

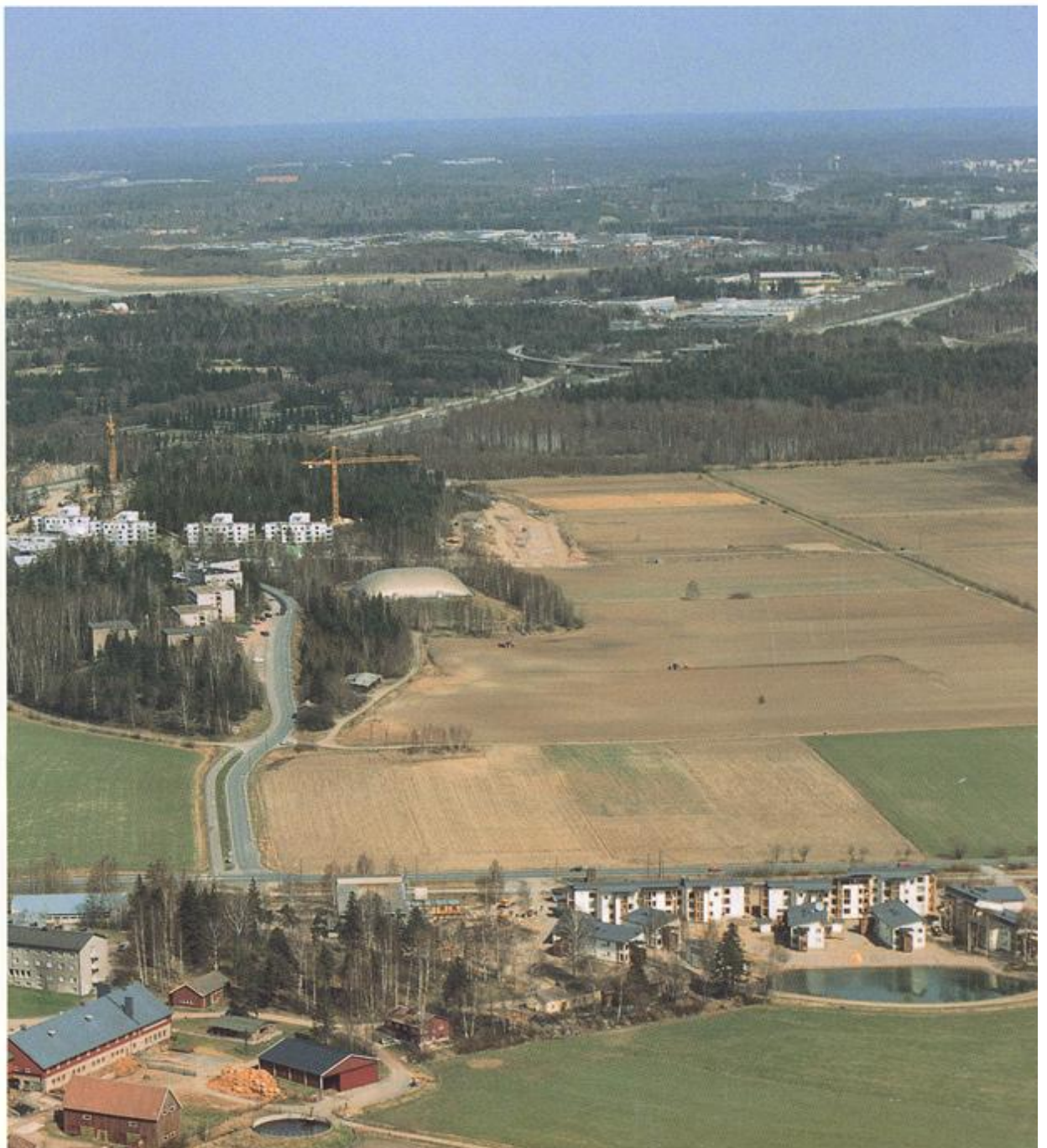


HELSINKI CITY PLANNING DEPARTMENT PUBLICATIONS 1998:6



AALTONEN – GABRIELSSON – INKINEN – MAJURINEN – PENNANEN – WARTIAINEN

ecological building criteria for
Viikki





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25 May 1997

CITY OF HELSINKI

CITY PLANNING DEPARTMENT

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Cover: Aerial view of Viikki from Latokartano

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DESCRIPTION PAGE

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ABSTRACT	<p>Ecological Building Criteria for VIIKKI is a method which defines minimum ecological levels for building and assesses the ecological degree of various development projects. Minimum ecological levels for building have been defined in a way that enables their implementation in residential building at a reasonable additional cost. Through fulfilling the ecological criteria cost savings during the use period will also be achieved. These criteria, whose purpose is to serve as a guide for design and implementation, will be appended to specific building regulations applied to city owned sites.</p> <p>The criteria examine building projects from the perspectives of pollution, natural resources, health, natural diversity, and food production. This evaluation has been particularly tailored to suit Viikki's conditions. The greatest importance has been attached to pollution, and the least to food production.</p> <p>Pollution is reduced by building more efficiently and less, by durable and recyclable buildings. Natural resources are conserved by building better and less using renewable and recyclable materials. Health is improved by creating a favourable microclimate around the building as well as healthy conditions inside the building. Natural diversity is enhanced by leaving as large a part of the land unbuilt as is possible, and by arranging access for the animal population into and through the area. Also the building's future demolition should be anticipated if the area is later needed as a field for food production.</p>
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PREFACE

The southern section of Viikki's Latokartano area is the first area in Helsinki where experimental ecological building is being carried out on a large scale. The plans and principle solutions of the area are based on two design competitions, the first of which sought an ecological town plan, and the second of which produced suitable sites and buildings for it.

"Ecological Building Criteria for VIKKI" has been commissioned by the Helsinki City Planning Department and the Ministry of the Environment to define the basic level for ecological building and to assess the ecological level of various development projects. The basic ecological level for building has been defined in a way that enables its implementation in residential building at a reasonable additional cost and that cost savings will be achieved during the occupation period. The criteria will be used when the city properties are let for building and as a part of the specific building regulations for all sites in Viikki, the purpose being to give guidance for design and realisation.

The criteria examine building projects with respect to pollution, natural resources, health, natural diversity, and food production. The evaluation has been specifically applied to suit Viikki's conditions, where the greatest importance has been attached to pollution, and the least to food production, depending on which of these the building in Viikki will have the greatest effect on.

The Helsinki City Planning Department and the Ministry of the Environment are interested in comments and suggestions for improvement the criteria presented herein. These criteria will be further developed for use in the building of Viikki's other sections. It is to be hoped that these criteria will stimulate a broad discussion focusing on the goals of ecological building, and will assist others responsible for the implementation of ecological building projects in the preparation of evaluation methods for their own projects.

These criteria have been prepared by a working group consisting of Professor Kai Wartiainen (Arkkitehtitoiminta Oy Kai Wartiainen), Tero Aaltonen, MSc. (Insinööritoimisto Oy Matti Ollila & Co), Juha Gabrielsson, MSc. (Juha Gabrielsson Oy), Raimo Inkinen MSc. (PolStop Oy), Joel Majurinen BSc. (Konsulttitoimisto Joel Majurinen Oy), and Ari Pennanen MSc. (Haahtela-kehitys Oy).

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1 INTRO- DUCTION

BACKGROUND

The environment and its ecosystems have been understood either in a human-centred way or in a nature-centred way which refuses the priority of the humankind.

The judgement of the nature-centred mode of thinking on the human-centred thinking is hard: the human-centred mentality sees the environment only through its use value for the humans, the environment is merely the thing that surrounds us and the whole concept is pejorative.

The nature-centred viewpoint demands the recognition of nature's intrinsic value and its rights. The flourishing of all life on Earth is a value in itself. A smallpox virus is as valuable as a flying squirrel. In that way, the limiting of human activities and especially the radical reduction of the world's population would best advance the cause of nature.

At the geological scale nature is unyielding, and human powers to affect it are. During the history of the Earth, life has been almost totally destroyed at least five times, the last time occurring 66 million years ago. Still, nature appears dynamic around us. The ecosystem can be examined in a human-centred way without a guilty conscience: it will lead more easily to actions and possibly also to results.

Following the Newtonian way of thinking, it would be natural to first define the environment in which humans want to live, then study the means by which such a balanced condition could be achieved, and finally implement this condition. In this way, for example, the quantity of carbon dioxide in the atmosphere ideal from nature's standpoint would be specified, the circulation of carbon in the environment would be exactly ascertained, and finally, the building sector would be integrated as one component into the controlled carbon cycle.

This, of course, is not possible because nature is a dynamic system, not a static state. Sabre-toothed predators have always developed when large-sized prey have appeared in nature. Generally, predatory animals can eliminate the populations of their prey at the same time as they destroy their own stock. Besides being dynamic, nature is also complex; the previously described pattern is repeated in thousands of ways in micro-organisms.

The Newtonian control of nature is also not possible because the opinion field of the human society is dynamic. During the 1960s, the traffic in Finland killed more than 1000 people annually. It was then decided to impose general speed limits. If human life were irreplaceable, as is taught in schools, speed limits would have been reduced to 10 kilometres per hour. A level of less than 500 fatalities per year was, however, accepted by the society at that time.

Instead of attempting to define the ideal future, it is socially more convenient to determine if present conditions or those of the near future are good. If not, then an attainable direction is set. Presently the reduction of carbon dioxide and sulphuric emission into the atmosphere appears to be politically sensible. The direction is therefore set; the level will be set by the political climate as time goes on.

BETTER BUILDING ECOLOGY IN VIKKI

In this report the environment is assessed from the viewpoints of pollution, sufficiency of natural resources, health, natural diversity, and sufficiency of food. The intent has not been to rank these factors in any order of importance; the view is that all are important to create a favourable ecosystem for people. In that way this report attempts to provide a universally valid discussion forum about building and ecology. In Viikki, however, the factors which building influences most have been considered operatively most important. The universally valid discussion forum has therefore been developed into an evaluation process pertinent to Viikki, in which partial factors have been weighted according to their operative significance.

Pollution

The building materials industry consumes energy, building maintenance consumes energy, and traffic in the built environment consumes energy. Energy use in general releases carbon dioxide, sulphur, nitrogen, and particles into the atmosphere. Demolished buildings are currently taken to refuse dumps in their entirety also creating a problem.

Building in Viikki can significantly affect the level of environmental pollution. **Pollution can be reduced by building less, by building more efficiently (energy use, traffic), by building durably, and by building recyclable structures. Technical choices and innovations can affect the energy consumption in manufacturing and maintenance.**

Natural resources

Building embodies directly, significantly and over a long term natural resources. The use of concrete, gravel, and wood, for example, change the landscape. Non-renewable energy resources are extensively used in the manufacture of many building products.

Building has a relevant effect on the use of natural resources. The easiest way **to influence the use of natural resources, is either by building better and less, or by using the kinds of resources that are renewable, and whose consumption is therefore acceptable (currently wood and recycled materials).**

Health

In connection with ecological building, health usually means physical health. This is improved by banning building materials known to be, or suspected of being, toxic. Physical health is further enhanced by creating a favourable micro-climate around the buildings as well as healthy and comfortable conditions inside them.

A psychically healthy living environment is just as important. Its implementation, already more problematic, is further made more difficult as the formerly homogeneous society is fragmented into increasingly dispersed segments. What is a gateway to Paradise for one may be infernal for another. The solution could be a strong profiling of an area or sub-area, and the provision of balanced supply elsewhere, as well as generally making

the changing of apartments easier. **Health can be affected by building “better in a better way”.**

Natural resources

Natural diversity is necessary to maintain life on the earth because nature's large gene pool enables nature to easily adapt to changing conditions, and because polymorphic nature is an advantage to the medical sciences as well as being pleasant in peoples' minds.

Building in Viikki can affect natural diversity only to a limited extent. The chances of survival for the animal population can be improved by leaving as much of the land unbuilt as possible and by arranging access for the animal population within and through the area to safeguard genetic exchange. This is easiest accomplished by building less and with higher density.

Food production

On global level the effects of building in Viikki on food production are extremely limited. In theory, the humus otherwise remaining under buildings could be transferred to the unbuilt area, where grain cultivation could be replaced by more effective food production. Because of population growth and limited possibilities for food production, it is reasonable to prepare for the future dismantling of buildings located in field areas to facilitate the return of the land for cultivation. The most direct methods of building are **to build using less surface area and more intensive land use.**

IMPACTS OF BUILDING

Building in Viikki primarily affects the use of natural resources and pollution. The expedients are either technical or social.

Technical expedients

Exerting an effect with technical expedients is the easiest way to approach for the general public. In this case the problem is solved by engineering sciences and in a way that does not significantly affect an individual's

daily choices. Here the expedients include:

- The selection of building materials whose polluting effects on nature will be minimal.

- The use of technical or architectural innovations which reduce the consumption, at a reasonable expense, of energy, water, as well other resources required for building maintenance.

- The saving of materials and the use of recyclable materials.

The aim has been to prepare goals and measuring principles for the expedients above to be used in Viikki's site reservation provisions.

Social expedients

The only factor that is sure to create change in all five ecological sub-areas described above towards the desired direction is the reduction of building and higher density. In Viikki it means higher housing density and more efficient building.

This possibility to affect must continuously be kept up as the first and foremost. By its very nature, this influential expedient is personalised and consequently more difficult, requiring individual responsibility for ecology in daily life. It also requires a reshaping of attitudes; increased housing density runs contrary to the goals currently held by our society, that Finland's residential density should be reduced to the level found in Sweden.

Viikki's construction offers a unique opportunity to initiate a societal debate concerning peoples' housing activities. Besides natural diversity there should also be a demand for diversity in housing. Different types of dwellings should be accessible to different kinds of people in different life situations, as opposed to the current lack of alternatives. Increased housing density must not inhibit housing activities, but should instead result in a more effective exploitation of the dwelling space (living/sleeping, eating/working). The motto is: Not big but grand.

One of the most important criteria of Viikki's ecological building experiment is to study alternative housing models. Floor plans should disclose that same housing functions may be satisfactorily carried out using less floor area. If successful, the experiment would produce new floor plans and cheaper housing.

THE FOUR-STEP IMPLEMENTATION OF ECOLOGICAL CRITERIA IN VIIKKI

The initiation of ecologically conscious building is not just addition of a few new features to the present-day building practices. The issue is about a total change in the building mechanism that has become unresponsive to new needs. A sensitive recognition of all factors influencing, their complex connecting and parallel interaction are of fundamental importance. Isolated criteria and disconnected actions are not enough. The splitting of reality into separate scientific fields helps the limited human capacity to think and observe; **in reality there are no mechanisms that can be separated from each other. Environmental problems were born just because solutions have been searched for sub-problems isolated from the whole, without paying attention to other viewpoints.**

In the current situation it is essential re-learn how to operate in the multivariable reality, and to practise flexible, dynamic, and reflexive problem solving using scientific knowledge. More important than to find one single truth is to accumulate experience from novel steering mechanisms and to make sure progress into the right direction in several fields, to avoid gross errors, and to leave the hunt for the final solutions for the future time when more reliable knowledge is available on the various components of the complex issue.

In Viikki, increasingly ecologically conscious building will be enhanced through a four-step process: using **minimum level of ecological criteria** applied to all projects, using **PIMWAG** points which give incitement for significant experimental projects with a high expectation value, radical experimental **image buildings** advancing ecological building, and **follow-up studies** increasing information to be started in connection of the building process. Also in these pollution, sufficiency of natural resources, health, diversity, and food sufficiency will be used as viewpoint into ecology.

The standard of Finnish building has collapsed because building is no longer considered a multi-dimensional problem. A tradition has been born in which answers are sought for one question at a time without regard for other factors. If ecological building and its components are to really become high-level export products for the building industry, **the centre of attention of the experimental building in Viikki must first be focused on raising the standard of building, and at the same time prepare the above mentioned third step radical building complexes, which genuinely can affect the housing functions**, for our difficult climatic conditions. The marketing of user-oriented components in milder climates will be more successful through convincing reference projects than through questionable single-eyed producer-oriented experimental product collections.

The reference building and minimum levels for ecological criteria

To illustrate the standard of current building, a conventional apartment building design has been used to represent the average state of building in the Helsinki metropolitan area. The building's key figures have been calculated. The reference building's key figures and solutions have then been used to achieve positive changes in selected sub-areas of ecology with smallest possible stakes. The point of departure has been to permit an approximately 5% growth in investment costs, but at the same time, use must become more economical so that the total expenses over the 50-year examination period will be reduced.

Energy calculations have executed using the BEE and Motiwatti software and they will be used also in the future.

The general numeric properties of the manipulated reference building have been converted into minimum requirements. The required minimum level can be achieved in a number of ways. These are supplemented by other minimum requirements for factors affecting ecology with the purpose to make these fairly simple and creating small additional costs. Achieving the minimum level for all five required viewpoints, as well as adhering to the town plan will be the "ecological" transfer conditions of the site.

PIMWAG system

food production	1
diversity	2
health	3
natural resources	4
pollution	5

PIMWAG points are used to evaluate the quality of experimental building projects. Sub-areas affecting ecological quality are evaluated using various weighting coefficients applied to Viikki:

In order for building in Viikki to be considered comprehensively ecological on the level of the whole area and its sub-areas, all designs shall meet the system's minimum requirements. These requirements have been designed to be attainable with a reasonable investment. By improving the building's ecological properties above the minimum level, the site developer accumulates PIMWAG points. The system is open-ended to allow site developers to orientate themselves and collect points following to their own ecological preferences and sets of values. The maximum number of points attainable is 30. A design that has collected 10 points can be viewed as representing an ecologically excellent project; exceeding the 20 point mark requires exceptional innovation and an extensive grasp of ecological principles from the project group.

According to tests, minimum requirements can be attained with an

approximately 5% increase in building costs. This cost increase should be covered using conventional housing funding. On the other hand, it should be studied if the emphasis on ecology could be compensated by other design choices affecting the building economy (volumes, efficiency, facade materials, the area's surface materials, equipment...).

The funding of ecologically outstanding or innovative projects can be arranged for instance by the following means:

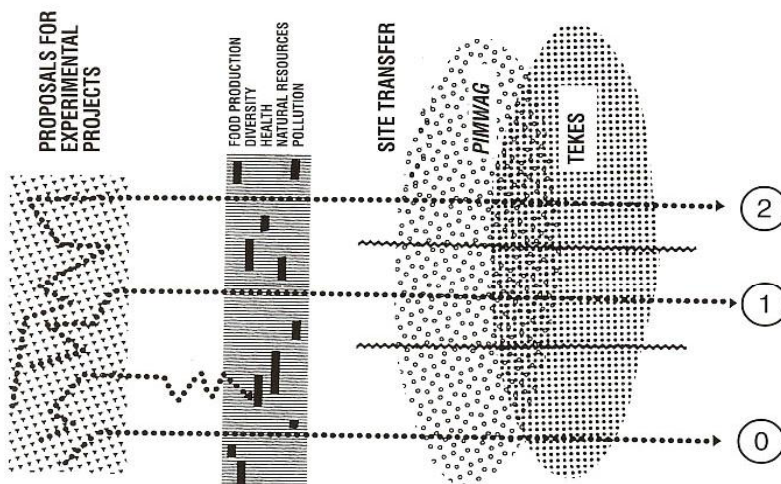
- Government support for ecological experimental construction and product development (Technology Development Centre TEKES, The Ministry of the Environment, and the Ministry of Trade and Industry).

- City policy on fees and charges.

- Town planning creates economically favourable basis for the design of the area (parking requirements, connection charges, floor area specifications, etc.)

Image-oriented experimental building

The image-oriented experimental building is aiming to create exceptionally high quality buildings able to attract attention. These shall always be linked to medium-term follow-up studies and commercial product development projects.



Follow-up

The purpose of follow-up studies is to secure that the experiments will function and to fill gaps in knowledge. Special attention must be given to the creation of new applied knowledge as well as to the identification of knowledge gaps.

2 PIMWAG METHOD

(PO 1)

PIMWAG POINTS

		Difference from the reference building
Minimum	3 200 kg/m ² , 50 years	-20%
1	2 700 kg/m ² , 50 years	-33%
2	2 200 kg/m ² , 50 years	-45%

(PO 2)

PIMWAG POINTS

		Difference from the reference building
Minimum	125 l/resident/day	-22%
1	105 l/resident/day	-34%
2	85 l/resident/day	-47%

POLLUTION

The building's emission load into the atmosphere or soil must not exceed approved values, nor must the quantity of non-recyclable waste generated by the building exceed approved values. The values are calculated per gross square meters of floor area.

CO₂

Substances that pollute the earth's atmosphere, as the oxides of carbon, sulphur and nitrogen, are released primarily because of energy use. All these emission quantities yield parallel correlation with energy use; for that reason, only limits for carbon dioxide emissions have been set for projects in Viikki.

The carbon dioxide emissions for the reference building over a 50-year period have been calculated as 4000 kg/m².

CO₂ emissions for a 50-year period of building occupation will be measured using the BEE software, designed for Viikki's design competition. The software takes into account the production of the examined building materials, 50 years of servicing, and CO₂ emissions caused by building maintenance. Construction site CO₂ emissions are left outside the scope of the examination.

Waste water

The quantity of waste water is described by the water consumption during the building's occupation. There is generally a direct correlation between incoming and waste water. Recirculation/purification systems reduce both to the same degree. The correlation weakens if, for instance, rainwater is used directly as household water without recirculation.

Based on general statistics, the water consumption of the reference building is 160 litres/resident, day.

Reduction in water consumption must be shown in the sanitary drawings of the building and will later be metered during follow-up. Follow-up will be implemented by apartment-specific remote-read meters which monitor hot and cold water consumption. The service manual required for each building explains the correct use of water saving devices.

Construction site waste

Construction site waste is measured in kg/m² of gross floor area. Construction site waste does not include surplus earth. The reference building's estimated construction site waste quantity is 20 kg/m².

The amount of waste can be reduced, for example, by sorting building waste, using pre-cut materials and employing reusable equipment. Decreases in waste quantities will be indicated in the building specification.

PO 3

PIMWAG POINTS

		Difference from the reference building
Minimum	18 kg/m ² , 50 years	-10%
1	15 kg/m ² , 50 years	-25%
2	10 kg/m ² , 50 years	-50%

Waste produced by residents

The solid waste load during the occupation period is measured through the quantity of mixed waste. The reference building's mixed waste quantity is 200 kg/resident, year.

Mixed waste reduction is shown in the waste management plan (possibility for sorting with necessary spaces) and will later be monitored in the follow-up. The service manual required for each building explains the correct use of waste collection point.

PO 4

PIMWAG POINTS

		Difference from the reference building
Minimum	160 kg/residence, year	-20%
1	140 kg/residence, year	-30%
2	120 kg/residence, year	-40%

Eco labels

Pollution can be limited by giving preference to materials meeting the criteria for Nordic or EU eco labels.

The use of materials meeting the eco label criteria will be shown in building specifications.

PO 5

PIMWAG POINTS

Minimum	No requirements.
1	Floor coverings and glues, or interior paints and lacquers fulfilling criteria.
2	Floor coverings and glues, and interior paints and lacquers fulfilling criteria.

NATURAL RESOURCES

More moderate use of natural resources can be achieved through building less, through durable and recyclable building or by using renewable natural resources. Reducing energy consumption conserves non-renewable fossil fuels.

Fossil fuels / purchased heating energy

The consumption of fossil fuels is measured by the used total primary energy, composed of the quantity of heating energy (including hot water)

NA 1

PIMWAG POINTS

		Difference from the reference building
Minimum	105 kWh/m ² , year	-34%
1	85 kWh/m ² , year	-47%
2	65 kWh/m ² , year	-59%

purchased during the occupation period, the quantity of electrical energy purchased during the occupation period, the embodied energy of the building materials, and the energy needed for building maintenance over a 50 year period. The primary energy calculation also takes into account the energy loss during its production.

The reference building's heating energy consumption is 160 kWh/m², year.

Heating energy consumption is measured using the Motiwatti software. Follow-up is implemented using apartment-specific remote-read meters.

NA 2

PIMWAG POINTS		Difference from the reference building
Minimum	45 kWh/m ² , year + possibility for flexible local adjustment	-0 %
1	40 kWh/m ² , year	-11%
2	35 kWh/m ² , year	-22%

Fossil fuels / purchased electrical energy

The reference building's electrical energy consumption (housing corporation + resident electricity) is 45 kWh/m², year.

Electrical energy consumption is indicated in the electricity use plan. If the use of electrical energy leads to significant reductions in total energy consumption, minimum requirements may be waived. Follow-up will be implemented apartment-specifically.

NA 3

PIMWAG POINTS		Difference from the reference building
Minimum	30 GJ/m ² , 50 years	-19%
1	25 GJ/m ² , 50 years	-32%
2	20 GJ/m ² , 50 years	-46%

Fossil fuels/ primary energy

The reference building's primary energy consumption is 37 GJ/m², 50 years.

Primary energy consumption is measured using the BEE software. The software measures the embodied energy of the materials selected for examination and the energy used by the building during its occupation, over a period of 50 years. It does not measure the construction site energy consumption. It means that the BEE software is more reliable in reporting the differences between alternative solutions than the absolute use of primary energy. The efficiency ratio of energy production, as well as emission levels, compare to Helsinki Energy Company values.

NA 4

PIMWAG POINTS	
Minimum	Conventional solution
1	15% of apartments flexible or housing functions concentrated in common spaces
2	15% of apartments flexible or housing functions concentrated in common spaces, and multi-purpose spaces designed for buildings

Floor plan flexibility, common space use, and multi-functionality of spaces

Increasing the residential density can have the most significant effect on the use of natural resources. A floor plan that is satisfactory for a small

number of residents, yet permitting family growth without significant plan changes, can serve the family in different life situations, conserve natural resources, and allow increased residential density if necessary. By increasing shared use of spaces, it is possible to remove functions such as clothes washing, drying, or sauna bathing from individual apartments. Multi-use spaces permit services and jobs to be situated closer to housing, reducing the need for traffic.

Measurement is performed by requesting a statement from the Area Co-operation Group.

HEALTH

The building's interior climate must be healthy. The building may not become subject to health risks (mold, etc.) caused by moisture problems. The building must be comfortable.

Interior climate

Goal values have been set for interior climate, building works, and finishing materials according to Classification of Indoor Climate, Construction, and Finishing Materials 95 (Finnish Society of Indoor Climate and Quality).

The fulfilment of criteria is shown in the building specification.

HE 1

PIMWAG POINTS

Minimum

SI	Interior climate, Class 2
PL	Purity, Class 1
ML	Purity of finishing materials, Class 2
2	
SI	Interior climate, Class 1
ML	Purity of finishing materials, Class 1

Management of moisture risks

The management of moisture risks is indicated in design documents. Measurement is performed by requesting a statement from the Building Regulation Department of Helsinki.

HE 2

PIMWAG POINTS

Minimum

2	Conventional adequate solution Moisture risks are well undercontrol
---	--

Noise

To reduce the health risks caused by noise pollution the norms have increasingly been tightened. To achieve a good sound insulation level in the area, it is recommended that the most recently proposed norms be used (Ministry of the Environment proposal 28 November 1996).

The fulfilment of criteria is shown in building specifications.

HE 3

PIMWAG POINTS

Minimum

1	No additional requirements New norms (under preparation)
2	Noise insulation clearly exceeds above norms

HE 4

PIMWAG POINTS

Minimum 1	Adequate solution Excellent solution
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HE 5

PIMWAG POINTS

Minimum 1	Conventional solution 15% of apartments with alternative solution
2	30% of apartments with alternative solution

Exposure of site to wind and sun

Measurement is performed by requesting a statement from the Area Co-operation Group regarding the yard design.

Alternative floor plans

Living comfort can be increased by increasing housing diversity. Measurement is performed by requesting a statement from the Area Co-operation Group.

NATURAL BIODIVERSITY

The natural vegetation type of the site and its surroundings shall form the basis for the planning of plant selections and plant associations for the site. Species-rich solutions featuring domestic varieties will create a durable natural diversity for the site. Micro-organisms and the plant population should be able to exchange genes with the natural surroundings through nature corridors. It should be possible for certain larger animals (hare, squirrel, birds), to live in the area. As large a quantity of storm water as is possible should be used on the site without drainage.

BI 1

PIMWAG POINTS

Minimum 1	Plant selections based on identified vegetation type. Plentitude of species and their multiple layers characterise the vegetation.
2	Garden design has created new vegetation types that increase natural diversity.

Plant selections and natural vegetation types

The Viikki area is composed of fields reserved for the cultivation of a single plant species. Because it is not possible to support the existing plant population, the points system is specially tailored for Viikki's conditions.

Measurement is performed by requesting a statement from the Area Co-operation Group.

BI 2

PIMWAG POINTS

Minimum 1	Conventional adequate solution Only the water from the building foundations' drainage system is discharged
2	Rainwater is used to create an enriched ecosystem.

Storm water

Measurement is performed by requesting a statement from the Area Co-operation Group.

FOOD PRODUCTION

The solution enables the continuation of production of food suitable for people. Utilisation of composted humus and rainwater are required. The solution should enable the site to be returned to food production at a later stage.

Planting

Measurement is performed by requesting a statement from the Area Co-operation Group. *

(SU 1)

PIMWAG POINTS

Minimum
1
2

Conventional solution
One third of planted bushes and trees are useful plants. Residents are given good opportunities to cultivate plots themselves.

Topsoil

Measurement is performed by requesting a statement from the Area Co-operation Group.

(SU 2)

PIMWAG POINTS

Minimum
1

The site's topsoil is used in the Viikki area.
The site's topsoil is used on the site.

PIMWAG EVALUATION

	MAX	GRADE	PIMWAG
10 POLLUTION	10		x 10/10 =
CO ₂	2		
Waste water	2		
Construction site waste	2		
Residents' waste	2		
Eco labels	2		

8 NATURAL RESOURCES TOTAL	8		x 8/8 =
Heating energy	2		
Electrical energy	2		
Primary energy	2		
Flexibility, common use	2		

6 HEALTHINESS TOTAL	9		x 6/9 =
Interior climate	2		
Moisture risks	2		
Noise	2		
Wind protection, solar impact	1		
Alternatives, multi-purpose use	2		

4 BIODIVERSITY	4		x 4/4 =
Plant selections	2		
Storm water	2		

2 FOOD PRODUCTION	3		x 2/3 =
Planting	2		
Topsoil	1		

PIM WAG

TOTAL

111
112

3 CONCLUSIONS

The work proved to be just as challenging as had been expected.

The goals were focused to establish reasonably attainable **minimum objectives and criteria** for ecological building using the means of today's building practices, as well as to create an open and transparent **model for steering experimental building** that will be supplemented by more comprehensive data at a later time. Both subsidiary goals were achieved.

1. Current building can be made ecologically more rational through the quickly tightened regulations. Study of the reference building revealed that an additional investment of approximately 6% will achieve significant improvements while at the same time making it economically possible to achieve a workable solution over a longer time span. In the example calculation, 50-year life span costs were decreased by 1%.

2. Finnish building has emphasised quantity at the expense of quality. **Moving from limited technological possibilities to unlimited possibilities, realising at the same time that those unlimited resources are extremely limited is the essence of the present time.** To maintain at least a satisfactory domestic standard, not to mention export quality, the building industry and the building culture must be radically transformed. This will not succeed without special measures initiating the change.

To achieve significant experimental building capable of steering the developments it is required that approximately 10% of total investments be directed to the development of new solutions and their experimentation.

3. In light of the tests conducted, the PIMWAG system has worked and it has helped to focus on the most essential factors. It favours solutions which positively affect ecology from many directions. Naturally, the system cannot be perfectly balanced but it steers towards the right direction. The operational development of the system, i.e. the activity steering towards better ecology of building, requires experimental use and an extensive three-year follow-up study to clarify the area's functioning and its steering system.

The changes during the development work are one example of how the PIMWAG system can function in principle. As the knowledge base grew and basic data was adjusted, it was possible to alter tabulations without compromising the primary goals. To achieve reliability, the submissions to the latest design competition must be checked using control calculations in order to initially calibrate the point system.

4. Successful experimental building requires also the availability of the research plans of the development and experimental projects, the preparation

of the building maintenance manual, and a product folder describing the materials and solutions employed.

5. The starting point of the work was to prepare the criteria through calculations. After fine tuning, their final calibration has to be carried out empirically. We recommend that this stage be started.

POSTSCRIPT

Due to the complexity of the task, it was clear from the outset that the work would remain “unfinished” in all respects. At its best, when the work is handed over, there can only be openings into a continuously expanding area. Work in several significant subsidiary areas had to be given up when it became obvious that sufficient certainty for their operational implementation could not be achieved, either due to time constraints or the complexity of the subject. These included, among others, lists of banned and recommended substances based on various criteria. Another well worked area was the use of natural resources analysed by building parts.

For example, a calculation method was developed for exterior walls, roofs, interior partitions and interior surface finishes through which it would have been possible to estimate the effect of the use of each material in these building parts, subject to wear and continuous renewal, on land fill waste per year - in other words, how much natural raw materials would become un-reusable. Experimental calculations showed dramatic differences of importance between the life cycle effects of different materials, but there were not even mediocre guesses available to give values to the global significance of their production chain or their prevalence, even though we all know for sure that there is a staggering difference if you use a 400-year old oak or a 20-year old poplar.

Helsinki 25 May 1997

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APPENDIX: Examples of PIMWAG criteria fulfilment

CO₂ emissions (GWP)

kg/m² /50 years

PO 1

PIMWAG
POINTS

Difference
from the
reference
building

Minimum	3 200 kg/m ² , 50 years	-20%
1	2 700 kg/m ² , 50 years	-33%
2	2 200 kg/m ² , 50 years	-45%

EXAMPLES OF EXPEDIENTS

Conventional	4000	
Minimum	3200	<ul style="list-style-type: none"> - Improved insulation of envelope. - Heat recovery from exhaust air. - Warm water energy consumption lower than usual. - Electrical energy consumption lower than usual. - Apartment-specific metering of energy consumption. - Guidance for energy saving measures (instructions). - Selection of building materials.
1 point	2700	<ul style="list-style-type: none"> - Clearly improved insulation of envelope. - Effective heat recovery from exhaust air. - Warm water energy consumption clearly lower than usual. - Electrical energy consumption clearly lower than usual. - Apartment-specific metering of energy consumption. - Guidance for economy measures and demonstration of consumption (money spent). - Effective use of passive solar energy. - Use of low CO₂ emission materials. - Optimisation of the use of materials (recycling).
2 points	2200	<p>IN ADDITION TO THE PRECEDING</p> <ul style="list-style-type: none"> - Effective buffer zones. - Active use of solar energy for heating. - Active saving of electrical energy by for example making use of time dependent tariffs.

Water consumption

(litres/residence, day)

PO 2

PIMWAG POINTS		Difference from the reference building
Minimum	125 l/resident/day	-22%
1	105 l/resident/day	-34%
2	85 l/resident/day	-47%

EXAMPLES OF EXPEDIENTS

Conventional	160	
Minimum	125	- Modern bathroom fixtures (4 litre flush, one hand tap with limit stops). - Water meters, resident advice.
1 point	105	- Besides previous, dual volume flush toilet seat (4 and 1,5 to 2 litres), apartment-specific water pressure control, water saving shower head, intensified advisory services and monitoring of pressure control.
2 points	85	- Besides previous, use of rain/grey waters.

Construction site waste

(kg/m² excluding surplus earth)

PO 3

PIMWAG POINTS		Difference from the reference building
Minimum	18 kg/m ² , 50 years	-10%
1	15 kg/m ² , 50 years	-25%
2	10 kg/m ² , 50 years	-50%

EXAMPLES OF EXPEDIENTS

Conventional	20	
Minimum	18	- Sorting of construction site waste according to latest Helsinki Metropolitan Area Council regulations.
1 point	15	- Besides previous, utilisation of earth and rock materials and timber on site stemming from construction phase; minimal storage.
2 points	10	- Besides previous, boards and timber are ordered to ready-cut sizes; use of reusable forms in casting.

Waste produced by residents

Accumulated mixed waste
(kg/residence, year)

PO 4

PIMWAG
POINTS

Difference
from the
reference
building

Minimum	160 kg/resident/year	-20%
1	140 kg/resident/year	-30%
2	120 kg/resident/year	-40%

EXAMPLES OF EXPEDIENTS

Conventional	200	
Minimum	160	- Separate collection of biodegradable waste, collection of cardboard, kitchen cabinet designed for waste sorting.
1 point	140	- Besides previous, collection and utilisation of garden waste, block-specific glass collection, goods exchange centre in connection with reception for problem waste, apartment-specific receptacle for problem waste.
2 points	120	- Besides previous, block-specific collection of metal, wood waste, textile waste, and box packaging waste; building-specific composting.

During the construction phase, conditions can be created that will help reduce resident generated waste. Waste reduction will, however, depend on the residents themselves and their behavioural habits. For that reason resident advisory services and follow-up require separate projects.

Eco labels

(criteria as in Nordic or EU eco labels)

PO 5

PIMWAG
POINTS

Minimum	- Conventional
1 point	- Of such paints, lacquers, glues, or surfacing materials for which eco label criteria exist, at least two examples used fulfil these criteria.
2 points	- Of such paints, lacquers, glues, or surfacing materials for which eco label criteria exist, or for which eco label criteria are being prepared, the majority used fulfil these criteria.

Consumption of purchased heating energy

kWh/m², year

NA 1

Expedients as for PO 1 without material related requirements.

Purchased electrical energy

NA 1

The use of electricity is essentially and directly linked to modern social life, making possible activities that would otherwise be impossible.

The use of electrical energy, in other words the use of electrical appliances, is largely determined by our daily living patterns. The following example is a calculation for a four-room apartment and related common spaces:

1. Lighting

6 energy-saving miniature fluorescent lamps are used, switched on for an average of 8 hours per day throughout the year.

6 units x 0.04 kWh/day x 360 days x 8 hours = 691 kWh / 6,91 kWh/m².

2. Hygiene

Laundry is washed once a week throughout the year.

5 kWh x 50 weeks = 250 kWh / 2.5 kWh/m²

3. Food

Food is prepared once a day throughout the year, coffee is made 3 times a day throughout the year, a refrigerator/freezer operates throughout the year, and dishes are washed by machine daily.

2 kWh x 360 days = 720 kWh / 7.2 kWh/m²

0.1 kWh x 3 x 360 days = 108 kWh / 1.08 kWh/m²

1.7 kWh x 360 days = 612 kWh / 6.12 kWh/m²

2 kWh x 360 days = 720 kWh / 7.2 kWh/m²

4. Entertainment

Television is viewed an average of 4 hours a day throughout the year.

$0.1 \text{ kWh} \times 360 \text{ days} \times 4 = 144 \text{ kWh} / 1.44 \text{ kWh/m}^2$

5. Electricity use in the building

The building's electrical power consumption is 14 kWh/m^2 , including pumps, fans, lifts, and other equipment in common use.

The total energy consumption is 44.5 kWh/m^2 , which gives no PIMWAG points.

1 point would be earned by reducing consumption, for example by the amount used by the dishwasher.

2 points would be earned by further reducing consumption by the amount used by the freezer.

The efficiency of today's electrical appliances is excellent so that to reach a higher level requires a completely new philosophy of function and use, equivalent to the progress seen in, for example, product development of mobile telephones.

This development can be promoted and prepared for in the way that the implementation topology allows the addition of one's own functions at the level of the apartment, the building, and the block.

Apartments shall have connections and controls for:

- information networks and LON building control system
- two-way TV and radio networks
- fixed connection and cordless telephone networks
- the mains system
- an independent 12 V solar panel for eco electricity production.

The latter can be used, for example, for:

- additional ventilation of a greenhouse
- additional ventilation of living space
- 12 V outdoor lighting

Space and equipment in each building for the following:

- computer networks and LON building control system
- private TV and radio network connections and selectors
- controls and selectors for telephone traffic
- eco electricity production by wind-powered generator

The latter can be used, for example, for:

- telecommunication systems
- decorative lighting
- energy source for other eco devices

Space and equipment in each block for the following:

- computer networks and LON building control system
- private programme TV and radio broadcasting and selectors
- controls and selectors for telephone traffic
- eco electricity production and/or heat production using non-fossil fuel.

The latter can be used, for example, for:

- the mains system
- the heating network
- own needs at the level of the block

Generally the selection of self-powered and so-called passive equipment and systems is recommended in design solutions, for example windows and mirrors instead of electric lighting, natural ventilation, mechanical doorbells, etc. Otherwise, energy-saving models are to be employed.

Primary energy consumption

GJ/m² / 50 years

NA 3

Expedients as above, emphasising materials selections from the standpoint of low primary energy consumption and optimum use of materials (recycling).

Interior climate

HE 1

Finnish Society of Indoor Air Quality and Climate, "Classification of Indoor Climate, Construction, and Finishing Materials" 15 June 1995, goal values. Refer to document, the enclosed is only a condensed outline.

Indoor climate class	SI	CONDENSED OUTLINE
Conventional	S3	<ul style="list-style-type: none"> - Meets requirements set by public authorities. - Room temperature in winter 20-24°C. - Air change rate exceeds 0.4 times per hour. - Total volatile organic compounds (TVOC) concentration under 0.6 mg/m³. - Noise level of HVAC equipment under 28 dB. - etc
Minimum	S2	<ul style="list-style-type: none"> - Room temperature in winter 21-23°C. - Air change rate exceeds 0.6 times per hour. - TVOC under 0.3 mg/m³. - Noise level of HVAC equipment under 25 dB. - Finishing materials shall consist primarily of classes M1 and M2. Class M3 materials may be used up to a maximum of 20% of the room's interior surfaces, however not to exceed 1 m²/floor m².
2 points	S1	<ul style="list-style-type: none"> - Room temperature 21-22°C. - Air change rate exceeds 0.8 times per hour. - TVOC under 0.2 mg/m³ - Noise level of HVAC equipment under 25 dB. - Finishing materials shall consist primarily of class M1 materials. Class M2 materials may be used up to a maximum of 20% of the room's inside floor area, however not to exceed 1 m²/floor m². Class M3 materials only in small quantities. - Recommended purity class for building works P1.
Purity class PL for building works		
Conventional	P2	<ul style="list-style-type: none"> - Conventional purity class for ducts, their handling and installation.

		<ul style="list-style-type: none"> - Filters for air conditioning equipment minimum EU4, exhaust air to be filtered (EU3) before regenerative heat recovery. - Use and servicing instructions for air conditioning equipment. - Intake air ducts to be checked and cleaned if necessary at 5 year intervals. - Requirements for filter replacement. - Protection of supplies to be used in interior spaces during transport and storage. - Requirements for cleaning of spaces.
Minimum	P1	<ul style="list-style-type: none"> - Ducts to be cleaned from inside and plugged at the plant, supplies placed in closed containers, ducts protected during transport and storage. If transported inside each other, the outer surface must be as clean as the inner surface. - During installation, the open ends of ducts must be sealed for protection against dust during pauses or interruption in installation. - Ducts shall be easily cleaned. - Duct system shall be cleaned before operational testing. - Ducts in hollow-core floor slabs shall be accessible for cleaning and shall remain dry and clean. - The cleaning of silencers must not cause fibres to be released - Air conditioning equipment must not be used during the construction period. - Intake air filtration class EU7. - Restrictions for the use of regenerative heat recovery. - No return air. - Air conditioning motor and belt transmission separated from intake air flow. - Requirements for filter replacement intervals. - Protective wrappings of building materials to be used in the interior shall be removed only immediately before installation. The indoor air shall be clean and dry during the installation of finishing materials. - Spaces must be marked with "P1 space" signs. - Special requirements for cleaning.
Purity class ML for finishing materials		
Conventional		Materials not tested for emissions.
	ML3	Materials not tested for emissions, and materials whose values exceed class values.
Minimum	ML2	Emission-tested materials whose emissions do not exceed the given values, for instance total TVOC emissions under 0.4mg/m ³ per hour, insignificant material odour (percentage of unsatisfied observers under 30%).
2 Points	ML1	Emission-tested materials whose emissions do not exceed clearly more stringent values, for instance total TVOC

emissions under 0.2mg/m² per hour, insignificant material odour (percentage of unsatisfied observers under 15%). This class also includes the following natural materials: brick, natural stone, marble, ceramic tiles, glass, metal surfaces, sawn timber, and logs.

Storm water

HE 2

Examples of expedients

Minimum

Conventionally adequate solution

1 point

Out of storm water, only the water from the building foundations' drainage system is discharged; in selection of the surface materials of parking areas, walkways, and service roads their capacity to retain water is to be observed; rainwater is led as a surface flow to thematic water basins on the site.

2 points

In addition to the above, rainwater is used to create enriching ecosystems; rainwater collection barrels under apartment and service building drainpipes, water to be used for watering gardens and cleaning tools; along the thematic water basins plants with high water retention capacity; water absorption well.

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