JUNGMANNSCHULE ECKERNFÖRDE

Energy Production and Consumption

Comenius Group Germany

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Prologue

Using energy, in particular electrical energy, has been established as a life quality. For many years, electrical energy has been a matter of course, which lead to the situation nowadays, that energy is consumed by many societies in abundance with less or even without any attention for pollution and its aftermaths.

In frame of the Comenius project in year 2012/13, we decided to do some research on how to lower peoples' energy consumption.

In the following the results we worked out will be presented and described.

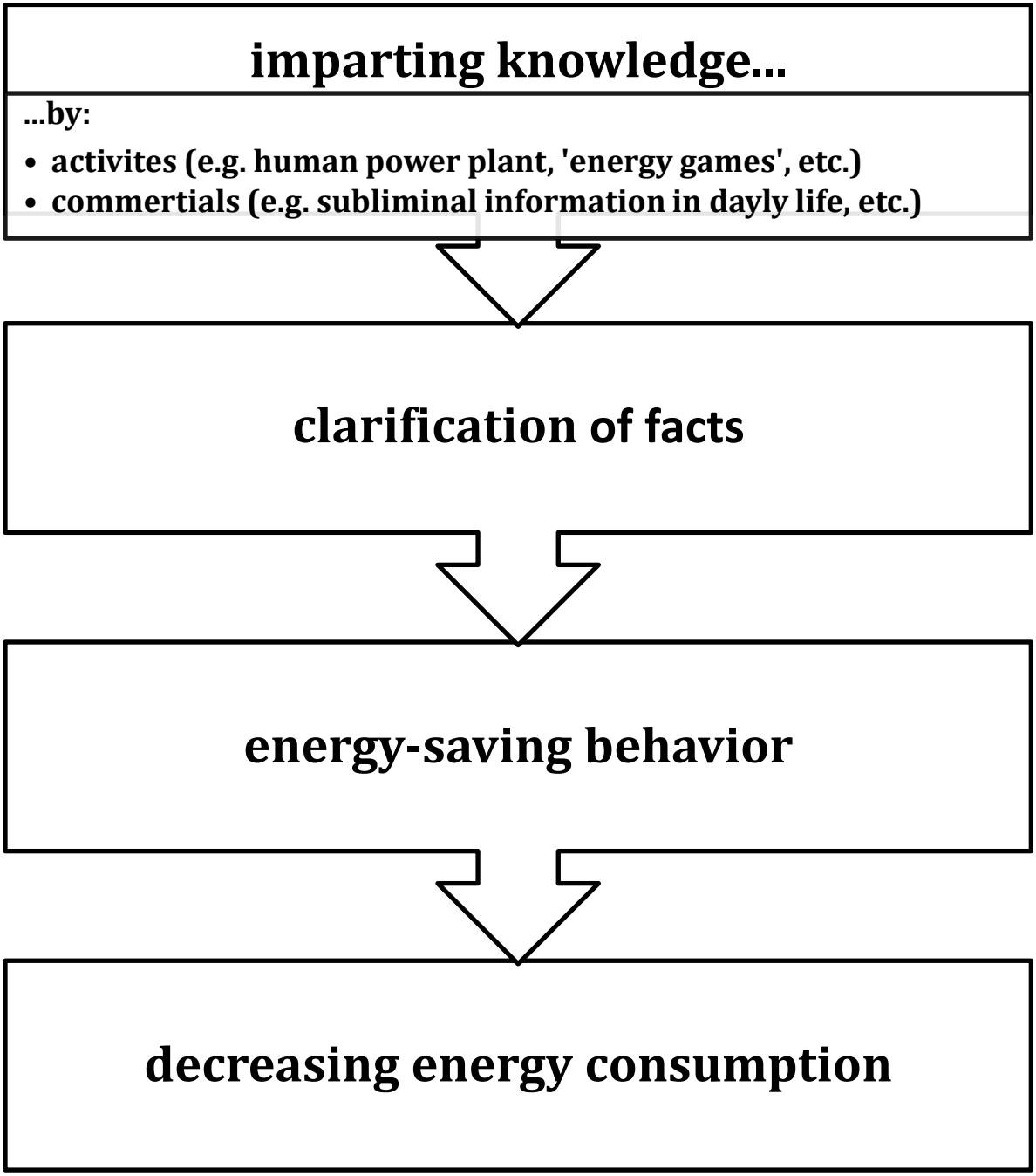
Prohibition or conviction?

There are studies which verify increasing global temperatures, caused by climate warming gases. The probably most significant of such gases is carbon dioxide (CO_2), which is emitted in plenty of tons every day as exhaust gas of cars, coal power plants, factories and similar. Essentially the energy consumption needs to be lowered. Due to it, the generation of energy in an excess amount will have to be avoided. But: Turning over to renewable and CO_2-free sources isn't sufficient…

…the question rises up: '*How to change the peoples' mentality?*'

We're convinced that conditions or even prohibitions - imposed by governments or similar organizations (e.g. EU) - are rather draconic methods than the correct way for reaching those aims. Instead of this, people need to be committed to the sense to save energy by using energy-saving applications and to disclaim on dispensable items using energy.

'Conviction but no prohibition.'



This process is in ours' opinions the key to change peoples' mentality.

P r o c e d u r e

In order to impart information on energy production and its aftermaths, involving activities are predestinated, in particular for children but also for laymen. Therefore we developed following devices:

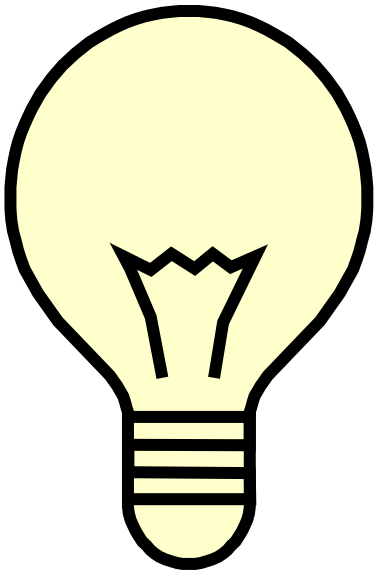
(1) The **'Human Power Plant'** (see pages 4-10)

(2) The **'CO_2-boxes'** (see page 11)

(3) The **'Power Balls'** (see page 12)

It appears reasonable to carry out those activities as components of a 'one-day-workshop'.

Specific information on energy production, consumption and pollution may be given by presentations (posters, multimedia) basing on the activities. They help to open the peoples' minds and make them remembering the facts.



‘Human Power Plant’

Most people turn on their lights neither knowing about the effort to produce energy nor imagining the great energy flow they make use of. It’s the intention of ours to give an imagination by producing electrical current by muscle power using the Human Power Plant. People will recognize they’re unable to keep up lighting a 100Watts light bulb properly.

The device consists of a bicycle driving a car alternator. The benefits of this constellation are its simplicity and low cost. To make the alternator spin, it is necessary to jack up the rear wheel of the bicycle. The rotation is transmitted by car multi-v-belt from the rear wheel to the alternator. In order to apply the belt, the back tyre and tube need to be removed.

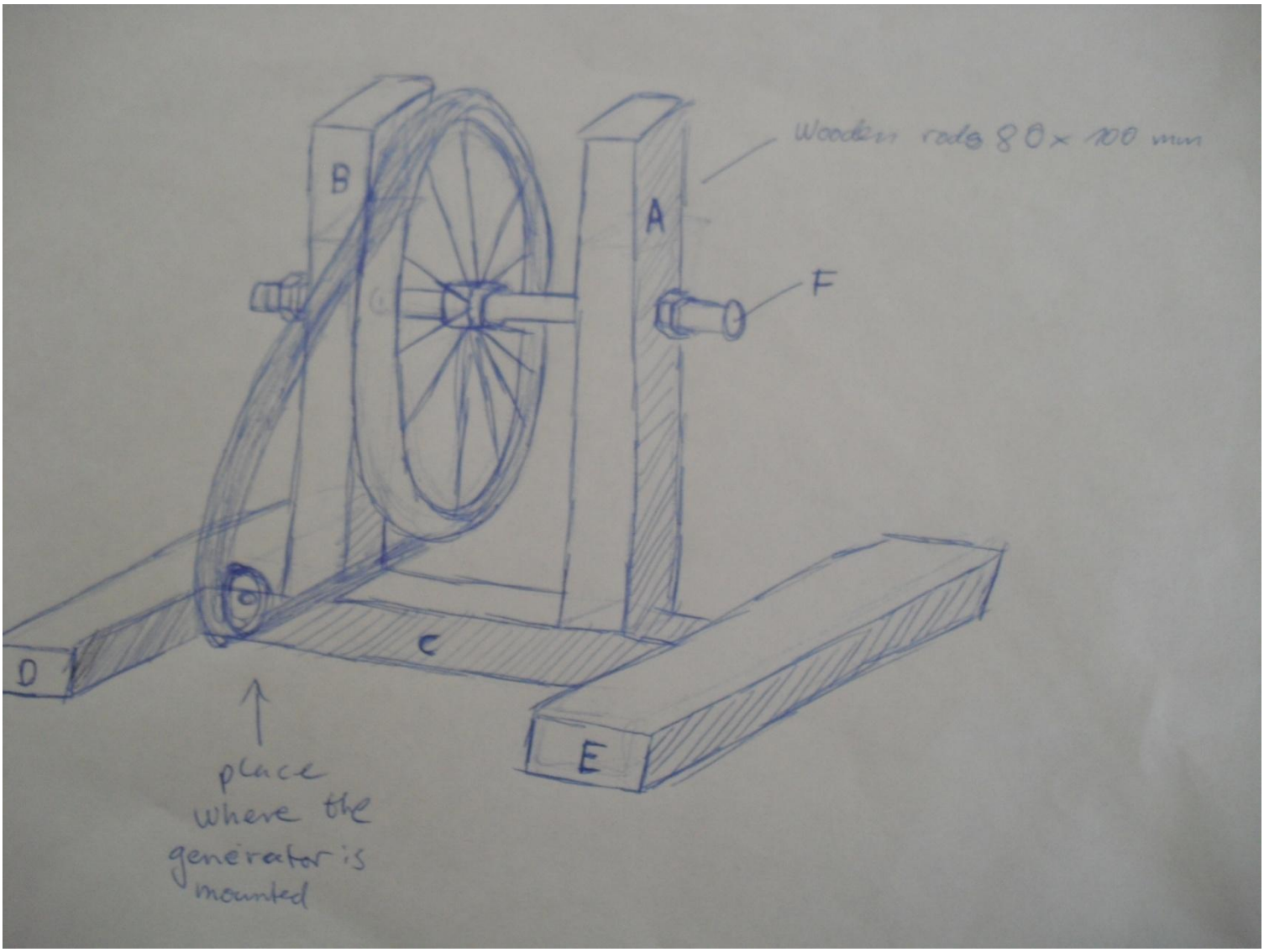
The wheel jack may be made of wood or steel. We created to versions for twice materials, compared by the following table:

steel	wood
severe to tool (welding, drilling etc.)	easy to tool (less and simple tools are required)
less steel stores, harder to acquire	available at every tool shop or wood dealer
long durability, great stability	short durability, poor stability (take care!)

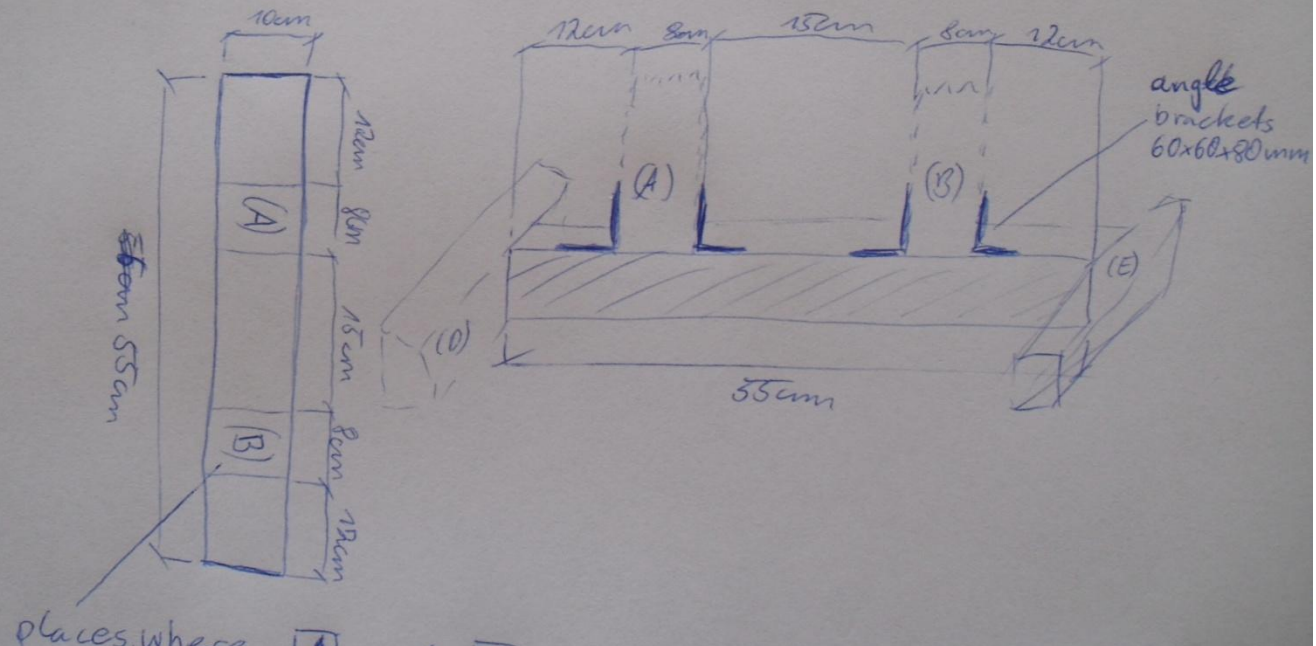
Surprisingly, twice versions have similar charges (approximately 120€/100£).

Hence, the decision whether to use steel or wood depends on the available facilities and working skills.

A used car alternator can be acquired at junk yards or eBay for very low cost. The benefit on those generators is particularly that they already contain a voltage regulator which constants the output voltage to 12-14 Volts. It may be transformed to 230V AC by an inverter (available at electronic shops, ≈50€/42£). Unfortunately the mounting of the alternators are often varying, for which reason we cannot give any description on it. Firstly the wooden jack for a 22”-26” bicycle is shown. In case of any questions you may contact the Comenius facebook group.

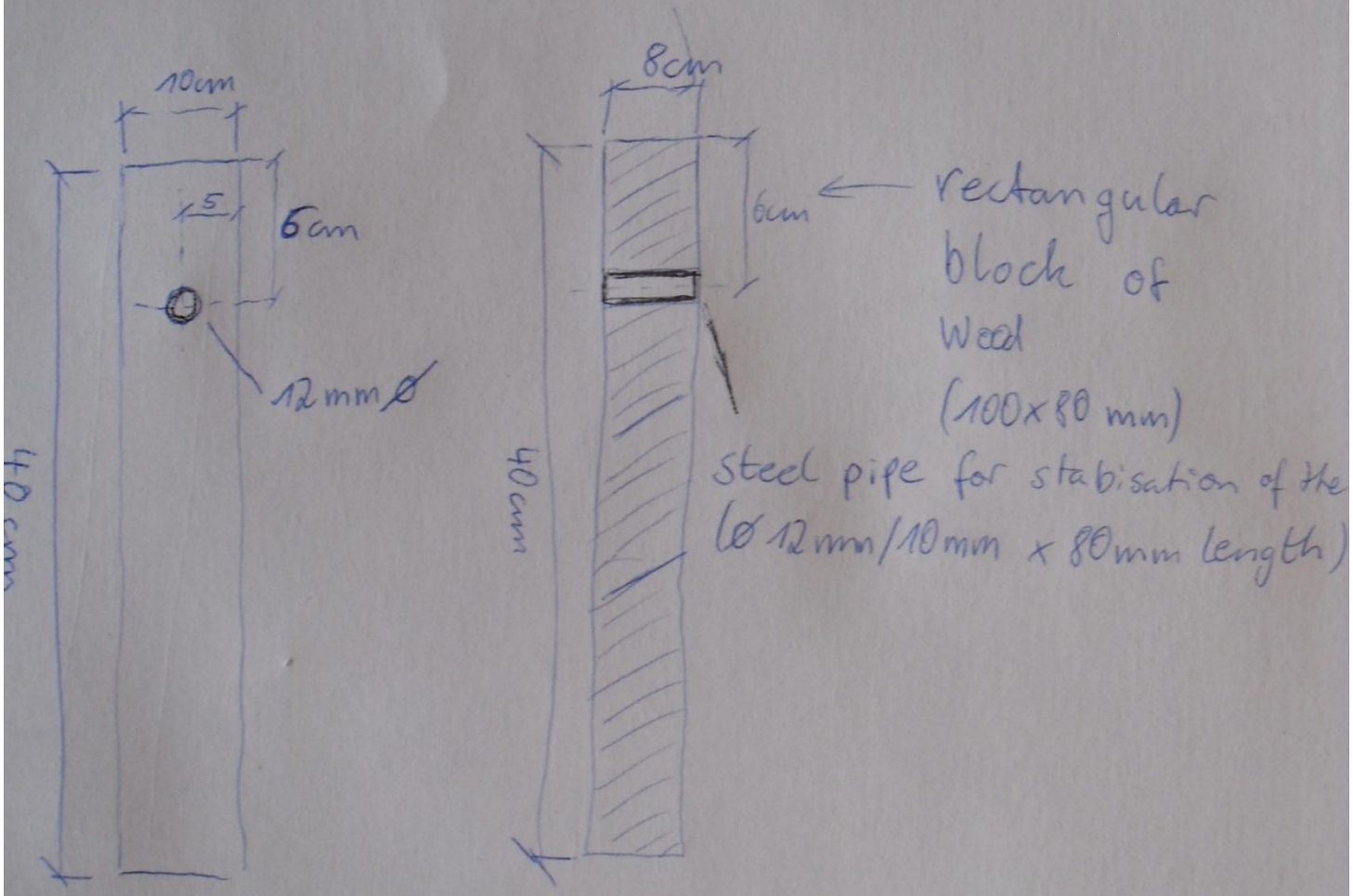


C

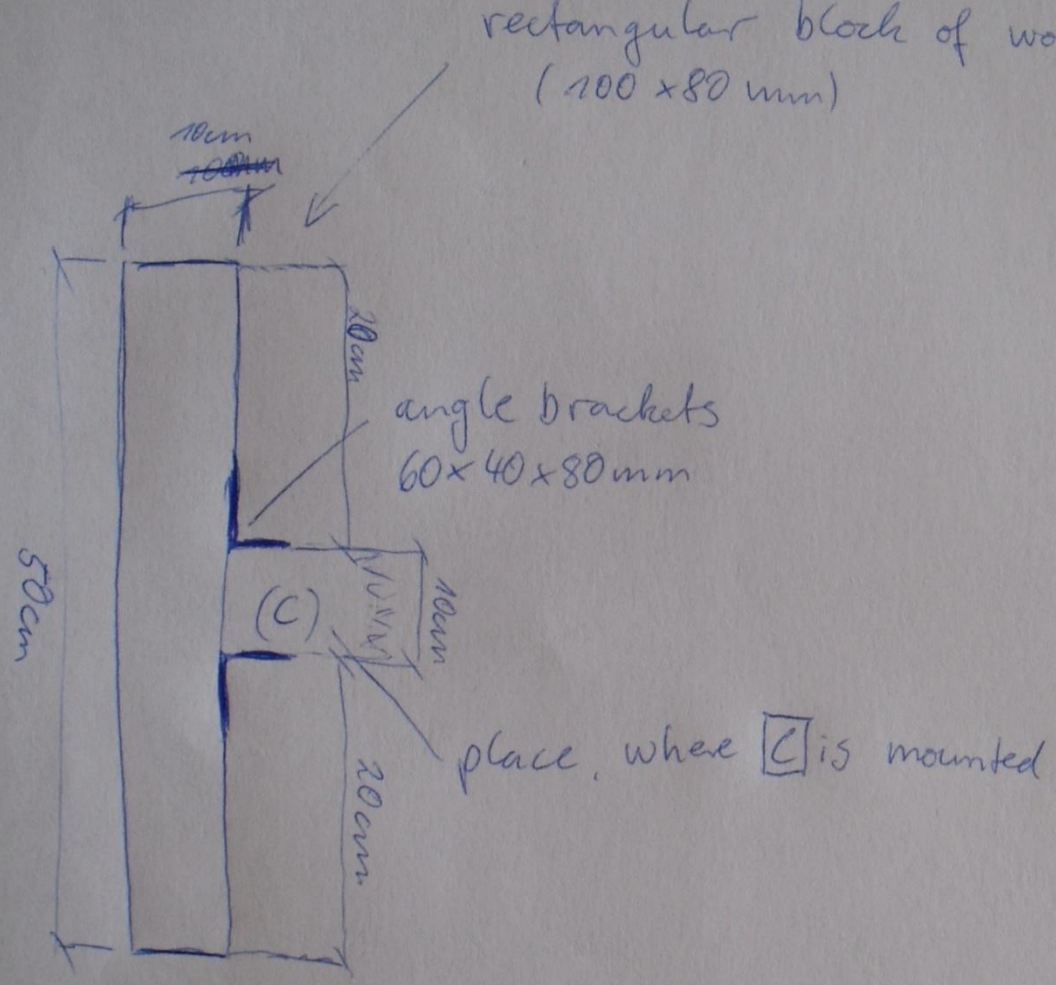


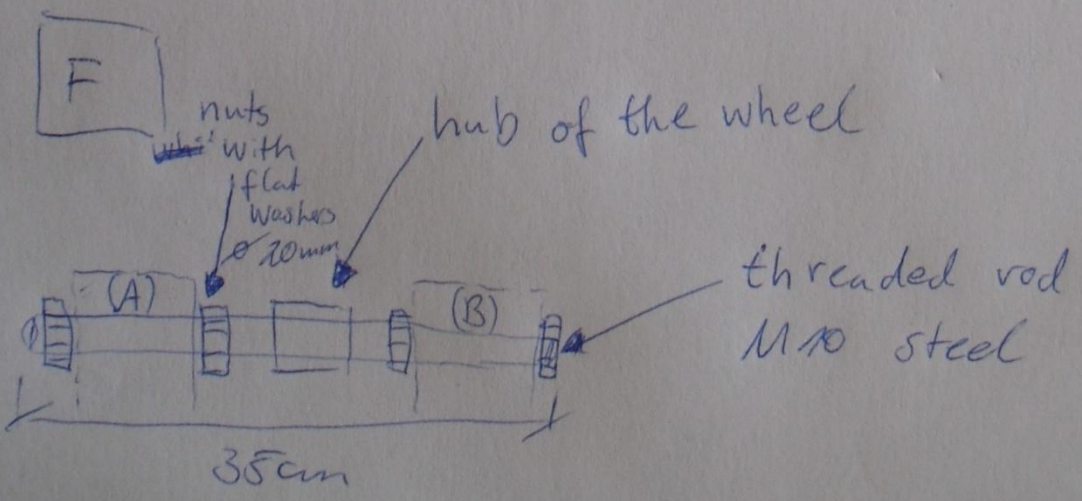
places, where A and B are mounted

A = B


10cm
5
6cm
12mm Ø
40cm
8cm
6cm
40cm
rectangular block of wood (100x80 mm)
steel pipe for stabisation of the
(Ø 12mm/10mm x 80mm length)

E = D

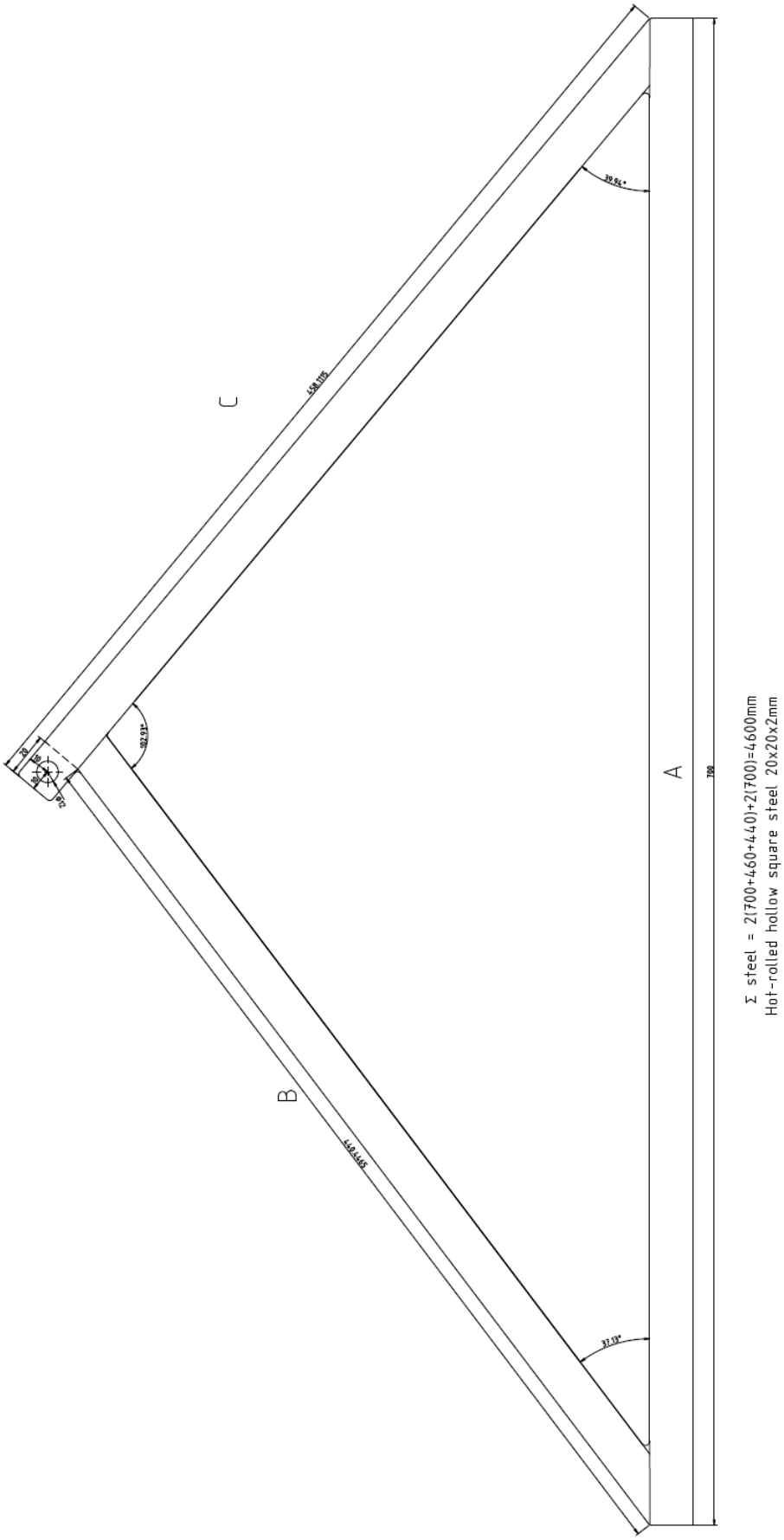

rectangular block of wood
(100 × 80 mm)
10cm
20cm
angle brackets
60×40×80mm
50cm
(C)
10cm
20cm
place where C is mounted


F
nuts with flat washers ø 20mm
hub of the wheel
threaded rod
M10 steel
(A)
(B)
35cm

Due to the required toughness, hard wood like beech or oak is to be used.

We decided to build up the steel version made of 20x20x2mm square bare steel. The following graph shows the exact values of a jack for a 22”-24” bicycle.

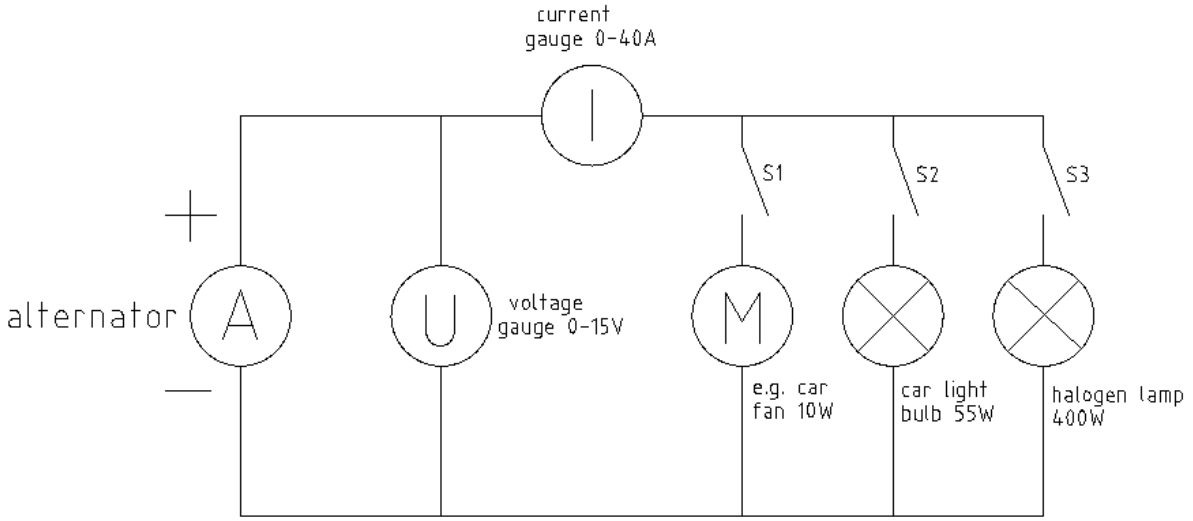
Values are to be round, but accuracy should not fall below 5/10mm.



The rear wheel shaft of the bicycle is replaced by a thread rod (metrical, diameter usually 8 or 10mm) overlapping approximately 30mm at each side. The 12mm drill at the upper end of the triangles serves as retainer for each excess end. The elements are fastened by M8 or M10 screw nuts. Optionally, the stability can be highly increased by two anti-roll bars being mounted at the end faces of the 700-mm-bars. It may have excess ends (plus 250mm at each end) to avoid tipping.

As mentioned before, the alternator regulates itself to a voltage of 12-14V independent of the rotor revolution speed. Nevertheless a minimum revolution speed of approx. 1200min^{-1} is required to excite the magnetic field. Since the gear ratio (pedal ↔ rear wheel 1:3, rear wheel ↔ alternator pulley 1:10) is around 1:30, a pedal frequency of 40min^{-1} is sufficient. Essentially the belt has to be tensioned by a thread shaft or tension belt in order to prevent slipping (pretension approx. 20kg).

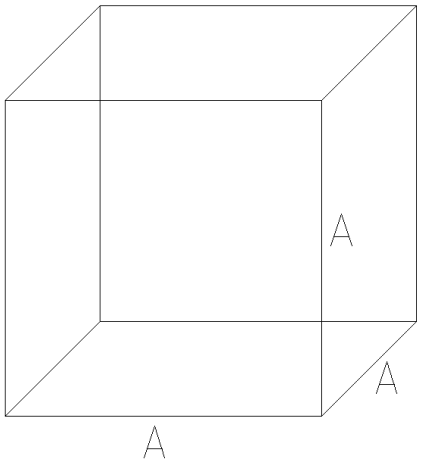
The electrical load is embodied by different devices, e.g. a fan for car applications or automotive spot light bulbs. The demand can be varied whit aid of switches. Voltage and current are optionally displayed by gauges. Notice that the copper wires should measure at least 2,5mm^2 (current may exceed 40A!). Consequently automotive high current are to be utilised. In the event of claiming 230V AC, an inverter may be used.



‘CO_2-Cubes’

The cubes are made for visualising the amount of CO_2 emission.
For each energy source (coal, beech, hydroelectricity, wind energy) exists one cube with the volume of CO_2 that is emitted into the environment for each kWh being produced. It is built up out of 12 wood strips that represent the edges of the cube. The corners are fixed with screws and angle brackets. So the contemplator may realise easily, how harmful the way of producing energy is to the environment.
As shown in the drawing below the edges of the cubes have the following dimensions:

(1) Coal (lignite): 268 litres ⟹ A=65cm
(2) Beech wood: 155,5 litres ⟹ A=54cm
(3) Wind energy: 20,3 litres ⟹ A= 27cm
(4) Hydroelectricity: 12,2 litres ⟹ A=20cm
(5) Nuclear power: 15,1 litres ⟹ A=24cm



‘Power Balls’

For the ‘Power-Balls’ we use five bins of the same size and around table tennis 100 balls. Each bin represents an electronic device (announcing it): a microwave (600-1200W/h), a Fridge (40W/h), a hair-drier (800-1200W/h), a toaster (1000W/h) and a Plasma TV (140-600W/h). Each ball represents an energy use of 40 watt per hour.

The task for the students is to guess how much energy is consumed by the specific devices by putting the balls into the bins. Afterwards the real relations are presented: which amount of energy is used by each device in reality.

The use of experiment is to show in an amusing way how much energy we use every day and to eliminate the misapprehension that big devices are cause the most demand of electricity.