LOW ENERGY HOUSE
That is building which annual needed energy for heating is 40-60 KWh/m², which is not the same in all countries. Somewhere it goes to 15 KWh/m²/year. For that you need good insulation of walls, quality glazing but still you need one of traditional heating systems and it is also necessary to have forced ventilation without use of waste air heat. All joints must be air tight with the value under 1.5 change of air within one hour.

THREE LITER HOUSE
In its system it is similar to low energy house but annual consumption of energy for heating must be below 30 KWh/m², air tightness below 1 change per hour. Construction must be without thermal bridges. With traditional heating system there must be solar system for heating of sanitary water or system of recuperation to use waste air heat in the system of forced ventilation. It is better if both systems are applied (solar device for heating of sanitary water and ventilation with recuperation).

PASSIVE HOUSE
That is building in which dwelling comfort is provided without usual heating systems. Annual heat for heating must not exceed 15KWh/m² which is valid in all countries. Ventilation is mandatory and it must be through recuperation which insures return of waste air heat. Air tightness must provide less than 0.6 changes of air per hour. Construction must be executed without thermal bridges and total primary energy can be maximum 120 KWh/m² per year.

ENERGY INDEPENDENT HOUSE
That is a building which provides all necessary energy from its own solar system and it is not connected to public network. In comparison with zero energy houses it differs in size of solar collectors and summer extra energy is accumulated for winter.

PLUS ENERGY HOUSE
Providing of energy from alternative sources is such that it achieves extra which is then released to public network.

COMPARISON OF HEAT LOSSES IN DIFFERENT TYPES OF BUILDINGS
All mentioned may look confusing for most of those who want to build the house because they are not from that branch. Therefore you have Krivaja experts who will explain it simpler. End goal which customer needs to get is comfort of being in his own home. If customer is provided comfortable dwelling in the house then the purpose of building is justified. Level of comfort and, also the level of price are increased with increase of level of house. In definition of energy saving houses we defined 6 levels of houses. Most of the houses which have been built in south east Europe during last 20 years and which are being built today do not fall in any of mentioned levels. Comparing values of heat losses for those houses and passive house we shall come to, for common people, incredible data.

While heat losses in passive house are 10 W/m² at the same time in classic free standing building which is built of hollow bricks of 25 cm thickness and mortared from both sides, which has windows with double glazing 4+16+4 those losses are up to 150 W/m². Newer buildings of this type which have thermal façade with Styrofoam of 5 cm thickness have losses of around 120 W/m². Krivaja low energy house has heat losses of around 30 W/m² and price wise it almost does not defer from house which has losses of 120 W/m².

Further you can see table with data n energy consumption for one house of 218 m² with 4 quality insulations.
Standards for passive house are:

- Coefficient of thermal conductivity of all construction elements must be less than 0.15 W/m² K and at self standing buildings it is even recommended to be below 0.1 W/m²K. Coefficient of heat permeability U shows how much heat goes through m² of construction surface (ceiling, wall, window etc.) at temperature difference of 1K and it is expressed in W/m²K. Smaller value of U means better thermal insulation.
- Perfect air tightness which at 50 Pa pressure difference must be less than 0, 6 air changes in one hour.
- Glazing with Uw below 0, 8 W/m² which enables net gains of heat in winter.
- Window frames with Uf less than 0, 8 W/m²K.
- Efficient use of electric appliances (class A and A+).
- Low heat losses in preparation of sanitary water.
- Low energy consumption of ventilation system.

Characteristic specific values for passive house are:

- Annual heat needed for heating is less than 15 KWh/m².
- Total consumption of electric energy below 18 KWh/m²/year.
- Heat losses below 10 W/m².
- Total consumption of primary energy is below 120 KWh/m²/year.

Primary energy means renewable energy sources (solar energy, water energy, wind, geothermal energy) and not renewable energy sources (coal, oil, gas, electric energy, energy in power plants).

ZERO-ENERGY HOUSE
That is a building which satisfies total amount of required energy for one year from solar source. In summer extra energy is given to the network and in winter it takes it from there and annual balance is even. Layer of insulation is such building is 40-60cm.

ENERGY INDEPENDENT HOUSE
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For achieving of standard of energy saving house each component is important and specially heat shell, shape of building, content and quality of execution. One has to sort out reduction of heat energy, give solution for all thermal bridges and during construction constantly supervise quality of execution. At the end quality of execution and design must be proved by certificate.

Principles which have to be respected during designing of the house are:

- Orientation of the building
- Usage of obtained heat of sun radiation through glass surfaces
- Accumulation of solar energy
- Shape of building
- Thermal insulation
- Doors and windows
- Protection against summer overheating
- Technology of building without thermal bridges
- Air tightness
- Ventilation systems
- Construction systems

Each of these principles is very important and must be analyzed by architect and every detail of solution of reduction of heating cost must be defined before building. All these details are developed in Krivaja design bureau and there are every day changes in accordance with achievements in contemporary practice. With all mentioned it is important to say what is generally known that prefabricated house has many advantages comparing to other construction systems.

Here are some basic advantages:

1. High level of finish in process of production where it is easier to control execution and raw materials,
2. Faster building which with this pace of modern living has significant meaning,
3. High possibility of insulation and prevention of thermal bridges,
4. Exclusion of humidity from all parts of the house,
5. Construction is light and requires cheaper foundations,
6. Building with ecologic materials,
7. Resistance to earthquake is advantage which this construction system has not used enough and testing (elaborate) performed by Krivaja prove it,
8. Larger net useful surface than net useful surface in classic building for the same level of energy grading...

At the end, there is one more advice for proper choice which you can get in Krivaja. Inform yourself about experience of buyers of prefabricated houses and especially buyers of Krivaja houses and see how they look after long use.
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built houses has more than 60 % of low energy ones and the rest are „standard” and „comfort” which are built in the area of Balkan countries. Even their properties of energy efficiency are far better than in classic houses which are built in this region which is visible from the table.

Ministry of environment, area management and construction of Republic of Croatia has already introduced Regulation about energy certification of buildings according to which they made 8 energy grades of buildings from A+ to G and it is expected that soon energy grade B is usual for Croatia. That corresponds with low energy building. Several following facts supports the expectation that BiH will soon have such Regulation as support to build at least low energy houses if not passive ones:

- Annual increase of passive houses in Germany is higher than 100%
- Since spring 2006 in Frankfurt is in power decision on construction of all buildings financed from city budget on the level of energy standard of passive house
- 2008 in Austria they opened one thousandth attested passive house
- Value of real estate: besides location, size, with certainty it will be its energy efficiency,
- With the same or lower investment costs, exploitation costs of such real estate are far lower comparing to classic real estate,

**Directive of EC:**

- On energy properties of buildings 2010/31/EC (From 2019 all new buildings need to be almost zero-energy), 20/20/20 from 2020.
- On energy services and efficiency in final consumption of energy 2006/32/EC,
- On energy properties of buildings 2002/91/EZ …
KRIVAJA PREFABRICATED HOUSES
DEVELOPMENT, CONSTRUCTION AND FUTURE

KRIVAJA – prefabricated houses - development which lasts 60 years.

If you need a new house we advise you to quickly inform yourself about conditions which need to be in the object where you planned to spend the rest of your life and life of your children. All those know Krivaja architects and sales people, who are constantly being educated through training and practice. Your job is to visit them and after that decide. After decision they are at your disposal till moving into the house. Construction of prefabricated houses progresses constantly for 60 years and Krivaja is the only company in the area of Balkans and wider which has that continuity. It is generally known that there is no company which built more houses than Krivaja. Third reason why not to exclude Krivaja before decision on supplier is completeness of service. We are the only factory that produces complete house because we have:

- Drying kilns for drying of wood.
- Production line for walls in small and large panel.
- Production of joinery.
- Production of wooden constructions, as classic and trusses so the laminated beams with the span up to 50 m.
- Production of thermal insulating boards.
- Our own people for designing and assembling in all conditions.

Because of all this when you come to us you need to express your wishes and we shall make them real. Of course, if you like any of our 400 type houses you can chose it or with our help alter it and we can start with realization immediately. Tens of thousands of built houses, schools, kinder gardens, business facilities still serve their purpose worldwide.

To make sure about our possibilities it is enough to take a look into certificates which Krivaja had for decades and today is one of rare manufacturers of prefabricated objects which products were tested on many European institutes and for that its house can have CE mark.

Future of building of Krivaja prefabricated houses as energy saving houses

ENERGY SAVING

World is facing consequences of its behavior during last century. First it was lack of fossil energy sources that was noticed, then the awareness of influence of emission of bad gasses on the environment and then global warming. All these are consequences of human actions because of which more and more gasses are released, first of all carbon dioxide (CO2) which comes from burning of fossil fuels. Since about 40% of produced energy is connected with needs in objects and larger part of it is used for heating-cooling, appliances, lighting and warm water it is clear how much is important to reduce the use of the energy as well as development of technologies for production of energy from alternative sources. All this was long ago recognized by Krivaja experts and they started with development of concept of the house that saves energy. So besides so called „standard” and „comfort” house, Krivaja offers attested low energy and three liter house and it works on development of passive house. For low energy house we did corresponding attest.
## EXAMPLE OF CALCULATION OF HEAT LOSSES FOR HOUSE MK-218

**WITH DIFFERENT TYPES OF BUILDING**

**FOUR QUALITIES OF INSULATION**

<table>
<thead>
<tr>
<th>Quality</th>
<th>U value for walls</th>
<th>U value for ceiling</th>
<th>U value for floor</th>
<th>U value for windows</th>
<th>U value for doors</th>
<th>Permeability of window fugue</th>
<th>Permeability of door fugue</th>
<th>Heat losses (KW)</th>
<th>Heat losses W/m²</th>
<th>Consumption of energy for heating per season KWh/year</th>
<th>Consumption of energy for one year per m² (KWh/m²)</th>
<th>Consumption of heating fuel per year</th>
<th>Price of energy for season (heating fuel 1,5KM/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K.1.</td>
<td>0,11</td>
<td>0,3</td>
<td>0,6</td>
<td>0,65</td>
<td></td>
<td></td>
<td></td>
<td>4,78</td>
<td>23,75</td>
<td>7425</td>
<td>34</td>
<td>742</td>
<td>1100 KM</td>
</tr>
<tr>
<td>K.2.</td>
<td>0,13</td>
<td>0,3</td>
<td>0,75</td>
<td>2,0</td>
<td></td>
<td></td>
<td></td>
<td>8,65</td>
<td>43,25</td>
<td>13433</td>
<td>67,2</td>
<td>13433</td>
<td>2350 KM</td>
</tr>
<tr>
<td>K.3.</td>
<td>0,17</td>
<td>0,6</td>
<td>0,7</td>
<td>1,2</td>
<td></td>
<td></td>
<td></td>
<td>15,137</td>
<td>95,5</td>
<td>29507</td>
<td>147,5</td>
<td>29507</td>
<td>5150 KM</td>
</tr>
<tr>
<td>K.4.</td>
<td>0,14</td>
<td>1,4</td>
<td>3,0</td>
<td>3,0</td>
<td></td>
<td></td>
<td></td>
<td>32,184</td>
<td>160</td>
<td>50006</td>
<td>250</td>
<td>50006</td>
<td>8750 KM</td>
</tr>
</tbody>
</table>

### NOTE:
1. Calculation of price for heating for a season is given just for the expenses of providing of heating fuel, minimum heating power 42700 KJ/kg without additional costs of electricity etc.
2. Calculation does not contain benefits from alternative heat sources and from recuperation system.
3. Also benefits of solar radiation are not calculated although in the concrete case it is a house with very large glass surfaces.