SBB, 12 private demonstration houses (note SB construction was not specified), and retrofit 20 existing institutional buildings (SB construction not specified). The actual tangible EEH project results will be 72 new SBB constructed, 95 new conventional insulated houses constructed, 53 existing houses retrofitted with insulation, three SBB ECC's built (Plus one ECC at MUST) and 440 ger insulated to nearly triple their original levels (although fuel savings of only half are expected as homeowners will take some of the energy efficiency gains as warmer temperatures). So it is clear that the EEH project will achieve direct pilot project GHG savings far greater than those projected in the EEH project's ProDoc and original prior MSP Brief.

In terms of the number of training courses and trained builders delivered by EEH, the number of courses offered and the number of attendees exceeded the project's targets. The evaluation of the training courses undertaken shows that the training provided by the project was of a high quality and relevant to the wider dissemination of super-insulated buildings in Mongolia. The project also achieved its target of proving the effectiveness of insulation in SBB and refurbished houses in real-world Mongolian conditions.

A key project output that was not specified in either the ProDoc or MSP Brief version of the project design was the development, deployment and establishment of the effectiveness of ger insulation blankets. This was an additional and highly significant project output designed and implemented on the initiative of the EEH PIU. Ger insulation blankets are widely and directly applicable to around 50,000 under-insulated ger in Ulaanbaatar alone, representing around half the private housing in the sprawling informal ger areas where most of the lowest income families live. Ger insulation blankets, as developed by EEH, are also amongst the most viable options for CDM (Clean Development Mechanism) additional project funding in Mongolia. CDM could, in principle, fund a significant fraction of mass ger insulation blanket project costs.

In terms of project sustainability, the expected replication outcome to be made possible by the EEH project, as stated in the EEH ProDoc and MSP Brief (and derived from ADRA estimates), was that 15,000 super-insulated (implicitly SB) buildings will have been built four years after project completion. This was stated to be a conservative estimate. In fact, this was a completely unrealistic estimate, unless EPS (expanded polystyrene) was to be the primary insulation material used (more on EPS later).

No mechanism(s) were identified in the project design as to how this huge number of super-insulated (SB) buildings' replications (15,000) was supposed to be achieved. In the ProDoc and MSP Brief it was further stated that 25,000 SBB buildings could be built in Mongolia in the next seven years, presumably from the project start time. This figure seems to have also been completely unrealistic (as were the related full replication CO_2 reductions of 115,000 tons/year (MSP Brief - p8 and ProDoc – p9). The ProDoc was slightly more realistic in its replication approach sought in that the demonstration SBB were to be built as private houses with a large component of homeowner funding, but neither UNDP-Mongolia nor the EEH PIU seems to have been aware of this important change or its implications, and in any case it just made the expected replication slightly less completely unrealistic.

Illustrating why the expected SBB replication levels of 15,000 – 25,000 WBB are completely unrealistic, the current known worldwide total of SBB is now probably around 2,000. Note that the only documented SBB numbers source that seems to be available is the International Straw Bale Registry Project website, which at 24 Jan 2007 gave a figure of 1,258 SBB worldwide, and the figures seem to be reasonably complete and accurate for China, the USA and Canada, which are the main SBB countries worldwide.

So Mongolia's 15,000 – 25,000 SBB replication target needs to be compared against an actual (current) worldwide total of SBB of probably no more than 2,000. When the project was being formulated, the number of actual SBB in the world would have been probably 500-1000, making the replication estimates for Mongolia even more unrealistic.

SBB is not yet a mainstream construction technology anywhere in the world. Mongolia already has the highest per capita number of SBB in the world. China has the highest absolute number of SBB in the world, but critically, this SBB deployment is being driven by 60% SBB construction cost subsidies. In contrast, the EEH project has been very successful in Mongolia in building 72 new SBB (amongst other tangible super-insulated building outputs), achieving a proportionately higher penetration of SBB than anywhere else in the world, and with a modest (for large-scale demonstration purposes in a very poor country) 20% subsidy level. Note that the EEH ProDoc specifies that a 10-20% subsidy level will be used, but the MSP Brief shows that a 100% subsidy level was envisaged in the project's original design. A higher allowable subsidy level would have enabled more super-insulated buildings to have been built by EEH, and in a shorter timescale. This is a key design change, and one that UNDP Mongolia and the EEH PIU seems to have been unaware of.

The EEH project design was extremely ambitious as regards the expected impact of the demonstration effect for SBB in Mongolia. Prior to EEH, hundreds of demonstration SBB had already been built, documented and publicized in many countries over a period of 25 years, and in no case had a spontaneous mass replication effect occurred, let alone from less than 100 SBB to a replication of over 15,000 – 25,000 SBB in four to seven years - as stated in the EEH project design.

A critical barrier to SBB mass uptake in Mongolia is the commercial baling of suitable straw for SBB purposes in the autumn in the northern grain growing areas, the SB storage over the winter, and the commercial supply of construction quality SB in urban centers from the following spring when Mongolia's warm weather construction season starts. Assistance with the commercial supply of construction quality SB was mentioned as a critical SBB success factor in the EEH MSP Brief (but not as a barrier that the project needed to remove), but was not mentioned at all in the subsequent ProDoc. This was an unfortunate and serious omission in the ProDoc, as the supply of suitable SB for SBB was found to be a major constraint, and prevented any SBB being constructed in the 2002 construction season when the project first started, as a tangible example of its importance. The lack of a commercial supply of straw available in urban centers from the previous year's harvest is a key remaining barrier after EEH's end, and is a barrier that EEH was not designed or funded in the ProDoc design to remove (ie this is a project design and not a project implementation omission).

The housing construction sector in all countries is understandably very conservative as houses represent one of the largest investments that people typically make in their lifetimes. Further, it is hard for an entrepreneur to capture the benefits of SBB compared to other innovative building structural or insulation products where brands or trademarks can be developed and utilized. So if SBB are to become a mass-market construction technology of choice in Mongolia (something not achieved anywhere else in the world yet) then it is likely to need continued technical, training, materials, and marketing support for the foreseeable future.

In terms of promoting super-insulate buildings, a focus on SBB alone was a major project constraint. In particular, and in contrast to SB, EPS (expanded polystyrene, and also commonly but inaccurately called "Styrofoam" in Mongolia) is the most common and affordable building insulation material in Mongolia. Note that in fact, "Styrofoam" is actually the proprietary blue XPS (extruded polystyrene) produced by Dow Chemicals and sold worldwide as a building insulation material. Polystyrene is made from styrene, which is in turn is made from petroleum. EPS is produced from a mixture of about 90-95% polystyrene and 5-10% gaseous blowing agent, usually pentane or sometimes CO_2. Ozone depleting CFCs are apparently no longer used as blowing agents for EPS or XPS.

In Mongolia, solid EPS is expanded into a foam using steam produced by coal fired boilers. Construction EPS insulating board is white, and usually of 5cm or 10cm thickness. EPS is used worldwide as a construction material and for food packaging, and is generally considered to be a safe product. Although the embodied energy of EPS is higher than for alternative insulation products used in other countries, such as fiberglass or mineral wool, the embodied energy of EPS used for building insulation in Mongolia would be recovered from reduced heating energy demand in 1-2 years of building operation. The EEH project had successfully insulated 95 new conventional houses and 53 existing houses with EPS (and in some cases also partly using mineral wool) before further use of EPS in the project was stopped. The reason apparently given by GEF for discouraging the use of EPS was its high embodied energy and its ozone depletion implications from the (former) use of CFCs as an EPS blowing agent. There was also presumably a desire to retain the project focus on commercializing SBB technology. This GEF non-EPS use policy provided a strong EEH focus on building the maximum number of SBB under the project, and contributed towards the project's success in promoting wider SBB technology in Mongolia. However, this non-EPS policy also limited the EEH project's direct GHG reduction results as well as the project's GHG replication potential.

The EEH ProDoc and MSP Brief output of exploring, investigating and designing recommendations for sustainable financing mechanisms was achieved. However, the establishment of a sustainable financing mechanism encountered practical implementation difficulties that could not have been anticipated. But with the passage of time, mortgage markets are developing in Mongolia with interest rates falling, the strict application of asset collateral requirements is being relaxed, development of micro-credit is underway, etc. The City Government of Ulaanbaatar has discussed with XacBank a mechanism to support the provision of loans for ger area insulation. This element is also a key element of the UNDP BEEP MSP currently under consideration by GEF for funding. So this sustainable financing mechanisms development output is now being achieved by other means.

The EEH project's ECC financial sustainability outcome sought (in the ProDoc) is useful as a general long term operating principle to maximize financial revenue possibilities within their activities, but was completely unrealistic in a 24 or 30 month project design context. In practice, the three "shop front" SBB ECC's and one ECC at the Mongolian University of Science and Technology (MUST) built by EEH will require ongoing "public good" funding by the Mongolian government and/or international donors if they are realistically going to continue to be able to provide "public good" building insulation and energy conservation information and support. It is not realistic to expect the ECCs to cross-subsidize their primary "public good" energy conservation information and support provision from commercial appropriable (where the service provided can be charged for) activities. Without "public good" funding, whichever NGO operates the ECCs will inevitably tend to focus only on appropriable activities and the particular interests of the NGO provided by their membership or other funding bases.

In retrospect, the EEH project design confused commercialization with the development of a technology, demonstration of the technology's effectiveness and communication of the results of using the technology. This was a design deficiency that reduced the project's long-term sustainability results.

Commercialization in the SBB context requires that all the necessary technology elements be commercially in place and easy for designers, builders and the public to access. For commercialization of any product or system to be successful, there must either be a high value niche market, or a mass-market opportunity giving economies of scale to enable the technology to win a significant market share against other existing and mature technologies. In Mongolia, the mature insulation technology that SBB needs to compete against is timber walled houses using EPS insulation. In other countries, the competitor for SBB is generally (timber) framed houses using bulk insulation, generally fiberglass or mineral wool. Both building construction types can provide super-insulated buildings with similar insulation values to SBB, so SBB do not offer a unique means to achieve building super-insulation. For equivalent insulation values, the cost is similar for SB, mineral wool and EPS in Mongolia (Table 2.2.5, Namkhainyam and Battsagaan, 2004). Load-bearing SBB with plaster finishes inside and outside can be the least expensive house construction method, and is appropriate for the Mongolian climate and low income homeowners. However, this is not the main method of building SBB utilized in mature SBB markets which are generally aimed at middle to high income homeowners, nor was this identified as the preferred SBB construction approach in the EEH project design for Mongolia.

For SBB to win significant market share in Mongolia from these established competing insulation and construction technologies is not a foregone conclusion simply based on SBB's better environmental friendliness and similar or lower construction cost compared to timber or timber framed houses using bulk insulation. The "valley of death", between the technical demonstration of a product or system and its mass-market deployment, faces SBB in Mongolia as it does any similar new product or system in any market in any country. This huge gap between subsidized technical demonstration and mass unsubsidized commercialization was not recognized in either the MSP Brief or ProDoc.

The EEH project has now proven SBB technology in Mongolia. The necessary technical conditions are in now place, the public and decision makers have a high awareness of SBB and the wider benefits of building insulation, and appropriate SBB designs for Mongolian conditions have been developed and disseminated. The negative perceptions of SBB derived from some previous SBB projects have been overcome. However, in retrospect, it would seem that in Mongolia, as in the rest of the world, SBB (along with other natural building technologies) is likely to be of greatest interest to home builders and those retrofitting houses who are particularly interested in the environment and nature, rather than mainstream low and middle income households per se.

There is a growing awareness, fostered by the EEH project, that insulation is the first priority for housing, followed by improved and high efficiency heating systems, followed by improved and smokeless fuels (eg high quality and affordable coal briquettes). However, the linkage between these elements was not included in the EEH project design.

Under the EEH project, new and simplified SBB construction standards were developed and implemented for SBB in Mongolia to remove what is a common building regulatory barrier facing SBB worldwide. However, in practice, most ger area housing in Mongolia is not inspected or certified by any state agency nor are there any practical penalties for not comply with building regulations, so it is not clear that the regulatory barrier of lack of applicable SBB standards was in fact a major barrier to SBB commercialization in Mongolia. Nevertheless, providing simplified and widely recognized SBB construction standards is a very useful EEH project output.

The delay in project implementation from the planned 30 months (in the ProDoc), to 5 years in practice, was largely due to unrealistic original project design timeframes, and partly due to lack of available suitable construction SB for the limited Mongolian construction season. In practice, the time extensions for the EEH project added considerably to the impact and sustainability of the project outcomes. The EEH project made numerous adjustments during its implementation, and with the exception of the decision (from GEF) to no longer continue using EPS as an insulation material (as above), the adjustments all seem to have added to the project's direct and longer-term impacts.

The EEH project has operated within its GEF budget. A home owner contribution of $521,000 was achieved, comfortably exceeding the parallel financing input of $210,000 from home builders specified in the ProDoc (and balancing the Raleigh International funding contribution that did not eventuate), and noting that the original MSP Brief did not specify any level of building owner contribution.

The EEH project has clearly added to Mongolian national super-insulated building human capacity, with a number of key technical experts who worked in the project now working in related activities and projects. Capacity has also clearly been enhanced in government ministries and agencies in the need for, and means to achieve in practice, super-insulated energy efficiency private housing.

The EEH project has exceeded its specified outputs in spite of receiving only 21% of the co-financing/cost sharing specified in the original MSP Brief, and around the same overall level of cost sharing and parallel financing as specified in the ProDoc (although the mix of sources and contributions from each source was very different in the project as implemented). This demonstrates that the project was implemented in a responsive and pro-active manner.

EEH has provided a solid basis for future UNDP and for other donor and other activities for the commercialization of super-insulated buildings in Mongolia. Specifically, the EEH project has laid the groundwork for the proposed UNDP-GEF MSP BEEP project activities in urban ger areas in Mongolia. EEH has also provided an excellent basis for the huge opportunities for wider uptake of ger insulation blankets through a mix of ger owner, CDM and donor activities. As a direct result of the EEH project, ger insulation blankets are now a proven and rapidly deployable technology that could reduce Ulaanbaatar's acute winter air pollution problems by around 30% at a total cost of less than US$15 Million.

5. Recommendations

(i) It is recommended that donors (specifically GEF and UNDP) continue to support the dissemination and mass-commercialization of SBB construction techniques in Mongolia as a long-term environmentally promising and natural material focused private housing and smaller building (up to three storey) construction option. For low-income households, the plastered load bearing SBB technology would seem to be very promising as one of the lowest cost super-insulated building construction techniques available in Mongolia. Alongside SBB as a long-term environmental and green construction option, more mainstream and widely available commercial super-insulated building bulk insulation materials such as mineral wool, fiberglass and EPS offer highly relevant and applicable short and medium-term super-insulation options in Mongolia. Properly engineered and specified timber frame housing would also seem to be highly relevant for Mongolia - to reduce costs and pressure on slow-growing construction timber supplies. These conventional super-insulation materials and techniques should be developed, demonstrated, commercialized and promoted alongside SBB in Mongolia.

(ii) Insulation and super-insulation materials and techniques have been demonstrated by the EEH project to be effective and widely applicable in retrofits of existing houses and ger. With the informal nature of private house construction, and the large stock of minimally insulated housing in Mongolia, it is not realistic to focus efforts only on new housing, especially as housing is frequently upgraded as funds permit, in a market with only embryonic housing mortgage availability at this stage. So future insulation and super-insulation efforts should also concentrate on insulation retrofits of existing houses and ger alongside new construction super-insulation.

(iii) The development and deployment, demonstration and proving of the effectiveness of ger insulation blankets is one of the key success stories of the EEH project. Ger use similar amounts of coal to private houses, and are generally used by the poorest and most vulnerable sectors of urban society. The next challenge is to move beyond providing such ger insulation blankets free of charge to a more sustainable public-private partnership ger insulation blanket funding approach. Micro-finance, partial credit guarantees, donor and Mongolian government support, and the use of CDM are all promising approaches that should be explored, combined and developed to continue the next steps to support the necessary mass deployment of ger insulation blankets in Mongolia.

(iv) A critical lesson that has been learned from the EEH project that is recommended for continued promotion is the necessity to continue and to strengthen co-operation between (in priority order): - (1) new housing and retrofit housing insulation and super-insulation initiatives; (2) develop improved and high efficiency/smokeless urban stove technologies for new and retrofit stove applications, and develop and implement their effective market deployment approaches; and (3) develop technically sound enhanced and smokeless coal-based fuels for use in ger area housing stoves.

6. Lessons Learned

The design, operation and results from the EEH project have identified a number of lessons applicable to future GEF and other projects in Mongolia and elsewhere, as follows:

(i) Demonstration of the effectiveness of a product or technique with full or partial donor funding is not the same as fully user-funded commercialization, as assumed in the EEH project design. The "valley of death" between demonstration and full commercialization is frequently glossed-over by over-enthusiastic proponents of a particular technology or approach.

(ii) Self-funding of ECCs is a laudable aspirational goal, but this goal risks being taken too literally in practice. If "public good" energy efficiency activities are expected to continue post-project, then ongoing international or local public-good funding will need to be provided. It is simply not realistic to expect NGOs operating ECCs to cross-subsidize public good information and support activities from their other commercial operations.

(iii) Demonstrations are far more effective when they are in the same sectors and use the same modalities as are expected for the following replications. In other words, the EEH original project design assumption of using demonstrations of fully funded institutional and social SBB was not a very realistic basis for leading to post-project fully private funded private SBB house replications.

(iv) Replications do not just occur because a good idea has been shown to work, rather there needs to be a plausible hypothesis of how the replications are supposed to occur. This link from demonstration to widespread commercial replication was rather unclear in the EEH project design.

(v) Projects need realistic targets of new technology replications, and these targets need to be set in the context of whether mass commercialization has already been achieved elsewhere in the world. It is unrealistic to expect that a niche technology that has been developed over decades in developed countries (such as SBB) will suddenly achieve mass-market and unsupported deployment in a developing country as a result of a single project.

(vi) The EEH project has shown the need to ensure that ProDoc's include all the project design information and rationale that are found in the underpinning project brief, esp if many project situation changes occur between the project brief finalization and the ProDoc signing, or it is in a fast moving sector in technical terms. Otherwise the project will encounter implementation confusion from knowing what to do but not why it is being done, as was the case with the EEH project to some degree.

Annex A List of Abbreviations

ADB	Asian Development Bank
ADRA	Adventist Development and Relief Agency
Aimag	Province center in Mongolia
BEEP	Building Energy Efficiency Project (the proposed follow-on UNDP-GEF project to EEH currently seeking GEF funding)
CDM	Clean Development Mechanism, a Kyoto Protocol flexibility mechanism
ECC	Energy Conservation Center
EEH	Energy Efficiency Housing (project) – UNDP-GEF MON/99/G35
EPS	Expanded Polystyrene Sheet (insulation), also called Styrofoam and polystyrene
GEF	Global Environment Facility
ger	Traditional Mongolian round nomadic family felt tent
ger area	Areas with a mix of *ger* and largely informal small private houses
GHG	Greenhouse Gases
GOM	Government of Mongolia
LFA	Logical Framework Approach
MACE	Mongolian Association of Civil Engineers (an NGO)
MCUD	Ministry of Construction and Urban Development
MSP	Medium Sized Project (of GEF)
MUST	Mongolian University of Science and Technology
NGO	Non-Governmental Organization
PDF	Project Development Facility
PEESS	Provision of Energy Efficient Social Services (MON/97/301)
PIU	Project Implementation Unit
ProDoc	Project Document (of UNDP)
SB	Straw Bale
SBH	Straw Bale Housing
SBB	Straw Bale Building
Soum	Local Administrative Center in rural area of Mongolia (322 in total)
Tugric	Mongolian National Currency (1USD=1200 Tugric)
UB	Ulaanbaatar (with 80% of urban residents and 40% of population of Mongolia)

Annex B Evaluation Methodology

The final evaluation methodology followed was to focus on assessing the relevance, performance, original and evolving rationale, implementation, financial management, realism and specificity of project results sought and project-end and post-project legacy of the project. The evaluation looked for and assessed early signs of potential project impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental goals. The evaluation also identified and articulated the lessons learned from the project and made recommendations that will improve the design and implementation of other similar UNDP-GEF projects.

The evaluation utilized an extensive review of project documentation and its evolving context. In particular, this approach revealed that there had been major changes to the project design and outputs between the MSP brief stage as approved by GEF and the ProDoc signed by UNDP and GOM. It was further found that neither UNDP Mongolia nor the EEH PIU was aware of the MSP Brief, although it had presumably been available on the GEF website since late 1999.

To guard against capture by project staff and their views, the evaluation team met with key stakeholders and visited a number of EEH project houses that had been super-insulated from new or as retrofits as a result of the project. No major discrepancies were found between project staff or UNDP Mongolia views and those of wider stakeholders, which usefully added to the robustness of the evaluation findings.

Annex C Review Mission report

List of persons and their organizations interviewed on final review mission

No.	Name	Position	
1.	Myagmar G.	Director of Construction, Housing and Public Utilities Department, MCUD National Project Director of EHH project	
2.	Tsogt A.	Senior Officer, Fuel and Energy Policy and Strategic Planning Department, Ministry of Fuel and Energy (MFE)	
3.	Tsend N.	National Project Manager, EHH project	
4.	Joscha Stillner	Programme Officer, Environment Cluster, UNDP CO Mongolia	
5.	Munkhbayar	City General Manager and Chief of City Mayor's Administration Office	
6.	Munkhbayar B.	Director of MUST's Energy Conservation Center (ECC)	
7.	Tsolmon B.	Director of Ulaanbaatar ECC	
8.	Dolgormaa O.	Director of Darkhan ECC	
9.	Ganmumur	Executive Director, Mongolian Association of Civil Engineers (MACE)	
10.	Oyuntsetseg D.	Project Manager, Improved Household Stove Project	
11.	Tsetsegmaa A.	Economics Officer, ADB Mongolia Resident Mission	
12.	Otgonbayar G.	Officer, Urban Development, Information and Public Relations Center.	
13.	*Ger owner*	Insulated Ger in Songino Khaikhan District of Ulaanbaatar city	
14.	*Ger owner*	Ger without insulation, Songino Khaikhan District of Ulaanbaatar city	
15.	*House owner*	Straw bale house, Songino Khaikhan District of Ulaanbaatar city	
16.	*House owner*	Private house insulated with EPS, Sukhbaatar city, Selenge Aimag	
17.	*House owner*	Private house with EPS insulation, Selenge Aimag	
18.	*House owner*	House insulated with EPS and straw-bales, Selenge Aimag	
19.	*House owner*	House with EPS insulation, Selenge Aimag	
20.	*House owner*	House insulated with EPS and straw-bales, Darkhan city	

Annex D Table - Specific ProDoc and Actual Project Objectives, Outputs, Costs and Changes

No.	Initial Objectives & Outputs	Estimated costs	Key Outputs & Changes during implementation	Actual costs & Remarks
1.	**<u>Immediate objective-1:</u> To reduce energy consumption and CO2 emissions in the housing sector**		Household fuel consumption was reduced by a factor of 2.5. 3,587 tons of coal/year was saved, 5,380 tons/year of CO_2 was reduced.	
	<u>Output 1.1:</u> 84 new SB houses. Indicators: (10-20% reimbursable basis) 1) 84 SB houses built 2) Replication monitored and tabulated.	$210,000 (Norway)	TPR meeting 19 May 2006 decided to: - Reduce the number of SB houses from 84 to 56; utilize the budgeted USD 36,500 for equipping a laboratory of MUST as an ECC, strengthening of ECC's human resources; conducting market survey and evaluation activities for ECCs 72 SB houses built with a 20% reimbursement level provided.	Reimbursement was $82,500. $3,000 for ECC market survey.
	<u>Output 1.2:</u> 50 houses refurbished with energy efficient materials and stoves. Indicators: (10-20% reimbursable basis) 1) 50 houses refurbished. 2) Replication monitored and tabulated.	$50,000 (Norway)	* 95 new houses constructed with conventional insulation materials, * 53 existing houses retrofitted with insulation (with 20% reimbursement level) * 440 ger insulated with 100% funding provided to prove new ger insulation blankets.	Reimbursement: $106,300 $22,100 $113,500 respectively
	<u>Output 1.3:</u> 6 provincial ECCs. Indicators: 1) 6 ECC built and equipped. 2) 6 ECC directors recruited. 3) ECCs provide training and other public services. 4) ECCs become self-financing.	$60,000 (GEF)	4 ECCs were established, namely Ulaanbaatar ECC, Erdenet ECC, Darkhan ECC. MUST ECC established recently. 4 ECC directors recruited. ECCs now operational. Training and EC services provided. MACE running the ECCs under a management contract with the EEH Project. Self-sustaining ECC operations surveyed, recommendations made and implemented.	$141,700 for 3 ECC SB buildings. $6,800 for ECCs' directors' salary. $153,179 for equipment.

	Output 1.4: Proof of energy efficiency in SB and refurbished houses. Indicators: 1) Energy savings in SB and refurbished houses measured and made public. 2) Cost versus benefits of SB and refurbished houses analyzed and made public. 3) Environmental impact of EC measures in the housing sector analyzed and made public.	$30,000 (GEF)	Fuel & Energy efficiency research conducted. The result of research proved the energy efficiency of EEHs in Mongolian actual conditions in occupied buildings.	$68,941 for contract with Balanced Solutions. $16,986 for contract with MUST.
2.	**Immediate Objective 2: To demonstrate the use of energy efficient technologies**	-n/a-	*Outouts 2.1 to 2.5 were wholly supported under the predecessor* ***project MON/97/301***	-n/a-
3.	**Immediate Objective 3: To increase in-country human resource and technical capacities for EC in the housing sector.**		A total of 49 training sessions organized and 1671 people participated in these training sessions (comprising 31 technology and 18 public awareness training sessions)	
	Output 3.1: A cadre of designers and builders trained in SB housing and refurbishment technologies. Indicators: 1) 30 engineers and architects trained in SB housing design and refurbishment work (1 course/year x 2 years x 15 engineers/course) 2) 180 builders trained on-the-job in SB	$30,000 (GEF)	40 engineers and more than 400 builders trained.	$30,000

	house construction; (6 sites/year x 2 years x 15 builders/site)			
	Output 3.5: University curriculum developed on EE in the building sector Indicators: 1) New curriculum developed at the university level for EC in the building sector. 2) 30 university professors and lecturers trained in new curriculum. 3) 100 engineering and architectural students enrolled in the new EC courses.	$30,000 (GEF)	The new curriculum was developed, tested, evaluated and improved at the Construction School of MUST; and 110 students participated in the new curriculum courses.	$5,000
4.	**Immediate Objective 4: To create an enabling environment for EC in the housing sector**			
	Output 4.1: Simplified and streamlined governmental procedures established. Indicators: 1) National norms and standards for SB houses and refurbishment are developed and approved. 2) Relevant provincial authorities are aware of these norms and standards.	$20,000 (GEF)	The standards (2); norms (2); and technological instruction (1) were improved and are being used by house builders. Introductory training on the SBH norms and standards involving 15 engineers and architects organized.	$3,000
	Output 4.2: Increased awareness of SB buildings and EC options. Indicators: 1) Importance of EC becomes widely	$20,000 (GEF)	The public has started understanding the importance of EE and EEH, saving fuel and managing energy costs. Distributed packages of information (posters, brochures, books, and handouts, and VCDs of energy efficient house construction and	$54,210

	known and accepted. 2) Positive aspects of SB housing becomes widely known and accepted.		energy efficiency concepts). Produced and aired 5 television reports, a television talk show (52 minutes long) titled "Insulated Houses Clean the Air" in cooperation with television studios and the Arirang television of the Republic of Korea, aired through English channel, worldwide coverage. Cooperation with local newspapers "Unen" and "Ardin Erkh" and 5 reports written on ger insulation, EE houses, technologies and project activities.	
	Output 4.3: Business management skills of private construction companies and ECCs are improved Indicators: 1) 120 people from construction companies trained in business management. 2) ECCs become self financing	$20,000 (GEF)	People from 113 companies were trained. ECCs operational on a management contract basis with the Project. Maximizing self-financing is a key focus of ECC operations.	$3,214
	Output 4.4: Sustainable financing mechanism for EC in the housing sector. Indicators: 1) Opportunities for financing the construction of SB houses are identified. 2) Recommendations are developed to increase EE housing construction. 3) Commercial/private credit is mobilized for the construction of private SB houses.	$70,000 (Norway)	Developed 3 options for SBH financing mechanism and delivered to stakeholders for approval. Funding organization refused to finance the financing mechanisms developed. However, an Agreement was established with Xasbank for issuing construction and mortgage loans to SBH builders. Around 10 families applied for a loan to Xasbank and their applications are being considered. Cooperated with 5 banks, provided 24 households with 180.8 million tugrug of loans for constructing and insulating houses.	

Summary of the Project Costs				
	Contractual services for the above	$180,000		$293,150
	Unspecified contracts	$17,000		$17,000
	Personnel	$283,400		$158,450
	Study tour, workshops & seminars	$135,000		$68,400
	Equipment	$75,000		$153,179
	Miscellaneous	$34,600		$34,821
	GEF total	**$725,000**		**$725,000**
	Personnel	$196,500		$174,500
	SB house	$210,000		$84,500
	Housing Refurbishment	$50,000		$241,900
	Other Contractual services	-		$64,330
	Financial mechanism	$70,000		-
	Unspecified contracts	$23,000		$35,300
	Workshops & seminars	$15,000		$19,700
	Miscellaneous, COA	$35,500		$28,120
	Total (Norway)	**$600,000**		**$648,350**
	Parallel Financing Home builders	$274,434 $210,000		$521,500
	UNDP			$68,000
	Lutheran Mission			$25,000
	Grand total	**$1,809,434**		**$1,987,850**

Annex E Consultants Terms of Reference[6]

1. Background

The Monitoring and Evaluation (M&E) policy at the project level in UNDP/GEF has four objectives: i) to monitor and evaluate results and impacts; ii) to provide a basis for decision making on necessary amendments and improvements; iii) to promote accountability for resource use; and iv) to document, provide feedback on, and disseminate lessons learned. A mix of tools is used to ensure effective project M&E. These might be applied continuously throughout the lifetime of the project – e.g. periodic monitoring of indicators, or as specific time-bound exercises such as mid-term reviews, audit reports and final evaluations.

In accordance with UNDP/GEF M&E policies and procedures, all regular and medium-sized projects supported by the GEF should undergo a final evaluation upon completion of implementation. A final evaluation of a GEF-funded project (or previous phase) is required before a concept proposal for additional funding (or subsequent phases of the same project) can be considered for inclusion in a GEF work program. However, a final evaluation is not an appraisal of the follow-up phase.

Final evaluations are intended to assess the relevance, performance and success of the project. It looks at early signs of potential impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental goals. It will also identify/document lessons learned and make recommendations that might improve design and implementation of other UNDP/GEF projects.[7]

The Commercialization of Super-Insulated Buildings in Mongolia project (Energy efficient housing-EHH) has been funded through the Global Environment Facility (GEF), the Government of Norway (GON), and the United Nations Development Programme (UNDP). It started in 2001 and was originally designed to end in 2004. However, the project was extended to end in Dec 2006. The evaluation will take place in Jan 2007. The objectives of the EEH project were:

1. To reduce the energy consumption and CO_2 emissions in the housing sector,
2. To demonstrate energy efficient technologies,
3. To increase in-country human resource and technical capacities for energy conservation in the housing sector,
4. To create an enabling environment for energy conservation in the housing sector.

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[6] These TORs follow the evaluation guidelines of the UNDP/GEF booklet "Measuring and Demonstrating Impact" available on the UNDP intranet website (last accessed: 28 June 2005).

[7] These three paragraphs are the standard introduction for final evaluations (Measuring and Demonstrating Impact).

II. OBJECTIVES OF THE EVALUATION

UNDP country office Mongolia is initiating this evaluation to determine to what extend the project has achieved its objectives and has improved the energy efficiency in buildings in Mongolia. The evaluation will also be sent to GEF to meet GEF's reporting requirements. The main stakeholders of this evaluation are the GEF, UNDP, and MCUD.

The EEH project activities are envisaged to continue in a modified manner in the BEEP project which has been designed with the assistance of a PDF-A grant and is currently being considered for GEF funding. The EEH evaluation will therefore be of value to the BEEP project once it is approved and being initiated.

III. PRODUCTS EXPECTED FROM THE EVALUATION

The evaluation report outline should be structured along the following lines:

Executive summary
Introduction
The project(s) and its development context
Findings and Conclusions
4.1 Project formulation
4.2 Implementation
4.3 Results
Recommendations
Lessons learned
Annexes

The evaluation mission shall be undertaken in the time period from Jan 12 till Jan 25, 2007 (12 working days in total) because of time constraints and the operational ending of the project. The evaluators are expected to be both familiar with this project and have experience in related fields such as energy efficiency and environmental protection projects. Therefore the suggested limited timeframe is considered to be sufficient.

The first draft of the evaluation shall be submitted to UNDP CO Mongolia at the completion of the country evaluation mission. Any feedback provided by GEF, UNDP or MCUD will be addressed by the evaluation consultants within 10 working days of receipt of the feedback.. The report shall not exceed 50 pages in total.

IV. METHODOLOGY OR EVALUATION APPROACH

The evaluation team should review the provided project documents and publications. The main sources of information will be provided through the project management team. Interviews with various stakeholders and field visits will add important information to the evaluation.. These include but are not limited to the following:

- MCUD
- the four ECCs in Ulaan Baatar, Darkhan and Erdenet
- UNDP
- MUST
- MACE
- other stakeholders

Representatives of these organizations should be interviewed. Other stakeholders as sources of information may include housebuilders, home owners of the retrofit houses and refurbished ger, skilled Strawbale house builders and students of MUST.

V. EVALUATION TEAM

This evaluation shall be done through a team consisting of an international expert and a national expert. The team should be familiar with the project and related fields/sectors. The international expert shall be the team leader.

a) Specific role and responsibilities:
The International Expert shall be responsible in completing and delegating of all tasks for the terminal evaluation to the National Expert. He/she will ensure the timely submission of the first draft and the final version of the terminal evaluation with incorporated comments from UNDP and others.

The National Expert will jointly with, and under the supervision of the International expert, support the evaluation. He/she will be responsible to review documents which are only available in Mongolian language, translate necessary documents and interpret interviews, meetings and other relevant events for the International Expert. He/she will work as a liaison for stakeholders of the project and ensures all stakeholders of the project are aware of the purposes and methods of the evaluation and ensures all meetings and interviews take place in a timely and effective manner.

b) Profile required/Qualifications:
The international consultant will be the team leader and should have an advanced university degree and at least 10 years of work experience in the field of sustainable energy or environment, sound knowledge about results-based management (especially results-oriented monitoring and evaluation). S/he should be familiar with UNDP/GEF projects and GEF policies and strategies and have sound familiarity with Mongolia, ideally with the project and its related field/sector. The team leader will take the overall responsibility for the quality and timely submission of the

evaluation report in English

The national expert shall have an academic degree related to energy or environmental management and be familiar with the environmental conditions in rural and urban Mongolia. S/he shall have work experience with international development programs, preferably with UNDP/GEF. The ability to travel to rural Mongolia is required. An excellent working knowledge of English and computer literacy is required.

VI. IMPLEMENTATION ARRANGEMENTS

No.	Task	12-13 Jan	15-16 Jan	17-20 Jan	22-25 Jan
1.	Review of existing project documents; Evaluation design and detailed evaluation plan, discussion with UNDP and the NPM & NPD.				
2.	Briefing with UNDP Mongolia, MCUD, NPD, finalization of the detailed evaluation plan Meet with UNDP, MCUD, Project Staff				
3.	Field visits to different sites (straw bale house, conventional house with improved insulation material, retrofit house and insulated Mongolian ger and interview the beneficiaries in UB and Sukhbaatar city of Selenge aimag)				
4.	Meet with Stakeholders in UB. Interviews with partners (MACE, ECCs and MUST)				
5.	Drafting of the evaluation report				
6.	Debriefing with UNDP Mongolia, MCUD, and the NPD. Present Findings to UNDP and MCUD				
7.	Finalization of the first draft of the evaluation report				

The mission should submit the final report with the incorporated comments of UNDP Mongolia, UNDP-Bangkok, MCUD and the NPD in electronic form to UNDP Mongolia.

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VII. SCOPE OF THE EVALUATION- SPECIFIC ISSUES TO BE ADDRESSED

The section refers to the before mentioned section "III. PRODUCTS EXPECTED FROM THE EVALUATION." The (1) Executive summary, (2) introduction and (3) the project and its development context are more of a descriptive assessment. In the following parts the criteria marked with (R) shall be evaluated with Highly Satisfactory, Satisfactory, Marginally Satisfactory, Unsatisfactory:

(4) The findings and conclusions

(4.1) Project formulation

- **Conceptualisation and design** of the project **(R)** has to be assessed. This assessment should include the way the proposal is designed and the appropriateness of the problem conceptualisation. It should also assess whether the intervention addressed the root causes and principal problems in protecting the environment through CO_2 reduction. The logical framework should be assessed. The assessment should highlight where lessons were learned over the course of the project and the extent that they were incorporated in the project design.

- **Country-ownership/Driveness**. Assess the extent to which the project idea/conceptualization had its origin within national, sectoral and development plans and focuses on national environment and development interests.

- **Stakeholder participation (R)** Assess information dissemination, consultation, and "stakeholder" participation in design stages.

- Replication approach. Determine the ways in which lessons and experiences coming out of the project were/are to be replicated or scaled up in the design and implementation of other related projects.

(4.2) Project Implementation

- Implementation Approach **(R)**. This should include assessments of the following aspects:

  (i) The use of the logical framework as a management tool during implementation and any changes made to this as a response to changing conditions and/or feedback from M and E activities as required.

  (ii) Other elements that indicate adaptive management such as comprehensive and realistic work plans routinely developed that reflect adaptive management and/or; changes in management arrangements to enhance implementation.

(iii) The project's use/establishment of electronic information technologies to support implementation, participation and monitoring, as well as other project activities.

(iv) The general operational relationships between the institutions involved and others and how these relationships contributed to effective implementation and achievement of project objectives.

(v) Technical capacities associated with the project and their role in project development, management and achievements.

- Monitoring and evaluation **(R)**. Including an assessment as to whether there has been adequate periodic oversight of activities during implementation to establish the extent to which inputs, work schedules, other required actions and outputs proceeded according to plan; whether formal evaluations have been held and whether appropriate action has been taken on the results of the monitoring oversight and evaluation reports.

- Stakeholder participation **(R)**. This should include assessments of the mechanisms for information dissemination in project implementation and the extent of stakeholder participation in management, emphasizing the following:

(i) The production and dissemination of information generated by the project.

(ii) Local resource users and NGOs' participation in project implementation and decision making and an analysis of the strengths and weaknesses of the approach adopted by the project in this arena.

(iii) The establishment of partnerships and collaborative relationships developed by the project with local, national and international entities and the effects they have had on project implementation.

(iv) Involvement of governmental institutions in project implementation, and the extent of governmental support of the project.

- Financial Planning: Including an assessment of:

(i) The actual project cost by objectives, outputs, activities

(ii) The cost-effectiveness of achievements

(iii) Financial management (including disbursement issues)

(iv) Co-financing)

- Sustainability. Extent to which the benefits of the project will continue, within or outside the project domain, after it has come to an end. Relevant factors include for example: development of a sustainability strategy, establishment of financial and economic instruments and mechanisms, mainstreaming project objectives into the economy or community production activities.

- Execution and implementation modalities. This should consider the effectiveness of the UNDP counterpart and Project Co-ordination Unit participation in selection, recruitment, assignment of experts, consultants and national counterpart staff members and in the definition of tasks and responsibilities; quantity, quality and timeliness of inputs for the project with respect to execution responsibilities, enactment of necessary legislation and budgetary provisions and extent to which these may have affected implementation and sustainability of the Project; quality and timeliness of inputs by UNDP and GoM and other parties responsible for providing inputs to the project, and the extent to which this may have affected the smooth implementation of the project.

(4.3) Results

- Attainment of Outcomes/ Achievement of objectives **(R)**: Including a description *and rating* of the extent to which the project's objectives (environmental and developmental) were achieved using Highly Satisfactory, Satisfactory, Marginally Satisfactory, and Unsatisfactory ratings. If the project did not establish a baseline (initial conditions), the evaluators should seek to determine it through the use of special methodologies so that achievements, results and impacts can be properly established.

- This section should also include reviews of the following:

- Sustainability*:* Including an appreciation of the extent to which benefits will continue, within or outside the project domain after GEF assistance/external assistance in this phase has come to an end.

- Contribution to upgrading skills of the national staff

(5) Recommendations

Corrective actions for the design, implementation, monitoring and evaluation of the project
Actions to follow up or reinforce initial benefits from the project
Proposals for future directions underlining main objectives

(6) Lessons learned

This should highlight the best and worst practices in addressing issues relating to relevance, performance and success.

(7) Evaluation report Annexes

- Evaluation TORs
- Itinerary
- List of persons interviewed
- Summary of field visits
- List of documents reviewed
- Any questionnaires used and summary of results
- Comments by stakeholders (only in case of discrepancies with evaluation findings and conclusions that could not be resolved)

Annex 2

Documentation for Terminal evaluation

List of Documents to be reviewed by the evaluators:

- Project document
- Steering Committee Meeting Minutes
- Tri-Partite Review Meeting Minutes
- Audit Reports
- Annual Reports
- Financial Reports
- Mission Reports
- Outcome Evaluation Report
- Other Reports, Meeting Minutes, Correspondence and TORs as needed