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Renewable Energy &
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Promotion in
International
Cooperation

: Final Report :

ENERGY EFFICIENT CONSTRUCTION IN RURAL AREAS AND CITIES

RENEWABLE ENERGY TRAINING CENTER (RETC) PYONGYANG

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Contents

0. Summary

(max. 1 page, with main results explained in 2-3 sentences)

During the three years of this project the Energy Center (EC), the leading agency for the dissemination of the knowledge about renewable energies in North Korea was trained in the field of energy efficient construction (in Switzerland known under the label Minergie). Besides an in depth workshop and study tours for specialists to China and Europe, Agape international also offered an awareness one-day workshop on this topic for key players and decision makers. EC then adapted the new know-how in three different ways:

- They designed their new planned Renewable Energy Training Center (RETC) based on the five basic EEC principals.
- Second, they renovated an existing eight-year-old two-story office building of an agricultural cooperative farm (Ryokpho) with the goal to reduce the heating demand. This was done by applying 50 mm of Styrofoam insulation on the walls and the roof and replacing the existing windows with high quality windows.
- The third application was the design and construction of a typical village one family farmhouse in the traditional design, but with the same applied insulation techniques. On both buildings, a solar thermal unit and photovoltaic panels were installed. Calculations show a decrease of 50 - 80% energy demand.

The three applications are all practical model cases for further in-country training that EC already started in the last two years.
The technical foundation about energy efficient construction (EEC) was laid with two workshops by the Swiss Minergie specialist Dr. Werner Hässig. The first workshop in November 2010 laid the basis for this project, the 2012 course gave a second impact to raise the awareness about this topic and it's potential to a wide range of experts and policymakers. In parallel EC was multiplying the new know-how from workshops and study tours to a total of 1186 in-country participants that showed up in 11 training courses (average 100 students per course, all together 34 training days) with topics ranging from improving cooking stoves to geothermal energy to calculating energy demand of buildings.
EC compiled the new know-how also in the first in-country book on this topic and printed 1000 copies of it and will spread it further as an e-book version. Besides this various newspaper articles and TV documentaries helped raise the awareness for renewable energies to common people in the country.
EC was also provided with the necessary equipment to measure the calorific values of e.g. coal, calculate heat flow, evaluate u-values of various insulation materials and make energy assessments for existing buildings.
During the project cycle a solar thermal factory, a greenhouse plastic sheeting factory and a producer of solar PV cells and LED lamps started production and insulation material such as Styrofoam became widely and easily available on the civil market.

1. Objectives

(Describe the project's initial main objectives; mention if they changed during the project)

The project was aimed at the dissemination of the knowledge about energy efficient construction work (design, planning, and construction) in combination with the use of alternative energy sources (wind, sun, and biogas). This was demonstrated in a practical manner with the construction of a typical village type house, the planning and design of a new training center of the Energy Center in Pyongyang based on current standards in Switzerland / Europe (Minergie / Minergie-P / Swiss Building Energy Regulation (MuK-En)) and applying energy efficiency principals during the renovation of an two story office building. It was also aimed to make proposals for the adaption of existing construction laws so that this aspect can be taken into consideration in the future. The buildings are aimed to be a model for further buildings within the country whether it be the countryside or in cities. The know-how about implementing energy efficient standards in design and construction work was transferred to at least 100 domestic specialists that are able to train others.

2. Technical Solution / Applied Method

(Describe the technical solution / the applied method)

The method to disseminate the know-how about energy efficient construction (EEC) was to train a group of experts in this field with workshops in country (by a Swiss expert) and study tours abroad (China / Europe) that had a practical look and information exchange on specific projects in this field (construction, financing, policy development, material). This new knowledge about EEC was then applied in the two main fields: Renovation of existing buildings and design and construction of a new building. In parallel, a series of in-country workshops with bigger groups of local experts helped to spread and disseminate the new know-how acquired. This was supported by translating technical books and leaflets in this field from German or English into Korean and compiling and publishing the first Korean technical book on EEB.

For the renovation and construction, insulation and tightness as well as passive solar gains through windows were applied as key issues for energy efficient buildings. A focus was also laid on evaluating local materials for building construction (e.g. insulation). For this, the project supported the acquisition of a series of specific measurement equipment to measure the current situation and improvements.

3. Results

(Describe activities progress and results achieved at the end of the project, specify to which extent objectives have been reached, report changes and discrepancies compared to initial objectives)

3.1. Development and installation of energy efficient buildings for rural areas and cities

Based on the gained know-how through the workshops on Energy Efficient Construction (EEC) from Mr. Hässig in November 2010 (pre-investment to this project) and March/April 2012 and the study tours in China (January/February 2012) and Europe (March 2013) (for details see 3.2 Training) the Energy Center had enough input for starting to adapt the principals of energy efficient construction into praxis. First stage was the planning and design. This then was adapted in two specific construction projects (new village building and renovation of an existing office building, see chapter 3.1.5).

3.1.1. Planning and Design

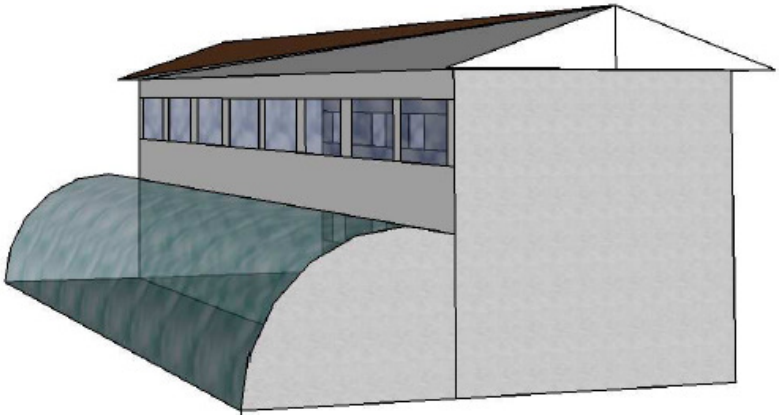
The challenge was to keep the different ideas about what kind of object to work on (small village house and big village house or small city building) and the usage of it and

the different processes (design, renovation, new construction) all together in focus. The planning and design process went through different stages and circles with many changes. The project site had to be moved after three years from Duru Island to Ryokpho County to insure that the construction part could be realized. Finally, all planned steps were realized in one way or the other.

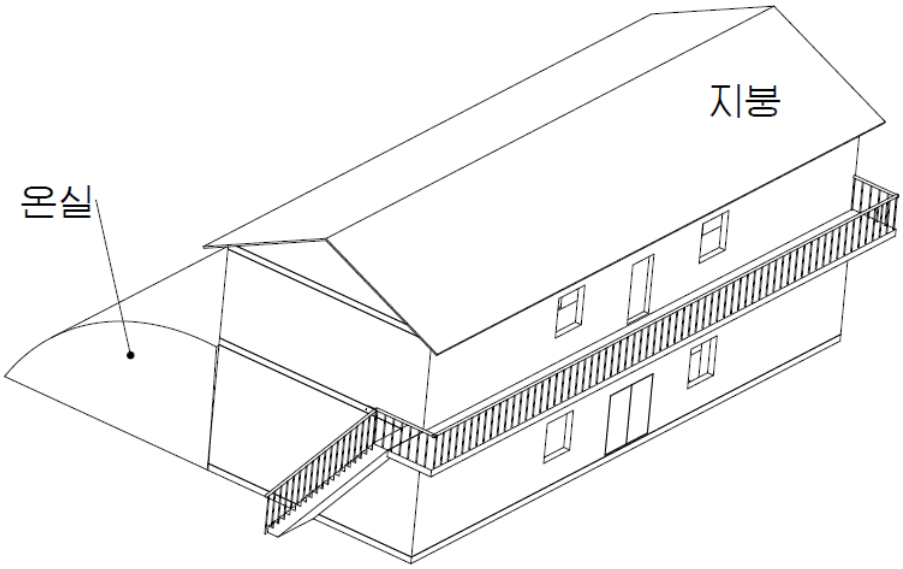
3.1.1.1 Planning and design of a large village house/small city house

The main design and planning process for this was done with the assumption of it being realized in Duru Island as the new Renewable Energy Training Center (RETC). The local regulations on farmland usage for construction made it clear early that there would be only limited space for the whole site. Because it is on a farm, all the farmland outside the compound of sub work team 3 belongs to the productive land that is highly protected by law. Each new building needs a special permit. Therefore the amount of space allowed for the RETC (internally called Control Room) was cut down to only one area that puts together building and green house because agricultural area is so precious in this country.
The design itself got some good inputs through the challenge of putting the greenhouse together with the building and in adding a second floor to it. It became a compact unit of living and production. The idea with the greenhouse attached to the south side uses the solar thermal energy. The south wall is also used as heat storage and heat exchanger, by letting pass thru the hot air from the green house.

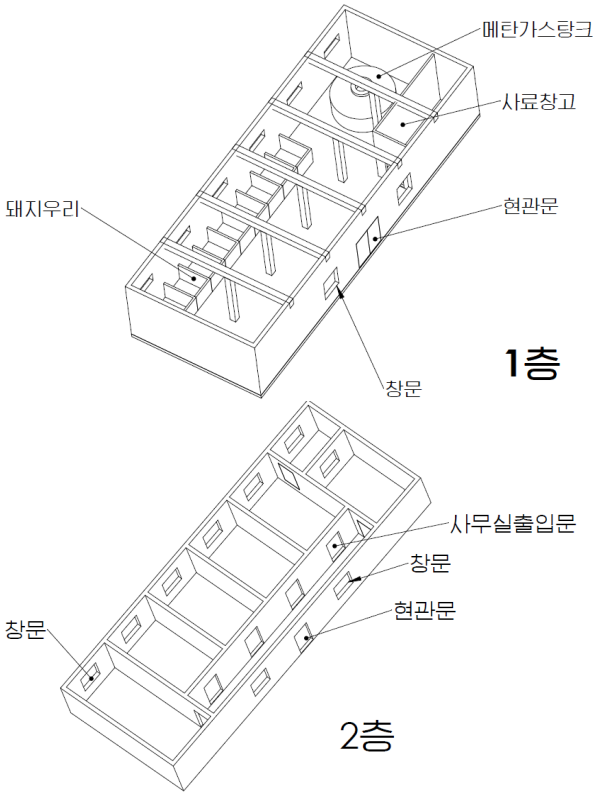
The goal was to find a good balance between culture (traditional Korean building, adapted to way of living …) – technology (EEC, biogas, wind, solar…) and environment (natural local resource, low energy, integrated production …).



First design drafts (2012) – based on the discussed figures: Length = 18 m, width 8.5 m – total 153 m^2, plus same size for green house on south side. Long side south oriented, big windows towards the South, small windows on North side. Two Floors.



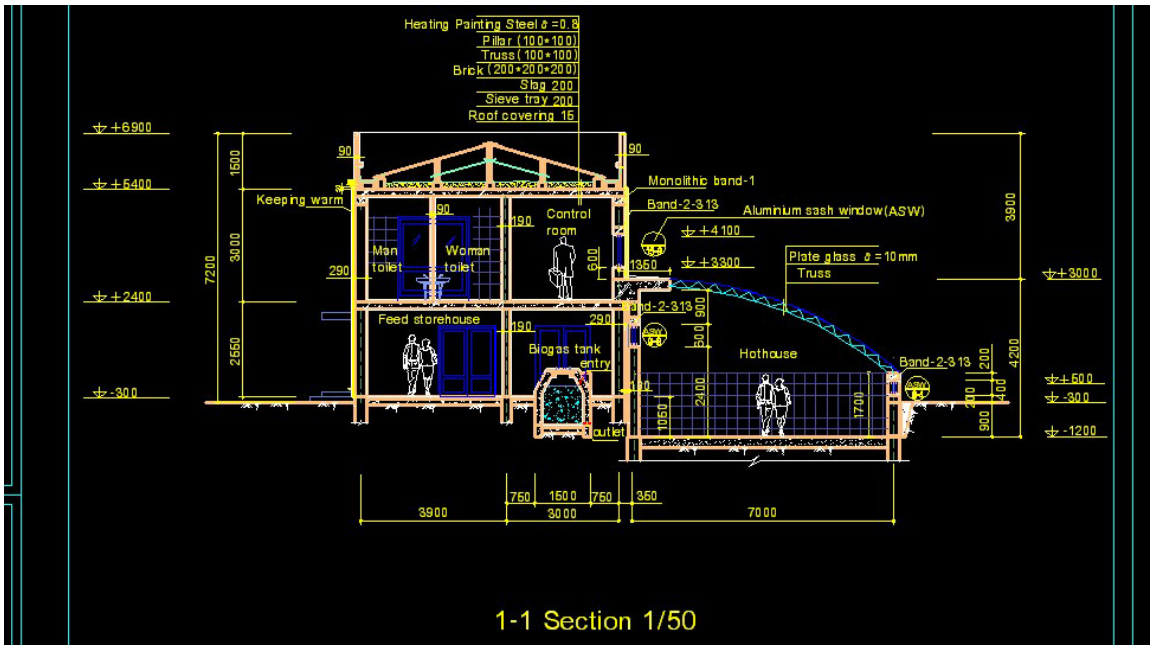
Advanced Draft EEB Duru Island



Draft of first and second floor on EEB Duru Island

For the development of the methodologies and software for planning and design of an Energy Efficient Building (EEB), the Korean Project Team has engaged many stakeholders in this activity. After the two workshops on EEC in Pyongyang, many Korean organizations were interested in the EEB project and actively participated in this activity (Paekdusan Academy of Architecture, Pyongyang City Design Institute, Electricity Design Institute, Pyongyang City Planning Institute, etc.). These have discussed different options for EEB construction. They were all summarized in the design of the EEB for Duru Island in the format of CAD drawing which was delivered to Agape international and Mr. Hässig by the training mission in March 2013. In addition, a first budget was set together.

CAD Drawing of EEB Duru Island: Outside view (from North East)



CAD Drawing of EEB Duru Island: Inside details

This design and drawings were also used for energy calculation during the stay in Europe and Mr. Hässig's technical assessment on the model (see chapter 3.2.3.2). After the return from training in Europe, the Project Team studied the Excel sheets for the calculation of Energy use (based on the Swiss Norm sia 380.1 – Results see Chapter 3.2.3 and Annex E) and they are under modification for application to Korean context (e.g. temperature curves, inside room temperature). Experts from different stakeholder organizations are pooling their expertise for the development of Korean version.

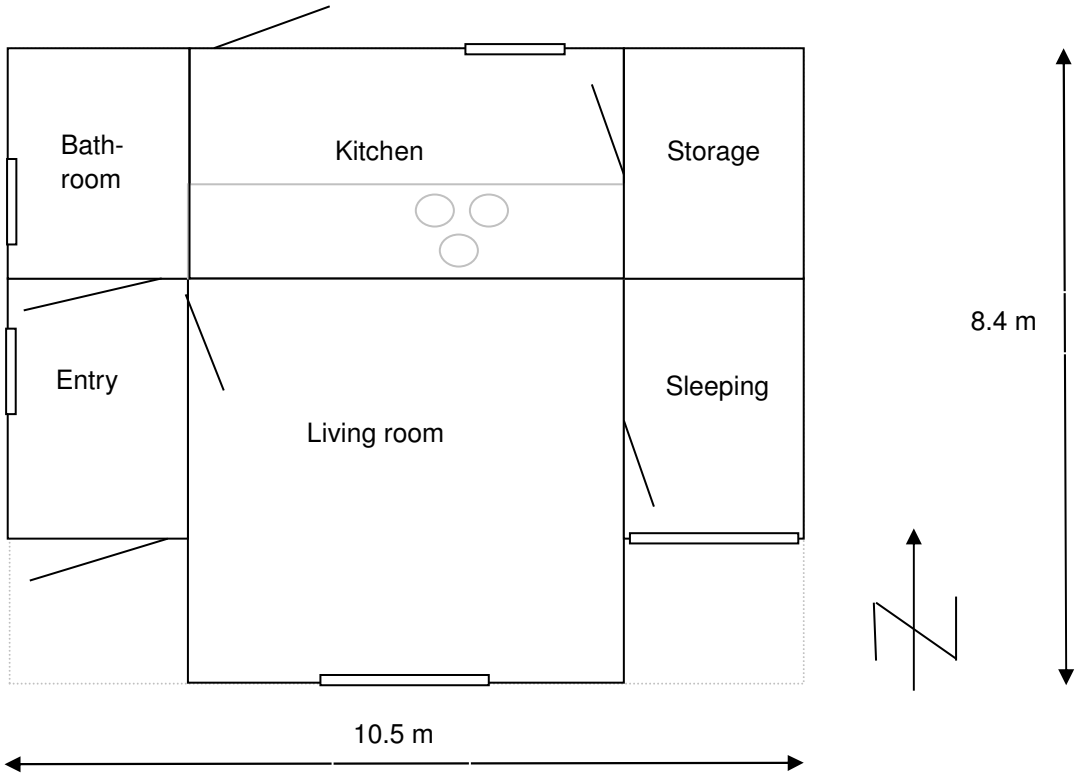
3.1.1.2 Planning and design of a typical village house

After moving the demo site from Duru Island to Ryokpo Vegetable Cooperative Farm (hereinafter refer to Ryokpo) begin of 2013, according to the local situation, the Project Team had to restart technical preparation for construction of a new village house as EEB.

After the visit of Mr. Stefan Burckhardt in June, 2013, the Project Team started to seek permission for the construction of new village house in Ryokpo. The permission was available at the end of October. With an assumption of that permission, the Project Team has started the design of the new house in advance. Because they didn't have enough time, they engaged Ryugyong Construction Design Institute (RCDI) again in the design and control.

At the first place, the Korean Project Team tried to adopt all original EEB ideas in the new design. There were very hot discussion and intense debates between related parties. Final conclusion was that it would still take time to reach Minergie standards in Korean context. So they decided to adopt a transitional design which integrates Korean life and architecture style and EEB principles.

The usage was taken over from a standard one family farmhouse with one living room and an extra bedroom, a kitchen on the north side with an extra storage room. The living room got the traditional "Ondol bang" floor heating (as Korean people are used to it), for the bedroom, it was skipped. All construction materials were locally available. Controlled airing was not included – the concept was too new to be implemented for a single-family house.



Ryokpho Village Farmhouse: Usage of rooms. Outer dimensions. Placement of windows (West side 2 windows (double-glazing), South side 2 windows (triple glazing), north side1 window (double glazing, sliding window)

3.1.2. Characteristics, availability and price of needed material

At the beginning of the project, there was only very limited information about what kind of insulation material is available in the country. One goal was to start collecting this information and make it available and public. First attempts have been made and can be checked in Annex A. For the material used in renovation and construction also price information are available. Still more efforts should be done to really get an overview and to keep it updated.

The situation on the market about the availability of Styrofoam changed a lot. At the beginning of the project, polystyrene (PS) was only available through one or two companies. At least one producer was starting to produce locally (still importing the raw material). Until 2014 the situation changed in that way that there are now 5-10 producers / importers that offer different qualities and compete in the price. Right now the most common products have a thickness of 50 mm, but thicker boards will get more available soon (in China 80 – 120 mm are used).

EC was also provided with the necessary equipment to measure the calorific values of e.g. coal, calculate heat flow, evaluate u-values of various insulation materials and make energy assessments for existing buildings. The detailed list can be found in Annex B.

During the project cycle a solar thermal factory (Solarheat Equipment Center, Pyongyang, 2012), a high quality window producer (Haewon Furniture Company, 2012), a greenhouse plastic sheeting factory (Nahumg Youth Chemical Complex, 2014) and a producer of solar PV cells and LED lamps (Kwangmyong LED and Solar cell Factory, 2014) started production.

3.1.3. Adaption of construction laws

The existing law in D.P.R.K. (from 1970) sets a target temperature of 20 – 22℃ for the living room for spatial heating. This target was set in a time where there was still much more energy available (coal, electricity). Nowadays the energy lack became serious. Authority members asked about figures and laws in China. During the mission in China, CABR explained the law framework and standards in China. This is a good input for the work of the group within D.P.R.K. EC is in contact with Kim Tchaek University, the Ministry of Construction and Survey (institute of thermal energy, engineering, central space heating institute) and Kim Il Sung University. They were all involved in the construction of new apartment blocks (goal 100’000 new apartment until 2012). The Ministry of Construction and Survey is suggesting modifying the existing construction law: Heat loss target for apartment walls is 0.6 W/m^{2}K. During discussion with EC they realized that this value is still high – the new agreed value is now proposed to be 0.4 W/m^{2}K. The fear is that this will raise the construction costs – a final decision will be taken after the finish of the pilot project. In addition, the idea of control valves for each apartment (not room!) is discussed.

New buildings at Changjon Street at night – for these high rise building (constructed in 2010 – 2012) inside insulation was applied which can cause problems with mold.

The goal of making specific proposals for adapting construction laws is still too high to achieve within the framework of this project. During the implementation of this project, the awareness of many stakeholder organizations had considerably improved and the construction and operation of demo EEB buildings will be significant stepping-stone for the higher construction standards. However many stakeholders are still insisting that the renovation and construction costs are too high to afford for local residents. The Project Team will conduct cost-effectiveness analysis in terms of short- and long-term operation.

During the renovation and construction of demo buildings, contrary to original estimation, the Project Team has used all domestically available materials (or at the worst domestically produced). The Korean Project Team considers this as good news for the general application nationwide. After the operation of demo buildings, the Project Team will submit recommendations to the authorities concerned for improved construction standards and laws. The simulation in Annex E shows, that insulation of buildings is economically viable even in the circumstances of Korea.

3.1.4. RE components for buildings

3.1.4.1 Building up RE demo

During the project cycle, EC made various efforts to build up demo application for the use of renewable energy sources (sun, biogas, wind).

a) In 2010, there was no producer of solar thermal units in country. Therefore EC has designed a simple solar-heat collector to pre-heat water for goat milk processing in the cheese dairy in Samhun Ri. In 2011, EC dispatched technicians to farm for the assembly, installation and trial of the system. They had to renovate the roof and install a water tank on the roof. According to the manager, thanks to the solar heating system, they could considerably decrease the amount of wood consumption. The solar thermal unit is driven only by gravity. There is no use of electrical pumps. A year later a further improvement was made by also using the waste heat from the chimney. This needed an adaption of the size of the chimney and running the cold water pipe through it.

Do it yourself: Simple Solar thermal unit on a cheese dairy with black plastic hoses and plastic shielding. First demo project and practical application of using solar energy in rural areas.

b) On the new village farmhouse and the renovated office building a 120 l solar thermal unit was installed in combination with a PV panel, to run the pump for the water cycle. The solar thermal units were bought from the new Solar Products Development Centre in Kwangbok Street in Pyongyang, that started in country production in 2012 (see also chapter 3.3.3).

Solar thermal water heating unit (120 l) on renovated office building (left) and new village farmhouse (right).

c) Besides heating up water with the sun, green houses are another way of using the sun to improve agricultural production. Vegetables can be grown also over the winter and harvested much earlier in the year than without greenhouse. From the economic viewpoint, EC decided to test its idea of solar-only-heated greenhouse (500m^2). The greenhouse will be a model of the cycle of heat and material. Well-insulated semi-pit shaped building will provide appropriate temperature for vegetable and animal growing even in wintertime. The green house was finished before the winter 2013/14. It produced cabbage, radish and pumpkin from February/March on (planted in November).

Construction of 500 m^2 greenhouse – final framework with steel saving design (right)

The construction needed several attempts – goal was to optimize the use of iron. In the current stage, every second iron bar is reinforced as double bar. The saved iron was handed over to the cooperative farm and they are building another green house with it. The process tried to find the optimal balance between static (stability) and costs. The North face protection of upper part with cement tiles was too heavy and were therefore replaced with rice straw mats.

The biogas reactor was not built yet (as of June 2014). Also there are no pigs yet because the construction approval from the environmental ministry was not ready. The goal is to use the excrement from pigs for biogas production and the gas will be used for cooking and disinfection. Final products from biogas fermentation will be used for vegetable growing.

3.1.4.2. Prototype of serial production for 300 W wind turbine
Because EC has been concentrated on the EEB demo construction, they did not invest yet in the arrangement of wind turbine production line. On the other hand they are now going to reconstruct their own office building. In the new building, they are expecting to have space for production processes. At that time, they will provide equipment and tools for these items.

In the last five years three 300 W wind turbines of the new design were up and running. For technical approval, the new designed wind turbine had to run without failure for 3 years in the field. In Samhun the first turbine was installed in 2008 (autumn), the second one was installed in Pongchon County (Hwanghae Province) in 2009 (autumn), the third one in Sunan district (just outside of Pyongyang) in October 2011. Approval documents were handed in but there was no update whether they were passing.

EC set up a budget for pilot production: 5000 €. But did not specify yet in detail the list of material and equipment needed to install the production line. Production steps and parts that can be done by EC itself: tail, tower, blade, rectifier, cover, drilling work, screws, assembly. An external partner is needed (factory) for precise drilling of the iron core. Expected production time for 100 turbines: 2 months (0.6 days of work/ unit) with 10 persons working on this. EC is still interested in this and would like to implement this in a next project.

The blades and the generator for the 300 W wind turbine.

3.1.5. Construction / Renovation

a) Construction

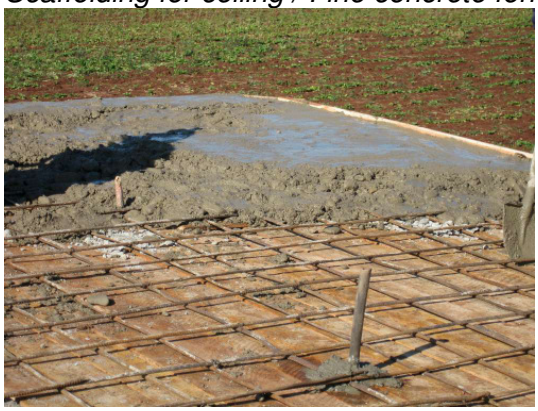
Also in Ryokpho it was a challenge to get the construction approval. In September / October, the whole cooperative was busy with harvesting. Digging of the foundation was started end of October. With the limited time frame, construction was started at the beginning of November 2013. To finish the construction before winter and project deadline, the Korean project team had to invest more money and work force.
The main processes of new construction were as follows:

- Foundation and brick work
- Ceiling work
- Covering whole façade with PS panels and plastic netting
- Korean-style roof construction
- Finishing outside walls with plastering
- Placing insulation windows and doors
- Inside trimming for finish


Ryokpho Village farm house: Foundation and brick work


Polystyrol panels (50 mm) ready to be attached to walls


Scaffolding for ceiling / Fine concrete formwork




Pouring of concrete / Bypass for chimney


Application of insulation south side / Covering with netting and plaster on north side


Wooden roof structure (except south front) / Insulation of ceiling – “cold roof”


Covering with typical Korean roof tiles / South facade


Inside and outside finishing work / West facade


Washing room with warm water tank / Pump for solar water heater


Kitchen with two different stoves / High quality window (double-glazing) in bathroom


Solar water heater installation (120 l tank). Produced in-country

The main construction was finally finished in time on December 31st, 2013. The inside finishing was delayed to spring 2014 to let the construction dry out properly. Final work was completed in April / May including the installation of solar thermal collector and PV panel. The inauguration took place on June 23rd, 2014.

Inauguration – with amongst others Head of SDC office Pyongyang, Head of Foreign Department SCST, Project Director, Agape international, Ryokpho farm manager and technician, Project Director EC, Liason officer SDC

A list of the used construction material and the construction costs are available in Annex A. With an extra cost of 10-15% for EEC measures, this project shows a comparable value to projects in Switzerland and proves that the investment during the construction is the cheapest way of applying it.

The energy demand is about 60-80% smaller than for a non-insulated building. Various options were compared to find a balance between energy efficiency and cost optimization. Detailed calculation details can be found in Annex E: Based on an estimate of 7t of coal/year as current heating demand of a conventional building and a price of 18 €/ton of standard low calorific coal in country the investment would pay off in 20-25 years. This also seems to be a reasonable first estimate. Nevertheless, it also shows that energy prices are highly subsidized (about a factor 10 to Switzerland) and that a move from subsidize of energy to insulation could have a huge impact.

EC will to continue monitor the building and work on more specific figures and pay-off estimates under local price fluctuations and changing market situation for EEB construction material.

b) Renovation of existing office building

With the move to Ryokpho the sub farm unit, the eight-year-old public and office building was chosen for renovation and applying EEC principals. The Korean project team organized bidding for the renovation of existing 2-storie building. The Paekdusan Academy of Architecture and the Ryugyong Construction Design Institute (RCDI) have participated in the bidding. Both of them had some experience in outer wall insulation with PS. They provided their own renovation design and schemes. Proposals from the former were too theoretical and complicated to follow, so the Project Team decided to adopt the proposal from the latter. The RCDI had also undertaken the responsibility for monitoring and technical control of the renovation site.

A team of professional construction workers was engaged in the renovation. Main processes of the renovation were as follows:

- Adjusting of original façade of the building to make it even and stable for attachment of Polystyrol (PS) panels;
- Attaching 50 mm PS panels and plastic netting with nails and adhesive mortar;
- Replacing original windows with high-quality insulation windows;
- Taking away old roof insulation (cinder) and insulating roof with 50 mm PS.

- Replacing old roof plate with new corrugated steel plates (roof is now waterproof again);
- Finishing outer façade with plastering and painting;
- Installation of solar-heat collector and PV on the roof.
- Inside trimming for control rooms.


Enlarging window frames / Application of insulation


Drilling holes for fixing nails / Attachment of nettings


Plastering over insulation / Installation of new sliding window (north side)


High quality window / Outside view south side after finishing

The renovation work took place from the mid of October to the mid of November, 2013

Windows were an important part in the renovation. But also a costly part. For the North side cheaper sliding windows were chosen that allow manual airing during the summer month in the stairways. In winter, they will be taped and an additional plastic will be attached to improve insulation. This as a compromise between cost and energy efficiency and comfort. For the south side advanced two and three layer windows were used, produced by Haewon Furniture Company that produces based on German windows standard (newly opened). Ten wooden double layer wooden frame windows and 2 three layer plastic glass windows were used. They allow comparison of the different construction styles.

A list of the used construction material and the construction costs are available in Annex A.

3.1.6. Maintenance

This step could not be implemented during the project cycle, because the construction was delayed until end of last year / begin of that year. The following attempts are made to get the most out of this during the years to come:
The village farm house is now inhabited by the sub-farm units technician and it's family. This person bring with the technical understanding to live in and maintain the new building. EC is installing a series of temperature sensors to measure inside and outside climate and compare calculations of heat demand with real live experience. The amount of heating material will be measured during the next winter. In addition, the operation of the solar thermal unit and the PV will be monitored closely.

EC will bring its staff to live and work in the renovated office building to monitor the small wind test field. Besides the already installed 300 W wind turbine, a 1 kW turbine is to be purchased from China for comparison. Various other small-scale wind turbines from other producers will also be installed and measured.

3.2. Training / Capacity building

3.2.1. In country training and workshops

EC invested a lot of energy to spread the new expertise of the project with in-country training and workshops to reach the goal of 100 specialist in this field. The following list shows the training courses with subject, dates, location, and number of participants. 1186 participants showed up in 11 training courses (average 100 students per course, all together 34 training days).

Date / Topic	Duration, Place, Participants
March/April 2010: Cooking with fuel, energy saving stove	Duration: 2010.4.5-8 (3 days) Place: Energy Center, Pyongyang Articles on exhibition: 32 Participants: 150
Sept/Oct 2010: Experience exchange from wind energy / solar energy	Duration: 2010.9.14-17 (3 days) Place: Grand People's Study House, Pyongyang Participants: 140
September 2011 Substitute fuel, energy saving application	Duration: 2011.9.11-14 (3 days) Place: People's Commission of Yontan County, North Hwanghae Province Articles on exhibition: 42 Participants: 120
October 2011 Wind energy / solar energy (follow up course)	Duration: 2011.10.25-27 (3 days) Place: Energy Center, Pyongyang Participants: 85
October 2012 Biogas and Solar Greenhouses	Duration: 2012.10.1-4 (4 days) Place: Grand People's Study House, Pyongyang Participants: 135
October 2011 Geothermal and heat pump	Duration: 2011.10.5-7 (3 days) Place: People's Palace of Culture, Pyongyang Participant: total 70
November 2012 Renewable Energy: Follow-up workshop based on feedback of earlier trainings	Duration: 2012.11.12-15 (3 days) Place; Grand People's Study House, Pyongyang Participants: 114
March 2013 Geothermal and heat pump (2nd edition)	Duration: 2013.3.4-6 (3days) Place: People's Palace of Culture, Pyongyang Participant: total 110
April 2013 Calculation and Insulation of existing building	Duration: 2013.4.2-5 (3days) Place: People's Palace of Culture, Pyongyang Participants: 140
August 2013 Domestic insulation materials and their improvement	Duration: 2013.8.5-7 (3 days) Place: Energy Center, Pyongyang Participants: 97
October 2013 How to use energy diagnostic equipment Measurement and calculation of energy efficiency	Duration: 2013.10.14-17 (3 days) Place: Three Revolution Exhibition, Pyongyang Participants: 125

3.2.2. Training abroad

Study Tour in China (February 2012)

The mission was originally planned for mid to end of November 2011. Due to procedural problems from the Korean side, the mission was postponed to begin of February. Getting exit visa for the Korean experts is still a challenging procedure that needs a good preparation and experience from the coordinator. Experiences in the past show, that every second attempt to plan a visit abroad fails to be successful on the original time plan.

Milestones in the planning process should be set and enforced to help overview progress and unexpected delays.
The mission finally took place from January 30th, 2012 (leaving Pyongyang) to February 10th, 2012 (arrival in Pyongyang) with a total of ten days in China (one day added during mission)
Participants:
Project Director, Agape international
Divisional director of the EC, Renewable energy development, Project Director on Korean side
Section chief of the EC, Section Energy saving
Researcher, specialist for insulation material
Researcher, specialist for renewable energy
International officer of SCST, Project coordination

In the preparation process a list of topics was set together, that should be covered by the visit. A lot of them have been successfully covered (green), were planned but cancelled (yellow), were not covered (no partner, red):

a) Energy Efficient Building

a1) Design institute of EEB

- visit an institute where EEB is designed and discuss with specialists : Sunlay Design Group
- learning about standards of EEB: GIZ Beijing and CABR

a2) EEB under construction and/or completed new buildings

- seeing a building and a construction site: Harbin – DENA project
- discussing with experts : Harbin – DENA project

a3) Renovation of old buildings into EEB

- visit renovation sites: GIZ – pilot project Beijing,
- discussion with renovation experts : GIZ – pilot project Beijing,

a4) Practical learning about insulation methods and materials

- see an insulation material exhibition: STO Shanghai, Hongsheng Group, Harbin
- visit insulation material production lines

b) Renewable energies in EEB

b1) Geothermal energy

- see individual buildings using geothermal energy: Harbin – DENA project
- see a geothermal power plant: Harbin – DENA project
- see a geothermal pump production line

b2) see application of solar energy in EEB

c) Energy saving technologies and measurement

c1) Infrared cameras

- see these cameras in practical application, understand their functioning,
- Discuss recommendations for purchase of IR cameras for use in Korea: This point was covered during the workshop of Mr. Hässig. He purchased a second hand camera in Switzerland. for the project

d) Heat flow measurement

- see a laboratory that measures the thermal flow in various materials as : Tshingua University Beijing, HIT, Harbin
- basis for decision making which materials are best applied for what Tshingua University Beijing, HIT, Harbin
- study the instruments and check purchase possibilities Tshingua University Beijing, HIT, Harbin

The Chinese office of “Gesellschaft für Internationale Zusammenarbeit (GIZ)” helped a lot in getting the necessary contacts and links for this mission.
During the preparation a number of international and Chinese organizations were approached and asked for support and cooperation of this training mission. At the end visits to major policy makers and key companies in China were possible. All showed a great interest in DPRK and there is more potential for support during project implementation. Harbin Hongsheng Group is interested in investing in DPRK and wants to join the trade fair in Pyongyang in May 2012.

A list of visited institutions and the final program can be found in Annex C.

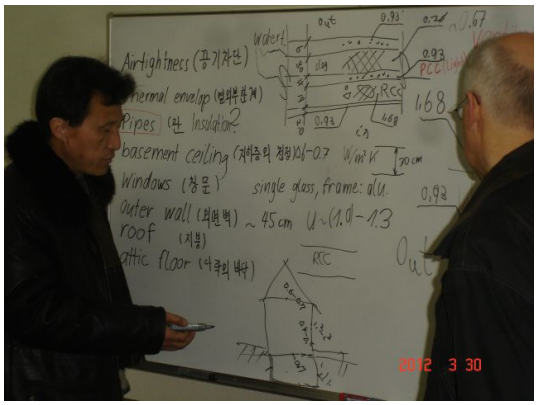
In response to the visit of his company in China the fellow senior engineer of Harbin Hongsheng Group got an Invitation from the EC and the “Peaktu San Academy of Architecture”. He and his wife, who is head of the company, visited the DPRK begin of August 2012. The topic of the visit was how to implement the new designed insulation material into the DPRK. Several options were discussed but as no agreement reached. Even with specific interests of Chinese companies it is difficult for Korean agencies to bring them down to real business opportunities and long-term partnerships.

Study tour Switzerland / Germany
In March 2013 the Korean Project Director and Project Coordinator visited Switzerland during a 10 day study tour (3.-14. March 2013). The goal was to discuss final issues on the planning and design with Dr. Werner Hässig (Hässig Sustech GmbH). It also opened the chance to visit the Minergie Expo in Lucerne and get a great overview on latest technology and updates on Energy efficient construction. Especially alternative insulations methods such as straw / clay and sheep wool were discussed. Also a company for small hydro was visited, three companies with small scale wind and a designer for Stirling engines with solar thermal as heat source.

For details about the program and a list of visited organization see Annex D.

3.2.3. Invitation Lecture, International consulting

The theoretical foundation for this project was laid with the first workshop about *Energy Efficient Buildings and Renewable Energies for Buildings* from November 17th-19th, 2010 (pre-investment to this project). It showed that this topic was of great interest. As a conclusion, this project was formulated and put together.



Second EEB workshop in Pyongyang in March 2012 with Dr. Werner Hässig, Hässig sustech GmbH

From March 26th to April 4th 2012 there was the second workshop with Dr. Werner Hässig, but this time the focus was on the construction of the cover of the building. It was done in two parts:

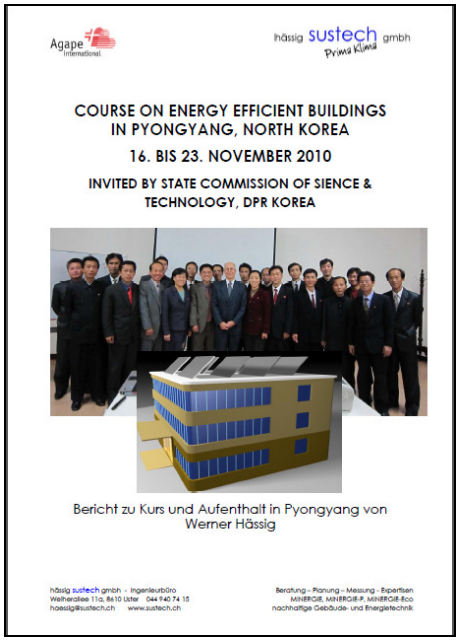
- One day for policy makers – **Energy Efficient Buildings and Energy Auditing** – to give a broader audience an overview in this field (short version of the 2010 workshop) and
- a four days workshops for specialists with also including the idea of the Energy Building Permit: **Energy Auditing - Energy Building Permit**

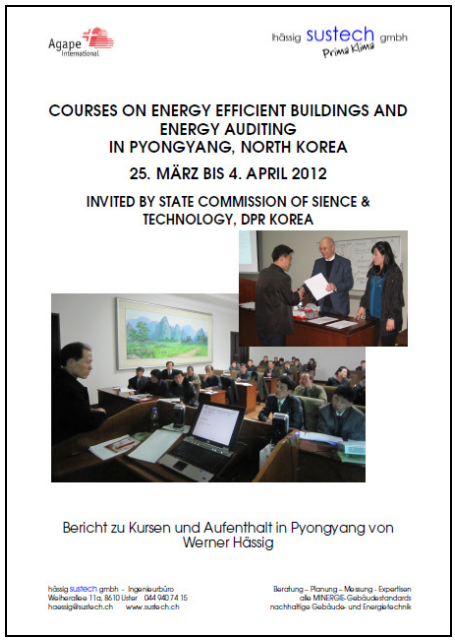
All important institutions and organization of the building and energy sector in D.P.R.K. were represented. The Energy Center was overwhelmed by the interest and had to limit the number of participants per agency. Again as in the 2010 workshop a wide variety of experts (architects, engineers, heating specialists, building administration, material specialist, etc.) had the chance to meet and discuss with and get to know each other, something not often happening in the country. The experience from 2010 helped a lot to focus on relevant elements and to include the participants with discussions, tests and practical tasks.

Institutions and agencies of participants (number of participants)

Energy Center (17), State Commission of Science & Technology (4), Ministry of State Construction Control (5), Central Heating Research Institute (4), Pyongyang University of Construction and Building Materials Industry (1), Paekdusan Academy of Architecture (2), State Planning Commission (2), Branch Academy of Construction, State Academy of Sciences (2), Pyongyang Urban Planning Institute (4)

The workshop was done by using many pictures and practical experience. Especially the practical examples, for instance the exposure and the appliance of the infrared camera, were well received. A total of 60 experts (architects, physicist, experts of EC, construction authority, material experts) took part in the workshops. The Feedback from the participants was very good. They all got a certificate of attendance for their courses which was much appreciated.





For more details see annex E “Expert Workshops with Dr. Werner Hässig (Hässig Sustech GmbH)” and the two reports about the workshop and visits in Pyongyang (*Hässig [2010]* and *Hässig [2012]).* They include details about the workshop, detailed program and participant list and photos.

For training course material (9 different Power Point slide sessions (English / Korean), videos and photos) please contact the lecturer Dr. Werner Hässig. He is open to give these lectures also in other countries.

As a **result** of this workshop the construction authorities (Ministry of construction) want to change the **standard of insulation from 5-8 to 22 cm for apartment blocks with 30 or more floors.**

The challenge for the participants will be to apply these principals in their daily work because cheap insulation material is still rare. Therefore the introduction of straw (houses) could be another good concept for the application in rural areas, because rice straw is widely used for cooking.

International consulting March 2014

During the expert visit in Switzerland and Germany Mr. Hässig and his team (www.sustech.ch) gave a four days intense course on the application of SIA 380.1 – the Swiss norm about thermal energy use in construction (“Thermische Energie im Hochbau“). Besides a practical introduction on the background and the calculation with Excel (free template of cantons, see also Annex E for calculation on new building) a door blower test on a zero-emission building was performed and various buildings visited. Also a visit at the Minergie Expo in Lucerne (March 9th, 2013). Finally the calculations for Minergie checking were also performed. The planned EEB in Duru Island was designed with the following values:

MINERGIE ¶

hässig sustech gmbh
Prima Klima

¶

Summary EEB Duru Island – Calculation of total heat energy Qh¶

- **Energy reference area (ERA)¶**

1st floor: total area = 130.2 m2¶
2nd floor: total area = 130.2 m2¶

- **Thermal building envelope: (total heat energy: 268 MJ/m2a)¶**

Component	Area (m2)	U-value (W/mK)	Insulation/type	Insulation thickness (mm)
Floor to ground	130.2	0.21	Cement bubble	300
Wall to outside/exterior	200.7	0.15	Polystyrene (PS)	200
Wall to unheated	47.4	0.15	PS	200
Roof to unheated	130.2	0.15	PS	200
Doors	5.1	2.1	Wood	50
Windows	30.0	2.9	Double-glazing, no infra-red coating	-

- **Boundary conditions¶**

Climate: Davos (mountain village in Switzerland – cold winters)¶
Indoor room temperature: 20 °C¶
Building typical use: office (III) or school (IV)¶
Surcharge for thermal bridges Minergie: 15%¶
Surcharge for thermal bridges Minergie-P: typically 25-40% or more¶

The following recommendations were made:

Improvements

Optimization	New U-value (W/m2K)
Windows with infra-red coating	1.0-1.8
Walls, roof with 300 mm insulation	0.10

Total heat energy limits
Qh,li = **295 MJ/m²a** Swiss energy code
MINERGIE/-A (90% Qh,li) = **266 MJ/m²a**
MINERGIE-P (60% Qh,li) =**177 MJ/m²a**

Summary
With the values in the table summarizing the thermal building envelope and the given ERA, the requirements for the Swiss energy code are achieved and the limits for Minergie almost. Minergie-P could be achieved by implementing the suggested improvements and further optimizing/minimizing the thermal bridges.
The improvement in the energy efficiency in the building envelope will contribute to reducing the heating energy required for the building and improve the comfort for the occupants of the building.

3.3. PR and Education

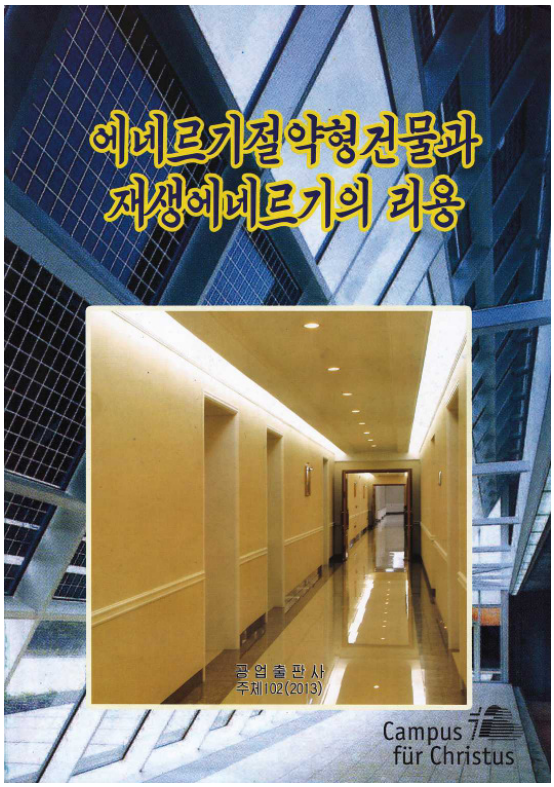
3.3.1. Handbook and leaflets on EEC

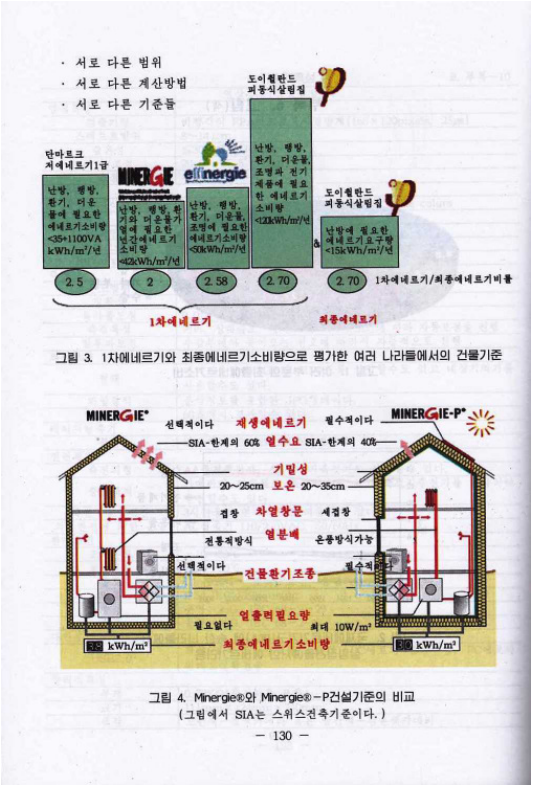
During the project a series of publications were translated into Korean:

- The leaflet “Energieeffizientes Bauen” Heft 16 was translated in Korean. Also many of the PowerPoint slides from the workshops with Dr. Werner Hässig.
- In further the “Wärmedämmvorschriften (2009)” of the Kanton of Zurich.

3.2. Handbook for Renewable Energy
From the end of 2012, Korean side designed a book on EEB. This was the first book in Korea on EEB. Many technical information from trainings and study tours have been studied and many technical experts participated in technical consultation. There were

three main authors: Mr. Choe (researcher of Science and Technology Management Research Institute, SCST, member of Korean project team), Mr. An (professor of Pyongyang University of Architecture), Mr. Jang (Divisional Director of EC, technical consultant of the Project).
The book was published in October 2013 with 1000 volumes and the final title is “Energy Efficient Building and Renewable Energies”.
In December 2013 in Pyongyang large-scale national-level training for construction personnel took place. During the training, the book was on exhibition. Feedback from training participants was very good. The Project team is now preparing a distribution plan to be submitted to SCST. Many educational and research institutions and authorities concerned will be on the list.





First Korean publication on EEC (140 pages)

3.3.2. e-education

The Energy Center in North Korea translated 2012 the book “Renewable Energy - Power for a sustainable Future”, by Godfrey Boyle into Korean. It is a technical reference book with the basics of wind, solar, tidal, geothermal, biogas (more than 450 pages) and published it as e-book. The translation was done in cooperation with the “Kim-Tchaek-University”, the “Central Information Agency” and the “Grand People Study House”.

Wind energy – Websites with different answers to Wind energy – public in the Korean Intranet – over 100 webpage's (subpages)

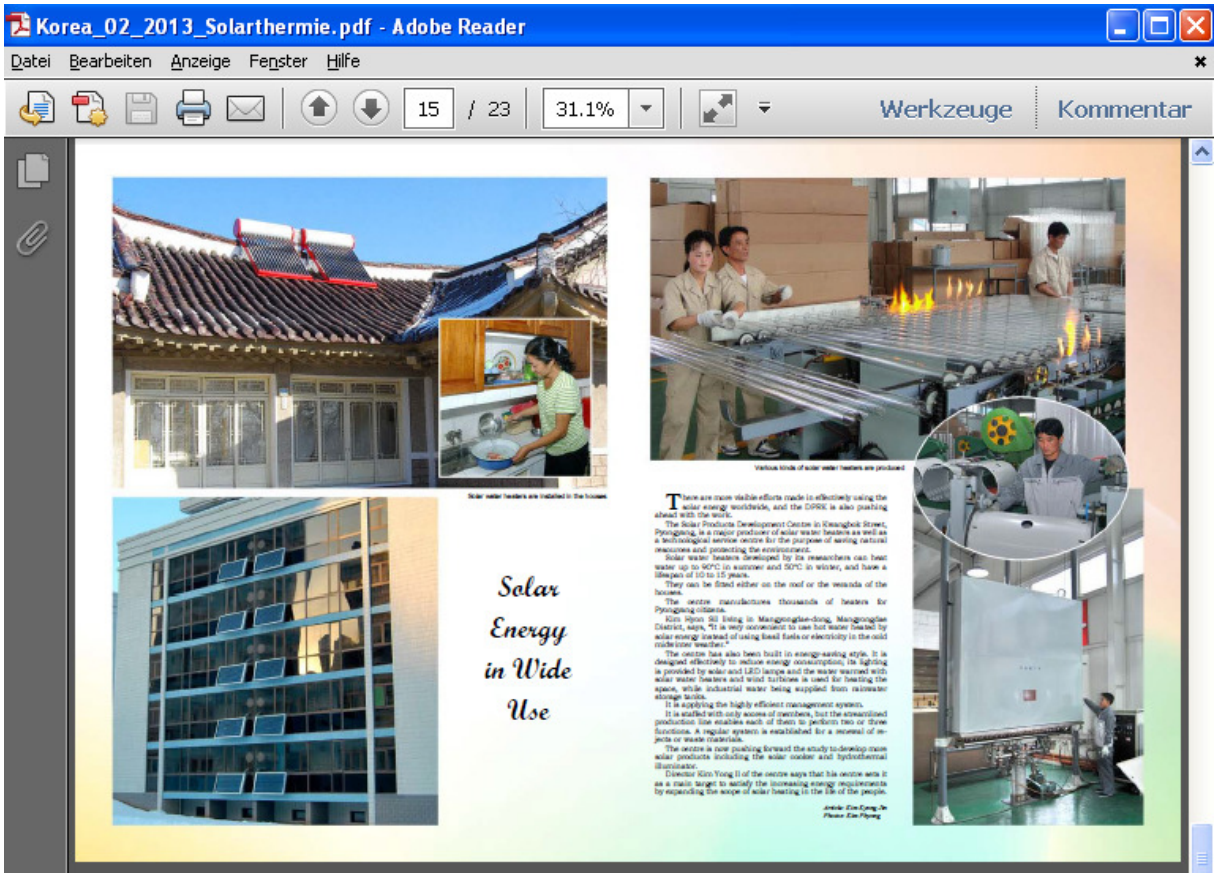
3.3. PR and Publication

Every three month the EC is publishing a booklet from 30 to 40 pages and a print run of 100 to 200 pieces. The content of this booklet are the latest things about energy in in general and renewable energy in particular. This booklet is send to every province. The Receivers are the "Science and Technology Agency".

Movie about biogas – broadcasted on KCTV, 3 times in July 2011

Rodong Sinmun and other newspapers published a growing number of articles about Renewable Energy.

The journals Korea Today (3/2013) and Korea (2/2013) both brought big reports on the production of solar water heater from the newly established factory in Pyongyang (Solar Products Development Centre in Kwangbok Street). In the Korea (5/2014) edition the Nahung Youth Chemical Complex is presented with its new production line for three ply-plastic sheets (production capacity 10 million m^2) that meets the standards for green house construction (insulation capacity, UV radiation resistance, strength, etc.). The Pyongyang Times reports on June 14, 2014 about the production start in the Kwangmyong LED and Solar Cell Factory.

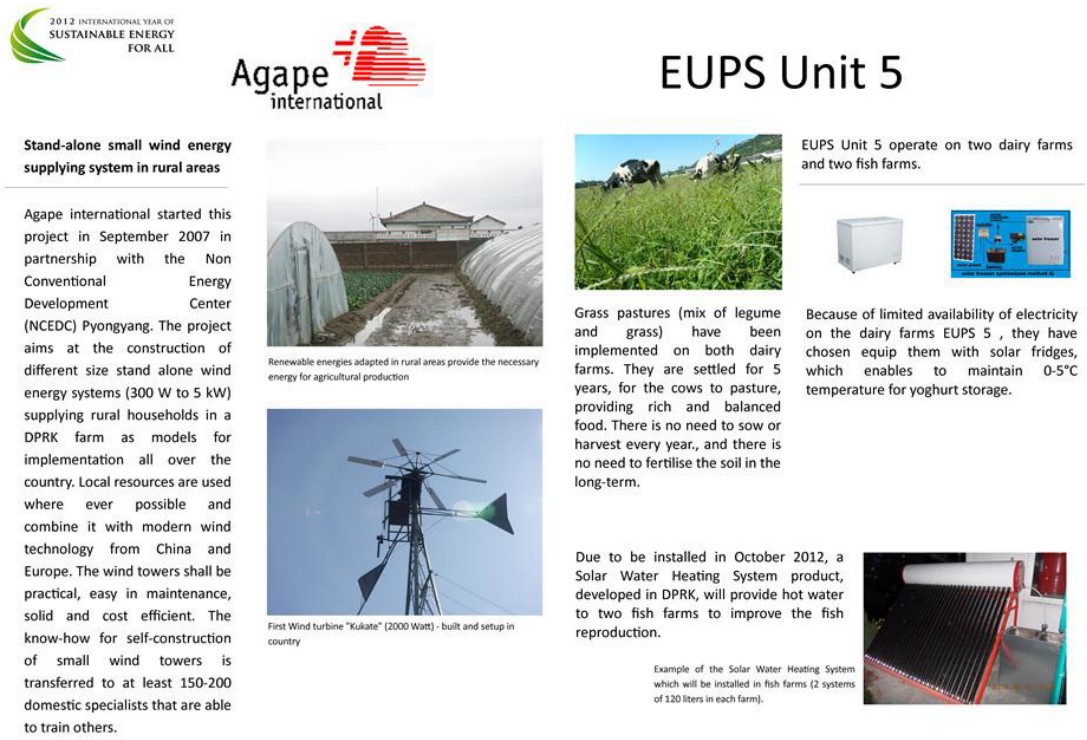


For further dissemination a video camera was purchased to produce more training material and document the construction of the new EEB building.

EC has participated in the development of multimedia materials for awareness enhancement and technical dissemination on energy subjects organized by SCST.

EC also provides technical information and consultations to various broadcasting and publishing institutions.

3.4 Exhibition “Renewable Energy”
The UNDP organized an exhibition to the topic “Renewable Energy” in North Korea. Agape international handed in three pictures to document its investment. The exhibition took place end of October 2012 in Pyongyang. Agape international met the Project Director of the UNDP renewable energy projects during their project visit (October 2012).



2012 INTERNATIONAL YEAR OF SUSTAINABLE ENERGY FOR ALL

Agape international

EUPS Unit 5

Stand-alone small wind energy supplying system in rural areas

Agape international started this project in September 2007 in partnership with the Non Conventional Energy Development Center (NCEDC) Pyongyang. The project aims at the construction of different size stand alone wind energy systems (300 W to 5 kW) supplying rural households in a DPRK farm as models for implementation all over the country. Local resources are used where ever possible and combine it with modern wind technology from China and Europe. The wind towers shall be practical, easy in maintenance, solid and cost efficient. The know-how for self-construction of small wind towers is transferred to at least 150-200 domestic specialists that are able to train others.

Renewable energies adapted in rural areas provide the necessary energy for agricultural production

First Wind turbine "Kukate" (2000 Watt) - built and setup in country

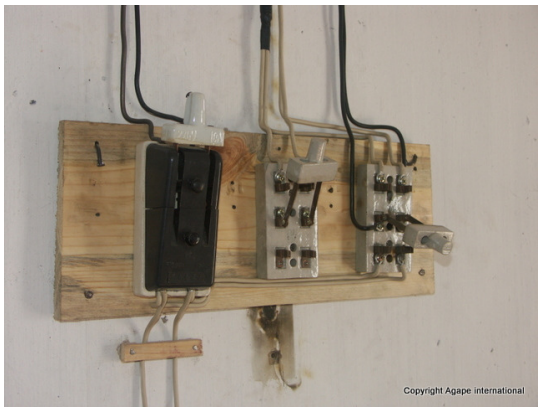
EUPS Unit 5 operate on two dairy farms and two fish farms.

Grass pastures (mix of legume and grass) have been implemented on both dairy farms. They are settled for 5 years, for the cows to pasture, providing rich and balanced food. There is no need to sow or harvest every year., and there is no need to fertilise the soil in the long-term.

Because of limited availability of electricity on the dairy farms EUPS 5 , they have chosen equip them with solar fridges, which enables to maintain 0-5°C temperature for yoghurt storage.

Due to be installed in October 2012, a Solar Water Heating System product, developed in DPRK, will provide hot water to two fish farms to improve the fish reproduction.

Example of the Solar Water Heating System which will be installed in fish farms (2 systems of 120 liters in each farm).



Electric switch

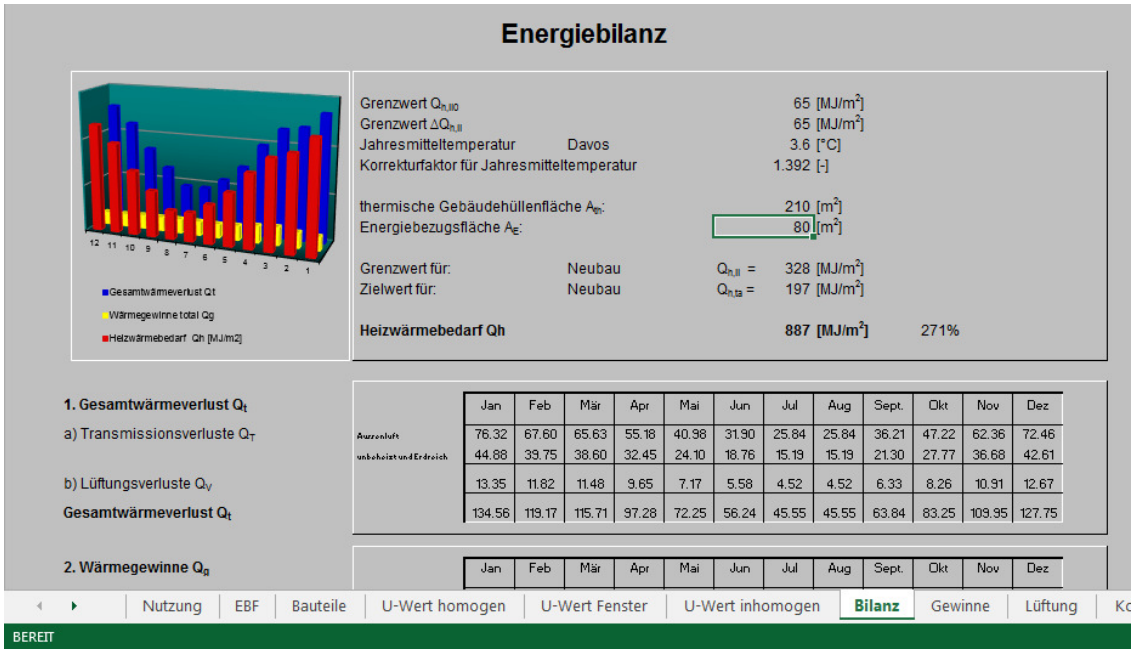
4. Impacts

(Show the project's socio-economic impacts, changes which have occurred, possible side-effects for the responsible organization and / or the partners)

The project showed that construction of new buildings based on EEC principals is possible and that the needed material is available in country. There are local producers or established import channels from China so that a house builder does not has to buy material in China or elsewhere abroad. This is an important factor because importing goods for Korean organizations or individual people is still very difficult or impossible. The cost barrier to make the additional investment is still high but early adapters have the possibility to go forward. In addition, policy makers like the Ministry of Construction Supervision have been familiarised with the new principals and are now able to evaluate construction approvals with EEB concepts.

If the countrywide construction laws start to ask for energy efficiency this project will help to influence and reduce the demand of energy in the whole country (->environment). It will influence the whole building sector and further influence the market for construction

material in making available material properties and give an overview of suppliers in country (->economy). Social consequences will be that the living conditions of people can be increased (directly by having warmer homes, indirectly by saving money for energy). Building insulation, tightness and good quality glazing will also lead to better space comfort in winter and in summer time and/or the need of less heating material. In rural areas, where people have to supply heating energy by collecting wood or straw saving the amount of this frees a lot of (working) time, that could be better invested in food production or education (if children have to do this work). Moreover, in city areas it will make the difference of how many people will freeze or not in winter with the limited amount of energy available.



Energiebilanz

Grenzwert $Q_{h,li0}$		65 [MJ/m²]	
Grenzwert $\Delta Q_{h,li}$		65 [MJ/m²]	
Jahresmitteltemperatur	Davos	3.6 [°C]	
Korrekturfaktor für Jahresmitteltemperatur		1.392 [-]	
thermische Gebäudehüllenfläche A_{th}:		210 [m²]	
Energiebezugsfläche A_E:		80 [m²]	
Grenzwert für:	Neubau	$Q_{h,li}$ = 328 [MJ/m²]	
Zielwert für:	Neubau	$Q_{h,ta}$ = 197 [MJ/m²]	
Heizwärmebedarf Qh		**887 [MJ/m²]**	271%

		Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sept.	Okt	Nov	Dez
1. Gesamtwärmeverlust Q_t													
a) Transmissionsverluste Q_T	Aussenluft	76.32	67.60	65.63	55.18	40.98	31.90	25.84	25.84	36.21	47.22	62.36	72.46
	unbeheizt und Erdreich	44.88	39.75	38.60	32.45	24.10	18.76	15.19	15.19	21.30	27.77	36.68	42.61
b) Lüftungsverluste Q_V		13.35	11.82	11.48	9.65	7.17	5.58	4.52	4.52	6.33	8.26	10.91	12.67
Gesamtwärmeverlust Q_t		134.56	119.17	115.71	97.28	72.25	56.24	45.55	45.55	63.84	83.25	109.95	127.75
2. Wärmegewinne Q_g		Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sept.	Okt	Nov	Dez

Results of energy bilance Ryokpho village farm house a built (2014). The total heating demand is 887 MJ/m2. This is 80% less than without insulation. And there is still potential compared with Swiss standard values.

Energy demand calculations based on sia380.1 made by Werner Hässig and Stefan Burckhardt based on the final construction of the village farmhouse show that this new construction needs 80% less energy than the current way of construction without insulation. Taking into consideration that in Korea 20 degree inside temperature are not the reality the real reduction in heating material (wood / coal) might be less, but it is still expected to be considerable. First cost calculation prove also, that the decided solution is at a good first optimum with potential for even further improvement if finances for thicker insulation (10 mm instead of 5 mm) are available or a changed system of subsidizing energy (reducing cost of insulation instead of heating material) will be applied. The detailed tools and methods, more results and details can be found in annex E *Application of sia 380.1 - thermal energy use in construction.*

Having accurate figures and feedbacks from the two pilot buildings will have a big impact to give clearer figures about the return of investment period. If that is convincing in the local context then EC is in a great position and also responsibility to push forward on this topic.

								Cost	Insulation		3.6 €/m2				Building		height	2.3
									annuity	years	interest				length	10.5	width	8.4
energy consumption area		80 m2							0.048	30	2.5%							
											energy reduction	additional energy demand						
			Total Energy	Δ Energy	Insulation (Styrofoam, net, nails)						economy: price for saved energy (pse)	economy: value of additional energy (vae)	window1: wood triple large	window2: wood double small	window3: Plastic sliding	Windows all		Insulation and Windows		
case	Qh [MJ/m2a]		kWh/yr	kWh	m2	€ Δ price	€ Total				€/kWh	€/kWh	290	125	44.1	€ Δ price	€ Total	€ Δ price	€ Total	Percent
0	**as built**	**887**	**100%**	**19711**		**175.1**		**631**					**580**	**250**	**44.1**		**874**		**1505**	**100%**
1	without PS on the roof	2178	246%	48400	28689	-88.2	-317.5	313				-0.0005					874	-318	1187	79%
2	with 10 cm PS on the roof	768	87%	17067	-2644	88.2	317.5	948			-0.0057						874	318	1822	121%
3	all with double glazed windows	870	98%	19333	-378			631			recommended		-580	500		-80	794	-80	1425	95%
4	without PS on the walls	3001	338%	66689	46978	-86.94	-313.0	318				-0.0003					874	-313	1192	79%
5	with 10 cm PS on the walls	702	79%	15600	-4111	86.94	313.0	943			-0.0036						874	313	1818	121%
6	with 10 cm PS on walls and roof	595	67%	13222	-6489	175.1	630.5	1261			-0.0046						874	631	2135	142%
7	without PS on walls and roof	4280	483%	95111	75400	-175.1	-630.5	0				-0.0004					874	-631	874	58%
8	all windows single glazed (u= 5.7, g=0.75)	1021	115%	22689	2978			631				-0.0091	-580	-250	264.6	-830	309	-565	939	62%
											0.0077	0.0077								
											reference = today's energy price (assumption for Korea 2014: 18 €/t low calorific coal (<2000 kcal)									

Hässig/Burckhardt (2014)

Ryokpho village farmhouse – variation of parameters and economic calculations

5. Future Prospects

(Show how the project can be replicated and / or implemented in a larger scale, identify possible next steps)

The **two model buildings** are very typical for Korea. One or two family farmhouses of this type are everywhere in the country side. Also office buildings like the one renovated are common on every cooperative farm – most sub units have one of this kind, either one or two stories high. There are at least 20-30'000 similar building throughout the country. The developed construction plans and the experience during construction can easily be adapted throughout the country. An important next step are now the monitoring of buildings inside and outside temperatures and exact measuring of the amount of heating material (low calorific coal, rice straw, wood) to compare with similar buildings.

The whole project made a first important impact to raise the **awareness** about EEC in the country. Many institutions and organization showed interest and became aware of the potential of EEC as a way of saving energy. The two buildings allow showing how EEC was put into practice and gives a platform to discuss experience with it like improved living standard, saving of heating material, no loss of seed potatoes during the winter etc. Besides technical figures the and personal experience some hard fact economic figures would help to display what investments has to be made and in what time frame it will pay back. The pre-investment into insulation in construction will be a major challenge, especially in the context of the country (or in general many developing countries) where the uncertainty that the investment will pay off is even bigger because there is a bigger uncertainty of the future. China has started to support insulation efforts in construction by subsidizing renovation work when certain minimum standards were applied. EC should think about which partners and bodies would be capable to develop the necessary framework to adapt the new knowledge, adapt construction laws and bring in the necessary incentives to apply them for the construction and renovation of new buildings.

It is encouraging to see that during the project cycle the availability of insulation material has grown and that a series of companies started to produce solar thermal units, PV cells, LED lamps and plastic foil for green houses. In cities, individuals have purchased small solar panels (2.5 – 10 W) to charge batteries, phones or lamps.

There is a big potential for the EC to use its new capabilities (know-how about the assessment of the energy use of buildings, practical experience in renovation and construction of EEB, new measurement tools and enforced laboratory capacity) to establish a series of services in the country, besides the already given workshops and trainings:

- With the increasing amount of available insulation materials in country and independent body should start to provide back checking of the published u-values of the producers. The gained know-how about producers and products should be published and updated regularly to help cooperatives and cities in getting easy access to this market. As seen a major challenge in construction projects is to find liable sources. EC should think about a suitable platform to publish and spread these information and maybe also develop a quality label for EEC material.
- The service and idea of a “Building energy certificate (Gebäudeenergieausweis)” would help owners of building to get a standardized picture about the quality of their real estate. It would also allow city authorities to decide where to invest time and energy in renovations of buildings (setting priorities). EC is equipped to offer such a service on its own or setup an agency that can provide it or support construction supervision authorities in setting up such a concept.
- Organizations and bodies that are in the process of planning and constructing new buildings should be supported if they are interested in applying EEC principals to widen the range of model buildings. EC should quickly develop a concept on how to offer services to builders and make a transparent description and price structure what these services imply and cost.
- EC as the responsible body for dissemination of the know-how about renewable energies and EEB should also promote something like the Swiss Minergie association (www.minergie.ch) that sets a label, offers training and services, brings together various actors (state bodies, provincial authorities, producers, engineering companies, architects), promotes good models, etc. During the project many actors were already involved in training and workshops and the project implementation. This impact and new cooperation should be developed further. It should be clarified whether EC has the necessary capacity and position or whether the State Commission of Science and Technology (SCST) with its function as an overseeing and coordination agency would rather fit to run such a network.
- EC has developed a series of good new inventions like heat radiation paint for cooking stoves that reduce the amount of wood needed by 20-40%. During the last 3 years they have been able to develop it to a customer friendly and easy to apply product. With the 300 W wind turbines another product is in the pipeline. If they find the necessary structures to go on the local market their investment will be profitable not only for Science but common people in rural areas with enough wind.

6. Conclusions

(Evaluate the project, summarize the strengths, challenges, lessons learned, improvements to be made, and suggest recommendations for future projects)

The goal that 70% or more of the planned activities were put into practice and documented was reached. Therefore the project was successful. The two hand approach with providing new know-how in the form of in-country workshops and study tours abroad with a wide range of opportunities to see and feel the new topic of energy efficient construction and then the phase of practical application of that in specific design and construction projects showed good results. EC was also able to process and compile the EEB know-how with the successful organization of 11 in-country workshops, the management of the construction projects and a wide range of publications.

The main challenge was keeping open communication between the project leader from Switzerland and the Korean project team in Pyongyang. Email was helpful to have contacts in between; also, it was usually easier to send emails than to receive information back on this channel. Project updates and documentation from the Korean project team was handed over in depth and detail mainly during personal contacts. In depth talks

helped to understand better what decision processes had taken place. In addition, the Korean project team made a lot of progress on the documentation of the project; it is still a challenge to report in depth on a written basis or to send out photos by email. Besides the high costs (emails in North Korea are still charged by kb (!)), handing over information about a project or its progress is still much more than just writing a report and has a completely different status in the local cultural context. Therefore, all additional options to meet the project team in China or Europe helped to understand the challenges and make the necessary decisions and project adaptions together. In future, a more standardized way of reporting and clearer reporting goals could be helpful. Supporting the Korean project with digital and video camera were already an excellent tool to give them tools besides written reports. Especially in the last stage of the project, this was an excellent tool for documentation. The video side of it was still pretty new and until now not yet fully explored and compiled.

Further workshops with international experts would be an efficient tool to continue Based on the feedback during the workshops, the following topics should be deepened:

- What kind of insulation (materials) can be used in which situation. How is the application?
- Importance of low-e-windows: Repeated explanation and practical demonstration (during construction)
- Tightening of houses without creating mold. Aeration of buildings.
- Further introduction to insulation regulations and practical application in Korea.
- Regulation of heating systems (this topic was not really elaborated yet, but there was a big interest about it)
- Renewal of long distant heat pipelines (possibly as CDM-project)

For projects in North Korea established relationships with the local project partner and a network of additional contacts (e.g. in the international community or SDC) are key for a successful implementation. Basic things like the transfer of project finances can become a major challenge because international bank transfers become restricted more and more. Finally, most project finances were brought in in person. Usually half of the costs for a certain project part were pre-financed the other half was then paid after successful implementation and documentation of the expenditures. Compared to the local turnaround the project was quite big for EC and handling with foreign currency is still something Korean agencies have to get used to. With the discrepancy of an official exchange rate and a market rate one has to be clear that some of the costs are as hypothetic as the official exchange rate. Therefore it was wise and helpful to focus international sponsoring on costs that anyway have to be paid in foreign currency (like all travelling abroad, fuel costs or imported materials / equipment). And leave local costs like in-country training or labor costs to the local partner to still make him partner and participant in the whole project also on the financial side.

Working long enough on a project proposal before starting and tracing it down in specific activities and tasks will also help to be successful. In this project, the detailed list of activities and goals helped to stay focused and check whether the project was on track.

For EC a major challenge was to find a suitable plot and object for the renovation and construction. They did great in being able to adapt to hurdles and changes – but this also was the key issue for the prolongation of the original two year to the final three year project cycle. Another aspect in project planning in North Korea are the many additional tasks any Korean agency, company or authority has to comply during the year. Some are expected like being involved in rice planting or harvest, other are unexpected like for example the “beautification campaign of roadsides” (with green grass in 2013) or nationwide efforts in agriculture (e.g. Sepho highland farmland cultivation campaign) or energy production (construction of new dams) that demand a lot of time consuming efforts by its staff.

Some of the challenges like the limited space for the new Renewable Energy Training Center (RETC) on Duru Island made a good impact on the design and planning process with the idea of a compact unit of living and production. There were also many ideas that came up during the study tours abroad on how to display various insulation materials on the model building and present those to the public. In the final stage all those ideas were unfortunately only brought to the design stage and not implemented in the construction. Hopefully there is more room in future projects to test out some of these ideas, once the first buildings have given "proof of concepts" – then variations can be taken into consideration. In addition, the monitoring and conclusion process is not yet finished but just started. It needs follow up in the next years to benefit most of the impacts of this project.

A next and important step would be to bring some of the things learned and adapted from research into service (whether it be public service or commercial service). EC and the SCST or also Paktusan Academy are from its nature research and training institutions, but not commercial businesses. Even with specific interests of Chinese companies, it is difficult for those Korean research agencies to bring them down to real business opportunities and long-term partnerships. It would be worth looking into it how in the local context the results and products can be "commercialized", meaning that they become available for a wide public (but may be less on the aspect of making the (big) business).

7. References

(Publications, reports, etc.)

During the project the following publications were studied, used, translated or published (for publication that were newly published and written as a result of this project see also 3.3)

Agape international. „Energy Efficient Construction in Rural Areas and Cities - Renewable Energy Training Center (RETC) Pyongyang: REPIC Projektgesuch", 23. August 2011.

———. „Energy Efficient Construction in Rural Areas and Renewable Energy Training Center", 1. Uptown Gurten, Bern, 2013.

———. Projekt Webseite www.agape.ch/nordkorea

———. Project website www.agape.ch/northkorea

———. „REPIC 2. Zwischenbericht Nordkorea 2011.22", 19. Oktober 2012.

———. „REPIC 3. Zwischenbericht Nordkorea 2011.22", 23. April 2013.

———. „REPIC 4. Zwischenbericht (Kurzbericht) Nordkorea 2011.22", 29. November 2013.

———. „REPIC Anpassung Projektaktivitäten", 24. Juli 2013.

———. „REPIC Zwischenbericht Nordkorea 2011.22", 29. März 2012.

Baudirektion Kanton Zürich. Wärmedämmvorschriften, 2009.

Building Energy Efficiency (EEB), und China Academy of Building Research (CABR). Pilot Project Tangshan - Baseline Study. Project Documentation. Sino-German Technical Cooperation Energy Efficiency in Existing Buildings - Project Output, 2007.

Burckhardt, Stefan, Werner Hässig et al.. Energy Efficient Construction in Rural Areas and Cities - Renewable Energy Training Center (RETC) Pyongyang: REPIC Schlussbericht. Final Report. Agape international, 8. August 2014.

Burckhardt, Stefan. Travel Report Study Tour China February 2012. Technischer Bericht. Agape international, 2012.

China Building Materials Academy, und Chongqing University. Survey Report on Energy-Saving Building and Products in China. Project Documentation. Sino-German Technical Cooperation Energy Efficiency in Existing Buildings - Project Output, 2007.

Choe, Kwang Hun, Mun Hyok An, und Yong Il Jang. 에네르기철약형건물과 체생에네르기의 리용. 1000. Aufl. Pyongyang, Korea: Energy Center, 2013.

„Energievollzug Kanton Uri". Zugegriffen 5. August 2014. http://www.energie-zentralschweiz.ch/execution/ur.htm.

„Energy Efficiency in Buildings - Business Realities and Opportunities". World Business Council for Sustainable Development WBCSD, 2008.

Enz, Daniela. Energieeffizientes Bauen. Heft. Konstruktionslehre für den Hochbau. LMK Lehrmittel GmbH, 2008.
———. 에네르기절약형 건물 (Energieeffizientes Bauen). Heft. Übersetzt von Energy Center. Konstruktionslehre für den Hochbau. LMK Lehrmittel GmbH, 2008.
German Energy Agency. 中国建筑节能简明读本——对照德国经验的全景式概览 (Handbook on Energy-efficient Building in China: Highlighting Best Practices in Germany), o. J. http://en.cabp.cn/list_mod.asp?ProdId=0776.
GIZ, und CABR. Handbuch - Energieeffizientes Bauen in der Volksrepublik China. Beijing: Fachverlag des chinesischen Bauministeriums, der China Architecture & Building Press, 2009. http://www.dena.de/publikationen/internationales/leitfaden-energieeffizientes-bauen-in-der-volksrepublik-china.html.
Hässig, Werner. Courses on Energy Efficient Buildings and Energy Auditing in Pyongyang, North Korea 25. März bis 4. April 2012. Technischer Bericht. Uster: hässig sustech GmbH, 19. April 2012.
———.. „Sustainable Renovation of Existing Buildings“. Powerpoint Slides gehalten auf der Energy Efficient Buildings and Energy Auditing - Introduction for Policymakers, Pyongyang, Korea, 27. März 2012.
———. „현존 건물들의 지속적인 갱신(Sustainable Renovation of Existing Buildings)“. Powerpoint Slides gehalten auf der Energy Efficient Buildings and Energy Auditing - Introduction for Policymakers, Pyongyang, Korea, 27. März 2012.
———. „1 과 기술, 방법 및 실행 (Part 1 Techniques, Methodology and Implementation)“. Powerpoint Slides gehalten auf der 건물의 에네르기 검사 (Building Energy Auditing), Pyongyang, Korea, 27. März 2012.
———. „2 과: 건물의 열특성결정 (Part 2: Determination of Building Thermal Properties)“. Powerpoint Slides gehalten auf der 건물의 에네르기 검사 (Building Energy Auditing), Pyongyang, Korea, 28. März 2012.
———. „3 과: 에네르기검사준비 (Part 3: Preparing an Energy Audit)“. Powerpoint Slides gehalten auf der Building Energy Auditing, Pyongyang, Korea, 29. März 2012.
———. „4 과: 에네르기검사의 실행 (Part 4: Completing an Energy Audit)“. Powerpoint Slides gehalten auf der 건물의 에네르기 검사 (Building Energy Auditing), Pyongyang, Korea, 30. März 2012.
———. „5 과: 조선의 발전전망 (Part 5: Korean Perspectives)“. Powerpoint Slides gehalten auf der 건물의 에네르기 검사 (Building Energy Auditing), Pyongyang, Korea, 2. April 2012.
———. „Part 1 Techniques, Methodology and Implementation“. Powerpoint Slides gehalten auf der Building Energy Auditing, Pyongyang, Korea, 27. März 2012.
———. „Part 2: Determination of Building Thermal Properties“. Powerpoint Slides gehalten auf der Building Energy Auditing, Pyongyang, Korea, 28. März 2012.
———. „Part 3: Preparing an Energy Audit“. Powerpoint Slides gehalten auf der 건물의 에네르기 검사 (Building Energy Auditing), Pyongyang, Korea, 29. März 2012.
———. „Part 4: Completing an Energy Audit“. Powerpoint Slides gehalten auf der Building Energy Auditing, Pyongyang, Korea, 30. März 2012.
———. „Part 5: Korean Perspectives“. Powerpoint Slides gehalten auf der Building Energy Auditing, Pyongyang, Korea, 2. April 2012.
Hässig, Werner. Courses on Energy Efficient Buildings in Pyongyang, North Korea 16. bis 23. November 2010. Technischer Bericht. Uster: hässig sustech GmbH, November 2010.
———. „Part 1 Climate, Architecture and Energy“. Powerpoint Slides gehalten auf der Energy Efficient Buildings and Renewable Energies for Buildings, Pyongyang, Korea, 17. November 2010.
———. „Part 2 Comfort and Energy“. Powerpoint Slides gehalten auf der Energy Efficient Buildings and Renewable Energies for Buildings, Pyongyang, Korea, 17. November 2010.
———. „Part 3 Wärmeschutz und Lüftung (Feuchteschutz)“. Powerpoint Slides gehalten auf der Energy Efficient Buildings and Renewable Energies for Buildings, Pyongyang, Korea, 18. November 2010.
———. „Part 4 Constructions for low energy and good comfort“. Powerpoint Slides gehalten auf der Energy Efficient Buildings and Renewable Energies for Buildings, Pyongyang, Korea, 18. November 2010.

———. „Part 5 Renewable Energies and Heating Systems“. Powerpoint Slides gehalten auf der Energy Efficient Buildings and Renewable Energies for Buildings, Pyongyang, Korea, 19. November 2010.
———. „Part 6 Utilities for Heating and Cooling“. Powerpoint Slides gehalten auf der Energy Efficient Buildings and Renewable Energies for Buildings, Pyongyang, Korea, 19. November 2010.
———. „제 1 편 기후, 건축 및 에네르기 (Part 1 Climate, Architecture and Energy)“. Powerpoint Slides gehalten auf der 에네르기절약형건물들과 건물을 위한 재생에네르기 (Energy Efficient Buildings and Renewable Energies for Buildings), Pyongyang, Korea, 17. November 2010.
———. „제 2 편 생활편의와 에네르기 (Part 2 Comfort and Energy)“. Powerpoint Slides gehalten auf der 에네르기절약형건물과 건물을 위한 재생에네르기 (Energy Efficient Buildings and Renewable Energies for Buildings), Pyongyang, Korea, 17. November 2010.
———. „제 3 편 보온과 통풍(방습) (Part 3 Wärmeschutz und Lüftung (Feuchteschutz))“. Powerpoint Slides gehalten auf der 에네르기절약형건물들과 건물을 위한 재생에네르기 (Energy Efficient Buildings and Renewable Energies for Buildings), Pyongyang, Korea, 18. November 2010.
———. „제 4 편 저에네르기와 편의를 위한 건설 (Part 4 Constructions for low energy and good comfort)“. Powerpoint Slides gehalten auf der 에네르기절약형건물들과 건물을 위한 재생에네르기 (Energy Efficient Buildings and Renewable Energies for Buildings), Pyongyang, Korea, 18. November 2010.
Harvey, Adam. Micro-hydro design manual: a guide to small-scale water power schemes. London: Intermediate Technology Publications, 1993.
Kerschberger, Alfred. Drei Pilotprojekte zur energieeffizienten Sanierung von Mehrfamilienhäusern in Nordchina. Project Documentation. Sino-German Technical Cooperation Energy Efficiency in Existing Buildings - Project Output. Beijing: Deutsche Gessellschaft für internationale Zusammenarbeit (GIZ), 2010. www.eeeb.org.cn.
Kuhtz, Christian. Doppelfenster, Trockenlegen, Isolieren ... Bd. 3. Einfälle statt Abfälle, Handwerk-Heft. Selbstverlag Christian Kuhtz Einfälle statt Abfälle, 2004. www.einfaelle-statt-abfaelle.de.
Leibundgut, Hansjürg, Leibundgut, Hansjürg, Leibundgut, Hansjürg. LowEx building design: für eine ZeroEmission Architecture. Zürich: Vdf Hochschulverlag, 2011.
Martinelli + Menti AG. „Berechnungsprogramm zum energieoptimierten Entwerfen und Konstruieren - Berechnung Heizwärmebedarf Qh nach Norm SIA 380/1 Thermische Energie im Hochbau (2009) - Excel-Programm Upate 2011, Ausgabe 2009, Version 8.3.1“, Januar 2011. http://www.energie-zentralschweiz.ch/pdf/sia%20380-1(2009)-win-8_3_1.xls.
Mathys, Christian. „Minergie, Minergie-P, Passivhaus Das Wichtigste in Kürze“. Amt für Umwelt und Energie BS, 8. September 2007.
Matzka, Dennis. „Abschlussbericht European Study Tour March 2013“. Agape international, 23. Mai 2013.
Minergie. „MINERGIE-P®-Anforderungen (Norm SIA 380/1:2009)“. Minergie, 2009.
———. „The MINERGIE®-Standard for Buildings - Information for Architects“. Minergie, Januar 2008.
Pfammatter, Ulrich. Bauen im Kultur- und Klimawandel: green traditions - clean future. Zürich: Vdf Hochschulverlag AG an der ETH Zürich, 2012.
SIA. „Thermische Energie im Hochbau“. Schweizerischer Ingenieur- und Architektenverein (sia), Zürich, 1. Januar 2009. http://shop.sia.ch/normenwerk/architekt/380-1_2009_d/D/Product.
Spies-Wallbaum, Holger, und Susanne Kytzia. Nachhaltig Bauen: Lebenszyklus, Systeme, Szenarien, Verantwortung. Zürich: vdf Hochschulvlg, 2011.
Solar Heat Equipment (Development) Center. 태양열물가열기 일 반상식 (Solar water heating - Introduction and application). Pyongyang, Korea: Solar Heat Equipment (Development) Center (태양열설비개발중심), 2012.
Sunlay Design. Sunlay Design 16 years. Beijing, 2011.
Wyss, Roland. „Geothermie in der Demokratischen Volksrepublik Korea - Stand und Möglichkeiten“. Dr. Roland Wyss GmbH, 24. März 2009.
Wyss, Sara. Determining Thermal Properties of Building Materials - Measurement Devices and Techniques. Uster: hässig sustech GmbH, 2011.

———. Thermal Insulation Materials For Energy Efficient Building Construction in Korea. Uster: hässig sustech GmbH, 2011.

Xu, Zhiyong. Report on EEB Demonstration Project Building No. 12 Huixin West Street, Beijing. Project Documentation. Sino-German Technical Cooperation Energy Efficiency in Existing Buildings - Project Output. Beijing: Beijing Un-Construction Group Co. Ltd. / Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ), 2010. www.eeeb.org.cn.

———. Summary Report of the Demonstration Project in Tangshan. Project Documentation. Sino-German Technical Cooperation Energy Efficiency in Existing Buildings - Project Output. Beijing: Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ), 2008. www.eeeb.org.cn.

———. The Road to Success Sino-German Technical Cooperation - Energy Efficiency in Existing Buildings. Project Documentation. Beijing: Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ), 2012. www.eeeb.org.cn.

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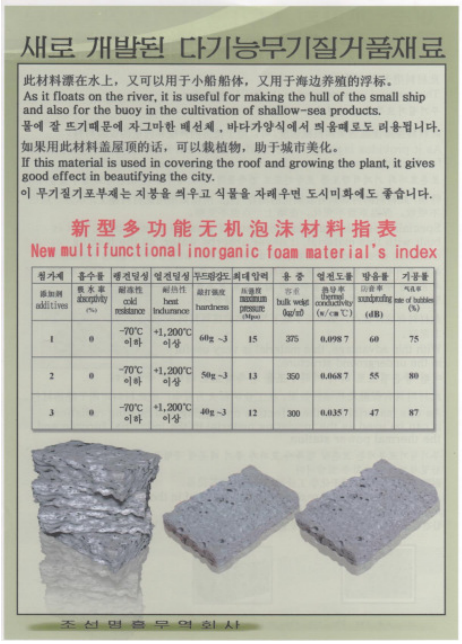
Annex A: List of materials, producers and prices

During the project cycle, the attention to new insulation materials raised quickly.

New insulation materials:

- Cement foam insulation material – research of Academy of Sciences lambda = 0.07 W/m^2*K (data of the developer). Disadvantage – can get wet and soaks moisture.
- Ash from thermal power stations – white ash – carbon free – good insulation – is used to produce “muck” (mix of clay and ash, baked – needs a lot of energy for production).
- Ash from straw burning – packed in plastic bags – problem: eaten by mice – needs poison against mice to be added.
- A new product of inorganic multifunctional foam (sold by Myonghung Trading Company, Pyongyang).
- Cement stone (Hohlstein / Schalungsstein) (sold by Taedonggang Kangchae Kongchang, Pyongyang)



- At the beginning of the project, polystyrene was only available through one or two companies. At least one producer was starting to produce locally (still importing the raw material). Until 2014 the situation changed in that way that there are now 5-10 producers / importers that offer different qualities and compete in the price. So the concerns about trusting an imported good came down.
  For the new apartments, many people try to get Polystyrene to put it inside the wall – massive problems with moisture and mold. A technical design to apply outside insulation was not successful, because they wanted tiles to be added on the outside. Plaster did not hold weight of tiles on top of Polystyrene. The visit of Hongsheng Group in Harbin was an eye-opener on how to do it in a successful way!

Another key question was to find local suppliers of high quality windows and solar thermal units and PV cells.

Windows:
With Haewon Furniture Company that produces based on German windows standard a local producer was found. The company started operation during that project cycle, but was not yet known at the beginning of the project.

Window Type		Price (€)
Plastic sliding window 15 pieces: Used for North Windows in Kitchen (Farm house, one) and Hallway (Office building)		44.1
Wood frame, double glazing 10 pieces: Used for south windows (Office building, except control room))		200
Wood frame, double glazing 2 pieces: Used entrance / bath room (West side, Farm house))		125
Wooden frame, triple glazing 2 pieces: Used for south side window of living rooms)		290
Plastic frame, triple glazing 2 pieces (Used south side control room (Office building))		270

Solar thermal units

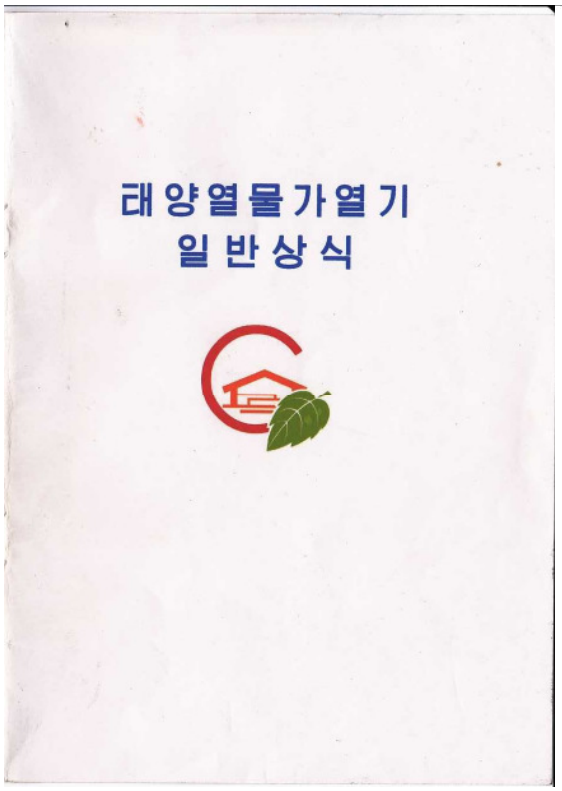
Solar Heat Equipment (Development) Center (태양열설비개발중심)

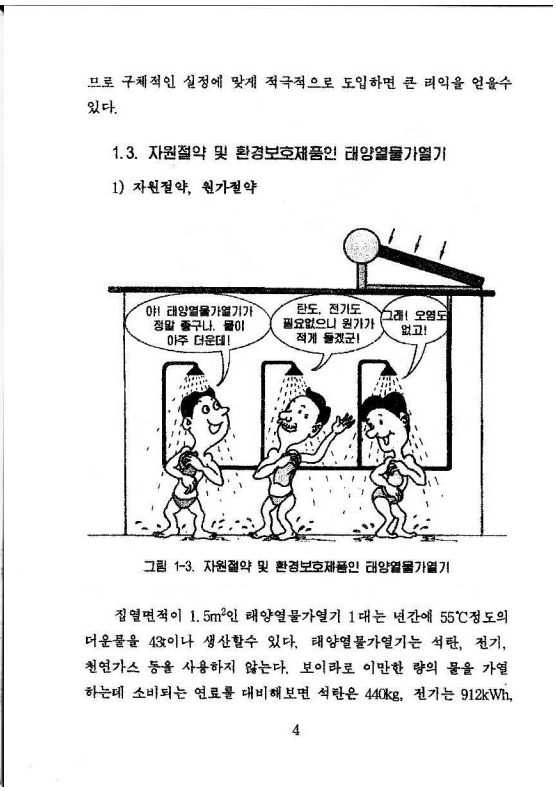
Mankyongdae-guyok Geum Sung 1 dong, Pyongyang

The solar thermal units come in 3 different sizes (120 l, 180 l)

Prices for 120 l unit: 600 – 700 Euro (including installation, additional fittings, pump, pipes are charged extra)

The Center also developed an introduction leaflet in Korean on solar thermal energy (36 pages):





므로 구체적인 실정에 맞게 적극적으로 도입하면 큰 리익을 얻을수 있다.

1.3. 자원절약 및 환경보호제품인 태양열물가열기

1) 자원절약, 원가절약

그림 1-3. 자원절약 및 환경보호제품인 태양열물가열기

집열면적이 1.5m²인 태양열물가열기 1대는 년간에 55℃정도의 더운물을 43t이나 생산할수 있다. 태양열물가열기는 석탄, 전기, 천연가스 등을 사용하지 않는다. 보이라로 이만한 량의 물을 가열하는데 소비되는 연료를 대비해보면 석탄은 440kg, 전기는 912kWh,

4

Annex C: Study tour China 2012 – List of institutions and topics, Program

Gesellschaft für internationale Zusammenarbeit (GIZ) GmbH
GIZ China was involved in several pilot projects on Energy efficient buildings in the last ten years. We had the chance to hear and learn from their experience and get the documentation and project reports. www.giz.de/china

Center of Science and Technology of Construction Center of Energy Efficiency in Buildings Ministry of Housing and Urban-Rural Development (MOHURD)
Project partner of GIZ for Energy efficiency in building
(http://www.giz.de/en/worldwide/16672.html)

Shanghai Sto Ltd.
Technical partner of GIZ - Sto - the specialist for thermal insulation on facades
Sto is one of the world market leaders in the thermal insulation of existing and new buildings, both on the facade and inside. Facade insulation saves energy and lowers heating costs. Additional products such as facade paints and facade plasters, rain screen-cladding systems, interior paints and acoustic systems round off Sto's diverse product program to make the company an all-round problem-solver for the construction industry, backing up an extensive product range with comprehensive advisory services.

Technological Development Center, Beijing Uni-Construction Group Co., Ltd.
Project partner of GIZ in demonstration project Huixinxijie, Beijing

Sunlay Design Group Co, Ltd.
Beijing Sunlay Design Group CO., Ltd, founded in 1990, is one of the designing companies, which firstly implemented the joint stock system directly under the administration of the Ministry of Construction, and has acquired the top-class designing qualification in 1994. After over a decade's development, it has grown into a medium complex with comprehensive designing capacity, possessing a designing team of over one hundred members.

Tian Jian Hua Yi, Building Energy Research Center, Tshinghua University, Prof. Liang Qiang Wei
Recommended by CABR. Various measurement instruments such as thermometers, thermal resistance, loggers, humidity, anemometer, flow sensors, hotbox.

Chinese Academy of Building Research (CABR)
Founded in 1953, China Academy of Building Research (CABR) is the largest and most diverse research institution in building industry in China. It used to be affiliated to the Ministry of Construction (MOC). Since 1 October 2000, it transferred from the public institution into a technology-based enterprise, affiliated to the State-owned Assets Supervision and Administration Commission of the State Council (SASAC). As the largest comprehensive research and development institute in the building industry in China, CABR carries out its mission in catering to the needs of building and construction industries nationwide, putting forward solutions for the key technical problems met in engineering based on applied research and development, providing technical development and consulting services, and undertaking building design and construction activities. It carries out common, basic and public technical researches required in this industry. CABR is responsible for the development and management of the major engineering construction and product standards of China. It exercises quality supervisions and tests on engineering construction, air conditioning equipment, solar water heater, elevator and chemical building materials. www.cabr.com.cn

Heilongjiang Chenneng Shengyuan Real Estate Co
This developer is developing a new construction in Harbin which is listed as one of China-German DENA demonstration projects for low energy building and passive house.

Harbin Institute of Technology (HIT)
CABR recommends Harbin Institute of Technology (HIT) with contact: Laboratories for heat flow measurement (hotbox for windows and wall parts, biggest in China), hot plate and heat flow measurement devices.

Harbin Hongsheng Group
The Harbin Hongsheng Group was established in May 1998, consists of Harbin the Hongsheng Real Estate Development Group Co., Ltd., Harbin the Hongsheng housing energy saving system R & D center, Harbin HONGSHENG Building Materials Manufacturing Company Limited and Ji Lin Hongsheng Building Materials Co., Ltd.. Group management team is competent, college education accounted for more than 60%. Enterprise managers always follow the country's industrial policy, the steady development of the enterprise, social services, confidence in the next few years, enterprises bigger and stronger, enterprise built to the real estate industry as the basis to develop new, earthquake-resistant building energy system and the production of EPS module construction energy-saving materials for the new economic growth point, multi-industry, both large-scale enterprise group, make a greater contribution to society. Product videos see www.hongsheng.org.cn

Annex D: Study tour Europe 2013 – List of institutions and topics, Program

List of visited organizations and events

Firma LSM Matzka, Deisslingen, Germany
CNC- und HSC-Fräsen, 5-Achs Fräsen, CAD/CAM, Elektrodenmodelling, Formaufbauten, Werkzeug- und Formenbau,Vorrichtungsbau, CNC-Senkerodieren, CNC-Drahterodieren, Laserschweißen, Elektrodenhalter, Kupferelektroden-Rohlinge, Graphitelektroden-Rohlinge www.lsm-matzka.de

Energia Globale, Trossingen, Germany
Energia Globale is a family owned company that developed the sun-wind hybrid turbine Aeroterm™. It is available in different sizes and performance levels. It is also available in kit form for the owner builder. With its solid environmentally friendly construction and legendary German engineering, the SunWindHybrid™ is sturdy enough to withstand even the strongest winds. www.energia-globale.com

Hässig Sustech GmbH, Uster
Engineering company for energy consulting for houses with MINERGIE, MINERGIE-A, MINERGIE-P, MINERGIE-Eco standard, passive houses and comfort aeration for private and public buildings (schools). www.sustech.ch

Rüesch Engineering, Herisau
Engineering company specialized on small hydro. Visit of hydro power stations Zürchersmühle with Cross Flow Turbine and Burentobel (axial Kaplan turbine) and Sittertal (normal Kaplan turbine) www.rueesch.ch

Wepfer Technics, Andelfingen
Mechanical company that developed besides many agricultural tools and machine the concept of a small scale wind turbine called Wepfair.

www.wepfer-technics.ch

Minergie Expo, Lucerne 07. - 10. March
Messe für energieeffizientes Bauen und mehr Wohnkomfort
Die in der Schweiz einzigartige Fachmesse zeigt mit den marktführenden Ausstellern den aktuellen Stand von MINERGIE und wohin sich energieeffizientes und nachhaltiges Bauen entwickelt. www.minergie-expo.ch/htm/minergieexpo2013.htm

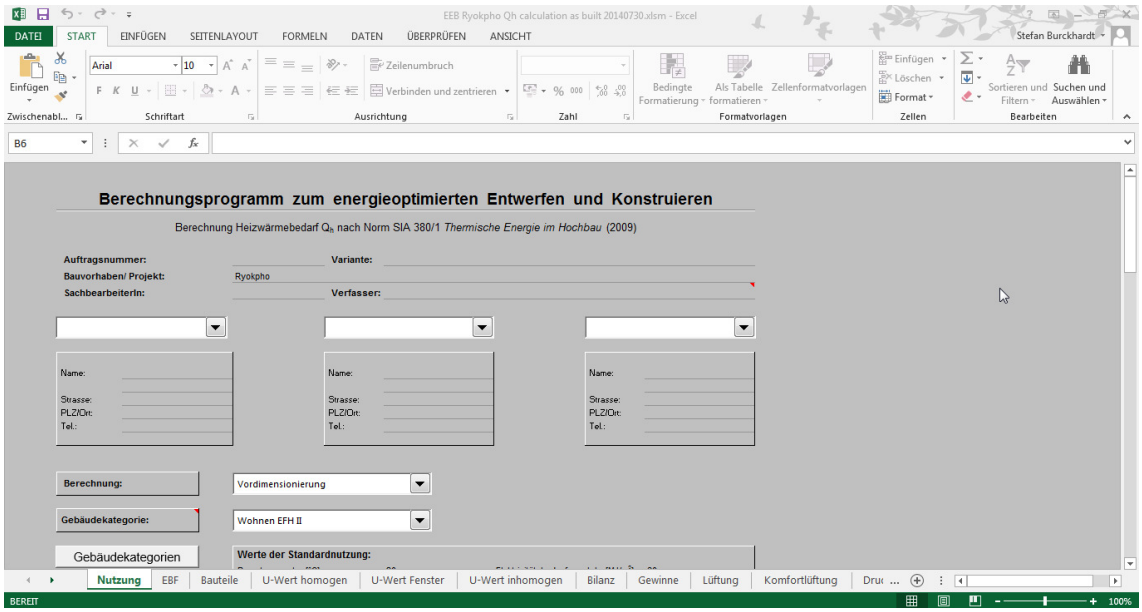
Sunvention Lörrach, Deutschland
Sunvention GmbH works in cooperation with nature to create multi-functional solar systems that bring together solar energy, water and organic food production, making decentralized solar technologies available for communities worldwide. Sunvention developed a solar driven Stirling engine that raised the interest of EC. Sunvention's SunPulse engines have proven that it is possible to efficiently transform solar radiation to mechanical and electrical energy at relatively low temperatures and small temperature differences. It has become possible to produce efficient machines with relatively simple technology. www.sunvention.de

Juwi, Wörstadt, Deutschland
juwi is a successful and highly expertised project developer for wind and solar energy plants. They offer the complete process chain: site selection, planning, financing and operational management. Juwi works in over 15 countries worldwide.
www.juwi.de

Annex E: Application of sia 380.1 - thermal energy use in construction

The cantons of central Switzerland offer a range of documents and Excel tools for the calculation of the thermal energy use in construction:
http://www.energie-zentralschweiz.ch/execution/ur.htm

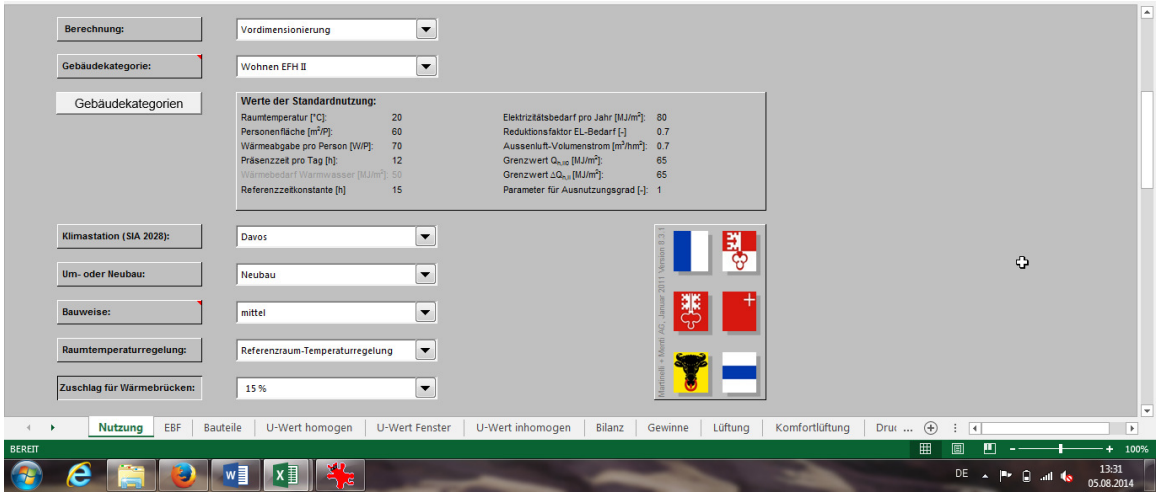
Their Excel calculation software “Berechnungsprogramm zum energieoptimierten Entwerfen und Konstruieren - Berechnung Heizwärmebedarf Qh nach Norm SIA 380/1 Thermische Energie im Hochbau (2009) - Excel-Programm Upate 2011, Ausgabe 2009, Version 8.3.1“ was used to calculate the effects of insulation measure fort the new village farmhouse in Ryokpho.



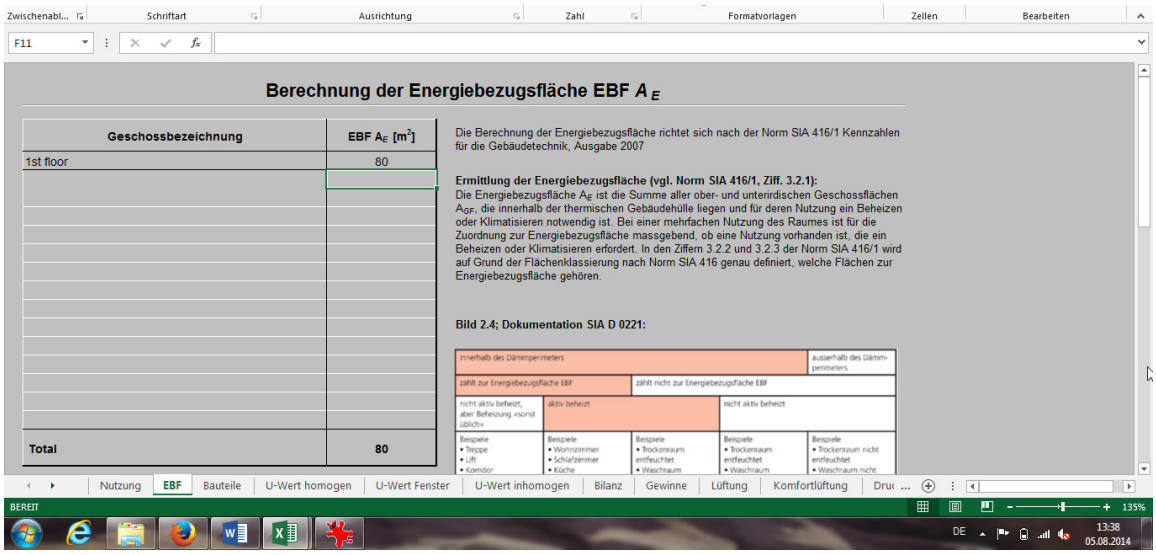
The software has five different modes of calculation. The design mode (Vordimensionierung) was used for the following results. A series of tabs allow to input further data.

Beside some project details like project name and involved people the two most important project parameters are the selection of the building categorie and the selection of the climate station. To simulate the situation in North Korea “Davos” was selected to simulate especially the winter situation, where the heating demand is distinguised by the outside temperatures. In the future the climate data should be changed with Korean data to continue to work with such a tool.

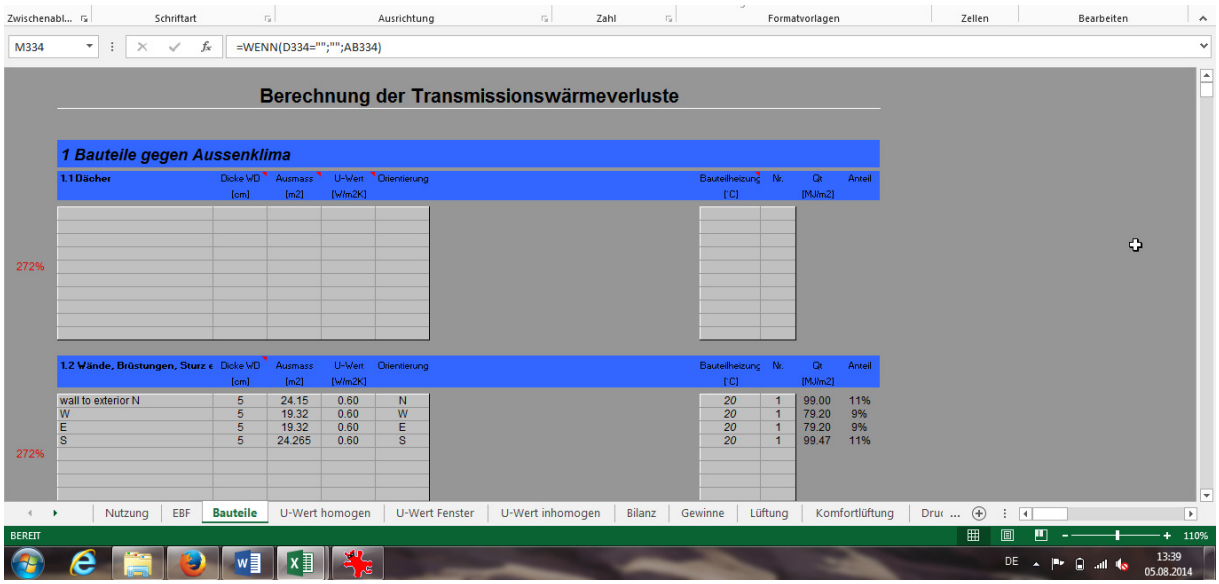
Futher information on the tab usage (Nutzung) are new construction or renovation, the building categorie (which defines a series of other parameters), the construction type, the temperature regulation and a percentage loss for heat bridges.



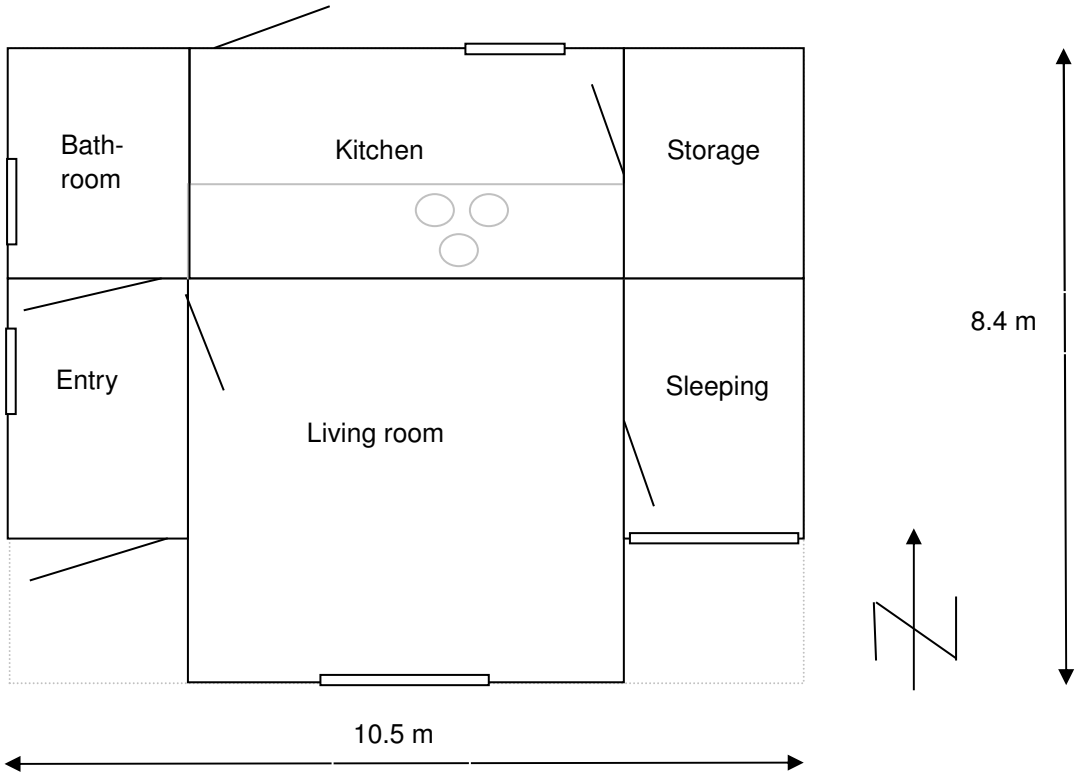
On the second tab (EBF) the energy demand area (m2) is defined. The page gives some advice on how to distinguish this area.



The third tab defines the different construction components, such as walls, windows, doors and ceiling.

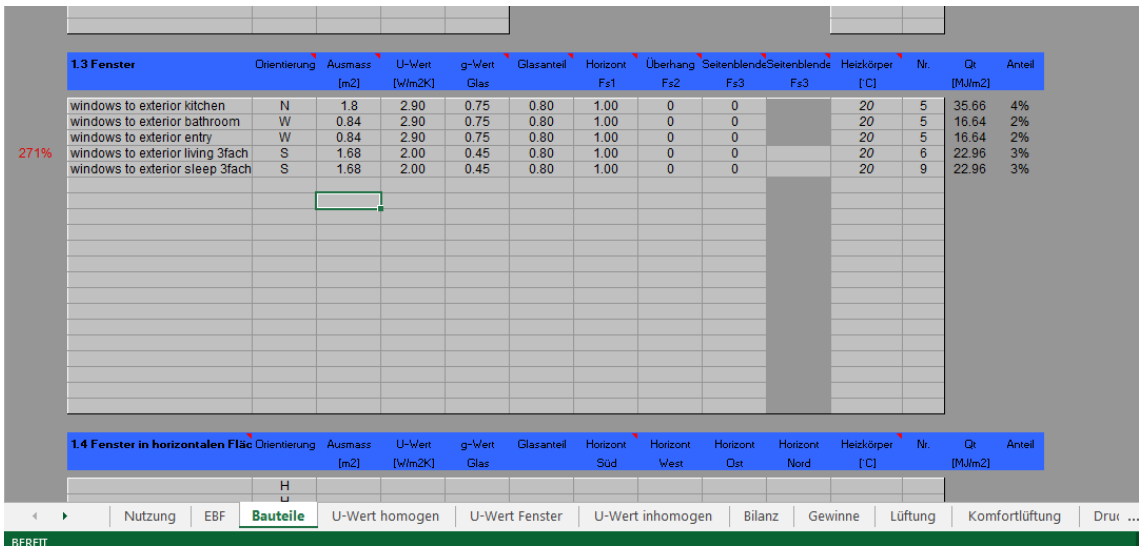


The new village farm house has four outer walls- North, West, East and South. All are insulated with 5 cm of polystyrol (column WD). Their areas are calculated based on the following drawing (building heigth 2.3 m).



And the details about the windows:

Window	Width	Height	u-value	type
Window1	120 cm	140 cm	0.2	triple
Window2	60 cm	140 cm	0.29	double
Window3	80 cm	140 cm	0.29	Double plastic sliding

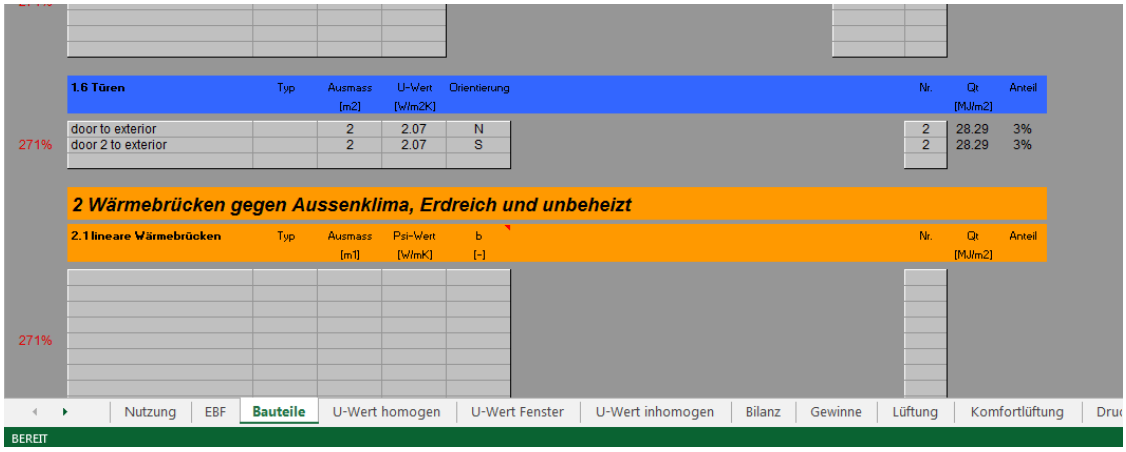


1.3 Fenster	Orientierung	Ausmass [m2]	U-Wert [W/m2K]	g-Wert Glas	Glasanteil	Horizont Fs1	Überhang Fs2	Seitenblende Fs3	Seitenblende Fs3	Heizkörper [°C]	Nr.	Qt [MJ/m2]	Anteil
windows to exterior kitchen	N	1.8	2.90	0.75	0.80	1.00	0	0		20	5	35.66	4%
windows to exterior bathroom	W	0.84	2.90	0.75	0.80	1.00	0	0		20	5	16.64	2%
windows to exterior entry	W	0.84	2.90	0.75	0.80	1.00	0	0		20	5	16.64	2%
271% windows to exterior living 3fach	S	1.68	2.00	0.45	0.80	1.00	0	0		20	6	22.96	3%
windows to exterior sleep 3fach	S	1.68	2.00	0.45	0.80	1.00	0	0		20	9	22.96	3%

1.4 Fenster in horizontalen Fläc	Orientierung	Ausmass [m2]	U-Wert [W/m2K]	g-Wert Glas	Glasanteil	Horizont Süd	Horizont West	Horizont Ost	Horizont Nord	Heizkörper [°C]	Nr.	Qt [MJ/m2]	Anteil
	H												

Nutzung | EBF | Bauteile | U-Wert homogen | U-Wert Fenster | U-Wert inhomogen | Bilanz | Gewinne | Lüftung | Komfortlüftung | Dru ...

And the doors:

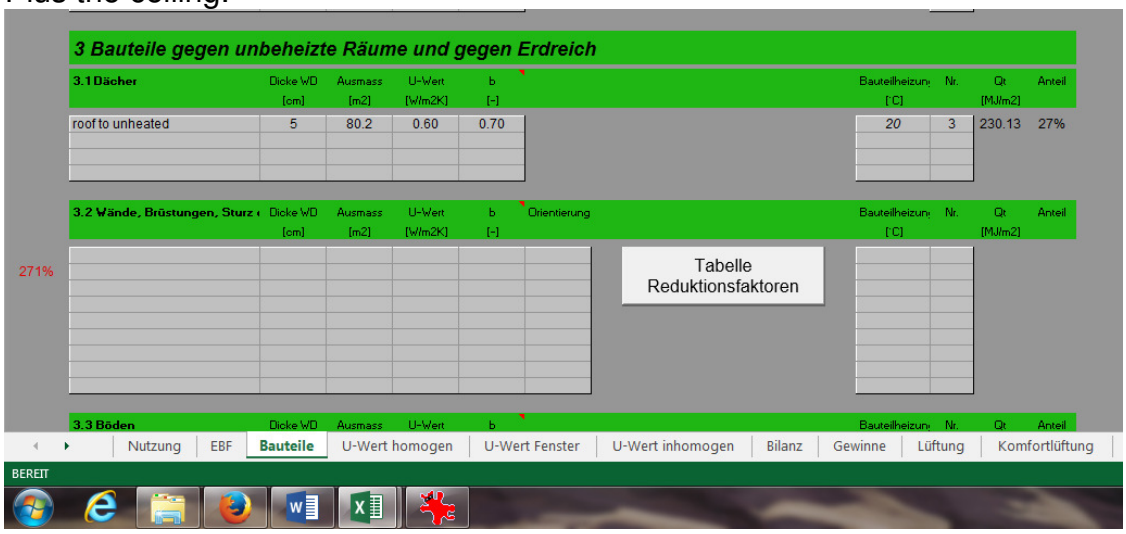


1.6 Türen	Typ	Ausmass [m2]	U-Wert [W/m2K]	Orientierung	Nr.	Qt [MJ/m2]	Anteil
door to exterior		2	2.07	N	2	28.29	3%
door 2 to exterior		2	2.07	S	2	28.29	3%

2 Wärmebrücken gegen Aussenklima, Erdreich und unbeheizt

2.1 lineare Wärmebrücken	Typ	Ausmass [m1]	Psi-Wert [W/mK]	b [-]	Nr.	Qt [MJ/m2]	Anteil

Plus the ceiling:



3 Bauteile gegen unbeheizte Räume und gegen Erdreich

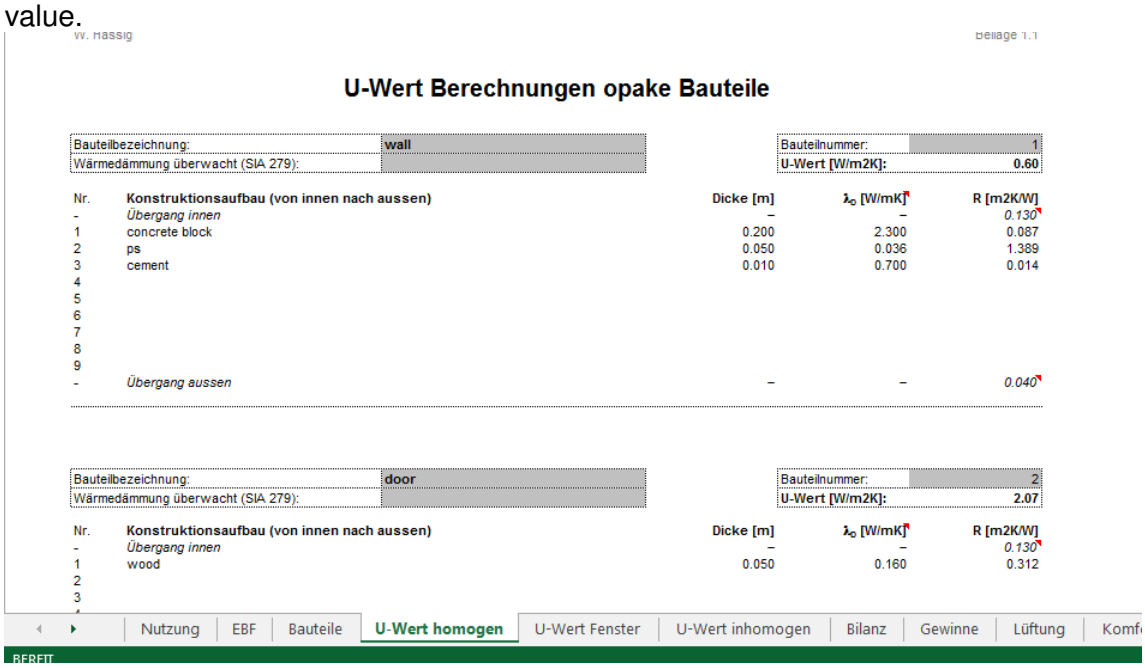
3.1 Dächer	Dicke WD [cm]	Ausmass [m2]	U-Wert [W/m2K]	b [-]	Bauteilheizung [°C]	Nr.	Qt [MJ/m2]	Anteil
roof to unheated	5	80.2	0.60	0.70	20	3	230.13	27%

3.2 Wände, Brüstungen, Sturz	Dicke WD [cm]	Ausmass [m2]	U-Wert [W/m2K]	b [-]	Orientierung	Bauteilheizung [°C]	Nr.	Qt [MJ/m2]	Anteil

Tabelle Reduktionsfaktoren

3.3 Böden	Dicke WD	Ausmass	U-Wert	b	Bauteilheizung	Nr.	Qt	Anteil

Detail calculation for u-values (e.g. wall with 3 layers) can be done on tab 4 (Bauteile): This allows to sum up different materials of different thickness and have a resulting u-value.



U-Wert Berechnungen opake Bauteile

Bauteilbezeichnung:	wall	Bauteilnummer:	1
Wärmedämmung überwacht (SIA 279):		U-Wert [W/m2K]:	0.60

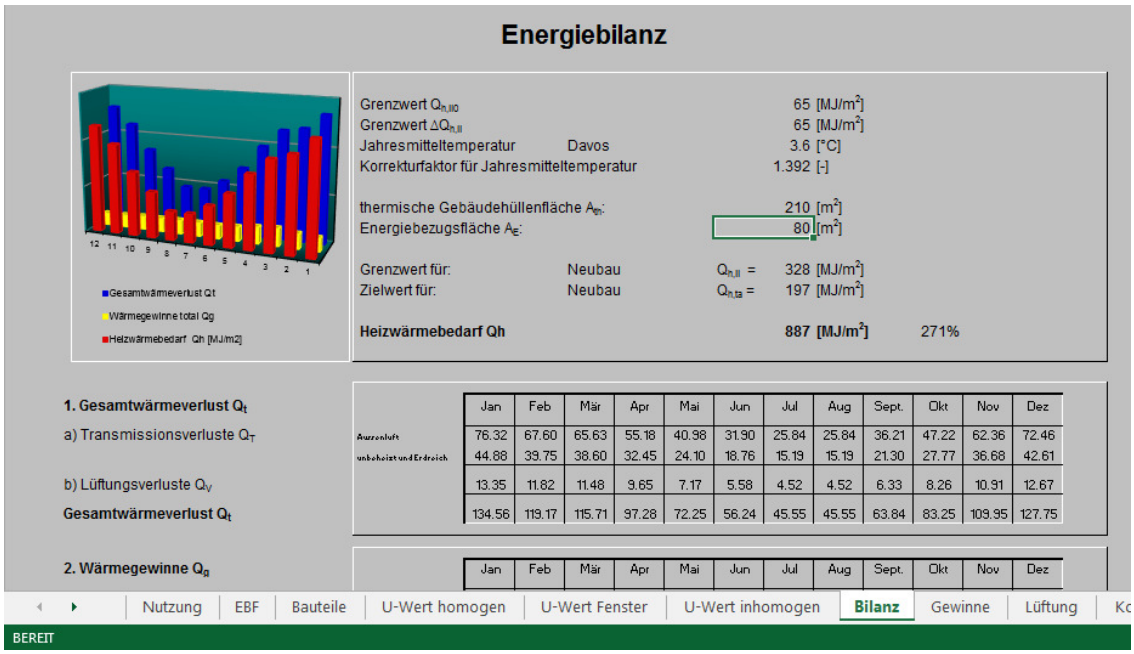
Nr.	Konstruktionsaufbau (von innen nach aussen)	Dicke [m]	λ_D [W/mK]	R [m2K/W]
-	*Übergang innen*	–	–	*0.130*
1	concrete block	0.200	2.300	0.087
2	ps	0.050	0.036	1.389
3	cement	0.010	0.700	0.014
4				
5				
6				
7				
8				
9				
-	*Übergang aussen*	–	–	*0.040*

Bauteilbezeichnung:	door	Bauteilnummer:	2
Wärmedämmung überwacht (SIA 279):		U-Wert [W/m2K]:	2.07

Nr.	Konstruktionsaufbau (von innen nach aussen)	Dicke [m]	λ_D [W/mK]	R [m2K/W]
-	*Übergang innen*	–	–	*0.130*
1	wood	0.050	0.160	0.312
2				
3				

Further details for u-values of windos or other parts could be calculated in another two tabs, but theser were not used.

On the balance tab (Bilanz) the results are displayed in detail with a graph:



Energiebilanz

Grenzwert $Q_{h,li0}$		65	[MJ/m²]
Grenzwert $\Delta Q_{h,li}$		65	[MJ/m²]
Jahresmitteltemperatur	Davos	3.6	[°C]
Korrekturfaktor für Jahresmitteltemperatur		1.392	[-]
thermische Gebäudehüllenfläche A_{th}:		210	[m²]
Energiebezugsfläche A_E:		80	[m²]
Grenzwert für:	Neubau	$Q_{h,li}$ = 328	[MJ/m²]
Zielwert für:	Neubau	$Q_{h,ta}$ = 197	[MJ/m²]
Heizwärmebedarf Qh		**887**	**[MJ/m²]** 271%

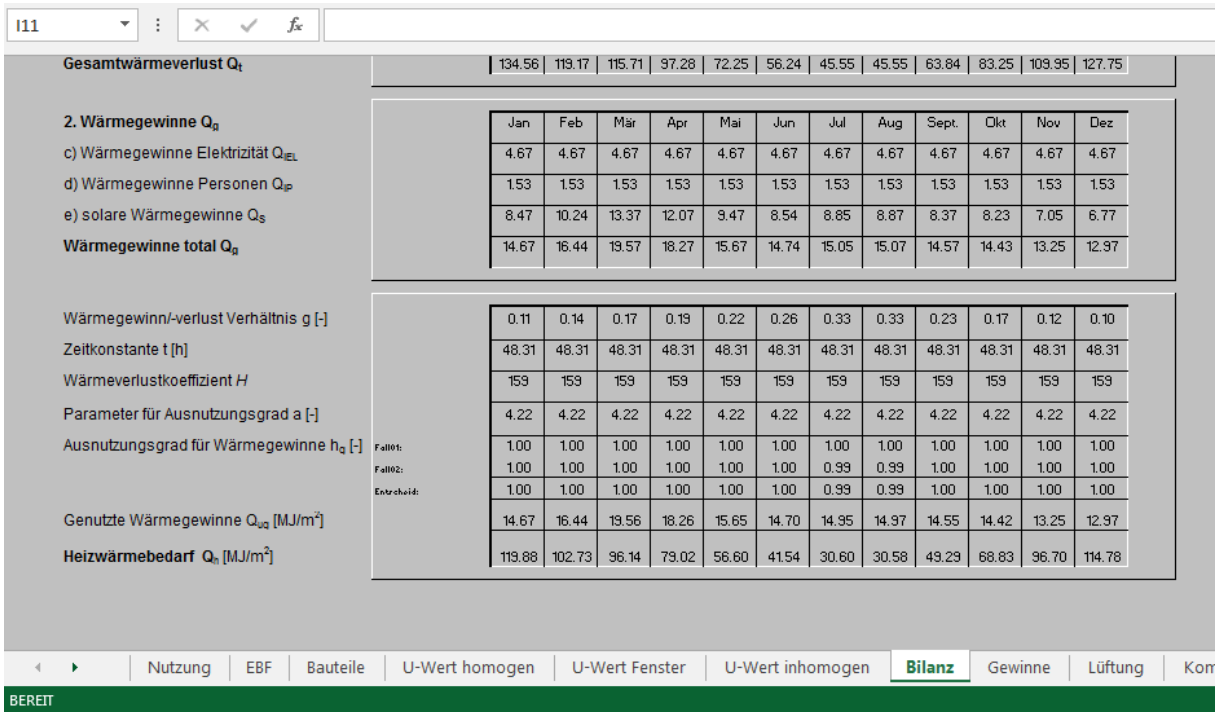
1. Gesamtwärmeverlust Q_t		Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sept.	Okt	Nov	Dez
a) Transmissionsverluste Q_T	Aussenluft	76.32	67.60	65.63	55.18	40.98	31.90	25.84	25.84	36.21	47.22	62.36	72.46
	unbeheizt und Erdreich	44.88	39.75	38.60	32.45	24.10	18.76	15.19	15.19	21.30	27.77	36.68	42.61
b) Lüftungsverluste Q_V		13.35	11.82	11.48	9.65	7.17	5.58	4.52	4.52	6.33	8.26	10.91	12.67
Gesamtwärmeverlust Q_t		134.56	119.17	115.71	97.28	72.25	56.24	45.55	45.55	63.84	83.25	109.95	127.75

2. Wärmegewinne Q_g	Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sept.	Okt	Nov	Dez

Nutzung | EBF | Bauteile | U-Wert homogen | U-Wert Fenster | U-Wert inhomogen | Bilanz | Gewinne | Lüftung | Ko

BEREIT

Results of energy bilance Ryokpho village farm house a built (2014). The total heating demand is 887 MJ/m2.



I11

Gesamtwärmeverlust Q_t	134.56	119.17	115.71	97.28	72.25	56.24	45.55	45.55	63.84	83.25	109.95	127.75

2. Wärmegewinne Q_g		Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sept.	Okt	Nov	Dez
c) Wärmegewinne Elektrizität Q_{IEL}		4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67	4.67
d) Wärmegewinne Personen Q_{IP}		1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53	1.53
e) solare Wärmegewinne Q_S		8.47	10.24	13.37	12.07	9.47	8.54	8.85	8.87	8.37	8.23	7.05	6.77
Wärmegewinne total Q_g		14.67	16.44	19.57	18.27	15.67	14.74	15.05	15.07	14.57	14.43	13.25	12.97
Wärmegewinn/-verlust Verhältnis g [-]		0.11	0.14	0.17	0.19	0.22	0.26	0.33	0.33	0.23	0.17	0.12	0.10
Zeitkonstante t [h]		48.31	48.31	48.31	48.31	48.31	48.31	48.31	48.31	48.31	48.31	48.31	48.31
Wärmeverlustkoeffizient *H*		159	159	159	159	159	159	159	159	159	159	159	159
Parameter für Ausnutzungsgrad a [-]		4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22	4.22
Ausnutzungsgrad für Wärmegewinne h_g [-]	Fall01:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Fall02:	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	1.00	1.00	1.00	1.00
	Entscheid:	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	1.00	1.00	1.00	1.00
Genutzte Wärmegewinne Q_{ug} [MJ/m²]		14.67	16.44	19.56	18.26	15.65	14.70	14.95	14.97	14.55	14.42	13.25	12.97
Heizwärmebedarf Q_h [MJ/m²]		119.88	102.73	96.14	79.02	56.60	41.54	30.60	30.58	49.29	68.83	96.70	114.78

Nutzung | EBF | Bauteile | U-Wert homogen | U-Wert Fenster | U-Wert inhomogen | Bilanz | Gewinne | Lüftung | Kom

BEREIT

Details about Heat gains and losses in each month are also displayed

energy consumption area	80 m2

Cost	Insulation		3.6 €/m2
	annuity	years	interest
	0.048	30	2.5%

Building		height	2.3
length	10.5	width	8.4

case		Qh [MJ/m2a]		Total Energy kWh/yr	Δ Energy kWh	Insulation (Styrofoam, net, nails) m2	€ Δ price	€ Total	energy reduction / economy: price for saved energy (pse) €/kWh	additional energy demand / economy: value of additional energy (vae) €/kWh	window1: wood triple large 290	window2: wood double small 125	window3: Plastic sliding 44.1	Windows all € Δ price	Windows all € Total	Insulation and Windows € Δ price	Insulation and Windows € Total	Insulation and Windows Percent
0	**as built**	**887**	**100%**	**19711**		**175.1**		**631**			**580**	**250**	**44.1**		**874**		**1505**	**100%**
1	without PS on the roof	2178	246%	48400	28689	-88.2	-317.5	313		-0.0005					874	-318	1187	79%
2	with 10 cm PS on the roof	768	87%	17067	-2644	88.2	317.5	948	-0.0057						874	318	1822	121%
3	all with double glazed windows	870	98%	19333	-378			631	recommended		-580	500		-80	794	-80	1425	95%
4	without PS on the walls	3001	338%	66689	46978	-86.94	-313.0	318		-0.0003					874	-313	1192	79%
5	with 10 cm PS on the walls	702	79%	15600	-4111	86.94	313.0	943	-0.0036						874	313	1818	121%
6	with 10 cm PS on walls and roof	595	67%	13222	-6489	175.1	630.5	1261	-0.0046						874	631	2135	142%
7	without PS on walls and roof	4280	483%	95111	75400	-175.1	-630.5	0		-0.0004					874	-631	874	58%
8	all windows single glazed (u= 5.7, g=0.75)	1021	115%	22689	2978			631		-0.0091	-580	-250	264.6	-830	309	-565	939	62%
									0.0077	0.0077								

reference = today's energy price (assumption for Korea 2014: 18 €/t low calorific coal (<2000 kcal)

Hässig/Burckhardt (2014)

Discussion of results and variation of parameters
With the built solution, the new building was insulated with 50 mm of Styrofoam on the walls and on the ceiling. Above this, a so called “cold roof” was added, which protects the ceiling from getting wet. Its insulation effect was not taken into consideration. To compare the effects of wall and roof insulation 8 different scenarios were compared with the as built case. The following table gives an overview on the results.

To evaluate, if some additional insulation makes sense, it is recommended to make a calculation as shown in table 1. The goal is to calculate the „price for the saved energy“, (pse) or if we reduce the investment for insulation it is the „value of additional energy“ (vae). This price/value we compare with the market price for the relevant energy.

For instance in case 1: if we skip insulation on the roof, we will save € 317.50 but the house will consume 28689 kWh per year more energy. First we multiply the investment cost by the annuity and divide than by the kWh. In case 1 we see, that the vae ends up by € 0.0005 for one kWh. This is much less than the reference price of € 0.0077. Therefore it is not worth to skip the roof insulation.

In case 2 we see that an additional insulation of 5 cm costs only € 0.0057 per kWh (35% lower than reference price). This measure makes sense to implement.

In case 3 we see, that the triple glaze windows don’t bring an additional effect or even have a slightly negative effect in winter in blocking the sun to heat up the rooms. So the additional costs for triple glace windows of 80 € based on the calculation with Swiss Davos weather data could be avoided. But we see also that the calculated difference is only 2% - so in place measurements and description of the comfort effects by the new inhabitants of the building will help to draw a final conclusion. But this case shows, that there is a limit, especially with windows where “better” windows can start to have a negative effect.

Case 4 shows that wall insulation has a great effect (338% of heating demand). Compared with case 1 it also shows that on this building we get the better effect in insulating the roof first for the same cost.

Cases 5 and 6 show what effect further insulation of the walls and the roof would bring. The both have a price of saved energy (pse) that is less than the reference price, so it is recommend to do so, if there a finances to invest in this right away.

Case 7 shows the comparison and the effect of the whole energy efficient construction (EEC): **The new model farm house saves 80% (887 instead of 4280 MJ/m^{2}a) compared to today’s standard construction.**

Case 8 shows that also single glazed tight windows (u= 5.7 (with 6 mm glass); g = 0.75) have a positive effect, especially if they are significantly cheaper than the double glazed windows. So if money is critical at the EEB investment this could be a compromise solution that under the taken assumptions could be recommended from the energy perspective. But it shows also, that just a slight increase of the reference energy price by 15% will take away this short term benefit. And it has to be considered also, that double glazed windows have a much better comfort. The surface temperature of the glazing will be less cold in winter time and therefore less condensation of water will result.
In considering this we recommend to use double glazed windows instead of single glazed windows as chosen in this project.

Annex F: Expert Workshops with Dr. Werner Hässig (Hässig Sustech GmbH)

Workshop 2010: November 17th- 19th, 2010
Energy Efficient Buildings and Renewable Energies for Buildings

Topic: Introduction to Energy Efficient Construction and Renewable Energies for Buildings.
Target group: Korean experts with the goal to raise the awareness.
Number of participants: 22
Institutions of participants: Energy Center (6), Construction Department of State Commission of Science & Technology (1), Energy Department of State Commission of Science and Technology (1), Thermo engineering Institute, State Academy of Sciences (SAOS) (2), Physics Faculty, Kim Il Sung University (2), Ministry of State Construction Control (1), Central Heating Research Institute (2), Pyongyang Urban Planning Institute (2), Pyongyang City Design Institute (1), Pyongyang University of Construction and Building Materials Industry (1) Branch Academy of Construction, State Academy of Sciences (2), Central Committee of the Korean Federation for the Protection of the Disabled (KFPD) (1)

Workshops 2012: March 27th, 2012, 9 – 17:30
Workshop1: Energy Efficient Buildings and Energy Auditing - Introduction for Policymakers

Topic: Overview about Energy Efficient Construction and Introduction to „Energy Auditing“.

Target group: Korean policy maker (including non-experts in this field) with the goal to raise the awareness.
Number of participants: 42
Institutions of participants: Energy Center (17), State Commission of Science & Technology (4), Ministry of State Construction Control (5), Central Heating Research Institute (4), Pyongyang University of Construction and Building Materials Industry (1), Paekdusan Academy of Architecture (2), State Planning Commission (2), Branch Academy of Construction, State Academy of Sciences (2), Pyongyang Urban Planning Institute (4)

Workshop2: March 28th- April 2nd, 2012
"Energy Auditing - Energy Building Permit" - a workshop for specialists

Topics: Follow-up on Energy Efficient Construction and basic training for „Energy Auditing - Energy Building Permit”
Target group: Korean experts with the goal to deepen technical understanding and interaction of various fields.

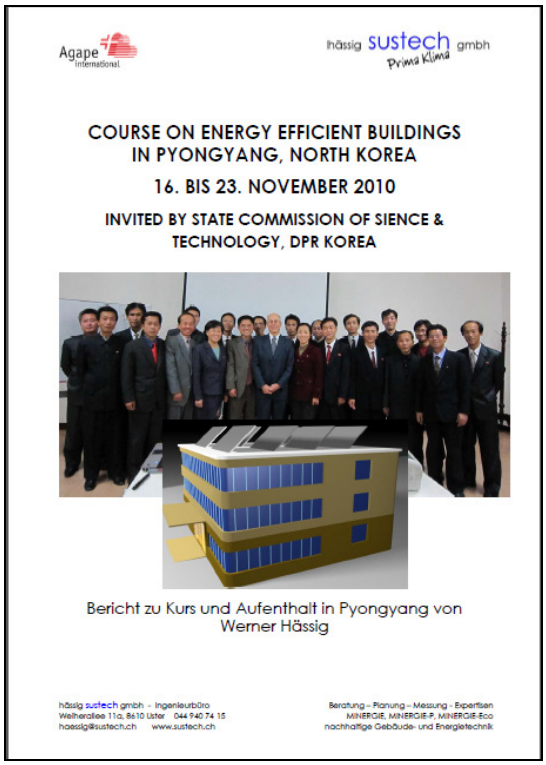
Teaching method: 8 blocks à 3 hours teaching in the class room. Two practical „case studies“ with field visits of two buildings and formulation of a technical consulting report as a practical application. Demonstration of Laser-IR-Thermometer, infrared camera and data loggers, final test and certification.
Number of participants: 22
Institutions of participants: Energy Center (7), State Commission of Science & Technology (3), Ministry of State Construction Control (1), Central Heating Research Institute (1), Pyongyang University of Construction and Building Materials Industry (1), Paekdusan Academy of Architecture (2), State Planning Commission (2),

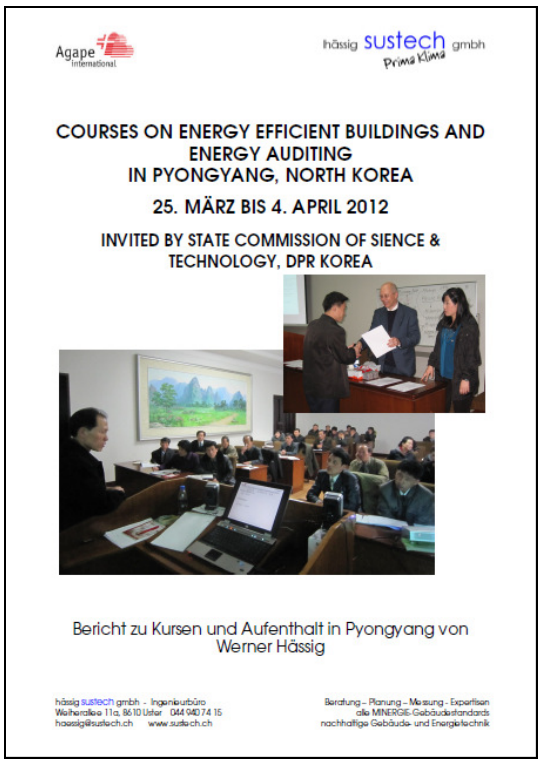
Branch Academy of Construction, State Academy of Sciences (3), Pyongyang Urban Planning Institute (1)

Conclusions about the workshops from the lecturer:
The whole course should be more structured with clear and specific goals per block. The general goal to present the important aspects of energy efficient construction were transported well. This was proven by the written feedbacks at the end of the course. The participants brought very different knowledge about the subject. Some knew how to calculate u-values, but the practical application was almost unknown. The very practical aspects also raised the biggest interest such as:
a) To document an energy audit with calculations and to see how economic insulation is
b) To test the infrared camera on the spot (was difficult because buildings were too cold and batteries did not last very long)
c) Testing the Laser-Thermometer – this is the best tool for an energy counselor

Further workshops are an efficient tool to work towards more energy efficiency. The following topics should be deepened:
- What kind of insulation (materials) can be used in which situation. How is the application?
- Importance of low-e-windows: Repeated explanation and practical demonstration (during construction)
- Tightening of houses without creating mold. Aeration of buildings.
- Further introduction to insulation regulations and practical application in Korea. The participants of the Ministry of Construction Approval showed big interest in adapting the rules and limits. It is suggested to follow a step-by-step procedure, as seen in China and regional parameters.
- Regulation of heating systems (this topic was not really elaborated yet, but there was a big interest about it)
- Renewal of long distant heat pipelines (possibly as CDM-project)

These topics would need careful preparation and would need to allow the development of various options that could be discussed, rated and also economically described.





Further details about the workshop, detailed program and participant list and photos are documented in *Hässig [2010]* and *Hässig [2012].* For training course material (Power

Point slides (English / Korean), videos and photos) please contact the lecturer Dr. Werner Hässig.