Architectural Quality of Low Energy Houses

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ARCHITECTURAL QUALITY OF LOW ENERGY HOUSES.

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INTENT AND PUPOSE: This paper expounds a systematic vocabulary concerning architectural quality in houses in general and low energy houses in particular.
The vocabulary consists of nine themes. Inside each theme, examples are given of how to achieve both architectural quality and good environmental performance.
The purpose is to provide a useful tool for communication and argumentation in order to further integrated design of houses with good architecture and good environmental performance.

BACKGROUND: Building physical strategies to create low energy houses affects architecture in many ways: High insulation to reduce heat loss means thicker building envelopes. Attempts to avoid heat conducting materials supplant stone facades in favor of wooden and other light constructions. The size and orientation of windows is crucial both to heat loss and solar heat gain as well as to architecture and indoor climate. The size of rooms and the spatial organization of houses are cornerstones of architecture which can also be related to the ventilation strategies. Attempts to store heat talk in favor of exposing heavy indoor materials.
This is just a few examples of how close low energy building physics and architecture are intertwined. Most building physical strategies have architectural potentials and can be used to ad character, expression and good indoor conditions to a house, if handed properly. If ambitious building physical strategies, as for instance in a passive house, are not combined with good architecture, there are two obvious negative consequences:
1. The inhabitants will have to spend their life in an environment of lesser functional, technical and aesthetical standard.
2. The distribution and prevalence of low energy houses will be obstructed by bad reputation. Dark and clumsy houses don't expand a market.

On the opposite, if low energy is combined with high architectural standards, low energy houses might prevail, also among that great majority of people who looks for a good, local environment for themselves and their family, before they think of caring for the global environment.

Building physical attempts can be measured and argued about in a logical and rational way. Civil engineers are good at this, and the best civil engineers can handle and explain many physical attempts as a whole. Architecture is most often argued about by architects. But even good architects are often not very good at this. Of course architecture is more difficult to be specific about: It cannot be quantified and is not always about logic and rationality. But still, architects should do better and be sharper than just referring to 'architectural quality', 'spatial quality' or the big, mysterious 'wholeness'.

METHOD: The development of the vocabulary is based on literature studies and a cross-disciplinary research project [Marsh & Lauring, 2005] carried out as an iterative process, where environmental knowledge and conditions in Denmark were mapped and organized in the four categories Indoor climate, Energy, Materials and Water; where housing quality where described according to Vitruvius´s terms of Strength, Function and Beauty; and where environmental optimization and architectural quality were united in the design of examples of detached housing, terraced housing and multi storey housing with carbon dioxide emissions reduced to 60% below standard. The vocabulary and the given examples have the character of assessments based on knowledge and experience.

<u>THE VITRUVIAN TRIAD</u>: The vocabulary concerning architectural quality lends its main structure from the triad formulated by Marcus Vitruvius Pollio, who was a Roman writer, architect and engineer. Vitruvius is the author of *De architectura* from app. 25 BC, known today as *The Ten Books on Architecture*. It is the only surviving major book on architecture from classical antiquity [Gordon, 2003]. Vitruvius is most famous for stating that architecture should contain the three qualities of firmitas, utilitas and venustas – that is firmness, usefulness and beauty, often referred to as the Vitruvian triad. Firmitas is commonly translated to durability, sometimes to strength. *De*

architectura was rediscovered in the fifteenth century and was an enormous source of inspiration for renaissance architecture and in the centuries to come. Up till the nineteenth century the Vitruvian triad stood unshakable as the main definition on the essence of architecture. Since 1990, Vitruvius has experienced a renaissance amongst environmental architects: He is conscious of the importance of relating architecture to the local climate, and his triad is a practical one. Where postmodern builders might fail to handle constructions with competence and tend not to worry about the finesses of utility while hailing aesthetics as autonomous qualities, to Vitruvius strength, usefulness and beauty stands equal. Neither of them can be expelled. They are cornerstones in the triangle that defines the field of architecture.

But is an antique theory really relevant from a modern environmental perspective? Well, from an environmental point of view, it seems obvious that architecture should be useful. Valuable material and energy resources should be used with care, where it serves a good purpose. Environmental architecture should also have strength and durability. The longer the house lasts, the lesser resources are used and lesser waste is produced per year. Only should one have in mind that the main environmental impact normally relates to supplying the house with energy for heat and electricity, not from building it [Marsh & Lauring, 2000]. A durable house should therefore be designed for very low energy consumption, or be prepared for energy saving alterations.

Should environmental architecture also hold aesthetic qualities? In the sense that architecture constitutes the local environment of human beings who (in most cases) have a sense of beauty, it should. One could also argue that beautiful buildings are more likely to be taken care of and protected from decline, thus saving material resources.

All in all the Vitruvian triad seems relevant when it comes to environmental responsibility.

But is the definition broad enough? One could argue that Vitruvius' theory only focuses on architecture as a local phenomenon, where good architecture nowadays should have a broader focus, including the reciprocal, physical interaction with the outer environment - the global atmosphere, for instance. Three conditions speak against including such interactions in the definition of architecture itself:

1. If physical interactions are included in a definition of good architecture, one could claim that economic or social interactions with the outer environment should be included too. This would soon leave us with a definition so broad, that the focus is lost.
2. The physical interactions with the outer environment are quantifiable by nature. Making them part of a definition of architectural quality, would only confuse things in general and scientific approaches in particular.
3. The Vitruvian triad is well known and holds a lot of authority. It is better to build upon it, thus letting it support a modern, environmental approach.

It is therefore chosen to develop the Vitruvian triad, still understanding good architecture as a local phenomenon, but with special regards to the physical interactions with the outer environment.

Book I, chapter III, 2nd verse: 'All of these must be built so that account is taken of strength, function and beauty. Account will have been taken of strength when foundations are carried down to the solid ground and materials are wisely and liberally selected; of function when the disposition of rooms of each kind is flawless and presents no hindrance to use and when each element is assigned to its suitable and appropriate exposure; and of beauty, when the *symmetriae* have been calculated correctly so the relative measurements of the members will give the work a pleasing and elegant appearance'. [Gordon, 2003]

This is Vitruvius' own definition of his three key terms. Since Antiquity, symmetry has lost its position as a correct principle of building design, while artificial lighting and ventilation systems have moved in.

In modern terms we speak of the functional, technical and aesthetical qualities of a house:

The functional qualities of the house are named utilitas and concern the organization and usefulness in relation to the needs of the occupants.
The technical qualities of the house are named firmitas and concern the physical, functional and aesthetic strength and durability of the materials, constructions and technical installations.
The aesthetic or sensuous qualities of the house are named venustas and concern the design in details as well as an entirety.

As this definition [Marsh & Lauring 2005] shows, it is difficult to separate sharply the three qualities. One may speak about aesthetic durability: We throw out plastic parts, because they do not age with grace. Is this a durable or an aesthetical phenomenon?
The difficulty of separating the qualities becomes more obvious if we try to sub-divide the three key terms. But that is what we will try to do knowing very well, that systematic structure - at least in human science - seldom fits reality in detail.

THE CONTEXT. The vocabulary is directed first and foremost for designing new buildings. The kind of building we have in mind is a house - in the sense of 'dwelling'. The house can be detached, terraced or a multi storey house. The individual housing unit is thought of as being relatively small and not luxurious - like in social housing, expecting that our aim for environmental responsibility does not allow us to use an abundance of volume or materials for each family. Small housing units provide us with certain architectural problems: We have to think careful and economically in order to establish good space. And our aesthetics cannot rely on marble or gold. We have to make the best of more humble materials.

AN OVERVIEW. Here is an overview of the vocabulary. As seen below, each of Vitruvius's three key terms are subdivided into three, giving us all in all nine terms:

Utilitas: Spatiality – Accessibility - Utility.

Firmitas: Robustness – Adaptability - Patina.

Venustas: Daylight – Experience - Character.

<u>UTILITAS</u>. The functional qualities of the house are named utilitas and concern the organization and usefulness in relation to the needs of the occupants.

SPATIALITY. How rooms are proportioned, formed and combined.
The basic function of a house is to provide a space for living that is sheltered from the outdoor climate. Therefore spatiality is the first and basic functional quality. Spatiality is also an aesthetic quality, though. In some buildings, for instance a church, the aesthetical aspects of space may be more important than the strict functional, but in small housing units functionality will prevail.
The space of the house can be defined as the volumes that are limited by walls, floors and lofts. Spatiality is a more complex subject that also includes the perception of space. This perception is dependant on the color and texture of the internal surfaces, and can go beyond the physical limits of the building, as you perceive through windows. Spatiality is often characterized by the opposites open and closed: A dwelling must contain a lot of functions that calls for separation due to noise, damp or wishes for privacy. But the many separations may - especially in small housing units - result in a lot of small rooms, where no room really raises above the claustrophobic. An effort to achieve openness should therefore be part of the architectural strategy.
Spatiality reflects contemporary ideals and values. Historically seen, the modernism of the 1920'es marks an important break, where closed rooms are supplanted by open, floating space, and where big glass facades open up to the surroundings. Mies van der Rohes pavilion for the international exhibition 1929 in Barcelona is a famous example of floating space. [Curtis, 1996]
<u>Make fewer but bigger rooms.</u> For instance by placing kitchen-, dining room- and living room-functions in one big room. Environmentally this will provide better conditions for natural ventilation [Marsh & Lauring, 2003], reduce the use of materials for inner walls, and it may reduce the need for indoor space, if the gangway area is reduced.

Make smaller room smaller to make big rooms bigger. Small rooms can be given a size that allows them exactly to contain for instance bed, wardrobe, table and chair. This can leave space for very big rooms that are not so functionally predestinated. There can be exiting spatial contrasts between small and big rooms, and environmentally the conditions for natural ventilation may be improved.
Make long glances possible. A perception of openness may be furthered be enabling long glances through the dwelling. For instance by placing doors en suite, so one can look through several rooms and perhaps finally through a window, or by designing transparent inner walls. This strategy may also give better daylight conditions thereby reducing the need for artificial lighting.
Secure good height of rooms. This is a key strategy of spatial quality that may further natural ventilation and allow the windows to be placed higher thus throwing daylight deep into the rooms.

ACCESSIBILITY. How the occupants can access the rooms, installations and furniture.
Many people, elderly in particular, have reduced motile, sensory or cognitive functionality. Good accessibility means modest demands for functionality. In dwellings the motile functionality is in focus, and staircases are a typical problem.
Gather related functions. Place the kitchen close to the scullery, the kitchen close to the dinner table, and the bathroom close to the laundering. This will reduce the walking distances. Gathering service functions may reduce the need for pipes and tubes. It may also reduce the heat loss from hot water pipes and secure a quicker supply of water with the needed temperature.
Reduce the number of levels. From the point of accessibility there is only one level in each dwelling.
Make sideways passage possible. Doors may represent a barrier to wheel chair users, so an open plan layout may be preferable, also accommodating natural ventilation. Good accessibility in general will reduce the need for alterations once the house is going to be used by persons with reduced motile functionality, and will thereby reduce the use and waste of building materials.

UTILITY. The capability of the dwelling to accommodate and support the activities of the occupants and their need for storage.
Many activities are dependant on the presence and placement of certain types of furniture. The possibilities of furnishing are therefore an important precondition for utility. It is preferable that a dwelling can be furnished, arranged and used in different ways over time.
To use the furniture in a comfortable way, you need some operating space, for instance in front of beds or closets. Also, furniture should not block gangways. Once the furniture, operating space and gangways have taken their share, ideally some part should be left as free space supporting free movement, activities not related to furniture - and a sense of freedom.
The modernism of the 1920'es was in Scandinavia sometimes nicknamed functionalism. No coincidence, as this architecture meant a break through for a more functional attitude and an aim for a higher utility, with Margarete Schütte-Lihottzkys Frankfurter Küche as the archetypical example [Curtis, 1996]. In Denmark the utility of dwellings reached a high point in the 1950'es, whereas the end of the century has meant a decline due to more focus on style than utility. [Nygaard,1992]. Abundance, also when it comes to the typical amount of space in new housing units, may have weakened the focus on economic plan solutions and utility.
Give the housing unit a general utility. The sketching of furnished plans may secure that the housing unit can be furnished appropriate in several ways, including rooms shifting function. The individual rooms must be sufficiently large and regular to house specific furniture and functions. A general utility will reduce the need for material resources for alterations.
Combine operational space and gangways. This is an important key for economic use of space. As for instance if a small room is provided a breadth so that furniture can be placed at two opposite walls and the (double) operational space at the same time can be used for walking through. Economic plan solutions may reduce the need for housing area and thereby the need for materials, heating and ventilation.
Make furnishing for light demanding activities possible close to windows. Such activities are often related to tables or to chairs for reading. The use of high insulating windows allows sitting or standing close to windows without cold draughts. By utilizing the daylight, the need for artificial lighting is reduced.

Let climatic conditions influence the organization of the housing unit. The most important conditions are the path of the sun, the light and heat related to the sun, and the temperature defining the conditions for thermal drift. Sleeping rooms should be oriented to the north or east, if coolness is wanted in the evening. Living rooms may be oriented to the south and west, to benefit from solar heat. Kitchen and dinner place should be protected from overheating due to west oriented windows. In two-level dwellings, sleeping rooms may be placed on the lower and living rooms on the upper floor, to benefit from the principles of thermal drift.
Spatial organization according to thermal conditions will reduce the need for heating and ventilation.

FIRMITAS. Firmitas characterizes the technical qualities of the house and concern the physical, functional and aesthetic strength and durability of the materials, constructions and technical installations.

ROBUSTNESS. How the construction of the house as a whole is robust in relation to function, action and lifetime.
The house must not sink or break down due to its own weight and the weight of snow, furniture and people. The house must also be able to withstand climatic actions in the form of wind, sunlight, heat, cold, rains or snow. And the house must withstand the actions from the occupants including the use and diversion of air, water, heat, electricity and garbage connected to a multitude of installations. Though materials are chosen according to the expected impacts, the individual parts of the house will last for a great variety of years. The robustness of the construction will depend on how worn-out parts can be repaired or replaced without destroying the sound parts of the house. Robustness is therefore not only about lasting long but also about the potentials of renewal.
Since the mid-seventies, Danish building techniques have been greatly influenced by attempts to minimize heat loss including thick layers of insulation and layers to ensure air tightness. There has also been a huge escalation in the number and size of technical installations and their share of the total building costs. As these changes have come gradually, the building techniques have typically only been slightly revised. The question is however, whether the environmental conditions – which seem to be sharpened everyday decade – and the technical changes should allow for revolution rather than revision of the strategies for constructing modern housing.
Design buildings that withstand the physical impacts. Such an advice may seem banal, but the postmodern attitude of ‘anything goes’ transferred to building techniques has caused a lot of complicated and hazardous roof and façade details in a field of light and unproven materials. A simple roof shape without roof valleys but with big overhang can prolong the life of both roof and façade. The design of façade details must secure drainage of water. Façades should not necessarily be designed in only one material: Stronger cladding can be used near the ground, at corners and in gateways where the risk of heavy physical impacts are bigger.
Construct for renewal. Building components with short lifetime should not be build into constructions with long lifetime as is seen with roofing underlay for instance.
Reversible joints are important. Screws and bolts, clips and grooves are preferable to nails, glue and strongly adhesive joints. Renewable construction strategies will reduce the use of material resources and strongly improve the possibilities of recycling.
Separate raw house and installations. The technical installation often has a short lifetime, physically and functionally. Instead of building them into long lasting constructions, the pipe work can be visible realizing its aesthetic potentials or it can be placed in installation channels so big, that a human being can inspect, repair or replace the used parts. This will save material resources including metals with short supply horizons. Installation channels will facilitate the installation of energy saving systems and equipment in future years.

ADAPTABILITY. How the house can undergo spatial, constructive or technical adjustments and changes.
The adaptability will depend on the character of the bearing system. Traditional bearing facades or the bearing partition walls of industrial high rise limits the spatial possibilities in different ways,

while the column-deck system leaves more freedom for spatial changes. The adaptability also depends on to what extend pipes and tubes and other installations get in the way.
Adaptability may add to the architectural character of the house. A famous example is Rietvelds Schroeder Haus from 1924, where the upper floor is one big room that can be split into small rooms by accordion or sliding doors [Curtis 1996].
Separate permanent and temporary parts. Adaptability can be furthered if there are architectural and technical clear distinctions between more permanent parts including the bearing system, and more temporary parts that should be easy to remove when the functional needs of the occupants changes. This can mean a distinction between heavy and light parts using opposites as part of the architectural strategy. The temporary parts must be attached with reversible joints, and eventually the joints can be visible as part of the architectural narrative. Such strategies can reduce the use of materials for modifications. In a material-saving perspective a general utility are preferable to adjustments that are again preferable to reconstruction.
Concentrate pipe work and installations. As mentioned before there are environmental perspectives in separating the installations from the raw house, for instance by incorporating an installation-channel. If kitchen, scullery and bathroom are placed next to the channel, the pipe work is concentrated thereby giving more freedom for spatial changes in the rest of the dwelling. Apart from saving materials such a strategy can mean less heat loss from the utility water system, and the occupants shall not wait for hot or cold water to emerge instead of lukewarm.
Make adjustment to climate possible. Basically the house or housing complex must be formed and oriented towards the wind and sun in order to achieve good indoor climate with the lowest possible need for supplied energy. Subsequently adjustable elements such as shades can be added. Windows and shades might be automat controlled in order to function while no one is at home.
Make environmental improvements possible. Installations, pipes and tubes should be easy to access for environmental alterations. The building envelope might be prepared for installation of solar panels or solar cells, in order to reduce the need for supplied energy without reducing or compromising the architectural expression.

PATINA. How the material surfaces of the house are worn and aged.
Patina may be caused by climatic impacts, dust and air-pollution, microorganisms and insects, or the occupants use and cleaning of the dwelling. Technically seen, patina is a negative process breaking down surfaces. Architecturally, patina may be a positive process adding qualities to a building over time, perhaps being part of a conscious architectural strategy, as for instance using copper cladding expected to turn green.
Choose materials according to the intended architectonic expression. In architectures rational and modernistic oriented periods, smooth and homogenous surfaces are often preferred, securing focus on form and space rather than materials. Such architecture may be dependent on looking new and fresh, wherefore patina is often opposing aesthetic intentions. This can be costly in the long run both economically and environmentally, of which the concrete high rise of the sixties are a good example. Modernistic cladding should be chosen carefully regarding the need to look new. In architectures more romantic periods, rough unpainted surfaces are more typical as the tactile and material qualities are given more importance. Patina is more accepted here, reducing the need for painting, repairing or renewal, meaning less use of material resources.
Choose materials that do not require a lot of maintenance. Surface treatment is estimated to constitute fifteen percent of the total environmental impacts from building materials, including energy and carbon dioxide emissions [Marsh & Lauring, 2000]. It is therefore important to choose materials with a patina that seldom calls for treatment, or materials that can be treated environmentally friendly with water, lime, linseed oil or silicate.

VENUSTAS. The aesthetic or sensuous qualities of the house are named venustas and concern the design in details as well as an entirety.

DAYLIGHT. How daylight is admitted to the rooms of the house.
Daylight covers direct sun light as well as diffuse light reflected from the sky, from clouds and outdoor environment and from the building itself. Direct sunlight is – compared to diffuse light -

characterized by clear direction and sharp shadows. It has a strong intensity and causes much heat. It is dominated by red and yellow colors and is perceived as warm and golden. It is shifting and unstable as its direction and strength depends on the path of the sun and the presence of clouds. Diffuse light is more stable and homogenous casting soft shadows and causing lesser problems with reflection or glare. The colors are cold or neutral.

In architectures modernistic periods, like the nineteen twenties, -sixties and -nineties, much glass was used in the facades giving lots of daylight but also problems controlling the indoor climate. Between the modernistic periods, more romantic periods with lesser use of glass emerged. Environmental strategies has been both passive - reducing the window areas in order to reduce heat loss, and dynamic - adding big glass facades facing south in order to gain solar heat.

Obtain sufficient daylight. In northern climates a strong intake of daylight is normally desirable. The size and placement of the windows are crucial. Light shining through façade windows are normally estimated to descend one meter per two meters in horizontal direction why rooms must not be too deep to be fully lit. Windows in high positions will cast the light deep into the rooms, and bright interior colors will reflect the daylight. If the building envelope is thick, the window reveals may be inclined in order to let the light in.

The more daylight the lesser need for artificial lighting and use of electricity. But environmentally the proportion of windows should also be done in order to minimize heat loss and prevent overheating in the summertime, which calls for smaller windows. Windows should all in all be used economically being placed in close relation to light demanding functions and rooms.

Obtain visual comfort. Visual comfort is dependant on sufficient light but also on avoiding glare and reducing reflection. Glare appears where the contrasts are strong, for instance a sunlit window in a dark wall. Such glare can be reduced with inclined window reveals, light window frames and light colors on the window wall, or by two-sided intake of light.

Working tables should normally be placed in a right angle to the window, but computer screens may have to be turned away form the light to prevent reflections.

Daylight without discomfort prevent that the curtains are drawn and artificial lighting is turned on.

Utilize the varying qualities of the daylight. Day lighting of dwellings is about comfort and atmosphere. Both warm sunlight and cool diffuse light should be admitted to a dwelling. The direct sunlight in particular is a dynamic phenomenon, allowing the occupants to experience the interior change character. The light tells about the passing of the day and the year, shading trees and reflecting snow and water. Thus windows should be oriented towards different views and corners of the world.

EXPERIENCE. How the house facilitates sensuous experiences.

If the human senses are listed according to physical range, the order is normally vision, hearing, sense of smell, of touch and of taste plus the kinesthetic sense related to the movement of the body. Vision often dominates the planning, designing or mentioning of architecture to a degree where the other senses are suppressed or forgotten. But dwellings represent a small architectural scale and frame the most intimate parts of our life, wherefore short range senses must not be forgotten.

While the historicism of the nineteenth century displayed many types of surfaces and tactile qualities, acoustics and kinesthetic challenges, modernism cleaned it up with light whiteness and floating space. In general the twentieth century has represented a move towards emphasizing visual qualities on behalf of the tactile. But rational and romantic approaches still battle.

Activate several senses. Besides visual qualities the dwelling must have tactile and acoustic qualities. The harder and smoother the surfaces are, the more reflection of sound and noise there will be. Perforated materials, perforated bricks for instance, may reduce problems of resonance while increasing the regulation of moisture, which again may reduce the need for ventilation. Many occupants like the smell of wood. Wood is also good for regulation of moisture. Making room for green plants may facilitate stabilization of the indoor climate.

Choose interior materials according to their ability to conduct heat. If the surfaces that the occupants frequently touch feel cold, a higher room temperature may be chosen, resulting in more use more use of heat. Therefore wooden floors or linoleum may have advantages to stone or tiles. On the other hand, heavy materials may be preferable in rooms that receive much solar heat. Heavy materials storing heat from day till evening may reduce the need for heating.

Accentuate contrasts. This may be a way of sharpening ones senses and increase the amount of experiences. Light-heavy, soft-hard, warm-cool, stretched-loose, convex-concave, calm-dramatic, rough-sophisticated, light-dark, gigantic-human, rhythmic-irregular, natural-ceremonial, bigger-smaller, close-distant are some of contrasts to use in architecture [Rasmussen, 1975]. The use of a two-sided rather than one-sided architectural approach can have environmental potentials: A high-insulated, thick building envelope opposed to transparent parts giving daylight, solar heat and a view. A light building envelope designed to insulate opposed to heavy indoor materials to accumulate heat and stabilize indoor climate. Permanent raw house parts opposed to contemporary parts such as installations. Such opposites will save materials and energy.

CHARACTER. How the house expresses a conscious aesthetic intention.
Character is what differ architecture from mere building. Character is the heart of architecture and constitutes a cultural statement. Opposite ‘experience’ that will grow with the number of sensuous impacts character might be related to an economic use of effects. Character is an aesthetic phenomenon but may be closely related to the functions, the constructions or the environmental strategies and elements of the building.
Historically, architectural character has often been about the relation to nature. The rationalists and modernists wanted to control nature and stated this in geometric and ‘cultural’ forms, whereas the romantics tended to idealize and sometimes imitate nature.
Environmental architecture does not necessarily belong in one of these two categories. Architecture might work with nature and climate neither idealizing nor expressing control. Plus, there may be very rational reasons for learning from nature.
Accentuate the interplay between house and climate. The climate changes during day and year, whereas the house must provide a relatively stable indoor climate with a minimum of supplied energy. This can be done with the help of winter gardens, double facades, external shading, solar chimneys or light reflecting mirror pools, all adding to aesthetic expression and environmental performance.
Utilize greenery as part of architecture. Trees and plants, façade greenery, green roofs, balconies with flowers and interior gardens may be an integrated, important part of the architectural expression. Deciduous trees give shade in the summer but access of daylight in the winter, thus supporting low energy strategies. Trees, benches and façade greenery soften heavy winds and reduce heat loss. Plants filter out polluting particles and balance temperature and air moisture both indoor and outdoor.
Build modern. The conditions of society including the environmental conditions have changed so radically, that architecture cannot just rely on experience or the ideas and images of past times including modernism. If the house is to achieve high utility value and good environmental performance, the new conditions must part of programming and analyzing and not only rhetorical. Profound research and programming coupled with the urge and courage to seek new solutions lead to architecture that does not copy, but in the best cases are innovative and path-breaking.

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