Development of energy-efficient and environmentally-sound housing in Russia

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Introduction

The Habitat Agenda (1) has formulated a global plan of action aimed at improving living conditions in urban and rural settlements. The Habitat Agenda states, among others:

> *"Adequate shelter means …adequate space; physical accessibility; adequate security;…adequate lighting, heating and ventilation; adequate basic infrastructure, such as water-supply, sanitation and waste-management facilities; suitable environmental and health-related factors; and adequate and accessible location with regard to work and basic facilities: all of this should be available at an affordable cost"* (Habitat Agenda, paragraph 60).

An environmentally sound house is the one that uses renewable sources for power supply and applies local systems for processing organic wastes and domestic effluents. Houses of this type are well known globally (2-5). Siberia is a large territory with severe climatic conditions. It encompasses one-fifth of the total Russian population and experiences more profound dwelling problems than the rest of Russia. In general, there is a tendency among the population to leave blocks of flats and move into individual housing.

The first part of this paper analyses briefly the state of the housing problems and the main tendencies in reforming the construction industry. Priority directions of eco-housing design and some technologies for the development of energy-efficient construction are discussed in the second part. The final part describes particular actions aimed at the development of programmes for the individual ecological housing construction in some regions of the Russian Federation.

Current low-income housing situation in Russia

In general, almost 22 per cent (9 million) of families live in adequate dwellings. The rest reside in dilapidated houses, communal flats or hostels. Many dwellings are inhabited by two or more married couples (6). According to other references, 46 per cent of the residents in Russia are dissatisfied with their dwellings (7). On average, 4 persons occupy about 3 rooms. Therefore, nearly one-third of the population is living below the living conditions adopted in the Russia Sanitary Norm (9sq. m per capita).

Living conditions in west, east and far east Siberia are worse than in the European parts of Russia by all parameters. In early 1989, Siberia accounted for 21.8 per cent of the total population of Russia and only 19.3 per cent of total available housing. The most urgent aspect of the housing crisis in Siberia is the absolute deficit of dwellings. Low-and moderate-income families are provided with living spaces below the available statistical values.

At present, only 351 flats are occupied per 1000 Russians, in contrast to the needed minimum of 385 flats (in advanced countries – the number is 412-471 flats per 1000 persons). Among 11 Russian economic regions, three Siberian regions were ranked as the last ones as far as living space is concerned. The housing shortage is more profound in Siberia than in the European part of Russia. In 1994, dwelling commissioning in Siberia was rated at 41 per cent of the value in 1989. In Russia, it was 55 per cent, and in European part of Russia it was 59 per cent. The characteristics of housing problems differ between urban and rural areas in Siberia. Large cities suffer absolute dwelling deficit, whereas rural houses are usually less comfortable. To meet the minimum current dwelling demand in Siberia, it is therefore, necessary to provide 43.7 millions sq. m of housing space. Migration of people from north Siberia to the southern regions also increases the dwelling deficit in these areas. Assuming a forecasted migration increment of 2 million people and taking into account the current dwelling deficit for the indigenous population, 2.1 million individual houses and flats must be built by 2005. Considering that each family has an average of 2.6 members, nearly 5.4 million people, or 16 per cent of the Siberian population, will need new dwellings.

Reforms in the construction sector

Up to spring 1990, the construction sector of the former USSR was centralised. Housing construction was by mass frame and panel methods. State organisations and enterprises were the customers. Middle- and small-scale construction enterprises built plants, office buildings, standard multi-storey flats and individual houses in regions. Construction units of the Ministry of Defence, provided partial housing for servicemen.

Private housing construction was encouraged by individual initiatives, whereas State inspection of this process had a restrictive character. The latest Russian reforms changed the structure of industrial production considerably. State contracts for housing construction decreased dramatically. The construction industry, currently, undergoes a restructuring with the main emphasis put on low-storey buildings. Although the former State enterprises were transformed to joint-stock companies, most of them kept the same organisational structure targeted to large-scale construction. Since the construction of such buildings decreases steadily, the existing construction industry must be reorganised.

The Federal Programme on “Housing” envisages a transfer of responsibility of housing provision from national to local level. Reforms in the building industry are very promising. In recent years, 142 thousand small buildings have been built. The present state of the construction industry in Novosibirsk is discussed below as a typical example (8). There are 108 local plants supplying the construction industry in the Novosibirsk region. Basic building materials such as bricks, concrete products, timber, etc. are provided by 53 enterprises. However, there is no single modern heat-insulating materials’ production plant. This is the main problem hampering the development of the ecologically sound housing construction in Novosibirsk.

At present, 15 large-scale construction firms are engaged in housing projects in Novosibirsk. They have the largest share in the apartment building production, most of them being expensive dwellings. By the end of 1998, 2676 small-scale construction firms operated in the Novosibirsk region. According to the data of City Administration, they fulfil up to 30 per cent of the regional construction contracts. Their main activities include, repairing existing flats and other small objects.

However, the activities of these firms in the field of single-family housing construction are limited by high expenditures which is beyond budgets.

The current state of the building industry in Novosibirsk is characterised by decreasing production of materials. Compared with 1997, these outputs, in 1998, were rated between 55 to 85 per cent. Since the early 1990s, the Government has a policy, which supports individual housing construction. In the period of 1990-1994, the foundations of nearly 1000 individual houses were laid, but only a portion of them was finished. The following reasons will explain this situation:

- Enterprises and local authorities suspended financing and provision of service lines for individual house building.
- Many private builders overestimated their own financial resources and planned to build too large houses.

- Designs did not incorporate good heat-insulation techniques. Such houses required high expenditures for heating that was unreasonable to operate them.
- The building sites were, often, allotted in districts, which lacked utility systems and social infrastructure.

Housing in Siberia

Economic crisis has decreased housing production by almost 50 per cent. Financing housing construction from Federal Budget is negligibly low. Consequently, the volume of State construction has decreased four-times. Development of privately invested individual housing has become a priority. A survey of dwellers in Novosibirsk suburb regions proved that some 80 per cent of facilities built by their own and engage only small craftsmen to accomplish some particular work.

Legal and normative base

The development of ecologically sound mass housing construction in Siberia should be supported by an advanced legislative base. Legal reforms in Russia started in 1993 when the Government adopted the State programme on "Housing"(9). The main feature of the "Housing" Programme is the creation of adequate legislative base, privatisation of existing housing stocks, de-monopolisation of house-building and communal services. Accordingly, a housing market has been created which serves as the main mechanism for solving housing problems.

In compliance with the assignments of the "Housing" programme, 57 legislative acts, aimed at reforming housing sector, were adopted by 1995. Although so numerous, they did not form an integral system. Nevertheless, several of them adopted later, formed a basis for solving the housing problems at principal new levels.

Laws on "Energy Saving", "Partnerships of Housing-Owners", "Mortgage" are of fundamental importance. Unfortunately, the inadequacy of the latter hampers any progress, since most of the existing banks are still not ready for providing long-term credits at low interest rates.

The State Construction Committee has prepared normative documents concerning efficient use of energy (Instructions and Extracts from Sanitary Norms and Regulations, 1997). They initiated the process of introducing energy-efficient technologies in housing construction and operation. Following adoption of relevant laws at Federal level, the Novosibirsk law on 'Energy saving' in Novosibirsk Region" came into effect in 1997. This law forms the legislative foundation for the development of the "Ecodom" programme in the city of Novosibirsk and the Novosibirsk Region. Respective legislative and programme bases are now available in other Siberian regions. Initially the "Ecodom" programme (Russian abbreviation for "ecologically sound house") had the status of a local initiative project. However, in 1994, the Administration of Novosibirsk region issued a decree on "The development of ecologically sound housing construction in Novosibirsk region", thus supporting the work performed within the project framework. In 1995 the programme was presented at Parliamentary Hearings devoted to " Economy of Sustainable Development". Following the recommendations of the Federal Assembly, the main features of the "Ecodom" programme were included into Federal Programme "Svoi dom" ("Own House") (6).

Environmentally sound housing construction practice

Introduction

Most individual houses in Russia are constructed using traditional designs with no account for modern, energy-efficient and ecologically conscious technologies. This leads to one of the most urgent tasks, that is the development and wide-scale adoption of ecologically sound individual houses.

This part of the paper describes a basic project of energy-efficient ecological house design with special attention to Russian specific climatic conditions together with some technologies used in the production of building materials and Ecodom operations.

Heating and related CO_2 emissions

In conventional Russian single-family houses with fossil fuel-fired heating systems, the efficiency of fuel consumption per m^2 floor is 50 per cent when compared with flats in apartment buildings. Approximately 37 per cent of CO_2 emitted into atmosphere originate from individual houses, which comprise 23 per cent of total housing in Russia. CO_2 emissions from such houses are 157.5 million tons annually. The increase of CO_2 emissions from individual houses built in 1997 amounted to 2.67 million tons or 1.75 per cent of the above annual emission. The transition to mass construction of ecologically conscious dwellings will decrease the CO_2 emissions up to three times.

Ecodom – what is it?

"Ecologically conscious" behaviour

The prefix "eco" in the word "eco-house" implies, first of all, a certain "ecologically conscious" behaviour of people in their dwellings, the nearby plots, the habitations and the whole environment. To provide a sustainable equilibrium in such a system, it is necessary to achieve harmony between artificial human-created and natural environment.

People should coexist ecologically consciously with the nature surrounding their dwelling, improve biological activity of soil, facilitate vitality of plants, animals, birds, insects, etc. Preserving the surrounding nature, in its turn, helps to improve human life and health. The eco-house concept promotes transition from prodigal consumption of natural resources to the use of renewables and nature-rehabilitating operational methods (10).

Eco-house provides healthy living conditions

Eco-houses are favourable to human health using non-toxic materials. Since eco-houses are modern well-equipped dwellings, they require similar operation and expenses as an apartment in a conventional building. Owing to the used engineering systems and materials, the living medium in eco-house meets all sanitary requirements and standards. House-adjoining gardens encourage inhabitants towards healthy living.

What are the components of an eco-house?

An eco-house consists of three main parts. The first component is a heat-containing house frame. It is economically and technically expedient to heat an eco-house by solar energy provided that its heat-insulation properties exceed that of conventional house six times. If so, an eco-house requires no stove heating from February till late autumn. The second component is a life-supporting engineering system (heating, ventilation, processing of organic wastes and domestic effluents):

- the heating system includes a small heating boiler, solar heating with air and water and heat distribution (pilot solar collectors have proved to be adequate in Siberian climate);
- the ventilation system is designed as a heat-exchanger that allows recovering up to 70 per cent of energy from warm air leaving the house;
- the waste processing systems are based on the methods of composting, aerobic and anaerobic fermentation of organic and domestic effluents into a biologically valuable product.

The third component is a house-adjoining garden with bio-botanic plot. The plot serves for utilising processed wastes and may be used for efficient gardening and vegetables production (via bio-intensive). The garden represents an essential part of the whole eco-house system.

Energy efficiency in eco-house

High energy efficiency is the most important feature of an eco-house, since major part of operational costs is related to heating costs in the Siberian climate. Eco-houses save heating energy by means of heat-insulated walls and foundation, tight windows with triple or quadruple glazing. Power inputs are decreased by virtue of regular orientation of houses towards prevailing winds, space planning, creation of buffer zones as well as the passive and active use of solar energy and heat accumulators (11).

Bio-intensive technology to improve soil and environment

Bio-intensive technology allows intensified biological processing of organic wastes, producing organic matter for efficient gardening. Bio-processing is undertaken:

- in bio-reactors with benign conditions for living micro-organisms, and
- at house-adjoining plots where special compost-producers are planted.

These are the two methods to produce organic matter using bio-intensive technology for growing vegetables (12). The use of twice-dug beds matured with natural compost facilitates development of soil biocenoses optimal for growing plants. In Siberia, bio-intensive technologies increased the production of agricultural crops by about two times. Methods of permaculture also help to increase the biological activity of soil (13). Permaculture is aimed at the creation of interconnections between all natural components surrounding people, establishes respective rules and recommendations. It focuses equally on plants, buildings and habitation infrastructure (communications, energy and water supply, waste processing).

The goal of permaculture is the design and development of ecologically and economically efficient systems. These systems should be autonomous, produce no harm to environment, improve biological activity of surrounding mediums and, thus, provide self-sustainability for a long time. Permaculture uses inherent properties of local plants and animals, landscape, buildings and climate. It provides people with amicable living conditions in urban and rural areas, using minimum space.

An eco-house is a moderate-cost dwelling

An eco-house may be cost-effective for moderate-income families owing to:

- the use of appropriate technologies and local resources;
- efficient construction techniques using no heavy machinery and based on local labour;
- equipping houses with engineering systems step-wise and putting them into operation (first step – construction of minimum living space with the most needed engineering equipment).

Architectural design of an eco-house

Solar architecture in eco-house basic design

An eco-house architectural design including solar elements and compactness requires fulfilling the following conditions. The south side of the house (northern hemisphere) should provide maximum use of solar flux. This part of the house locates a greenhouse, solar collectors, solar batteries of photoelectric elements and heating elements of a solar water-heater.

Compact and heat-saving space planning

A conventional house in the Siberian climate requires heating almost every day of the year. Comfortable houses should provide each member of the family with single room. However, too large houses are inefficient, since they require more heating and maintenance. An efficient house should be reasonable-sized and compact. To minimize heat losses, house shapes should approach cubes. Furthermore, solar architecture requires a 1.5-times increase of house dimensions along east-west axis that provides maximum absorption of solar energy. An efficient energy-saving method is the construction of non-heated zones around the living space.

Heat-saving design of housing envelope

The main method to built an energy efficient eco-house is the use of heat-insulating external structures (house foundation, exterior walls, roofing, windows). To make solar architecture and solar heating economical, it is essential that the heat-protection of house envelope is increased by 5-6-times compared to conventional houses. The use of bricks or light concrete can not solve the problem of adequate heat-insulation, since the wall width in this case would have to be 1.5 m. This fact necessitates the use of special heat-insulators in the walls.

The modern construction industry uses commercial heat insulators (foam plastics, mineral wool of various types). By selecting heat insulator, it is very important to consider its life span. For example, glass wool and some foam plastics may decay in 2-3 decades. The life span of basal fibre-based heat insulators is much longer. Quite a number of heat insulators are available. Most acceptable ones amongst them are straw, flax rejects and rush (the latter is widely distributed in Siberia). These materials are efficient, cheap, and pest-resistant. If necessary, they could be treated with natural pest fighters (for example, powdered cedar needle). Regular wall design, anti-rodent small-meshed netting, wet-proofing may extend eco-houses an operational life of 100 years (such longstanding eco-houses do exist in North America).

"Growing" eco-house

There are many people who can not afford large houses. Also many small families with small children do not need a large house. The problem of shortage of living space arises later when the children and parents become older. Therefore, the base design anticipates the possibility of eco-houses to expand towards needed size ("growing" housing concept) without any reconstruction of the existing living space.

Conceptual design of energy-efficient and environmentally-sound house

An environmentally sound house is remarkably compatible with the definition of "an adequate shelter for all" provided in the Habitat Agenda. Essentially, all environmentally sound houses in any climatic condition and countries should meet the same requirements, namely:

- provision of adequate living conditions;
- energy efficient construction and operation;
- use of solar energy as an alternative power source;
- complete processing of organic refuses into sanitary-safe compost to be utilised at the homestead land;
- recovery and repeated use of construction materials;
- affordable to everybody;
- the optimum organisation of homestead land in order to grow vegetables and other useful plants for family consumption.

However, eco-houses, in each particular case, have their specific features. Short, hot summers and long, severe winters dictate special approaches for the eco-house design, operation and management. Besides, the conceptual design should consider the traditions and long-standing experience of building Siberian houses. The eco-house construction in rural regions is quite different from the construction in the countryside. Because of land deficit in large cities, the minimum area for utilizing organic refuses is allowed. For this reason and regarding the unsafe ecological situation in large cities, it is unreasonable to grow vegetables in open beds. Bio-intensive technologies, which were suggested in the project, allow efficient utilisation of organic refuses and growing vegetables in adjoining greenhouses. In dense-populated urban areas, the wastes may be processed directly in the houses and the products may be utilised at the city's green lawns and parks.

Design requirements

The design of eco-houses for Siberian conditions should meet the following requirements:

- maximum reduction of the construction cost (by means of family labour, among other things);
- seasonal and step-wise construction;
- use of local building materials and structures;
- avoidance of long transportation and heavy construction machinery;
- use of autonomous engineering systems for eco-house operations;
- combination of traditional architectural and building technologies with modern ones.

Structural systems and auxiliary facilities

The structure of houses with farmland auxiliary facilities is almost the same all over the Siberia. Usually, Siberian houses are equipped with a brick stove, include non-heated auxiliary facilities, a cellar for storing food reserves and are supplied with electricity. Most individual houses lack heated in-house toilets. Structures for eco-houses were selected with due respect to the traditional Siberian way of life. All engineering systems and auxiliary facilities of eco-houses have been designed assuming the possibility of step-wise construction and installation. Final construction and finished works may be performed by the family.

Energy supply, heat accumulation and ventilation

Ecodom is heated with a hot-water boiler and an auxiliary solar heating system, which includes the solar collector. Solar radiance irregularly arrives throughout day and year. To provide efficient solar energy, it is necessary to install the daily and seasonal solar heat accumulators. Water represents the simplest and most available daily heat accumulator. It maintains ecodom's heat inertia, uniform warm-up and hot-water supply for domestic needs. To keep the temperature stable throughout a day, water of several cubic meters is required. For example, assume the heat transfer resistance of exterior walls: R ($m^2 \cdot C°W$) to be 6 and the difference between inside and out-side temperatures to be 60°C, then the sufficient water tank volume equals 3.2 cubic m. Such an accumulator will provide a comfortable temperature in 100 sq. m eco-house for 10 hours and cool down from 70°C to 50°C in this time interval.

The seasonal heat accumulator absorbs energy in summer and releases it in winter (from November till February). The operation of traditional heat-accumulators is based on the thermal capacity of a working body (water, ground, gravel, etc.) or on the heat of phase transfer (paraffin). However, they can not store energy for a long period and, therefore, are less efficient in Siberian conditions. More promising for seasonal energy accumulation are the devices operating on reversible chemical reactions, which proceed with energy absorption and release (development of the Institute of Catalysis, Siberian Branch of Russian Academy of Sciences). These accumulators use cheap and widely available salts. Since the energy capacity of reversible chemical reactions exceed ten times the energy capacity of phase transition, the chemical accumulators are significantly smaller than accumulators of any other type.

High-energy efficiency is also achieved by low air infiltration. Fresh air is supplied through exhaust ventilation systems equipped with a heat recuperator. This system, as well as air-tight windows, serves to create healthy, comfortable microclimate in the house. Table 1 compares heat losses in a 200 sq.m eco-house with and without heat recuperation, assuming a temperature difference of 60°C (out-side temperature -40°C, inside temperature +20°C) and various heat-transfer resistances of exterior walls.

Table 1. Heat losses

Heat-transfer resistance of outer walls, (m^2 °C/W)	Heat losses through walls kW	Ventilation-related losses without recuperation, kW	Ventilation-related losses with recuperation (efficiency 75%), kW	Total heat losses, KW	
				With recuperation (efficiency 75%)	without recuperation
3	10.0	12.0	3.0	13.0	22
6	5.0	12.0	3.0	8.0	17
9	3.5	12.0	3.0	6.5	15.5

Obviously, if adequate heat insulation is provided, then, the main heat losses are related to ventilation. Therefore, together with heat-accumulators, heat exchangers in ventilation systems are important elements of eco-house's equipment. Ventilation design should be simple and affordable.

Water supply

Centralised water supply serves individual houses in large cities, since underground waters are usually polluted and require special treatment prior to communal use. In small cities and rural areas, besides centralised water supply, artesian wells are widely distributed. Individual water-purifying facilities in settlements and villages are scarcely used.

Processing and utilization of organic refuses and domestic wastes

Domestic wastes in eco-houses are separated at the stage of their appearance. Inorganic refuses are subject to secondary use. Organic wastes undergo composting and are then utilised at farmlands. Equipment for composting organic wastes (composters, composting biotoilets) is widely available. Specifically for Siberia, biotoilets should be installed in heated premises. This allows adequate conditions for micro-organisms, which digest organic wastes into compost, but enhances ventilation requirements. Biological purification of domestic effluents is quite feasible. Eco-houses operate when combined purifying system, which includes engineering equipment for the processing of liquid wastes (special aerobic and anaerobic bio-reactors) is followed by additional treatment of the obtained sludge in the ground.

It is possible to equip the eco-houses with usual flush toilets and use composters to process solid kitchen discharges. Ecodom Ltd. performed tests on the utilization of domestic effluents from individual houses in Siberian conditions (14). Utilisation of domestic effluents is one of the most important tasks related to the design of eco-houses. In this regard, works under the project were supplemented with an analytical review: “Ecologically sound dwelling construction - equipment and technologies for decentralized water purification”. The work undertaken considers current world-wide practices of decentralised purification of domestic effluents. It describes the most simple, cheap, reliable and ecologically conscious technologies with special emphasis on local conditions and, thus, helps designers and private-builders to choose the most adequate purifying equipment.

Greenhouse, kitchen-garden

The greenhouse is an important element of an eco-house, which, besides its direct function, operates as a passive solar heat accumulator and protects the house from winter frost and wind. An adjoining wall and the sub-greenhouse ground accumulator absorbs solar energy. A bio-botanic plot serves as an intermediate unit between the house and farmland. It consists of ground filters for the secondary composting of sludge from bioreactors.

Storage of food

Cellar is of standard design and has an entrance from the house and the backyard hatch. An ice-cellar is used to keep low temperatures in warm seasons. In winter the ice-cellar freezes slightly salted water and produces approximately two cubic meters of ice. Adequately insulated ice-cellars keep sub-zero temperature throughout the warm season until cold weather comes. An eco-house is equipped with a built-in kitchen icebox, intended for winter use. In Siberia, it can serve instead of usual refrigerator for 5 months of the year. All the equipment can be produced at small plants and workshops in compliance with available standard designs.

Computer design

One of the factors inhibiting mass construction of ecologically sound housing is the expensive traditional system of housing design. For mass construction, the process of design phase should be fast and cheap and should yield diverse projects, which can be easily modified according to customer’s needs. For these purposes, the wide distribution of computer modelling in small-scale construction firms and architect workshops is needed. Using only computer modelling and special software, it is possible to create a large variety of eco-house designs. Moreover, computer design essentially decreases the project cost and accelerates the preparation of particular designs according to customer’s request. The design should be relatively simple, so that a layman could read it, but comply with all existing construction standards and regulations. Based on this principle, particular requirements were formulated for the set of the design hard and software. The computer should:

- be capable to create and run data bases of typical structures;
- be operated by one highly-qualified specialist;
- include widely available and periphery devices;
- be cost-effective, so that small-scale architectural and construction firms could purchase it.

In compliance with these requirements, research on the project was continued using the most available hardware and software. After considering several foreign and domestic architectural design programmes, the Russia-based software bCAD, developed by Novosibirsk programmers, was chosen. The programme is much cheaper than its foreign analogues, whereas it provides almost the same facilities. Graphic software bCAD comprises modules for creating traditional two-dimensional drafts, computer modelling and animation. The programme potentials essentially facilitate the processes of architectural design, development, calculation and integration of engineering systems into the model. It has been used to design two eco-house drafts.

Two examples of ecohouse design

During the realisation of the "Development of Energy-efficient Environmentally sound Individual Housing Construction in Siberia" project, two models of eco-houses equipped with the above engineering systems were designed, using the bCAD software.

First model

The first model demonstrates the draft of a gable-roof eco-house. It exemplifies the principal arrangements of heating equipment and solar and ventilation systems. This design assumes the simplest architectural solution, displays the main elements and shows how they could be installed in an existing house. Based on this design, it is planned to build an eco-house-laboratory. The building is planned at the territory of the Institute of Thermal Physics, SB PAS. The land for the construction has already been allotted, and a team of experts for developing contractor design was composed.

Second model

The second model has a pyramidal roof. It exemplifies the arrangement of equipment for processing solid organic wastes into compost (Clivus-Multrum biotoilet) and for purifying domestic effluents. This design is a prototype of a demonstration eco-house, planned to be constructed in Downtown Novosibirsk. It will highlight the advantages of ecologically sound houses over conventional ones and will provide inputs to consulting and training seminars.

Efficient technologies for ecologically sound dwelling construction

Building the house frame is the most expensive among other construction steps. Whether the house will be energy-efficient, ecologically sound and will have a long-life depends on the building materials. In this regard, a second analytical review titled: "Ecologically sound dwelling construction building materials"(15) was prepared. It analyses the potentials of available building materials for energy-efficient and ecologically sound low-storey house construction. Existing materials are compared with regard to embodied energy, that is, the energy used in all stages of the material life, including extraction of raw materials, production, construction, operation, dismantling and reuse. Based on the criteria of embodied energy, the paper analyses the use of reproducible and non-reproducible natural materials, the ways to reduce energy consumption for production and transportation, methods to save the environment and provide building construction with high-quality materials.

Ecological dwelling construction allows the use of numerous technologies, which reduce the cost of construction and operation. Below, two technologies are presented: on-site production of building materials and heating ecodom by solar energy.

On-site production of construction materials

Building exterior walls and their insulation are the most resource-intensive stages. High cost of building materials and construction of exterior walls forces many builders to turn away from the decision to construct an individual house. Therefore, on-site production of building materials is one of the most efficient ways to decrease construction costs. First, it allows the use of local labour and, second, it minimises transportation costs. These facts allow people, with moderate incomes, to build their own houses.

Production of non-steam-cured concrete

A miniplant for producing non-autoclaved cellular concrete may operate directly on construction site. The cost of a miniplant equals almost the market cost of the building materials for one house. One miniplant is capable of producing building materials for 4-5 houses, each of 100-120 sq. m (per construction season). Cellular concrete has a low bulk density (600-900 kg/m^3) and, therefore, exceeds twice the heat-insulating properties of bricks. Since light-weighted cellular concrete blocks have large dimensions, the process of construction is fast and allows wide use of manual labour. Sanitary-hygienic properties of cellular concrete provide adequate microclimate in the house. The material is fire-safe, durable and is based on Portland cement.

A feasibility study and business plan for a small-scale production of cellular concrete (130 m3 monthly) have been developed and sent to the Executive Bureau of UNCHS (Habitat) in Moscow. Experts from the "International Consulting Centre – Development" have been engaged in the business-plan development. According to their recommendations, the project's executors initiated four private persons to purchase and put into operation a miniplant producing non-steam-cured cellular concrete. In several months the plant has been proved economically efficient and competitive. Moreover, it provides low-income families with additional employment and the possibility to construct individual houses. The development of a small-scale production of building materials is one of the tasks, which the established association will solve. Accumulated practical experience will be used at the second development stage of the programme for ecologically sound housing construction in Siberia and will allow increased employment opportunities and cost-efficient construction.

Production of soil-blocks

It is possible to manufacture cheaper building materials from soil, directly on a construction site. Foundation pits produce nearly 100 cu. m. of soil. This is enough for producing about 80-90 per cent of blocks required for the exterior walls masonry. The production technology uses admixtures of local soils, clays and a stabiliser. Soil-blocks are produced using the moulding extrusion method.

Industrial production of steam-cured cellular concrete

The SIBIT plant operates in the Novosibirsk region since 1994. It produces steam-cured cellular concrete building elements based on YTONG and cement-sand tiling (Keller technology). Advanced technical specifications of the cellular concrete such as its high strength, improved heat-insulation, fire-resistance and durability facilitate its use for efficient construction of multi-storey and individual houses. The technology allows producing wide assortment of building elements that are highly competitive.

Use of solar energy

Adequate heat-insulation of exterior walls is the main condition for the efficient use of solar energy in Siberia. Assuming that the heat transfer resistance of the exterior walls is R=6 m^2 . °C/W, then the heat energy produced by a 40 sq.m. air solar collector over a year will exceed the annual heat-losses in an eco-house by 1.4-times. Table 2 shows data for an eco-house of a total area of 200 sq.m. located in various Siberian cities.

Table 2. Feasibility of eco-house solar heating

	Heat losses in eco-house, GJ per year	Energy produced by solar collector GJ per year
Tomsk	85	108
Novosibirsk	82	116
Barnaul	76	127

The use of solar energy allows essential savings of organic fuels, provided that the eco-house is equipped with seasonal heat-accumulation. The deficit of solar energy from November to February governs the parameters of the heat-accumulator. Existing transformers of solar energy into electricity are expensive and thus stay beyond the budgets of moderate-income families. However, experience of some advanced counties shows that sometimes solar batteries are competitive with the traditional power supply in individual houses (for example, in the areas far from the power transmission lines). Extensive R&D of solar technologies and equipment are aimed, in particular, to decrease the cost of electricity generation.

Actions aimed at thedevelopment of eco-housing in Russia

Introduction

Studies have revealed that there is a tendency among Russia's population to solve their housing problems using private resources. This tendency forms the basis for mass development of ecologically sound and energy-efficient housing construction including reorientation of the existing construction practices.

The programme for the development of environmentally sound housing construction

In line with the guidance of Habitat Agenda, a concept and a programme for the development of energy-efficient and ecologically sound housing construction in Siberia and other regions have been proposed. The programme aims at converting existing practices of individual housing construction to mass construction of eco-houses in Novosibirsk, suburbs and other administrative regions of Siberia. It is expected to gain considerable energy savings and environmental protection as a result of modern technologies and bio-intensive methods to process and utilise domestic wastes. The programme developed for the city of Novosibirsk(16) focuses on moderate-income population groups and envisages the maximum use of local resources in combination with advanced world practices.

The programme consists of 5 stages and is planned for a period of 30 years. The first four stages are devoted to formation of eco-housing construction as a self-developing (self-maintaining) system.

Stage 1.: (organisation, 1990 - 1998) – introduction of the "ecodom" concept into social sense, formation of expert teams for the implementation of the programme and the design and construction of experimental ecodoms;

Stage 2.: (pilot, 1998 - 2003) – creation of pilot ecodoms with autonomous engineering equipment, and pilot eco-settlement. Construction of demonstration ecodoms in Russian cities;

Stage 3.: (technology, 1999 - 2005) – mass production of engineering equipment and accessories for ecodoms;

Stage 4.: (construction, 2005 - 2010) – self-maintaining process of ecodom construction;

Stage 5.: (2010 - 2020) – process monitoring and optimisation.

The Project of the United Nations Centre for Human Settlements (HABITAT) titled: "Development of Energy-efficient and Environmentally Sound Housing construction in Siberia" is the final phase of the first (organisation) stage of this programme. Following results were obtained at the first stage (1990-1998):

- the concept of ecodoms for Siberian conditions was developed;
- small-scale technologies for the production of building materials were adjusted;
- designs of ecodoms engineering equipment and structures were developed;
- ecodom was endorsed at several national and regional exhibitions;
- the basic project of ecodom was developed and approved by the Central Expert Board of the State Construction Committee of Russian Federation;
- the programme for Novosibirsk Suburb district: "Development of eco-housing for the period 1999-2005" was adopted;
- courses devoted to environmentally sound housing construction were introduced into curricula of Vocational School No. 55 and two higher education institutions in Novosibirsk.

The main problems that impede the implementation of the programme concern financial aspects and may be divided into two parts:

1. deficiency in the investment for new developments and for the adaptation of existing foreign technologies;
2. poorly developed financial mechanisms for the promotion of individual eco-house construction.

The first problem concerns not only the absence of financial support for the development of new designs, but deficient investments for the commercialisation of already developed equipment and technologies as well. This problem is typical for current economic situation in the country. To relieve the problem, it is necessary to improve the State and local investment policy. Basically, the problem could be solved through the development of a market for such equipment and technologies and the demand stimulation and formation of co-operative financial sources. At present, private builders invest in individual housing construction. Therefore, to solve the second problem, it is necessary to formulate stimulating policies for the rational use of these private financial sources.

The main participants of the programme

In order to implement the programme, an organisational scheme has been developed, which includes the International Social-Ecological Union, the Joint-Stock Company Ecodom and the Association for Sustainable Development of Human Settlements – Ecodom. Each member has its particular function:

International Social-Ecological Union (ISEU) – has an experience of 10-years working in the field of environmental protection. It includes more than 20 non-governmental organisation. In 1997, a programme "Eco-settlement of 21st century" was adopted. Since that time the ISEU fulfils the following functions:

- education in the field of environmental protection
- wide dissemination of knowledge about environmentally sound housing construction
- training seminars on the organisation of ecodom construction

Joint-Stock Company Ecodom – a member of the ISEU, serves the following functions:

- organisation of designing equipment;
- organisation of introductory courses on environmentally sound housing construction in curricula of educational institutions;
- contacting local administrations and authorities.

Association for Sustainable Development of Human Settlements – Ecodom, an ISEU member, which undertakes the following functions:

- design of ecodoms with special account for local conditions;
- construction of ecodoms;
- organisation of the production of building materials and engineering equipment;
- organization of private builders into partnerships within the legislative framework.

At present, the Association works under the second stage of the programme (construction of demonstration ecodoms). It constructs a demonstration ecodom in the city of Novosibirsk, prepares the construction of an ecodom-laboratory and starts to organising demonstration Ecodom construction in other cities of Russia. The design of demonstration ecodoms will be described in the present report.

Specialists training

To facilitate the development of ecologically sound housing construction, it is critically important to train highly qualified specialists in management and troubleshooting, economic, scientific and technical tasks. For this purpose, several higher educational institutes in Novosibirsk were selected to operate special courses. In close co-operation with professors and lecturers, a list of relevant themes was composed intended for further use in curricula. In compliance with this list, the educational materials "Starting to build an Ecodom", "Engineering systems of Ecodoms", "Garden and kitchen-garden in an Ecodom", "Starting to build Eco-settlement" are being prepared.

Agreements with educational institutions

As a follow up to discussions and interviews with the leadership of specialised educational institutions, special courses were defined and agreements concluded with some leading institutions in Novosibirsk. The courses will be developed on the basis of the information materials prepared in the framework of the current ecodom project. Particular themes, corresponding to the profile of the education institution, will be included in these courses in more detail.

Basic themes of the curriculum of the "Environmentally-sound housing construction"

Curriculum on ecologically sound housing construction includes the following themes:

- UN Conference on Environment and Sustainable Development, Rio - de-Janeiro, 1992 – Agenda 21;
- UN Conference on Human Settlements (Habitat II), Istanbul, 1996 – Habitat Agenda;
- Housing market and its problems;
- Regional dwelling provision programmes;
- The concept of energy-efficient ecologically sound housing construction;
- Modern construction sector - Development tendencies;
- Building materials and structures – New technologies;
- Ecodoms architecture: principles and particular features;
- Eco-settlements and organization of their building;
- Engineering systems of ecodom;
  - heat supply and accumulation
  - energy efficiency
  - water supply
  - processing and utilization of domestic wastes
- Social organization of eco-settlements.

Conclusions

Russia suffers a serious dwelling deficit. An essential part of the population resides in inadequate housing, communal flats or hostels. Many dwellings are inhabited by two or more married couples. The adopted State programme on "Housing" facilitated the following essential results:

- Sharp decrease of State-invested housing construction,
- Intensive development of privately-invested individual low-storey housing,
- Restructuring of construction sector. Apart from large construction companies, more than 140 thousand small-scale construction firms have been set up in Russia,
- Legislative principles have been geared towards energy- and resource-saving technologies and towards intensifying the role of the private sector in housing supply.

There is a tendency to implement programmes and projects aimed at environmental protection and recovery.

Recommendations

In order to provide a firm basis for energy-efficient and environmentally sound individual housing construction in Russia, it appears reasonable to:

1. Develop and adopt a Russian Habitat Agenda with special emphasis on the above mentioned tendencies and formulate regional Agendas. Particular attention should be paid to training personnel to be involved in ecologically sound housing construction in Russia;

2. Formulate a State policy, stimulating the private sector for the development of eco-housing. The main element of this policy should be the reduction of the primary investments for housing construction by private builders and small-scale construction firms;

3. Make efforts, within the framework of the "Own House" programme, to construct demonstration eco-houses in cities and regional centres of Russian Federation using local resources.

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Ecologically oriented construction practices in Ukraine

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Deterioration of the environment

General overview

Contamination of the environment is a crucial factor directly affecting the living conditions of the population. Emergence of sources of contamination is caused by people's activities aimed at producing consumer goods. Consequences of these activities cause modification of characteristics of all natural components, which negatively affected environment and health. Extents of these modifications depend on two basic factors: (a) concentration and composition of pollutants; and (b) natural self-purification capability. The latter conditions resistance of individual natural components to anthropogenic load.

A critical factor of worsening the environmental situation is housing construction and emergence of new populated areas. Effects of this factor become more and more noticeable as the population and new lifestyles emerge. Development and functioning of populated areas influence the eco-system: atmosphere, flora, soil, and partially climate. In doing so, influence of some components inevitably cause modifications of other components. In populated areas, there are changes in gravitation, thermal, electric, magnetic, and other fields of the earth as well as in chemical composition of groundwater.

Urbanization is characterized by creation of an artificial (technogenic) environment at the expense of natural environment. One of the effects on the environment is caused by pressure on soil, underground groundwater, contamination of surface water, etc.

Atmospheric air is most prone to contamination. Hazarduos substances spread in the thus raising existing contamination levels. In 1996, some 6 million tons of harmful compounds were emitted in the atmospheric air in Ukraine, most of which were made by power engineering, coal mining and oil and gas enterprises. There are districts in ukraine which account for over two thirds of all pollution in the country: Donetsk (39.5 per cent), Dnepropetrovsk (17.5 per cent), and Luhansk (11.1 per cent). However, economic crisis and production declines caused a 59.22 per cent decrease in emissions between 1990 and 1996. Today, a more serious problem of air pollution is caused by transport sector which accounts for over one third of all emissions in the atmosphere. In Kiev, L'viv, Poltava and many other cities this portion exceeds 70 per cent.

The principal source of contamination of surface water is wastewater from utilities, metallurgic and chemical industries (in 1996 they discharged 4,109 million m^3 of wastewater including 980 million m^3 of unpurified wastewater). In a number of regions, potable water has been contaminated by bacteriological and sanitary-chemicals. Contamination of soil is another chronic problem, the principal source of which is irrational use of pesticides and mineral fertilizer in the agricultural sector. Radioactive contamination resulting from the accident at Chernobyl Nuclear Power Plant is another source of danger for the population. Around nine per cent of the whole Ukrainian territory is contaminated with radionuclides. It comprises 55 cities, more than 2,100 towns/villages and more than 14 thousand km^2 of recreation resources.

Construction and air pollution

Production of construction materials is one of the major sources of air pollution. Production of cement, asphalt concrete, and glass is contributing to air pollution considerably. Air pollution is caused by:

- Regular emissions through special uptakes equipped or not equipped with air or gas filters;
- Irregular emissions from open storage of raw materials or manufactured products, transfer yards as well as those caused by deterioration of hermetic seal.

Basic pollutants emitted by construction material industry are dust, nitrogen, sulfur and carbon oxides. In terms of air pollution, the most intensive industries are cement, glass, lime, gypsum, and lime brick. Typical pollutants emitted by these industries are shown in tables 1 and 2.

Table 1. Average emission of dust per tone of selected products

Industry	Pollutants	Emission (kg/ton)
Cement	Cement, marl, and lime dust	15
Lime	Lime and limestone dust	199
Glass	Charge and lime dust	3.6
Ceramic products	Clay and fireclay dust	5.3
Gypsum and gypsum products	Gypsum dust	106
Non-ferrous construction materials	Rock dust	1.1 (per m^3 of crushed stone)
Lime brick	Lime and sand dust	14.9 per 1,000 bricks
Sanitary and technical equipment	Charge and sand dust	15
Ceramic brick	Clay and fire-clay dust	5,79 per 1,000 bricks

Another significant source of pollution in Ukraine is industrial and domestic solid wastes, which are 1.45 to 1.95 billion tons every year respectively. Only between 10 and 15 per cent of these wastes are used as secondary resources. The rest is dumped on a land of 160 thousand ha. The housing sector generates 38 to 42 million m^3 of domestic wastes. There are 656 waste yards occupying 2.6 ha. Domestic wastes are burned at four garbage disposal plants in Kiev, Dnepropetrovsk, Kharkiv and Sevastopol. Up to 11.5 per cent of all wastes are burned. Wastes contribute to the contamination of the environment and have a negative effect on all environmental components. Infiltration of dumps, burning of waste piles, generation of dust lead to contamination of ground- and surface water, deterioration of atmospheric air and land, shrinking of agricultural land and worsening people's health.

Energy in housing and in construction

Housing maintenance organizations, utilities, producers of construction materials, and construction enterprises consume some 30 per cent of all energy produced in Ukraine, which is equal to 75 million tons of fuel. About 85 per cent are used in the housing sector, 11.4 per cent is used in manufacturing construction materials, and 3.6 per cent is used in construction. The housing and communal sectors of Ukraine are the third in energy consumption among all other national economies. Housing maintenance enterprises and utilities consume 10 billion kWh of electricity and around 8 billion m^3 of natural gas annually.

Table 2. Average concentration of nitrogen, sulfur, and carbon oxides per m³ of emissions for selected materials

Industry and sources of emission	Concentration of NO_x in emission (g/m^3)	Concentration of SO_x in emission (g/m^3)	Concentration of CO in emission (g/m^3)
Cement			
Fuel for kilns (wet technology)			
Gas	0.15 to 0.20	0.05 to 0.01	–
Fuel oil	0.12 to 0.22	0.8 to 1.2	up to 2.5
Coal	0.1 to 0.15	1.2	2.5 to 10
Fuel for kilns (dry technology)			
Gas	0.04 to 0.06	0.04 to 0.09	2.5 to 5.0
Fuel oil	0.04 to 0.06	0.8	5.0 to 7.5
Lime			
Fuel for rotatory kilns			
Gas	0.2	–	0.25
Fuel oil	0.25	0.5 to 3.6	0.50
Coal	0.22	0.7 to 3.0	0.63
Fuel for shaft kilns			
Gas	0.004	–	0.90
Fuel oil	0.007	0.6 to 4.5	1.90
Coal	0.005	0.9 to 3.8	1.25
Glass			
Facing tile	0.03 to 0.07	0.12 to 0.3	–
Mosaic tile	0.05 to 0.16	0.05 to 0.01	–
Slag denitrified glass	0.08 to 0.16	0.07 to 0.13	0.02
Opal glass	0.006 to 0.03	0.003 to 0.01	0.02
Non-alkaline aluminosilicate glass	0.15 to 0.70	0.015 to 0.02	–
Crystal glass	0.05 to 0.17	0.03 to 0.1	0.02
Colorless glass	0.18 to 0.30	0.25 to 0.45	0.1
Stained glass	0.2 to 0.3	0.0015 to 0.002	0.02
Ceramic products			
Shaft and rotatory kilns	0.06	1.7 to 2.7	0 to 0.063
Kilns for sewerage pipes and acid-proof bricks	0.06	1.2 to 1.5	1.0 to 2.0
Kilns for facing tiles	0.06	1.3	0.3 to 2.5
Gypsum			
Fuel for shaft mills and gypsum pot			
Gas	0.1	–	–
Fuel oil	0.07	1.13	1.2 to 3.5
Coal	0.10	0.45	–
Rotatory furnace			
Fuel oil	0.12	1.20	–
Coal	0.11	0.38	–

The communal heat sector includes more than 7 thousand heating plants, 15 thousand km of hot water pipes and 3 thousand central heating boilers. Over 4,000 heating plants burn natural gas, 2,350 burn coal, and 450 burn liquid fuel. Heating plants, which are included in the Teplokomunenerho system, consume 8 billion m³ of natural gas every year. Almost half of this gas is consumed irrationally because of imperfection of burning technology, losses in heat pipelines and by consumers.

According to current Ukrainian norms, 180 to 200 kg of conditional fuel is burned to produce 1 Gcal heat, whereas in developed countries this norm ranges between 150 and 160 kg. Up to 40 per cent of produced heat is lost due to inadequate heat insulation of buildings, lack of heat measuring meters, centralization of heat supply, low efficiency and deterioration of existing equipment.

Studies show that more than half of the energy saving potential relates to heat insulation of external walls and windows of residential buildings through which 21.6 per cent and 26.6 per cent of heat is lost respectively. The total energy saving potential in housing and communal economy is estimated at 30 million tons of conditional fuel.

Production of construction materials, particularly, cement consume high amounts of energy. Unlike western technologies, Ukrainian industry is characterized by prevailing "wet" production technology which is inefficient. Using "wet" technology Ukrainian enterprises consume 244 kg of conditional fuel to produce a ton of clinker and 132 kWh of electricity to produce a ton of cement. However, the "dry" technology requires only 147 kg of conditional fuel and 159 kWh of electricity per ton of cement. Even with "wet" technology, western plants consume 190 kg of conditional fuel per ton of clinker and 70 kWh of electricity per ton of cement and 100 kg of conditional fuel per ton of clinker and 90 kWh of electricity per ton of cement under the "dry" technology.

It is planned to reduce power consumption in the construction sector by energy savings of 13 per cent up to the year 2000, by 26 per cent by the year 2005, and 45 per cent the year 2010 (as compared to 1990). Being guided by the Ukraine Law on Energy Saving, the Government has decided to develop and implement national energy saving programmes including:

- Long-term branch programme of energy saving (up to the year 2002) which is a component of the Comprehensive National Energy Saving Programme;
- National Programme for installing water and heat meters by residents customers during 1996 through 2002;
- National Programme to support generation and use of alternative and renewable energy sources and small hydro- and thermal-power engineering.

Ukraine pays particular attention to the development of geothermal power engineering because of the huge potential of this energy source. Basic direction of this development is creating geothermal plants to heat cities and heating systems with underground heat accumulators. Implementation of geothermal units of various destinations with the total capacity of 6,000 MW will result in saving some 6.5 million tons of conditional fuel by 2010.

With an energy crisis and the growing cost of energy resources, saving energy has become a critical problem which may be partially solved by installing metering services provided to residential customers. In order to ensure installation of meters, the Cabinet of Ministers of Ukraine has approved the National Programme for this purpose which is a component of the National Energy Saving Policy. The principal goal of this Program is to minimize the consumption of energy resources up to 50 per cent in water and heat consumption. Resources saved due to the installation of meters will be used for renovation of supply systems, technical modernization, and reconstruction of working units. In order to ensure the implementation of the programme, involved agencies have established a normative and technical basis, approved standard design solutions and methodological recommendations on installing meters in existing, reconstructed and new houses.

Ecologically oriented design and construction

Laws of Ukraine on "City Development Fundamentals", "Protection of the Environment", "Land and Water Codes" and other documents are principal guides establishing a basis for city development and ecologically oriented design and construction practices. All these laws are focused on protecting areas of particular ecological value; establishing areas of sanitary protection of land and water; establishing procedures for defining maximum permissible emissions; norms of contamination with chemical, radioactive and other harmful compounds; and preparing and implementing the State Cadaster of Land.

A Presidential Decree has set up priority tasks related to city development with emphasize on protecting the environment from harmful influence of technogenic and hazardous effects. The State Committee on Construction, Architecture, and Housing Policy envisages adjustment of oblast schemes for planning areas contaminated by the accident at the Chernobyl nuclear power plant and transforming towns/villages in contaminated areas where over 2.5million people reside. Today there are four regime zones in radioactively contaminated areas. The principal tools of protecting habitat in these areas are, primarily, prohibiting and restricting recreation and agricultural activities.

Common ways to solve urban development problems under ecologically unfavorable conditions are:

- Selecting optimal layout of residential, commercial, and industrial zones and optimal transportation based on ecological and hygienic principles;
- Establishing sanitary protection zones of water, resort/recreation objects and industrial production;
- Using underground space for garages, parking, transportation networks, warehouses etc.;
- Improving industrial and warehouse zones in order to raise efficiency of urban land use.

Two international competitions were conducted in Ochakov (in 1994) and Feodosiya (in 1997) with the purpose to test new concepts of an ecologically safe city. These competitions created the basis to identify approaches in developing ecologically safe cities based on local conditions.

A rational relationship between construction sector and ecology will be determined by documentation on city development to be prepared at the national, regional and local levels. This documentation will characterize the existing ecological status of specific areas and their ecological capacity and will define the content and priorities of nature protection measures.

The most important legislative acts showing the Government's involvement in environmental problems include: "Protection of Environment", "Protection of Atmospheric Air", "Ecological Examination", "Ensuring Population's Sanitary and Epidemiological Well-being", and "Waste".

There are also a number of normative and legal acts issued by different ministries and agencies regulating rules of protecting natural environment.

Examples of design and construction of ecologically oriented single family housing

Since 1991, the construction of State and cooperative housing has declined while the construction of private housing has expanded considerably. The development of ecological housing construction is based at three levels:

(a) At the pre-design level: Decisions are made on location of residential houses based on ecological and urban development considerations. Master plans allot most favorable areas for private houses. In so doing, designers are to comply with national construction and hygienic norms and are guided by seismic and radioactive contamination maps. Each construction site is subject to sanitary and epidemiological examination. Recently, we started examining individual sites with the purpose to detect geo-pathogenic zones and sources of radon emissions. Design specifications include concrete requirements to urban development solutions, infrastructure, and environmental protection.

There have been manifestations of technogenic factors in Ukraine during the last 15 years, which activated such processes as karst formation, slipping down of soil, and underflooding. In Ukraine, some 800 thousand ha of land, 240 cities and towns, and 138 thousand private houses are underflooded. On the whole, Ukraine has to deal with rather difficult geological and ecological conditions, which must be taken into account when designing and constructing housing.

(b) At the design level: Master plans are developed with due regard to the natural environment and climatic conditions which define construction techniques and types of houses. Although low-storey buildings are land intensive, they do not eliminate the upper fertile layer which is particularly valuable in Ukraine. It is required that design documentation include a special environment protection section describing measures on protecting soil, water, and air from contamination.

Each design is subjected to sanitary and hygienic expertise to ensure its compliance with normative requirements. On the whole, low-storey private housing construction is more ecological when compared with multi-storey buildings, since it ensures better protection of the environment and prevents technogenic loads considerably.

(c) At the construction level: The most important aspects in the ecological context are: technologies, construction materials and engineering equipment. In Ukraine, private housing construction uses basically, traditional wall materials – clay and silica brick, ceramic hollow stone, small blocks made of shell rock, pearlite and cellular concrete, and, to some extent, wood. All construction materials are subjected to sanitary and hygienic examination and certification. The production of these materials is not so energy consuming as the production of reinforced concrete. Therefore they are preferable from the ecological standpoint. Traditional wall materials are widely used in housing construction in rural areas. For example, the National Programme "Own House" envisages a yearly construction of seven thousand private houses and cottages primarily in rural areas using traditional construction materials. After the Chernobyl accident, construction materials have been subjected to radioactive tests as well.

Ukraine was the first among the former USSR Republics to develop and implement normative documents on radioactive testing of construction materials. According to State norms, each Ukrainian manufacturer of construction materials (cement, crushed stone, gypsum, lime, sand etc.) must have a certificate of radioactive quality to be given to all consumers.

While applying traditional technologies, Ukraine is developing modern techniques for private housing construction such as energy-efficient "thermohouse" (Ukrainian-German joint venture in Mykolaiv). "Thermohouse" is based on polystyrene foam casing and monolithic concrete. The system demonstrates good heat-shielding characteristics (25 cm of outer wall made under Thermohouse technology is equivalent to 150 cm thick brick walls). The use of artificial raw materials reduces the use of natural materials such as clay, wood and rock, etc. while good heat-shielding characteristics reduces the consumption of fuel for heating residential houses by 4 to 5 times. This proves the ecological soundness of this technology.

As for engineering equipment, Ukraine, side by side with traditional heating systems is implementing new systems for heating and hot water supply using solar energy and other renewable sources. In addition, there are systems in place, which automatically regulate heat emissions from heating devices installed in residential houses. According to expert estimates, taking all possible energy saving measures in residential and commercial buildings could reduce the yearly emissions of carbon dioxide in the atmosphere by 45 million tons.

Conclusions

The dynamic urbanization has given push to rapid development of cities. The number of cities and their population have recently increased by 13 and 20 per cent, respectively. As a rule, cities are expanding through development of surrounding areas. Four fifth of the country's GDP is produced in cities, which have also become principal consumers of natural raw materials, energy, and water. Multi-storey residential houses consume considerable amounts of energy and water at construction, operation and maintenance phases. Cities generate 4/5 of the total volume of pollutants of the air, soil, and water, thus, being major factors of chemical load on the environment. It should also be borne in mind that the accident at the Chernobyl nuclear power plant, seriously, damaged the Ukrainian ecology. Therefore, improving the ecological situation is crucial in ensuring a well-balanced development of populated areas in Ukraine. In view of these problems, Ukraine has issued relevant legislative and normative acts and has taken necessary measures.

Market reform has given push to the development of private housing construction based primarily on local construction materials, which do not require energy-consuming technologies, and “pure” construction systems. There are examples of using renewable energy resources in the private sector (particularly, in southern regions) which also contributes to improving the ecological situation.

Towards healthy and environmentally sound architecture

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Introduction

There is every compelling reason to focus on and promote healthy and environmentally sound architecture. Since building activities are responsible for approximately one third of ecological disasters, it leaves us no doubt that sooner or later buildings have to be designed and constructed in a sustainable manner. In the Netherlands, for example, there are already three editions of the National Environment Policy Plan, sometimes subtitles like 'To Choose or to Loose' (the environment) and numerous governmental guidelines and regulations nowadays called 'DuBo' (Duurzaam Bouwen, meaning: sustainable building) which advocate healthy and environmentally sound building.

Since 1970s, a non-governmental organisation – the 'Society (Vereniging) Integral Bio-Logical Architecture'(VIBA) – propagates the necessary harmony between people themselves, between people and the environment and, particularly, between people and the built environment. VIBA tries to show, how healthy and environmentally sound architecture, building and planning are important and how they should be developed. A foundation (VIBA EXPO) was also created in order to support VIBA's pioneering and long term ideas, trying to execute them on short term and also practically. It seems that VIBA EXPO is world's largest permanent exhibition on healthy and environmentally conscious materials, components, products and services. In Den Bosch, one can find – besides the office and library of VIBA – 1600 sq. m. of exhibition space. Most of the eco-bio-architects as well as the most conscious producers and contractors in the Netherlands are already members of the VIBA. Most of the so-called DuBo model-projects are designed and or executed by VIBA-members.

However, the development of sustainable building concepts in different regions might be quite different. North and south, east and west have different social economic, cultural and climatic conditions making it impossible to adopt universal approaches concerning building construction and sustainability.

While the International Council for Buildings, Research, Studies and Documentation (CIB), tries to bring together the official statements inspired by Agenda 21 in its Task Groups and Working Commissions, ECOHB, the Global Network of Organizations for Environmentally-Sound and Healthy Building, promotes a much more effective approach towards a sustainable development and survival.

Despite considerable efforts taken so far to build sustainable buildings, none of the results is enough to give a real hope, that those results will effectively help to improve quality of life everywhere. Therefore, we all have to work further in order to create awareness about the problems and to take practical steps towards creating a balance between people, buildings, and the environment. At the same time, we have to realize how important it is to consider the local and regional circumstances, demands, limits and also opportunities.

This paper illustrates some ideas, models, methods and examples on how healthy and environmentally sound architecture should be promoted and how this could contribute towards sustainable development and survival. In conclusion, some "Rules of Thumb" are recommended for future action.

Construction versus health and environment

One of the most environment friendly ways to behave is: not to build, because building activities will, somehow, hurt the environment. On the other hand, we need shelter, among other things, to protect ourselves against the weather circumstances and stay healthy. The opinion, that the environmental disaster can only regenerate without any influence of human beings, opposes our existence and needs to develop and flourish whatever this might be. Being – at the same time – a part of the nature, and being gifted by a high potency of free will and the ability to influence the surroundings significantly, we have to find a balance between the above given extremes. In other words, we should strive for a dynamic equilibrium.

In light of this, it can be observed that the construction activity opposes the environment, while its main function is, to maintain human health. But, looking deeper, the latter seems, to be unfortunately not always the case. Firstly, we impact the environment by our building activities so negatively that the revitalization of the environment becomes almost impossible. One of the consequences of this is the visible influence on our own health. Secondly, we are confronted, more and more, with the phenomenon of the Sick Building Syndrome, not only in office buildings, but also in dwellings and even in hospitals. Despite attempts to build for higher comfort, we often ignore the health aspects of buildings. This Phenomenon is highlighted in many studies, conference proceedings, etc. There is no doubt anymore, that a radical change in the way we build has to take place. We know this already for quite a long time.

Deterioration of the environment

Building activities change the natural environment by over-exploitation, pollution, and by deterioration of the surface of the planet. Studies have shown the manifold effects of winning, transporting, producing, using, maintaining, renovating, recycling and dumping of building materials and components. There are also so many models and methods available, that it is rather difficult to make a proper choice. The basic principles behind all of them have always been the same, which are very simple: The less a material is renewable, the more negative effects (like exploitation, pollution and deterioration) it will have on the environment. The more handling, treatment, adaptation is needed in order to produce a building/component, the higher is the chance for deterioration, pollution and exploitation.

Since socio-cultural environment is part of the whole environment, we observe also a certain influence of architecture on the so-called mental environment. Besides all good purposes, philosophers, historians and psychologists already studied the oppressive power, which comes from the built environment - inhuman buildings. For example, while the lay-out of the capital of an emperor or the gigantic governmental building of a dictatorial regime illustrate those influencing powers in the part, nowadays, it is the enormous diversity of different approaches which brings together the new balanced structures. However, there is the fatal fact, that the prestige of a certain (advanced but expensive) way to build hinders us to apply cost-effective methods in order to build for millions of roofless people.

Use of resources

Non renewable natural resources are limited on the planet. Consequently, we have to search for renewable materials and production processes, which also allow reuse. This postulate leads to the choice of materials, derived from growing biomass, with the condition of sustainable management concerning 'harvesting' those materials. For example, in order to ensure sufficient timber of cedar trees for continuous, 'rhythmic' building of the Ise Shrines, ancient Japan had a 500–years forestry policy. Nowadays, we should pick up such marvelous models, which have already worked practically in the past.

The already dramatically reduced tropical rain forests should be a warning signal for us. Regional and local resources have to be handled carefully and the treatments during production have to respect and include clean, wastefree and non-violent methods. Resources should be used according to the concept of continuous recycling or life cycle, as realized in nature. Above all, it is most important to share the still available and renewable resources with all the peoples of the world. Although several United Nations Conventions have been established to create a more balanced distribution of these resources in the world, we are still far away from a situation in which justice would be the ruling principle.

Before we deal with sharing the resources between states, it is the first duty to cultivate and to make use of the local and regional sources. This is not only beneficial for the identity and the character of a locality or region, but it makes also the transport easier and cheaper. Increased use of traditional and local materials can give new impulses for nearly forgotten technologies and, in many cases, would provide opportunities for employment.

Use of energy

Likewise the use of resources, excessive use of energy can, and did already, lead to exploitation and deterioration of the environment. Main sources of energy, like mineral oil, coal, and natural gas are not endlessly available. Although, estimates about the availability of those energy sources differ and although the prediction about future availability have to be adapted to new and more exact calculations, it is evident that fossil fuel will be exhausted once. We have to, therefore, intensify the production and use of renewable energy sources for construction and for the operation of the existing built environment. We need to explore, much more than ever before, the kinds of renewable energy sources that are applicable in the building industry. We have to be careful not to waste energy and to handle the process of production and application without negative side effects.

Active and passive application of solar power – directly or indirectly – belongs to the first possibilities and opportunities to save energy. Wind, hydraulic, tidal, water wave and earth heat form energy resources for local use on large scale. Hence, besides saving energy and using renewable sources of energy, a fundamental question remains to be answered – how far should we go with the use of energy? There is also the assumption that new inexhaustible energy will serve humankind without any problems. It perhaps, means that nothing will get lost in the cosmos. But we still have to think very carefully about energy economy at global level.

Pollution of earth, water and air

Building activities belong to the main part of human civilization, which are highly resource-intensive. Accurate estimations about the polluting effects of building activities are difficult but it seems that about one third of the whole pollution, stems from building activities. The production of metals, different mineral products, synthetics and paints are highly polluting. Although the waste on the site and in the production process, including hazardous waste, could be reduced in some countries, we are still far from advice of the Club of Rome, which warned us for the first time, a quarter of a century ago. The surface of the earth is covered by all kinds of buildings – in a way also as pollutants – besides the mental pollution.

All these pollution are already quantified in the recent past. We have now, to act towards a pollution and waste-free production of our buildings, as well as for renewal. The whole process from cradle to grave (or even from cradle to cradle) and the whole 'Life Cycle' has to be included into our programmes. Careful use of resources and energy contributes (fortunately) towards reduction of deterioration, pollution and finally health hazards and Sick Building Syndrome. The principle of a non-violent building practice has to be worked out which will help to solve the manifold pollution problems at several levels.

Eco-eco friendly architectural design

The doubling of 'Eco' in the title is not a mistake. It underlines, basically, the root of both Ecology and Economy, at least in the action oriented form of the disciplines. To bring those disciplines with their aims together again seems to be a difficult task. However, as long as we do not strive for good and holistic 'house keeping' or 'house holding', respecting the values of ecology and misusing economy for short term profits, we will not succeed to reach a sustainable development.

In the Dutch National Environmental Policy Plan of 1989, following the main line of the Brundtland Report, it is stated, among other things that: increasing recycling processes, improving energy efficiency, and improving quality (of life), are the basic conditions for sustainable development. How to deal with the fundamental contradiction of an increasing economy and restoration of the damaged environment, and changing consumption patterns of humankind, remains, however, an unanswered question. We predict that it will cost us approximately then times more in future than today to repair the environmental damages and cure health hazards caused by our today's negligence. Moreover, we even expect many costly attempts to help in cases, which later will be recognized as irreversible.

The only remedy for these sad circumstances is to carefully implement the rules and guidelines, manifestos, conventions and agendas in our daily life. An Eco-eco friendly architectural design has to include the health and environmental aspects and approaches. The realization will of course be dependent upon also political will and favourable regulatory environment.

Examples

In the recent times, more and more clients are asking for healthy and/or environmentally sound dwellings and working places. They seem, however, to be still in minority and there are not many experts striving towards buildings with the described qualities albeit many attempts by some NGOs and a growing number of governments.

Looking to conferences and various publications, one could get the impression that some progress is made. Numerous conferences are dedicated to sustainability, building and construction, often also in relation to health. Ten years ago, only the term sustainability was in use, nowadays, however, serious consideration is given to sustainability and its implementation strategies. The current demonstration projects, implemented by various professional and governmental institutions reflect a kind of usual sustainable buildings. The aims include:

- Replacing highly toxic materials or energy-intensive materials with clean materials or materials with less embodied energy;
- More efficient installations and equipment;
- Energy saving by using passive and active solar technologies, whereby the question remains whether active solar power with all necessary equipment is really more environment friendly than the traditional solutions; and
- Waste management during the production process of materials and on the site.

Excursions fulfilling these criteria, exhibitions, demonstration buildings and some competitions, held in order to gain ideas and plans for sustainable buildings brought the whole development clearly further. Surprisingly enough, the results of the competitions went hardly beyond the relatively easy reachable possibilities. And the usual way of sustainable building is still far away from a substantial contribution towards significant reduction in the use of resources and energy.

After a period (starting 1965) of designing and realizing a few (early historical) examples of healthy and environmentally conscious buildings, specifically, those labeled with: Integral Bio-logical Architecture (IBA), the author started to develop certain building principles and systems such as: Gaia-Building-Systems (GBS). It was shown that sustainability does not go (automatically) hand in hand with durability. There are at least two approaches, which basically could help the poor as well as the rich to reach sustainable building. This means that the problems of roof-and homelessness can be solved by rather easy efforts and extremely low-investments for large needs. One approach is to build mainly with easy and continuously renewable materials (much easier renewables than timber) such as: elephant grass, straw, reed, bamboo, Jerusalem artichoke, maize, sunflowers, etc. The other approach is to use highly advanced materials and products, but only in the smallest dimensions and quantities.

Both these approaches can be applied worldwide. A start, even based on some marginal traditions with similar developments, is already made. Building with e.g. strawbales and reed roofing, bamboo and various other agro-products is well known. Fabrics, foils and wires have also been used for building purposes.

The straw panel system (SPS)

The biggest volume of available matter, certainly including the most renewable materials, is the biomass on the surface of the planet, in all continents, grown each year. From the above-mentioned kinds of plants we are able to produce manually or industrially sandwich panels. Those panels are filled with honey-comb-like fillings of straws and straw-like pipes or materials. With some pressure, literally, the material provides us with a natural adhesive or glue, gets locally also higher strength, can become transparent, nearly like glass, reaches a high thermal insulation value (when thick enough), can be shaped in any desired form, but remains light in weight and easy to handle.

The briefly described elements or components can be composed to a building system. SPS can be applied for low, but also for huge and high (multi-storey) buildings in conjunction with a framing. The SPS is finally, fully biodegradable – after, perhaps, some other use in, a kind of, ‘cascade’.

The light metal system (LMS)

Metals belong to the ecologically most costly materials, because of their high embodied energy and the influence its production has on the natural surroundings. Metals actually are suitable to be transformed into the thinnest dimensions in wires and foils, which still can have adequate tensile strength.

Mainly with air, but sometimes also with sand or water filled, pipes, tubes or hoses can be produced, cushion – or mattress – like bags can be made, which all (or some of them) can be combined to a whole building system. Foils can also be applied, like fabrics in tent constructions and tent structures, but in these cases thermal insulation has to be added – at least in the most zones of the earth, either against cold or against heat or even both.

It is evident that, because of the corrosion of iron, non-iron metals or semi-precious metals will fulfil the functions in such a system to a greater advantage. Buildings made from metal foils in the form of tubes and bags with their typical shape are useful for multi-storey buildings. In case of multi-storey buildings, a skeleton is needed.

Non-violent building technology

In order to reach sustainable circumstances in our culture by, or – better to say – in spite of the building activities, we could and should develop an attitude and practical method towards non-violent building technologies. Non-violent behaviour is a demand not only for peace in a more limited meaning, but also for a healthy, environmentally sound, integral biological architecture. It is also a demand for a harmonious, dynamic equilibrium within human society and together with nature within and around us.

Survival of humankind, as we already have read or heard so often, and very plausibly argued, will only be possible in one world. ‘One world or none world’ became a convincing slogan or mission. The mission ‘One world or none world’ covers actually all necessary steps, needed to support the many parts, which we have to walk in different fields towards the strongly desired sustainable development. To operate non-violently is not only a need in politics, military and economy, but also in science, technology and art. Thus, we have to develop, learn and use a non-violent building technology already starting from the very first steps. During the whole processes of designing, planning, producing and building itself.

Non-violence is not only a question in the frame of human relationships, but also in the relation with nature on all scales from the micro-to the macro-cosmos. Although we have spoken already about a shift of paradigm in the last half century, this new shift will be extraordinary important on the path, which humankind will go towards a convenient future - a future free of violence; the violence which created injustice, the gap between poor and rich, the billions sacrificed in wars and the whole ecological disaster or environmental catastrophe.

Building activities with their complex and manifold impact on our culture and civilization have, therefore, their own responsibility for the quality of the whole. The place and meaning of architecture and building technology within the entire culture could become a prominent one. They could be carriers of messages of a healthy and environmentally sound approach and, moreover, as solution for the problems of the built environment.

Conclusion

It can be concluded that healthy and environmentally sound architecture was, is and will be possible. It needs the integration of the relevant factors in order to reach a balanced result and a holistic success. The international community is dedicated towards non-violence. The time is ripe, to join this intention also with the way in which we will build. The future architecture will combine the demands for health and environment, as the basis for our life.

Resources should be used selectively and carefully. Over consumption of non-renewable resources and energy should be avoided and cultivating and using renewable resources should be encouraged. Renewable energy production and application have to gain a high priority.

Pollution of earth, water and air is already forbidden. Now the time has come to clean our environment. Eco-friendly architectural design is not only a question of a certain architectural language or idiom, but is based on an economically correct behaviour. Ecology and Economy have to come (back) to their roots, in order to grow fruitfully into a sustainable future.

The various statements and postulates, hopes and wishes towards a healthy and environmentally sound architecture can, luckily, be illustrated by promising examples from the past and the present, from built objects and by developments of sustainable building systems.

Recommended by rules of thumb

In order to bring the sustainable architecture on a world scale into (best) practice, we have to exercise a non-violent approach and a non-violent technology. The principle of non-violence has not to be limited to building technology, but has to be the guiding mission in all fields. These optimistic conclusions can only be meaningful and successful, when all stakeholders work together. We have to find an international consensus, if we would like to realize a significant healthy and environmentally sound architecture.

In order to come to know how the things have to be done exactly and correctly, we need much more research. In fact, the moment that a precise result is found, it has the chance that it will become immediately invalid because of changes in the circumstances, which led to the result. Changes of sources or resources of production or applications and newly found possibilities of reuse of various components in building can easily change the just-found results. Therefore, it might be much better to follow rules of thumb towards sustainability than wait for changes and results. In this way, we can already avoid making the most strange and worst mistakes. The brief recommendations proposed in form of rules of thumb are the following:

1. **Location, orientation and use:** Choose a healthy site, consider the orientation, optimize the function.
2. **Space and mass:** Shape useful (closed or open) protecting space. Include identity and expression into the building mass.
3. **Canon, modular coordination:** Apply harmonious and ergonomic measures, in numbers, dimensions, weights – modularly coordinated – eventually in a meaningful way.
4. **Indoor climate, installation, furnishing:** Create cosy and comfortable indoor climate with minimal installations and a flexible

equipment and furnishing in order to have suitable atmosphere.

5. **Structure and construction:** Design simple, understandable and durable structures, which do not demand various kinds of means (e.g. elevators) because of their gigantic character.

6. **Energy and material:** use mainly durable, sustainable (available/renewable) easily reusable or recyclable, clean energy and materials.

7. **Production and building process:** Produce in a humanly healthy way with a wise choice concerning handicraft or industry, self-help and in cooperation and participation at all possible levels.

8. **The art of joining:** Join/connect/ compose all building parts or elements in a harmonious way, rather solidly but demountable, efficient.

Finally, collaboration belongs to one of the main methods on the way towards sustainability. In research, education and design, in theory and in practice, we have to cooperate with many different branches and the target groups in planning and in building.

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Environment – friendly housing construction in Belarus

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Introduction

The human settlement policy of the Republic of Belarus is based on Agenda 21, Habitat Agenda and Istanbul Declaration. The priority directions of this policy are to provide adequate housing, develop and introduce ecological and energy-saving technologies in buildings. This paper will outline some information related to these issues.

Correlation of environmental measures in the building sector

The National Concept and Strategy for Sustainable Development and the National Programme of Rational Use of Natural Resources and Environmental Protection for 1996-2000 were adopted in 1996. The main provisions of the National Programme of Rational Use of Natural Resources are based on the principles of renewing resources as well as rational consumption of non-renewable resources with their gradual replacement by renewable ones. It is aimed at developing waste-free technologies and utilizing different wastes of the industrial sector. This is significant in construction, because the sector uses about one-third of the entire national resources.

Over the last fifty years, the building sector has been developing dynamically in Belarus, using prefabricated concrete large-panel systems and applying technologies that used non-renewable resources, such as many strategically important minerals, excessively. At such rates of use, non-renewable natural resources will be depleted in the course of the next one or two generations and the physical environment of Belarus will be damaged irreparably.

Despite the use of resources, the problem of availability of adequate housing and mainly, the social housing, is still valid because of urbanization, economical hardship, and consequences of the Chernobyl disaster. Of 10,124 million citizens of Belarus, about 2 millions are in need of adequate housing. One of the most critical ecological problems of Belarus is the consequence of the Chernobyl disaster, especially the territory of the Gomel and Mogilyov regions. Over 20 per cent of this territory are contaminated by radionuclides and more than two million people have suffered from the catastrophe. The Republic, during the last thirteen years after the disaster, has been solving the problems of housing and resettling Chernobyl refuses, without any external assistance. Considering the nature of the disaster and the socio-economic conditions of resettlers, the country requires new concepts and technologies for ecologically clean housing.

Housing construction for one-fifth of the population could refresh the economy. However, the cost of one square meter of housing without infrastructure amounts to US $250. Studies show that not more than 4-5 per cent of the citizens are able to construct or purchase housing with their own funds. The share of the population, whose income is at, or lower than the minimum consumer budget is approximately 77 per cent.

It is known, however, that the cost of one square meter must not be more than two months average salaries. Therefore, the mean salary must be increased, but not exceed US $60 per month, or the cost of one square meter of housing must be lowered. This could be achieved by using appropriate building technologies using local, non-polluting and low-cost building materials. For a large part of the population this is, however, hardly possible.

The impact of buildings on the environment

In Belarus, the environment is changing for the worse due to technological processes that can result in an ecological crisis. Despite an essential reduction over the last 9 years in using non-renewable resources and energy, the state of the environment continues deteriorating due to transnational flows of atmospheric pollution, industrial and transport emissions, increase of pollution in water sources, etc.

The state of the environment of Belarus is determined by the effects of the building industry, which attributes to about 10 per cent of the national emissions of pollutants. The main consumers of natural non-renewable resources and the main environmental pollutants are industries using kilns. The large damage to the natural environment of Belarus was due to open pit mining of sand, clay, gravel, etc. Not only landscape, but also water balance is broken. The flow of non-renewable raw materials for the building industry undermines the balance of ecosystem, requiring large transportation distances that increase pollution as well.

Another key environmental pollutant is related to housing maintenance in cities. Buildings have central heating systems, water supply, and sewerage which, in 1998, consumed 54 per cent of national heat energy and produced the same amount of gaseous effluents (69 per cent) and sewage. The housing stock in cities consists mainly of prefabricated standard multi-story buildings that are inefficient in the use of energy. Buildings use 2-4 times more energy than in colder western European countries because of poor insulation of building envelopes, and of the absence of controlling devices and heat measuring meters.

The amount of emissions due to heating is about 60 kg/sq. m. floor space annually. The existing technology of urban wastewater treatment does not resolve the problem of utilizing treated wastewater. This is because of not separating industrial and domestic effluents in urban sewage systems. Fifteen per cent of domestic solid waste is subjected to processing, the rest is accumulated on polygons of storage close to settlements. Conventional industrial building technologies and the standard design solutions of the last decades resulted in polluting the environment, have not created a comfortable habitat and do not correspond to the principles of sustainable development.

It is evident that current ecological crisis will force existing technologies of the building industry to change. The building industry will also adapt itself to the concepts, designs and technologies that meet the principles of sustainable development and are in harmony with nature. Today, the first successful steps in this direction have already been taken in Belarus.

The use of non-renewable resources and energy in buildings

Practically, all raw materials that are in use in the building industry, except timber, are non-renewable. The building industry of the former USSR was highly dependent on energy. The energy costs for building 1 sq.m. large panel, multi-story housing is not less than 300 kg of standard fuel (sf) and 200 kW/h of electricity. In using the buildings, energy costs for heating are 120-280 kWh/ sq.m. annually, though the modern standards of northern European countries stipulate values of 50-70 kWh/sq.m. and less. Such a situation could be explained, not only by energy-wasteful technologies, poor insulation of buildings, worn out equipment, but also by a normative/legal base, which has began to change recently.

Over the last 9 years, the building materials industry has faced serious problems in Belarus because of economic changes and limited availability of raw materials. Mining of non-renewable raw materials has decreased 4.7 times for cement production, 1.5 times for walling materials, 2.2 times for modular concrete elements as compared to 1990 levels. During Soviet era, there has been an increase in the use of non-renewable resources in buildings. Individual homebuilders, however, used mainly technologies that relied on local, renewable, non-polluting and energy-efficient building materials.

This was, however, not a matter of concern as the reserves of non-renewable materials seemed inexhaustible and the losses in multi-kilometer heat transporting systems and the absence of heat meters in the flats were considered economically justified. It appeared that after several decades of intensive mining, reserves of oil and gas were over-exploited and the energy supply related issues, became the main economical problems. To solve the problem, the State spends up to 90 per cent of foreign currency reserves.

In the industries that have kiln processes, the country burns annually up to 2 million tons of imported fuel. The solution of current housing problems relies on using energy-efficient technologies, materials, as well new concepts. In many countries of the Baltic region, this trend has already started and the first results have been successful. In order to solve energy problems, a programme on Energy Saving in Construction for a Period of up to 2005 has been designed in Belarus. Experiments have also shown that it is possible to lower specific energy intensity of buildings. Belarus possesses large reserves of a biomass and agricultural waste that can be used in housing construction.

Ecological architectural design

In order to promote ecological concepts in architecture, close co-operation between the Ministry of Architecture and Construction, the State Committee on Energy Saving, architectural institutes, and no-governmental organization have been established. The principal focus of these efforts is to:

- Develop a concept and an architectural spatial urban planning and rural housing to meet the principles of sustainable development.
- Develop an energy/resource saving housing delivery mechanism using local renewable materials, including houses with low/zero energy consumption.
- Develop decentralized water supply systems and alternative strategies for managing water.

These efforts are reflected, for example, in designing an experimental residential building - Vulka 3 (1997-1990) - in the Brest city, multi-story buildings in Minsk (1999), projects of semi-detached eco-housed with zero energy consumption from straw bales, etc. The Division of the International Academy of Ecology in Belarus has designed an example of a passive solar house. The house has a sloped roof with southern orientation. The roof is a continuous water-air solar collector. A diurnal and seasonal ground heat accumulator is places under the house. The house is equipped with a forced ventilation system providing warm and cool air in the rooms through heat accumulated in the ground under the house during the summer. The house should be equipped with a local biologic wastewater purification system.

An important feature of this project is the use of natural renewable materials (wood and straw) that makes it ecological and low-cost. The energy intensity of such a house is 160 tines lower than that of conventional masonry house. The labour intensity is also 4-5 times lower and the thermal resistance of walls is not less than 10 which is 4 times more than the standard walls.

Practical examples of ecologically oriented buildings

Application of clean technologies

Technologies which are based on the principles of sustainable development and Agenda 21 are being developed and adapted to local conditions. This is done in close cooperation of all parties (The Ministry of Architecture and Construction, NGOs, such as the Belarusian Division of the International Academy of Ecology, etc.). In 1998, an experimental programme of ecological one-family housing was elaborated, according to which, every region should construct 2 experimental houses.

Between 1993 and 1999, the Belarusian Division of the International Academy of Ecology, with the help and partial participation of the State Committee on Energy Saving, the Ministry of Architecture and Construction, and foreign ecological foundations have successfully implemented a number of projects (the first in NIS region). These projects demonstrate that Belarus has potential for constructing labour-efficient, ecological and energy efficient small houses for solving housing problems. These projects were evaluated by several western experts at the European Conference of the Ministers of Environment (Orhus, Denmark, 1998) as examples of best practices in the central and eastern Europe. They also demonstrate the possibility of introducing programmes for cleaner production of buildings in Belarus.

The following projects have been reported in the domestic and foreign press:

- Ecovillage of Druzhnaya for the settlers of the Chernobyl zone. Since 1993, eighteen two-storey ecohouses made of straw-clay filling material have been constructed. Solar collectors and a biological wastewater purification system were installed. Annually, 2-3 houses are finished using wood chips-clay, etc. for walls.
- The first building using straw bales which was constructed during a seminar on transfer and adaptation of the American straw-bale technology in Belarus (Belarusian Division of the International Academy of Ecology - Solar Energy International, USA, with the support of the ISAR foundation, 1996).
- A standard project and building of the first three energy-saving ecohouses from straw bales was developed in 1997. They were of rural type in the Gomel region. The sale price for 1 sq. m. was less than US $120. Energy costs were reduced 90 per cent. The thermal conductivity of walls was about 10. The cost of heating was reduced 3-4 times. Construction of similar houses supplemented by seasonal solar collectors is going on in other regions of Belarus.
- Development of a design for building an experimental passive solar house using straw bales with alternative energy and a system of solar energy accumulation in 1998.
- Development of the project “Vulka-3” in Brest, repressing an experimental attempt to solve the complex problems of energy and resource-saving for settlements with different building heights.

The private sector shows great interest in ecological technologies and the use of local materials to reduce the cost of production. For example, Eco-project (a joint Belarus-German firm) has started the production of straw-clay bricks for building ecological houses. These are popular in Belarus and are exported to Germany. Conventional buildings made of timber - have also been further developed. These houses constitute considerable segment of the market of low-rise houses in Belarus. There are, however, problems complicating the spread of low-cost and ecological technologies. These problems include:

- Attitude of the population. People are used to heavy and resource/energy intensive designs using brick and concrete.
- Absence of interest among large building enterprises to construct low-cost buildings (the less the cost - the less the profit).
- A low level of normative or legal base to stimulate the use of ecological technologies and the lack of experience among professionals who are used to typical large-panel housing systems.

Insufficient attention is given to introducing the alternative and decentralized energy-saving systems of life support. The solution of current problems will lead to increasing the volume and improving the quality of new ecological housing in Belarus. All stakeholders have to realize the importance of application of ecological technologies in building social housing. By so doing, it is obvious that a sustainable development could be achieved in the country in a more speedy manner.

Greening the housing sector in Poland: Looking for a new deal

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Sustainable building development in Poland

The term "ecological" has become very popular in the Polish building industry in recent years. Unfortunately, this has only become the most recent advertisement trick to enhance the sale of products and has not caused a real change in environmental thinking and acting within the building industry. This raises the question: what actions have to be taken to establish environmentally friendly construction practices in Poland which are applied regularly rather than as a short lived fashion or false label?

Generally, there are two main areas in which change could occur:

- The ecological awareness has to be increased in the society.
- Sustainable development policies at the national and local levels need to be formulated and implemented.

A substantial change in these two areas would allow the building sector to assume a major role in implementing sustainable practices in the future. In Poland, many studies have been conducted on the issues of sustainable development. However, no effective implementation strategy has followed so far. Only a small part of the political elite associates sustainable development with "Polish" eco-development. In the opinion of the author, most policy makers do not fully recognise the meaning of sustainable development. With such a precondition, it is difficult to demand the formulation and execution of sustainable development policies.

According to a survey conducted by OBOP (1) (Public Opinion Research Centre) in October 1997, people think that the main problems in Poland are: unemployment (63 per cent of responses) and housing (21 per cent of responses). The necessity to eliminating unemployment and the housing deficit in a sustainable way does not seem to be part of the awareness.

State of housing in Poland

In 1995, there were 11,277 million flats in Poland (0.2 million of them were not inhabited due to renovation, tenants changes, etc.). Therefore, 11,056 million flats were occupied by about 12,5 million families. The housing deficit is calculated by subtracting the number of households from the number of flats in a given year. Currently, the potential deficit is estimated to be 2,142 million flats (2). However, the actual housing deficit is much higher. According to a quite pessimistic forecast published by the Housing Economy Institute, the housing deficit in Poland will increase in the future and in order to satisfy housing needs by the end of 2010 an estimated 3.78 million flats need to be built.

This forecast took the internal migration index in Poland, calculated by GUS (Chief Central Statistical Office), into account. The internal migration (from the countryside to towns), caused by better jobs and the availability of higher education in cities, will be about 1,8 million people between 2000 and 2020. A barrier for people to move is the lack of available flats and a "shallow" market of premises exchanges. As the availability of new family apartments decreases, flat transactions will become increasingly important.

The number of newly built flats has steady decreased since 1989. In 1997, the rate of new flats was lower than the number of flats lost. Currently, there are 286 flats for 1000 inhabitants. In this respect, Poland is about 30 – 40 years behind most western European countries. In 1990s, 405 – 470 flats per thousand inhabitants were available for western European citizens.

However, the average flat size increased during this period. The main reason for the increase was the fast growth of individual houses. Newly built flats are also bigger and when apartments are renovated small flats are combined. The average size of co-operative flats in 1996 was 64 m^2 and will be 70 m^2 by the year 2010 (GUS forecast).

In 1995, the average available floor area per person was 18,5 m^2 which is still lower than the European index of 20 m^2. About 70 per cent of Poles live below this European index, whereas each western European inhabitant has 30 m^2. living space available and the average American citizen occupies about 65 m^2.

One quarter of the housing stock consists of substandard flats of which 58 per cent have insufficient sanitary installation, 23 per cent are in bad technical conditions, and 18 per cent are over populated (3). The 3 million substandard flats need to be renovated and 1,3 million should be demolished because of extreme decay. Most apartments are owned by the municipalities and are dilapidated. Throughout Poland, a total of only 250 thousand communal flats have been modernised. An additional problem is the poor conditions of the prefabricated block buildings. The wear of the prefabricated panels at the joining points may cause a danger to the extend that sudden evacuation of large numbers of people from these buildings might be required.

The housing sector has a great impact on the national economy. The size of its contribution to the national economy depends on the construction of new houses, the type of the houses as well as the kind of modernisation works. These factors will determine the speed and the range of quantitative and qualitative changes in the building industry in Poland. Due to the high demand for adequate housing, the building industry could contribute substantially to the Polish economy in the future. Since the building industry is very well equipped, it will be able to grow without having to increase its capital expenditure drastically. This expected growth will also substantially contribute to the reduction of unemployment. About 60 – 70 per cent of the building costs are for building materials and their transportation. To reduce the amount of materials used, an effective materials management will be important to reduce the cost of buildings. The environmental impact of the production processes of building materials, transportation and generated waste are also substantial and will need to be addressed properly.

Environmental problems related to housing stock in Poland

The majority of dwellings in Poland need urgent renovation if not demolition. All this renovation and the construction of new buildings will have a considerable impact on the environment. The production of new building materials and their transportation will consume energy and natural resources. In addition, large amounts of heterogeneous construction waste will be generated due to demolition, renovation and new building projects. This waste is transported to waste dumps, which is usually illegal. Not only will this process diminish Poland's natural environment, it will also threaten the well being of the future generations.

In the past, houses were built according to different technical and sanitary standards. Existing buildings often do not fulfil current insulation requirements. It is quite common to find coal-burning stoves in old houses. In larger cities, many houses and flats are linked to the large-scale, coal-burning district heating systems, though many of these systems are of rather poor quality. The lack of insulation and adequate control possibilities in the dwellings result in high-energy wastage for heating. Currently 65 per cent of Poland's energy source is coal which produces 60 per cent of all electricity and 80 per cent of heat for district heating. Gas, mostly imported from Russia, has become more widely available and is growing in importance. The energy prices are continually growing while subsidies are gradually withdrawn.

Water consumption in Poland is twice as high as in western European countries. The poor condition of the mains causes considerable water losses. In addition, most flats are not metered individually and people have no incentives to save water since they don't have to pay individually for it. Paradoxically, renovation and modernisation has increased thermal comfort in old buildings however, resulted in the increase of energy and water consumption. This is an additional environmental impact, which should be addressed before starting renovations.

The advent of market economy in Poland brought a wide range of new building materials than before. Lack of experience of many building companies in applying new technologies results in lower quality of buildings and increases the maintenance costs. The market is far from being stable yet. This creates chances for promoting ecologically sound products that are least harmful to the environment. New buildings constructed in suburban areas contribute to uncontrolled expansion of cities at the cost of agricultural land or other green areas. An extension of the infrastructure lines, as well as transport, influence negatively the natural environment.

There is a real danger that, while attempting to reach a higher level of development, the same kind of mistakes that were once made in western countries may be repeated in Poland. An appropriate understanding of environmental problems is of paramount importance for central and local governments. Without clearly defined policies and views on the relationship between development and the environment, mistakes on a large scale are possible. To avoid these, the introduction of sustainable building is recommended, not only as a policy but also in practice. As part of the inner-city renovation programme in Szczecin a Demonstration Project in Sustainable Renovation has been implemented which is, briefly, described below.

A demonstration Project on sustainable renovation in Turzyn area, Szczecin, Poland

The Project was set up to serve two main purposes (5):

1. On a local scale, it ought to provide sufficient verifiable data facilitating formulation of a local environmental policy, applicable within the framework of the long-term programme of renovation of the inner-city area.
2. Thanks to adequate provisions for the transfer of knowledge in the Project, it should allow dissemination of the practical results to other local authorities nation-wide.

The Project has been executed in close co-operation with the Municipality of Szczecin and the Dutch Ministry of Housing, Spatial Planning and Environment, the Neitherlands.

Location of the project and the start of Szczecin renovation programme

Szczecin, with a population of 427.000, is located 130 kilometres west of Berlin, near the Polish-German border. Harbour and shipyard industry forms a sound base for the vital economy of the city. Szczecin, is surrounded by a vast forest and numerous lakes. The closeness of seaside adds magnificence to the possibilities of tourism in the area. In 1993, Szczecin celebrated the 750-year anniversary of the City Rights' Charter. In its rich history, one can find Polish, Danish, Swedish, German, French and Jewish traces.

After the World War II, Szczecin became part of Poland. Unfortunately, the old city centre was heavily bombed during World War II. After the war, the Polish authorities declared it a conservation area and took efforts in reconstructing important buildings, although changes that took place after the war in the oldest historic core of the city raise certain doubts. Majority of historic buildings constructed at the turn of the century have remained though intact. But the authorities failed in making necessary repairs. It was only in 1970s that the area was declared also a conservation area. Several buildings underwent major repairs financed from the city's budget. Comprehensive renovation started only recently. The protection of cultural heritage constitutes a salient and integral part of the new Master Plan for Szczecin adopted by the City council in May of 1994 (6).

The principal part of the inner-city area in Szczecin is formed by a well-planned compact housing development of high architectural quality, built in historic eclectic style in the last quarter of the l9th century. Attractive street layout, undoubtedly influenced by the Paris example, provides good access to all parts of the downtown area. The inner-city area of 56 street blocks is at the same time the most important concentration of retailing and services in the whole region, being also a principal housing ward for about 60 thousand inhabitants.

Since the buildings in this area have not been properly maintained for the last 50 years, they now require comprehensive and extensive renovation. At the end of 1991, the City established a municipal renovation team, which was given the task of preparing, in close co-operation with several Departments of the Municipality and active consultation with external institutions, a document called „Renovation Strategy for Szczecin Inner City Area". The document was widely discussed in 1992 and was formally approved by the City council in May 1993. In November 1993, the Polish Citie`s Association awarded Szczecin Renovation Strategy the first prize in a competition titled: „Innovations in Cities".

The strategy gives priority to comprehensive renovation of whole blocks of the inner-city area, instead of previous practice of haphazard repairs of individual buildings. The strategy distinguishes two financial models of renovation. The first one is a „commercial model", in which private investors renovate buildings, in which the retail function may provide for high revenues. The other is a „public budget" model, where the City finances renovation of buildings in commercially less attractive parts of the inner city area. This model should include State financing as well, but unfortunately the Polish Government has not decided yet about clear rules regulating its participation in financing renovation. In February 1994, a programme of renovation commenced in block No 27, one of the blocks in the so-called "Turzyn" area in the western part of Szczecin.

The implementation of the „public budget model" could have started quickly, as a result of the thorough preparation of renovation of a block of 400 flats in Turzyn area in Szczecin. At present, building works are in progress. In September 1994, the first tenants returned to the renovated flats. The project is a social and technical test-field for Szczecin renovation programme. The City's intention to adopt ecologically sound renovation measures was well received by the Dutch Government who decided, in 1993, to support financially „Ecological Renovation Demonstration Project". The grant encompassed research and financing additional investment necessary for implementing the ideas of sustainable renovation in 1995 and 1996.

Goals of renovation

Renovation was supposed to achieve the following goals:

- improvement of housing conditions in the inner-city area by lowering housing density and eliminating sub-standard housing;
- preservation of historic architectural and planning values of inner city, accompanied by functional improvements;
- comprehensive improvement of the technical state of buildings and increased provision of parking and recreation facilities;
- introduction of modern technologies and products taking into account environmental issues;
- integration of renovation with privatisation policy;
- provision of adequate relocation housing for the present inhabitants, where necessary.

Technical scope of renovation

In its technical aspect renovation involved:

- improvement of the standard of the flats: combining very small flats, increasing sunlight access, providing a bathroom, a kitchen and a balcony or loggia for each flat;
- improvement of the technical conditions of buildings, with a limited amount of structural alterations and demolition;
- installing modern bathroom and kitchen utilities and heating systems meeting ecological criteria;
- improvement of planning standard: eliminating undesired functions, separating public and private

spaces, increasing provision of green areas, playgrounds and parking places, preservation of the historic character of this part of the city.

Out of the total of approximately 400 flats in Turzyn, block No. 27 and 127 are part of the Demonstration Project in Sustainable Renovation.

Traditional approach to repair and renovation in Poland

Traditionally, awareness of the environmental effects of repair and renovation had little or no impact on the technical design and on-site execution. In the context of the inner-city area in Szczecin, there was considerable understanding and acceptance of the need to preserve and conserve the cultural values of buildings. This, however, was not usually seen as being linked to environmental problems. In the past, the specific conditions of a centrally planned economy fostered the superiority of socio-political factors over economic considerations. Notions of re-use and repair of technically sound original elements of buildings were not, generally, welcomed by structural engineers and economists. Thus, in the context of major repair of a building, the total replacement of, otherwise still sound timber floors and windows, was rather normal practice 2 to 3 decades ago.

The Turzyn renovation programme established a new practice of public participation. Information exchange meetings, bulletins, consultations with inhabitants, setting up information centres form an integral part of the renovation process in Szczecin. Today, it is important to mention that the confidence of inhabitants in city's intentions is growing daily, despite various changes in legislation resulting in much higher rents and higher contributions from owner- occupiers towards costs of renovation.

The objective of this Demonstration Project on Sustainable Renovation was to identify those technical solutions in building renovation which would considerably lower its environmental impact in comparison to both the situation before and after renovation. This broad objective was elaborated in detail in a feasibility study by the experts from the Technical University of Szczecin. Saving energy and water and the use of environment-friendly building materials and products were the main points of concern. Additionally, the questions of indoor climate, greenery in open spaces, waste collection and management were considered. The financial programme of the Project was based on the realities of ongoing standard renovation in the Turzyn area. Concepts worked out during studies and analyses, were to be subsequently translated into concrete technical solutions divided into three levels.

Level A - solutions applicable on the widest scale (100 flats)

From the start of the Renovation Programme and, even before issues such as saving energy and the quality of indoor climate were given adequate attention. For this reason, the standard of renovation in the Turzyn area was already relatively high. Hence, the differences between the standard Turzyn solutions and those specified later within level A of the Project were not very significant, and involved only little extra expenditure. This should, in the future, facilitate incorporating level A solutions into the technical standard of renovation, implemented without any special financial assistance.

Level B - solutions of limited applicability (23 flats)

The solutions adopted within this level of renovation, generally, required substantial additional expenditure, although the results achieved are also noticeable. For some time to come, this level of renovation would probably not be considered as the new standard. It is, however, quite realistic to expect some elements of the solutions specified within level B gradually entering into wider practice, and forming the new technical standard of renovation within the next decade.

Level C - experimental solutions (4 flats)

In order to produce data that will allow the present standard to be placed in an even wider perspective, a limited number of experimental solutions was implemented – limited, first of all, for financial reasons. These solutions will be subject to close scientific scrutiny in terms of performance.

The budget for additional capital expenditure within the Demonstration Project amounts to NLG 240.000: 1000 NLG per flat on level A, 5000 NLG per flat on level B and 10.000 NLG per flat on level C. Principal costs of renovation were born by Szczecin municipality. The project was planned for three and a half years, and divided into three phases. In reality it took longer time.

Phase 1 (years 1994-1995) involved studies and analyses leading to the formulation of concepts of saving water and energy, as well as using environment friendly building materials and products. These were applied in the context of the ongoing renovation of buildings within the block No 27 in the Turzyn area in Szczecin. In principle, this phase produced the Phase 1 Report, giving an account of the results of studies and analyses, containing also assumptions about the effects of recommended alternatives.

Phase 2 (years 1996-1997) involved practical execution of identified technical solutions during the renovation of buildings. The output of this phase will be the practical implementation in 127 renovated flats using the technical and material solutions recommended in the Phase 1.

Phase 3 (years 1997-1998) involved monitoring and evaluation of the results and the impact of the technical solutions applied within the Demonstration Project. The assessment took into account not only technical and scientific performance, but also the attitudes and reactions of the inhabitants. Conclusions from research and practical experience should be collected and edited in form of a practical guide, to assist organisers and executors of similar renovation projects in Szczecin and in other Polish municipalities. In each phase of the Project, relevant information had to be disseminated, through workshops, articles, brochures and lectures. In this way the experience gained will be shared with different target groups in Poland and abroad.

The Project partners are:

- Working groups of experts from the Technical University of Szczecin (Szczecin Polytechnic);
- Design office Studio A4 in Szczecin;
- Municipal Renovation Team of the Municipality of Szczecin;
- W/E consultants sustainable building (formerly Woon/Energie foundation) in Gouda (from Dutch side);
- The Dutch Ministry for Spatial Planning, Housing and the Environment (VROM), The Netherlands.

Water

Adequate supplies of water have become more and more difficult to maintain. Central parts of Poland have experienced a considerable drop in the level of ground water over the last few decades. Surface water is, generally, still polluted and requires costly purification and treatment to make it potable. Before renovation, buildings usually have a very low standard of sanitary installation. It is still not uncommon for flats to share toilets accessible from the landings of common staircases. Radical improvement of the standard of flats by renovation, normally, brings about a considerable increase in water consumption. By using specific technical solutions, it is possible to provide better standards without directly increasing overall water consumption. Solutions aiming at reducing the domestic consumption of water in flats after renovation, were considered in four groups:

Group I - losses due to the excessive pressure of water in sections of the installation.

Group II - kitchen and bathroom utilities.

Group III - possibility of using rainwater for toilet flushing.

Group IV- possibility of using recycled grey- or wastewater for toilet flushing.

Results of the feasibility study

In all 127 dwellings included in the Project, special dynamic diaphragms or adjustable pressure regulators should be installed between water meters and kitchen and bathroom utilities. Water saving toilet flushers and taps with water saving perlators should be specified, especially in kitchen sinks and bathtubs. In level B and C flats controlled volume toilet flushers (single flush 3 litres, average use 6 litres), should be installed. Additionally, detailed methods of calculations allowing for the selection of the optimal diameters of pipes could be employed. Facilities allowing for full water-metering, i.e. a main-meter on the connection to the building and meters for cold and hot water in each flat are already routine.

Concerning the possibility of using rain- or recycled water for toilet flushing it was concluded that the current low price of drinking water makes these solutions unfeasible. It would make sense to use non-drinking water for toilet-flushing in a limited number of flats, and the use of rainwater cleaned in a root-zone filter might have been, financially and ecologically, a very attractive solution. However, in the context of particular buildings at 26 Pocztowa Street (level B) and 26/27 Pocztowa Street (levels B and C), it was eventually decided that this was not feasible. The reason for this was the lack of room for a root-zone filter, plus the fact that, according to Polish health and sanitary regulations, such an installation would require a considerable protective zone, comparable to one required for a sewage treatment installation.

Energy

According to the three-step strategy of sustainable building, reducing energy consumption may be achieved by:

- limiting the use of energy for space heating (better insulation and limiting transmission losses);
- increasing the share of renewable energy sources (e.g. solar energy);
- using non-renewable sources of energy as efficiently as possible (e.g. installing highly efficient condensation boilers).

In the context of the Demonstration Project in Turzyn, the strategy implied the steps described in the following paragraphs:

Limiting the heat losses

Firstly, thermal insulation of buildings had to be improved. Secondly, windows, and in particular glazing needed special attention. The existing timber windows were repaired and reused. In level A buildings, the inner pane of glazing was made of low-e glass (thermofloat). This, however, made it possible to achieve the K value of 2.4 W/sq.m K. Where the existing windows were replaced, the pattern of double-frame windows was repeated or the new type windows with double thermal glazing were used.

In level B building, even better thermal performance of windows was assumed. It could have been achieved, either by retaining the original timber frames, putting in special glazing (thermal glazing for the outer frame, and low-e pane for the inner frame), or by specifying new construction and triple glazed timber windows (standard double thermal glazing on the outer side and a single low-e pane on the inner side). For level C building (courtyard building), all windows should be of the new type, made of timber, either thermal-glazed with low-e panes and filled with argon, or triple glazed (double thermal glazing filled with argon on the outer side, a low-e pane on the inner side).

Use of passive solar energy

Near the south-east corner of the courtyard building at 26/27 Pocztowa Street, a vertical set of glazed balconies adjacent to living-rooms was designed for level C flats on the first, second and third floor. The balconies had to be patent-glazed on three sides, using thermal glazing in steel frames, with the sections on the front side sliding to open. The surface of the solid 25-38cm brickwork masonry wall forming a backdrop of the balconies should be painted dark. The glazed balconies should act as chambers where the air will warm up before being sucked into the flats. Due to lack of financing, the idea of passive solar energy use was not realised according to the feasibility study.

Efficient heating installation

In the case of block No 27 a district heating network fed from a co-generating plant is the principal source of heat for space heating and domestic hot water supply. This source will be used for level A buildings. For level B and C buildings, the source of energy is natural gas. A group gas boiler for 27 flats in buildings at 26 and 26/27 Pocztowa Street was installed. For level C flats, solar-collectors are used as an additional heat source for domestic hot water. As all buildings within block No 27 received new central heating installations, individual metering were provided, allowing for a system of individual metering and billing of each flat. Heat meters in flats, were planned to be connected to a data collection and transmission system, allowing for central reading and data storage. Likewise, the consumption of cold and hot water in flats could be metered, and data transmitted electronically to the central reading device of a computer system. This could be important both during Phase 3 of the Demonstration Project and in the subsequent routine administration of the renovated buildings. For this purpose, a custom-made system was needed. Lack of finances did not allow metering to be realised in the mentioned way.

Ventilation

In order to avoid problems of condensation due to the better insulation of buildings, special attention had to be given to ventilation. Therefore, mechanical ventilation was used in all renovated buildings. The same system was applied in the flats renovated within the Demonstration Project. The system involves using electrical extract fans with triple speed control in each flat, with intake of the air either through purpose - made, controllable ventilation slots in windows, or simply by uncontrolled air leakage into flats through windows.

Building materials

The usual three-step strategy of sustainable building regarding building materials is to:

1. Limit the use of materials (proper architectural design);
2. Use renewable or recycled materials (repair as much as possible);
3. Use materials that have the least environmental impact.

In the Demonstration Project, the second step - repairing instead of replacing - was especially relevant for windows, doors and timber floors. Further steps involved the limited use of non-renewable raw materials, the use of as many recycled and renewable materials as possible and the use of materials that involve the least environmental impact.

In the Demonstration Project, a point of reference was needed, which in this case is a particular building in block No 27. In order to facilitate and co-ordinate the selection of building materials, some 110 functional units - building elements (or processes) were identified, according to the classification method designed by Prof. Zenczykowski and widely used in Poland. The Environmental Preference Method (7), developed in the Netherlands, was used to assist actual selection. Using this method, materials and products currently on the market were compared and ranked according to their environmental impact. The result was not an absolute assessment but a relative ranking of environmental preference. Materials clearly adverse to the environment were grouped under a heading: „other“. Each functional unit was assigned some alternative building materials, together with justification of the choice. Besides the environmental preference certain non-environmental criteria were also applied in order to make the building materials alternatives more realistic and suitable for the Demonstration Project. Cost, technical quality, acceptance and the availability on the market were considered.

Waste

Separation of waste in households requires more space for common waste collection points in the neighbourhood, allowing for separate collection of various kinds of solid waste. Such spaces may be created in outdoor areas or in common basements. Separation of waste requires also some facilities in each flat. A storage place under the kitchen sink in the form of special boxes and other provisions, are possible, e.g. in the hall of a flat. In the case of a loggia or a balcony a small compost box can be placed there. In order to invite the inhabitants to compost their “green” waste, it is necessary to ensure a system of organic waste collection or to organise composting in courtyard gardens. Rethman, a private waste disposal operator, contracted by the City of Szczecin, has declared its readiness to recycle waste, but there is no system of separate waste collection in Szczecin in operation as yet.

Greenery

Before, there was almost no greenery in the courtyards of the blocks. There was not too much space for this, the sunlight access was limited, and there was no regular maintenance. The planned demolition of some courtyard buildings improved conditions for the greenery, providing more space and better lighting. Outdoor areas could have private, semiprivate and public spaces for residents, with provisions circulation. To large hard-surface areas should be avoided, so as to allow rainwater to percolate the soil. The absorbent areas contribute to a more pleasant microclimate in the summer, being cooler than the surrounding heated-up walls, roofs, side walks and street surfaces. Besides the greenery in the courtyards, it was recommended that creepers be planted on the rear facades of the buildings and where possible, to arrange green roofs on the lower buildings inside the courtyards.

Special requirements for the execution of the work

Solar panels require special mountings, and the roof structure needs checking for its ability to support additional loads. Windows in level B and C required a well-detailed solution of fixing the third pane of glazing to the existing frame of a renovated window. Careful detailing of glazed balconies in three level C flats was also required. The suggested "green roofs" on selected low courtyard buildings required a well-detailed specification of plants, thickness and composition of soil and the maintenance instructions.

Monitoring

A room in one of the buildings was allocated, in which a computer and other monitoring devices were planned to be operated (Phase 3). The monitoring phase would involve a certain amount of inconvenience for the inhabitants. Special attention should be given to providing them with accurate information, and their co-operation is crucial for good monitoring.

Instructions for the occupants

Besides a general education of occupants on ecological issues, special instructions on how to handle, for example, the mechanical ventilation or the waxed timber floors, are the key to achieving the goal of the Demonstration Project for the future: savings in energy in a sound indoor climate and environment-friendly maintenance. However, the Turzyn programme is a heavy burden on the city's budget, requiring an equivalent of 3 million guilder investment yearly. To commence renovating next blocks the City expects financial support from the State.

The already running and planned renovation undertakings will significantly change the inner city's appearance within coming years. But the majority of the 56 inner city blocks will not be affected by these radical measures in the nearest future. That is why in March 1994, a third important part of the renovation strategy started to operate: a programme of small-improvement-grants for those tenants who are themselves improving the standard of their flats. This may involve for example creating of a bathroom in a flat which hasn't got one or replacement of coal stoves with a cleaner heating system etc. This small-improvements programme proved to be very successful, with nearly four hundred grants approved and disbursed in the first nine months of its operation. In 1995, the City allocated an equivalent of nearly 600.000 guilders for the small-improvement-grants programme.

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Passive solar housing architecture

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The goal: Maximum living quality coupled with minimum environmental impact

Achieving the best living quality, while utilizing 50 per cent natural resources is the desired direction for the development of new products and technologies. The desire will also seek to achieve the goals of the closed-cycle sustainability. In their book titled: "Factor Four", von Weizsäcker, Amory and Hunter Lovins demonstrate the current viability of such concepts. This goal, transferred into the housing sector means, simultaneously, an improvement in living quality and a significant reduction of the strain on the environment – "Maximum living quality coupled with minimum environmental impact".

By applying the principles of solar architecture in residential projects, it is possible today to construct low-energy houses which utilize 1/5 the heating energy of conventional new buildings, and just 1/10 the heating energy of buildings erected prior to 1970.

The physiology of residential dwellings as a science, as a discipline devoted to the research of human behavior and the perception of the living environment, has developed a profile of the requirements for a desirable or "healthy" dwelling. According to residential surveys, given a fixed budget, the next most important aspect of an apartment, after increased floor space is the direct sunlight. The desire for more sunlight during the winter months has been very pronounced, and was independent of whether respondents currently resided in sunny apartments or not.

It has been a goal of the work of the author of this paper to explore possible ways to extend the potential for a high living quality within single family houses and within small residential settlements into large housing designed to accommodate the tight budget constraints of social housing. In addition to many other important aspects of planning, sun-filled living spaces within public housing units deliver a quality directly comparable to smaller projects without added costs. Obviously, the principle position of every architect must be so, that each one would gladly reside in a unit of his or her own design.

Sunlit apartments

Sunlight is one of the most fundamental ingredients of life and of living quality. Sufficient penetration of direct sunlight into interior spaces, especially during the winter months, constitutes one of the most critical aspects of any building particularly, the residential ones. Through the penetration of infrared waves into living spaces, the effects of sunlight are set into motion. These long, heat carrying waves, have considerable positive effects on human health and contribute towards improvement in immune system capacity.

The physiological effects of sunlight can hardly be overstated. Sunlit dwellings have almost tangible positive effects on residents' behaviour. The repetitive daily cycle of solar radiation and natural light, have a significant influence on our comfort level, our moods and our activities. In recent years, through the development of visible light therapy as a way to treat seasonal depression, the relevance of the intensity of sunlight to hormone levels within the body has been recognized. For architecture, spaces utilizing solar glazing or winter gardens provide the best opportunity to fully experience the positive aspects of sunlight.

It is worth noting that the majority of buildings constructed over the past twenty years in Austria, which seek to make use of passive solar energy, have been single-family houses. Moderately scaled, multiple-family residential projects planned in a cooperative manner with the residents (participatory planning) also reflect a higher-than-average integration of passive solar energy planning approaches. Apparently, those people with the most highly developed sense of environmental responsibility and willingness to build ecologically using the sun as a central energy source, are private individuals. Although, supported in their decision making processes by experts with in-depth knowledge of these possibilities, the larger project clients and funding agents, both public and private, have paid little attentions to this important aspect.

Because of the intrinsic inefficiency of single-family dwellings (large exterior surface to interior heating volume ratio, high total lot area-to-net square footage ratio and the proportionally high costs of connection to public services), these types of buildings are generally not optimally suited to high levels of energy efficiency. It is rather the larger buildings such as multi-storey and high-density housing which offer the greatest potential for energy saving. However, with the engagement of willing financiers, appropriate subsidies and additional measures such as the development of uniform and internationally acknowledged energy use profiles for buildings, the goal of using passive solar architecture can be achieved. In this regard, the most effective projects are those which have been developed with the full participation and determination of the future residents. An example of such a project is described below.

Housing project in Perchtoldsdorf, Lower Austria

The project is a small-scale multi-family housing project utilizing passive solar energy and ecological materials, developed in a cooperative manner with the residents. The building, situated in an area of primarily single-family houses just south of Vienna, defines the corner of the block on which it is located through an L-shaped overall form. Three south-oriented and two southwest-oriented units function as a perimeter frame for the common garden which is separated from the street by the units. All common facilities such as covered parking, bicycle sheds, activity rooms are concentrated at the northeastern corner. Glass-covered walkways connect this area with each of the units.

The building concept suggested by the architects (optimal use of passive solar energy, including south-oriented winter gardens and shed roofs) was unanimously adopted by the residents. Also important was a unified appearance for the housing group as a whole. Materials and color schemes were discussed in several variations and agreed upon by the group, an aspect which does not weaken the individual character of the units. Other than the structural concept, several aspects were developed with individual members of the group such as overall unit size, design of the floor plans, etc.

The integration of solar collectors, the high-quality insulation and the construction of a cistern for garden irrigation and toilet water were introduced early in the planning phase and agreed upon by everyone. Technical details of the solar collectors, the common gas heating system, and the automatic ventilation system were developed with the building services planning office.

Urban design and solar strategy: The most economical route to a solar low-energy house

Solar construction, matched to a specific regional climate, is based upon a hierarchical series of measures, from macro to micro scale. Physical planning, urban design and the planning of individual objects, if developed in an integrated manner, can result in significant energy savings without added costs. Secondary parts such as buildings and mechanical equipment, etc. can further increase energy savings, although these measures, generally, involve increased costs. Primary decisions determine the larger urban structure and the approximate position of individual objects and can only be reversed through the full-scale removal of all these elements. Secondary measures, such as those involving the exterior building surfaces and the building mechanics, on the other hand, can be upgraded at a later stage.

Primary measures include the following: microclimate and location, regional planning and area zoning; determination of the building envelope; design concept for the building which should include: (a) solar gain maximization strategy for mid- and low-density urban housing with sufficient solar exposure, and (b) energy loss minimization strategy for high-density urban housing without sufficient solar exposure.

Secondary measures include: passive use of solar energy – passive solar technical building components (solar glazing, winter-gardens, solar exterior walls utilizing transparent insulation); use of building mass for heat storage as a function of passive solar technical building components; and mechanical installations for ecologically friendly energy retrieval. An example is described below.

Housing project in 22nd district, Vienna

The project is a moderately scaled residential building in which high passive solar gains and the use of ecological materials form the conceptual basis. The project consists of 6 lines of south-facing rowhouses, containing 41 residential units and one building for common facilities which occupies the center of the settlement. The client is the City of Vienna. The project is situated in a neighbourhood of single-family houses, close to one of the urban expansion zones. The rows of houses provide a transition from the small-scale area (to the south) to the larger scale block structure (to the north). Each unit incorporates a wintergreen with direct southern exposure. High passive solar energy gains and the 14 cm thick cork-insulation guarantee low energy consumption coefficients. In addition to ecological construction materials and the use of solar energy, the project tabled as „natural living“ project, also provides separate systems for drinking water and water for domestic use as well as grass-covered roof and a centralized waste collection and composting facility.

Solar components in low-energy houses: Solar glazing, winter-gardens

Housing project “Am Hirschenfeld”, Brünnerstrasse, Vienna

The project is a large-scale urban housing complex and consists of 215 residential units, a nursery school to the south and a commercial area in the front. The project is significant for its pioneering use of active ventilation with heat recovery in a social housing project. The client is the housing cooperative GESIBA.

A central component of the energy saving measures is an active ventilation system with heat recovery. This provides a solution for those units where cross ventilation is not possible, due to their location directly next to the four-lane heavy traffic street, and by their necessary separation from this side by a glazed circulation zone. To avoid internal drafts, fresh air prewarmed by the heat recovery system is then heated to room temperature in a district-heat register-damper. Ventilation units, located next to the elevator mechanical rooms, service 30 units each. The system requires 5.500 m3/h air intake volume, and achieves a 60 per cent effectiveness rate. Simple air exchange is planned, however, a functional reduction of up to 50 per cent is also possible.

The supply and exhaust air is fed though the cavities within the reinforced concrete hollow floor units thereby providing an economical installation of services. According to computer simulations and calculations, this housing project has approximately one quarter of the heating requirements of a conventionally built project of similar size.

The building components have been directly integrated into the energy concept (for example, extraction of solar energy, heat storage and distribution) in addition to their conventional function as space-dividing elements. The simple addition of architecture and building technologies has been replaced by the principles of multiple use and functional overlay of building components as part of the energy concept. A double-glazed circulation zone, parallel to the street, acts as an acoustical as well as thermal buffer.

Housing project "Osramgruende", Vienna

The project is a large-scale urban housing development containing a total of 520 residential units, as well as a day-care center for children. The client is the housing cooperative WIENSÜD. The project is composed of buildings integrating elements which optimize the use of passive solar energy, such as thermal glazing, winter-gardens and a naturally lit, glass-covered interior passageway. Through these and other measures, the energy index value of the building is reduced to 30 - 40 kWh/m^2 per annum.

Additional ecological systems include a heat retrieval system which extracts energy from domestic sewage water, combined with a water recycling system. Shower and washing sewage are collected centrally, where heat energy is extracted using a Menerga heat recovery system with heat pump (automatic heat exchanger cleaning and safety heat exchanger). The collected water, having been filtered once by the heat recovery system, is then filtered again by a water treatment system with UV- and nanofiltration, and used for toilet water. This type of water supply system becomes economically viable with a minimum of 250 units.

The residential housing block is part of an urban expansion zone, and achieves the very high-prescribed density of 4,1 within a 7-storey, south oriented building containing 89 apartments. Due to traffic noise of the street, the western portion of the project is constructed as a building with a northern circulation zone functioning as a thermal and acoustic buffer. The remaining units to the east are constructed with repetitively organised, centrally located circulation cores, allowing units to stretch from north to south. All apartments are organised to provide for the south orientation of the main living areas, the incorporated winter gardens and the loggia zone. The project was conceived as a low-energy residential housing complex, and is currently nearing completion.

Passive houses: the construction of the future

The newest development in the area of solar construction – the passive house – represents a further development of this process and bears testimony to the ability to realize these goals. Through the high-grade insulation of roof, wall and glazing areas, no critical building surfaces attain a negatively low surface temperature during the winter months, producing interior spaces of uniform comfort. A supply and exhaust air system maintains a high interior air quality at all times of the day and night, and supplies additionally heated air during peak times. Using conventional window ventilation methods, such a consistently high-interior air quality level, would not be possible during the winter months.

Combined with directly sunlit interior spaces, the passive house offers an ideal residential climate in winters while using only 1/10 the amount of energy of a conventional new building. Due to the efforts of the Passive House Institute in Darmstadt, Germany, it should become economically feasible within the near future to produce this type of housing. This would be possible, if, of course, the requisite solar urban planning structure can be established.

A comprehensive overview of the basic principles, the newest methods and the most recent findings about solar architecture, as well as examples of solar construction can be found in "Neues Bauen mit der Sonne", Second Edition.

Note: The architect of the housing projects described in this paper was the author.

Construction and environment in Albania

Festime Trebicka, Tirana, Albania

The inter-relationship between the environment and construction activities

Before political changes in 1990, internal migrations were strictly controlled by the State, in order to maintain balance between the cities and the countryside. After 1990, the free movement of population towards the coastal areas and urban centres has increased the number of people living in these areas. This has caused considerable environmental implications. Some locations are impacted severely by human activities, which are affecting human health negatively and degrading the environment. An overview on the general environmental situation in Albania is given in annex I.

Through several studies, a number of environmental problems, which are broadly as a result of construction activity, have been identified which include:

- Illegal housing in towns and along the coast;
- Construction in erosion and flood-prone coastal zones;
- Concentration of industries and other services on and behind the coastal strip;
- Negative impacts on archaeological and historical sites;
- Reduction of green spaces;
- Construction close to sensitive areas;
- Over-exploitation of natural resources such as sand and gravel from beaches and river beds for construction and timber from coastal and nearby mountain forests for fuel and other purposes;
- Loss of bio-diversity due to new developments such as urban settlements, etc.;
- Pollution caused by urban untreated sewage and waste waters;
- Pollution of rivers, beaches and harbors because of discharged solid waste;
- Environmental problems related to water management.

In the urban areas, the problems are twofold, namely:

- Rapid increase of illegal buildings, housing and expansion of informal activities in sub-urban areas, which create overcrowding, causes problems in water supply, electricity, road networks, etc.
- Expansion of towns beyond the bordering lines, occupying agricultural land, green areas, and sometimes eco-sensitive areas, etc.

Housing related environmental problems to be addressed are:

- Houses are constructed without obtaining permission and without respecting urban planning, heritage and tradition;
- Environment and public health issues are seldom taken into consideration;
- The legislation is, often, not environmentally oriented;
- There is a lack of institutional capacity, financial resources to implement legislation and appropriate planning control measures.

The majority of builders do not respect the planning and construction regulations and there is a disparity between the regulations and the practice. In Tirana, for example, the population has doubled in a very short period and this overcrowding has created considerable problems. In most cases, people are sheltered in an irregular way without having sufficient infrastructure services such as water and sanitation. As such, the environmental conditions of these settlements are very poor.
According to information obtained from the Ministry of Public Works and Transport, in the main towns, every occupant of a town/city has caused a reduction of 2 square meters of available green

space. Similarly, through increased construction activities, the air is also polluted considerably. It should be noted that, although, sometimes, environmental requirements are taken into consideration, problems still exist which need to be addressed vigorously.

Examples of environment friendly projects

An important step in the regulation of the interventions that affect negatively the urban environment is the preparation and approval of a new Planning Law and Planning Regulations. What are more important are the inclusion of the Environmental Impact Assessment as a requirement for urban planning, issuance of environmental licenses and other environmental considerations in this Law. A very good example is the CZM Plan for the whole Albanian coastal area that is prepared in collaboration with United Nations Environment Programme (UNEP) and the World Bank.

The Ministry of Public Works and Transport and Tirana District Council implements a land management project financed by the World Bank for the development of secondary infrastructure of two suburb areas. This project is important because it addresses problems of informal developments. It is important to strengthen the control mechanism in order to prevent the illegal developments. It is also important to prepare urban plans in order to guide the developments.

The Ministry of Public Works and Transport is also implementing a pilot project on improvement of urban conditions as stipulated in the Habitat Agenda of the Habitat II Conference and PHARE Cross Border Programme for highways and rural roads. The Ministry is also implementing a project for the new landfills in several towns including Tirana, Durres, Kavaja, Elbasan, Korce, Fier, Pogradec, Lezhe and Shkoder.

Proposed measures for improvement

Strengthening institutions is a necessary step to reduce the impact of construction and other harmful developments on the environment. An overview on the existing environmental legal and institutional framework is given in annex II. Planning frameworks and capability can be improved through: establishment of clear definitions and responsibility, the improvement of planning content in market economy conditions; promotion of strategic and action plans; and public participation in the planning process which focuses on capacity building at local level to solve planning problems.

Rapid population increase in the main towns is accompanied by increased demand for housing, urban services and employment etc. In the absence of Government's ability to cope with prevailing problems, there is need to promote public/private partnerships in order to control the situation. All actors in this process will have their contributions and interests as listed below:

Central and local Government: to improve living standards of population, to expand economic activities, to pay attention to environmental protection, to provide finance, and to adopt and enforce policy and legal framework.

Private sector: to increase its role and contributions.

Non-governmental-organizations: to be active in improving social, environmental, cultural, humanitarian conditions by awareness creation campaigns, training programmes and information systems.

Foreign donors: to provide financial support and investments to facilitate sustainability, and arrange technical assistance programmes.

Government's strategy must further be targeted towards:

- Establishing condition to increase delivery of housing for low-income people;
- Promotion of private sector development;
- Protection of the environment in the framework of sustainable urban development and optimization of the use of natural resources;
- Establishing a balance between the population numbers and the capacity of urban services such as housing, water/energy supply, sewage, green areas, etc.;
- Promotion of energy-efficient techniques in buildings.

ANNEX I

General environmental situation

Like other former communist countries, Albania has suffered from specific social and economic problems, including environmental degradation and poor natural resource management caused by economic mismanagement. Inherited problems include:

- Soil erosion associated with deforestation due to uncontrolled tree cutting;
- Contamination of surface waters due to uncontrolled discharge of industrial and domestic waste and complete absence of sewage treatment throughout Albania;
- Bio-diversity loss due to lack of resources for sound environmental management;
- Emission of toxic gases from thermal power and industrial plants in industrial areas.

After a drop in GDP in 1990-1992, 1993 marked, for the first time, an increase in economic activity of 11 per cent, followed by a further 8 per cent during 1994. Despite the general increase in production, many high polluting economic sectors such as mining, metallurgy, chemical and fertilizer industries have operated in reduced capacities and as a result, the discharge of polluting substances into the environment has also decreased considerably.

According to official sources, most parts of Albania have no obvious air pollution, but the phenomenon has been evident in industrial areas and large cities. Poor technological processes have contributed to large amounts of harmful emissions in the atmosphere. Air pollution from transport and domestic sources in the large cities has been much less then the pollution caused by industry (main industry fuels have been coal and oil which have a high sulfur content).

As regard to water pollution, the increasing usage of fertilizers and pesticides in agriculture has led to a progressive increase in the amount of polluted water. Similarly, industries such as copper, oil, paper, PVC, etc., have contributed to water pollution considerably. A great concern has also been the discharge of communal waters directly into rivers and lakes. Solid waste management has also been a great problem. During 1993-1994, serious problems caused by industrial and agricultural processes (construction, transport, trade, communal activity) were noticed, and in certain cases, this has led to critical situations.

Forests

An estimated 36 per cent of Albania is covered by forest. Over the past 50 years, forests have been misused in order to fulfill fuel demands. Accordingly, some 280,000 hectares of forests, which are more than a quarter of total forests, have been destroyed. In addition to industrial pollution, Albania's top environmental priority has been soil erosion and deforestation. The seriousness of the situation is due to the prevailing role of the agricultural sector in the national economy. Inappropriate methods of forest management, particularly in the districts of Berat, Elbasan, Skrapar, Permet and Tirana have been the main cause of this deforestation. The free market economy has had an immediate and negative impact on the forests, since short-term profits have been the main goal of privatized forest exploitation enterprises. During 1993-1994, the exploitation of forests has mainly been concentrated in the areas where regeneration was rather active. It should be mentioned, however, that the main reason of deforestation has been the indiscriminate use of fuel wood and timber for construction materials.

Other reasons for deforestation include; construction of private buildings; internal migration from rural to urban areas increasing housing demand; uncontrolled timber trade for, mainly, export purposes; domestic use of timber, for example: heating purposes (5,000 ha of forests have been destroyed between 1991 and 1992); provision of agricultural land through illegal deforestation; absence of forest services (planting trees); and absence of forestry protection legislation and policies. Over the last two years, the situation has somewhat improved because fuel wood is gradually being replaced by electricity.

The building sector

Limitations on free migration diminished in 1990. This movement has been more evident for the northeastern people, who have moved towards the coastal areas and the large cities. This unusual demographic change has caused expansion of the urban areas and a further reduction of urban green areas. Non-controlled construction of facilities and buildings has damaged and destroyed green areas and increased urban waste. The building materials production has also considerable environmental impact. For example, industry has been one of the greatest air polluters because of the dust and other greenhouse gas emissions, which is due to out-dated technology and facilities.

ANNEX II

Environmental legislation

Environmental legislation in Albania dates back to the 1970's. At that time, the formulation and adoption of environmental laws and regulation was not a priority, although it was accepted in principle. The legislation contained vague references to a general obligation: "to protect the environment, the water, the air and soil." There were no laws governing specific environmental fields such as forestry or fisheries. These were conceived only in general terms.

In 1985, the Council of Ministers, after reviewing the performance of each Ministry in environmental issues, assigned specific tasks to several Ministries and other institutions, including different levels of local government. The objective was to reduce pollution and to improve environmental and natural resource management. In the same year, the Commission for Environmental Protection moved from the Ministry of Health and Environment Protection to work under the authority of the Council of Ministers.

Since the State was the owner of all properties in those years, every environmental problem was solved directly by the concerned Ministry or by the State Arbitration Commission. In Albania, it was impossible to solve problems or conflicts. There were considerable irregularities. The most typical example was the mining enterprise of Fushe-Arrez, which damaged the land of an agricultural cooperative and through the State intervention has not paid reparations. Over the years, the technology has become out-dated and the situation has become more dramatic because the State has no funds to upgrade the technology.

The new Law on Environmental Protection, approved by the Parliament in January 1993, was based on legislation of different European countries. Several consultants from different international organizations and institutions were involved in its formulation. The Law has sanctioned, for the first time, the introduction of different procedures for the evaluation of environmental impact and licenses.

The objectives of the Law are to prevent and reduce pollution, bio-diversity conservation, rational management of natural resources, avoidance of over-exploitation, ecological restoration of damaged areas, preservation of ecological balance/quality of life and the safety, maintenance and improvement of the environment. The law has foreseen the procedures for the Environmental Impact Assessment (EIA) of different projects, which may have significant impacts on the environment. It has compelled all the physical and legal subjects that influence or might influence the environment, to get license. The existing activities that do not submit environmental licenses shall be closed down, interrupted or discontinued partially or totally, depending on the circumstances.

During the last years, the Parliament and the Government have approved a considerable number of legal acts, which are partially or totally focusing on environmental protection issues. In 1994, the Council of Ministers approved the National Environment Action Plan (NPEA) which presents a detailed explanation of the environmental protection strategy. The organizational, administrative, technical and legal measures foreseen by the NPEA include economic reform and economic restructuring, taking into account the environmental protection, strengthening legal and institutional framework, prevention of land erosion and pollution. NPEA also intends to integrate development programmes with economic and social sectors in order to achieve the goals of sustainable development.

Institutional framework

In the beginning of 1992, the Committee for Environmental Protection (CEP) with five employees existed under the authority of the Council of Ministers. The organizational structure of CEP includes: department of water, air and garbage control; department of nature conservation; department of project implementation, economy and environmental information; and legal office.

CEP has a number of Regional Environment Agencies and the number of employees in 1996 was 60. In addition, there are other important institutions and organisations like the Council of Territorial Adjustments, the National Water Council, the Tourism Development Committee, and the National Power Committee working at both national and local levels to protect the environment.

Some of the responsibilities of local Governments include: formulation and promotion of environmental protection programmes; provision of information and evaluation of environmental situation; control of environmental conditions; administration of local funds; selection of industrial sites for urban waste disposal and processing; allocation of permissions/ licenses according to environmental safety norms for economic and social activities taking into consideration local interests.

Housing and ecology: The Swedish experience

Ulf Troedson, Stockholm, Sweden

An integrated housing policy

The State and the municipalities have shared responsibility to implement the goals of Swedish housing policy. The State has guaranteed the provision of credits for housing and is also providing economic support to low-income households, allowing them access to dwellings of adequate size and standards. Responsibility for local planning and administration was delegated to the reformed municipalities, while, the State provides know-how, legal and financial means.

Municipalities have made arrangements to reduce speculative components of housing production, such as physical planning, building and land use control, construction, allocation of building rights, influencing the forms of tenure, and distribution of housing allowances. In order to reduce real estate speculation, the municipalities were provided legal means to acquire large areas of land for future development and urban expansion. An expanded right of expropriation and obligation for sellers to offer the municipality a first option land at the right price was the most important means.

The municipal housing production presupposed a right to establish non-profit municipal housing companies, which together with co-operative housing companies were favoured both with regard to access to credits and to adequate building lots. Municipal housing should be open to all categories of people, irrespective of their economic situation. They should be self-supporting and managed on a non-profit basis. One important principle of the municipalities was the maintenance of a desired level of high quality housing, when the private actor was hesitant. Such levels of housing production would have not been possible without the generous subsidy policies, which enabled households to acquire high standard housing.

The goals and the principles of Swedish housing policy were, widely, shared by private sector, citizens' organisations, municipalities, and by the real estate sector. Almost all housing has been constructed by private enterprises. An important role was played by the two leading co-operative housing associations: HSB and Riksbyggen. HSB, a national federation of housing co-operatives, was initiated by members of the tenants' movement as a reaction against the conditions that prevailed on the housing market in the 1920s. HSB is a multi-tier organisation with the objective of providing its members with quality housing. Riksbyggen, a co-operative housing union was initiated in 1941 by workers in the building unions to overcome unemployment in the building sector over a period of chronic housing shortage. Riksbyggen is, owned by associated building unions, popular organisations and housing associations. HSB and Riksbyggen have become leading agents in setting the quality targets for new housing, as well as in the improvement of residents influence and participation in housing management.

Some experiences from Swedish housing production in the past decades

The one million dwellings programme

In 1965 the Parliament decided that one million dwellings should be built in Sweden in the following 10-year period. A strong and forceful effort was needed to overcome the general housing shortage. As in many other industrial countries at that time, industrial building methods and large state subsidies were to be the means. New production techniques were employed, new products were tried and the site plans were organized to allow for maximum production speed and efficiency. Based on research, dwelling layout principles were developed to suit the needs of the families. These principles were made mandatory as minimum standards for financing and building permits.

The magnitude of the programme that actually was implemented in 8 years, may be understood by considering the total dwelling stock of that time which was around three million. The programme favoured large-scale projects by better financing, facilitated governmental and municipal planning procedures etc. The construction was carried out by private enterprises and most of the housing was privately owned, or was owned by municipal housing companies.

The programme was implemented in most parts of the country. The projects were dominated with multi-family and often high-rise buildings. They formed the basis for a massive wave of urbanisation, where not only people from Swedish areas, but also many immigrants from different countries were accommodated.

Improving the housing stock

When the housing market got less tight in early 1970s (partly as a result of the successful one million dwellings programme), families who could find better options, often, moved out of the estates of the programme. Many families wanted more living space, better outdoor environmental qualities and often preferred to live in a single family house with a private garden.

Responding to the oil crisis, to the need for substantial energy-saving measures and to the calls for general improvements of the existing housing stock, the Parliament, in mid-1970s, decided to launch a programme for housing rehabilitation, energy conservation, and improvement of outdoor environmental qualities in housing estates. One programme aimed at renovation of private and public housing built before 1960. Another programme financed improvements in run-down housing estates. In 1983, the Parliament adopted an ambitious Housing Improvement Programme for repairs, additions and modernisation, adding to the existing favourable Government support for housing renewal.

At the first stage, buildings built between 1880 and 1920 were renovated. Many small flats were merged into larger ones to attract families with children to the central parts of the cities and towns. Elevators were installed and kitchens and bathrooms were enlarged and modernised. Cultural values and social concerns did not always get adequate attention in the implementation of the programme. Despite the generous national subsidies, the improvements often resulted in sharp rent increases, displacing low-income families and people in need of cheap accommodation. At the same time, renovated inner city flats became attractive for households of relative affluence that could afford the high rents. Two-thirds of the dwellings produced after the completion of the one million dwellings programme were rather spacious single family houses, often built in the periphery of cities.

Increased building costs

The national credit expansion in the late 1980s resulted in growth of inflation with substantial increases in building costs and interest rates. Construction of new housing almost doubled. In 1990, construction of almost 70,000 units was started, that was equivalent to 1.7 per cent of the housing stock. However, unlike two decades earlier, it was not possible to keep the building costs down. Subsidies to the housing sector increased rapidly, despite attempts to brake their growth, including making deduction for interests less profitable at taxation.

This period was followed by an extremely deep regression in the early 1990s. A tax reform was to a large extent financed through the housing sector, increasing the average households' housing costs considerably. Households in the higher income layers could compensate this by lower income tax. For others, increased housing allowances gave a certain relief. In a few years, rising unemployment and pessimism regarding future prospects for the economy, made the demand for new housing to almost vanish. The production of new housing was reduced to approximately 90 per cent. In 1994, only 12,000 units were started. This was, to some extent, caused by an over production of the previous years and to some extent by the almost explosive raise in building costs. The financial crisis of the early 1990s made it clear that previous housing subsidies and housing allowances would have to be reduced.

Housing subsidies

An instrument of fundamental importance to the implementation of Swedish housing policies has been the involvement of the Government in financing. The Government offered long-term, low interest loans for the portion of the housing capital that was hardest to finance through the ordinary credit market. Almost all dwellings in Sweden are built with the support of the Government. Since 1975, there has been a general system of interest subsidies for housing, provided in the form of compensation for interest expenses related to construction or conversion of housing. Apart from minor adjustments, the system remained unchanged until 1992.

Since 1993, an entirely new approach has been applied to State support for construction and maintenance of housing. The allowance system is simplified and in the long-term allowances would diminish. Interest allowances are granted in proportion to the interest cost of a capital arrived at by a standard calculation. The standard sum is linked to the size of dwellings. The total State interest subsidies for housing in the fiscal year 1994/95 was estimated to SEK 32 billion.

As of 1992, investments in new construction and renovation are financed entirely from the capital market. Credits are usually loans, repayable in about 40 or 50 years. A State guarantee for the part of the loan with the highest credit risk, covering about 30-40 per cent of a guarantee basis, is obtainable upon payment of a charge. As part of the labour market policies, special subsidies were introduced in the spring of 1995 to support renovation, extension and improving the housing stock. As the subsidies cover also some major maintenance activities, the programme has led to considerable activity in the building industry.

Sustainable building development

The experience of Swedish methods and technology give evidence of progress and of failure. Buildings built in compliance with former require-ments, generally, resulted in well-functioning and adequately equipped dwellings in multi-family as well as single family houses. Criticism was often associated with the exterior of buildings and the quality of the outdoor environment.

The specialist and the general public have expressed their concerns on: the handling of certain modern buildings, the introduction of new techniques in the ventilation of buildings, the recent knowledge about the effects of exposure to radon within the building premises, and the widespread fears of negative impacts of certain electrical equipment in the buildings. Lack of knowledge in technical functions and qualities of traditional buildings has increased costs of renovating the existing old buildings. Insufficient competition and reliance on State subsidies is also part of the explanation for high building costs.

The building industry is an important partner to sustainable resource management. The Swedish industry needs to change its present practices when it comes to resource management, material flows, general recycling, and not the least, the management of potentially hazardous building materials and components.

The Nordic climate makes energy conservation an imperative process to achieve the goals of sustainability. The current abundance of nuclear and hydropower and electricity, has resulted in low consumer prices. To raise interest in the production of buildings for a future situation with higher energy costs, political interventions have been necessary. They have included extra taxation on electricity and subsidies for rigorous insulation of buildings. Heating of well-insulated new buildings will demand only 100 kWh/m^2 annually. In the existing buildings special programmes have been implemented to improve efficiency in the use of energy.

Healthy buildings

Recent studies show that Swedes spend on the average, 90 per cent of their time indoors. Many health problems related to draft, cold and poor hygiene are no more in existence. In recent decades, Swedes have, however, experienced health problems of new kinds that may be related to the indoor environment.

The reasons behind allergies and hyper-sensitivity, that seem to increase in Sweden in a worrying pace, are not quite clear. The need for cross-sectoral research, including building research, is generally agreed upon. Based on present knowledge, quality of indoor air, may cause allergy and hyper-sensitivity. Emissions from different materials are more frequent when the materials are in contact with moisture. According to several studies, inadequate procedures in the introduction of new production technology, in the use of new and untested materials and in the installation and maintenance of ventilation systems, are to blame. Discomfort and ill-health symptoms are more common in multi-family blocks than in single family dwellings. It is reported from the business sector that 40 per cent of men and 60 per cent of women working in offices, experience at least one symptom per week of allergies or over-sensitivity.

The Parliament took fundamental decisions in 1988, requiring a thorough review of the problems as well as proposals for preventive and mitigating measures. Consequently, a Committee was appointed for questions regarding „sick buildings“. In 1990, the Committee presented a report, suggesting a number of measures. Almost every year since then, the Parliament has considered proposals from the Government regarding in-door air. Decisions included: mandatory controls of ventilation systems in most buildings, mandatory negotiations during the building process, and insurance systems covering costs due to building errors.

About 130, 000 dwellings in Sweden are calculated to have or have had rates of radon that are higher than the recommended highest value of 400 Bq/cu.m. in existing dwellings. The radon rate in new buildings may not exceed 200 Bq/cu.m3. Most measures necessary to reduce radon levels in existing buildings are simple and inexpensive. It is mandatory for homeowners to arrange for acceptable conditions in their own buildings.

The alleviation of health problems in buildings is to a large extent related to controlling dampness in buildings and to proper maintenance particularly of ventilation systems. Well functioning ventilation systems obviously are a prerequisite for acceptable levels of dampness, radon and other emissions. Municipalities are responsible for the control of ventilation systems. A recent study showed that 60 per cent of the municipalities failed in carrying out controls to the extent expected by Parliament. A 1995 survey of the effects of on-going preventive and mitigating programmes showed remarkably little progress, in spite of satisfactory knowledge about how interior air pollution can be avoided, and how high rates of dampness or radon can be avoided.

A proposal was presented to Parliament in the spring of 1995 to allow SEK 2 billion be used for concrete measures to improve the indoor climate in dwellings and public premises, like schools and nurseries. The programme will include improvements in ventilation systems, sanitation and exchange of damp or emitting building components and other allergy preventing measures. Other proposals aim at improving efficiency in established control systems.

Ecology-based construction

The Swedish public has, over the past decades, showed an increasing interest in ecology-based construction as part of the development of environmentally friendly life styles. The eco-municipality project involves municipalities all over Sweden and the concept of eco-villages has won wide acceptance. Many initiatives have been taken by individual families, architects and builders to apply new ways of building design and new ways for adjusting buildings and the technical contents of buildings to local environmental conditions. Such new ecology-based approaches have often raised questions with regard to previous local land use and building control policies. As customers and clients ask for environmental impacts of construction, many builders now use environmental arguments in their promotion of housing projects.

Quite a few successful examples of technical solutions for ecology-based construction are found in Sweden. It is important that new experimental projects are carried out, that can serve as best practices and as sources of inspiration for future buildings. There are some forms of national support to ecology-based building projects. Funds for building research and for experimental construction may be used. Several projects have also been implemented through regular channels of support to buildings.

Waste management and recycling

Much waste is produced in the process of building, reconstruction and demolition. The quality and the chemical contents of building components play a crucial role for the impact of the building industry on resource management and on the environment. The annual production of waste from the building sector in Sweden was estimated to 1,750,000 tons in the early 1990s. Roughly 30,000 tons of lead, 400 tons of freon, 10 tons of cadmium and 400 kilos of mercury were included in the total waste production. Statistics in 1990, showed that 91 per cent of the total waste was brought to deponies, 5 per cent was burnt and only 4 per cent was re-used or re-circulated.

In recent years, there seems to have developed a common understanding of the need to radically improve resource management and re-cycling in the building sector. Some builders have started internal programmes to increase environmental awareness in their company. In the spring of 1995, the Government proposed an amendment to the Planning and Building Act requiring that a demolition plan be mandatory for the demolition of qualified buildings. The main purpose of the demolition plan is to ensure re-circulation of building materials and re-use of building components. This will be of importance also for the preservation and revival of buildings and of interiors being part of the Swedish cultural heritage.

Energy conservation

The energy crisis of 1970s resulted in the introduction of the first Swedish Energy Management Regulations in 1978. Regulations and rules for loans and allowances have since then guided energy use in housing. Between 1970 and 1994, the specific gross energy use for heating and hot water in Swedish housing was reduced from 340 kWh per m^2 to 220 kWh per m^2. For Sweden, this means that the total end gross energy use has remained at 150 TWh annually, while the heated floor-space has increased from 430 million m^2 to 630 million m^2. Energy use is thus more than 50 TWh lower than if energy management measures had not been applied. For consumers, this means an annual saving of SEK 2,5 billion.

Over the same period, the annual electricity use for hot water, heating, and household equipment increased from 15 TWh to 35 TWh, while transformation losses was reduced from 34 TWh to 19 TWh. Buildings use more than 50 per cent of the total electricity and options for using other energy sources are, however, manifold. Distribution technology has become simpler and more effective and remote cooling is a new technology on the edge of introduction. The technology for heat distribution should be oriented towards reparation, maintenance and more effective use of existing systems.

Public building control

Swedish legislation, regulating the quality of buildings, has recently been revised. The basic assumption is, only qualities of importance from the public point of view should be controlled by public authorities and that the developer has the full responsibility for construction quality.

The building control process is regulated by two laws, the Planning and Building Act of 1987 and the Act of 1995 on Technical Requirements on Construction Works. All buildings and other construction works have to meet the technical demands stipulated in the National Building Requirements. These requirements specify qualities of importance from public point of view, satisfying fundamental demands with regard to hygiene, health, environmental quality, energy conservation, water management and waste treatment. Also aspects on the design of dwellings and requirements to meet disabled persons needs of a barrier free environment are included.

Before starting construction works, the developer must inform the municipal building committee. Except for the simplest cases, the developer must produce a control plan for the works, to be approved by the building committee. The committee can demand the control plan to include inspection of layouts and design and of the works by independent bodies. Such bodies must be certified by a certification agency or be approved by the municipal building committee. The committee may also inspect the works itself. If the building does not fulfil the requirements, the committee may stop the works or forbid the building to be used.

All builders are obliged to appoint a person responsible for carrying out the control plan. Selection of that person has to be certified by a certification agency or approved by the municipal building committee (in the case of a single specified project). The certification agencies must have accreditation by a national board for accreditation. Professional builders of residential buildings are obliged to have an insurance to cover any fault and /or damage in the finished building.

New environmental policy

The development of industrialized, large-scale construction was an important part of the modernisation of Swedish urban areas. Swedish housing and built environment are, generally, of reasonably high standard. Many buildings and many parts of the built environment need to be adapted to new economic, social, cultural and ecological requirements to allow for a sustainable human development.

Calls for healthy homes and healthy buildings have high relevance. As the building industry is becoming more market-responsive, it must introduce eco-cycles approaches systematically and must manage flow of building materials and components efficiently.

Since Habitat II Conference, major changes in policies and legislation on environmental issues, on land-use planning and sustainability have taken place in Sweden. As of 1999, the Environmental Code has become the legislation that covers most environmental problems. The Environmental Code is the result of a major review of the environmental legislation. Specific laws on many subjects such as environmental protection, chemicals, etc. have been brought together in one code. It covers aims and general principles on the relation between human society and the environment. It also covers general land-use principles and replaces the earlier Natural Resources Act and is also, considerably, sharpened. Its overall objective is to safeguard a sustainable development.

The Environmental Code is supplemented by possibile Environmental Standards for certain areas. The standards can deal with noise, NO_x , etc. Furthermore, fifteen Environmental Goals decided by the Parliament, to be of guidance in the implementation of the strategies are also linked to the Codes.

The Planning and Building Act which governs the more detailed land-use decisions, in comprehensive municipal planning, in detailed planning and in building permits, is not included in the Code. The Planning and Building Act has, however, undergone a major review in 1996, strengthening the demands for considerations of sustainable development. The requirements for Environmental Impact Assessments have also been harmonised between physical planning matters and development projects. Sweden has also introduced a change in policies for the transportation sector. Investments in the road infrastructure are now turned mainly towards safety and environmental considerations.

The land-use planning in Sweden is already dealt with almost entirely at the local level in the municipalities. Only matters with impacts in several municipalities are dealt with a regional level. Central Government is active in land-use planning only through legislation, standards and principles. A three-year subsidy programme of SEK 7 billion is also in progress. It is directed towards the municipalities and the purpose is to encourage local investments for sustainable development.