



GUIDE FOR CITIZEN WORKSHOPS ON ENERGY MATTER



Funded by
the European Union



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Workshop Guides



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TECHNICAL FILE

Title

Guide for Citizen Workshops on Energy Matter

Ownership and Editing

AURORA Project - Achieving a new European Energy Awareness

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Index

Solar cooking workshop. Build your own solar cooker.....	6
Thermal imaging demonstration workshop.....	9
Hidden energy problems thermal photography contest.....	11
Public discussion: preparing for the next winter and beyond.....	14
Solar driven car race.....	16
Make a fun and thrifty draught excluder from scrap materials.....	18
Soldering and assembling of solar cells.....	19
Wattoteka & Termoteka.....	22
Guided thermal camera tour through the city.....	24
Charge your phone while riding your bike.....	25
Carbon Sequestration Game.....	28
Make your own PV module.....	29
Bike Tour and Thematic Talks.....	30
Solar Sound System Workshop.....	32
Solar Food Dehydrator.....	34
Contest: Photography about energy transition.....	36
Build your own energy sensor.....	37
Low-Cost Electronics Workshop with ESP32.....	39
Solar Bugs - Experience for kids to build their own solar toy.....	41

Introduction

This guide is a result of the European project AURORA – Achieving a New European Energy Awareness, funded by the European Commission under the Horizon 2020 programme (Grant Agreement no. 101036418).

AURORA aims to promote energy literacy, empower citizens to actively participate in the energy transition, and increase engagement with local communities regarding sustainable energy practices.

The project focuses on citizen-driven approaches to climate action, including the creation of energy communities and the implementation of educational and awareness-raising activities. Within this framework, the guide was created as a practical tool to support educators, facilitators, and community leaders in organizing participatory workshops focused on energy-related topics.

The guide presents a wide range of hands-on activities suitable for different levels of complexity and age groups. Each activity is clearly structured, detailing its educational objectives, estimated budget, space requirements, schedule, needed materials, and ideal number of participants—allowing for flexible and efficient implementation in diverse local settings.

Name of the activity	Solar cooking workshop. Build your own solar cooker
Previous experience	Cátedra de Energias Renováveis, Universidade de Évora, Portugal. AURORA Project.
Description	Building of a solar cooker.
Goals	<ul style="list-style-type: none"> - To acquire practical knowledge regarding solar cooking technologies - To adhering to sustainable and alternative options - To exploring hobbies outdoors - To enhance teamwork skills
Level of complexity	Low
Budget	Low. Materials and equipment are very cheap and easy to find at home. The highest price is for kitchen utensils and food.
Space	Start by choosing a nice and safe area to place it.
Timing	Build the solar cooker the day before you want to use, or very early in the morning of that day.
Materials and tools	<p>Canva infographics to choose one of the three solar cooker models proposed</p> <p><u>To build the cooker</u></p> <ul style="list-style-type: none"> - Thick cardboard to cut out pieces of at least as big as 70x70cm - Aluminium foil roll - Tape measure and masking tape - Scissors and cutter - Glue and double sided tape - Small piece of metal <p><u>To cook</u></p> <ul style="list-style-type: none"> - Oven thermometer - Dark pot - Oven safe glass casserole with lid <p>You can also print out the instructions of each link.</p>
Number of participants and guides	<ul style="list-style-type: none"> - Elderly and young adults – 1 person to guide 5-8 participants (+ 1 volunteer to help people with physical disabilities) - Children – 1 guide per 5 children (+ 1 volunteer)
Other requirements	<p><u>Weather</u></p> <p>Wait for a sunny day and start cooking around 10 a.m.</p>
How to proceed with groups of people	<p><u>Elderly</u></p> <p>Solar cooking can be one of the activities offered by community centres and nursery homes centres. Caregivers and volunteers can help, especially in physically demanding tasks.</p> <p><u>Students</u></p> <p>As a workshop for students, the solar cooker can become a very interesting approach to solar-powered household appliances.</p> <p>Ideally, organizers should bring an academic perspective, so the first step is to contact experts from universities and other educational institutions.</p> <p>It is advisable to do this activity in the context of a camping trip in rural areas, to show young adults how they can satisfy a vital need without using electricity and modern conveniences, as well as learning to live by the principle of near-zero emissions.</p>

	<p><u>Children</u></p> <p>In carrying out the activity, the young age of participants forces to increase safety measures, and it is mandatory to form small groups (3-5 children) assisted by adults to distribute tasks. Families can also be asked to join as volunteers, and sunny bank holidays can be a good opportunity.</p> <p>Within this age group, building a solar cooker teaches two good lessons: working together to achieve a goal and thinking about how to do things differently.</p>
Instructions	<ol style="list-style-type: none"> 1. Obtain some pieces of cardboard and cut them according to the dimensions indicated on the model. 2. Glue aluminium foil on the pieces of cardboard. Only apply glue on the matt side of the aluminium. The shiny side is preserved to capture and concentrate the sunlight. If you want a better result, use double sided tape, and a little of glue vertical lines (not spread). Press to adhere the foil to the cardboard. Trim the excess foil from the edges of the cardboard. 3. Draw the fold lines and fold with the help of a small piece of metal square, so that the folds are neat and deep. 4. Install the solar cooker as shown in the selected model in a safe area.
Important information that should be included	<p><u>Description of the device</u></p> <p>A solar cooker is a device that transforms light into heat; it is a solar radiation concentrator.</p> <p>Building a solar cooker can be a hobby and a way to pass the long sunny days, or a means to save money when cooking.</p> <p>The temperature reached by a solar cooker (100 - 300°C) is not as high as that of a gas or electric oven, but it does allow food to be cooked safely.</p> <p><u>General guidelines</u></p> <ul style="list-style-type: none"> - The best time to cook on a solar cooker is between 10 a.m. and 3 p.m. on sunny days. - Solar cooking means cooking outdoors. - Slow cooking preserves the flavour and nutritional value of food better. - It requires less attention because the food does not burn. - Cooking time is usually twice as long as in a conventional cooker. - The solar cooker may be located on the ground or on a suitable support. The container must be placed at the focal point formed by the panels. <p><u>Last tips</u></p> <ul style="list-style-type: none"> - Only apply glue on the matt side of the aluminium. The shiny side is preserved to capture and concentrate the sunlight. If you want a better result, use double sided tape, and a little of glue vertical lines (not spread). - To make the folds in the cardboards, use a small piece of metal, like a metal scalimeter. - A peg or a metal binder clip may be needed to keep together some pieces. - Align your solar cooker with the sun - On windy days, you can use a thick thread to maintain the stability of the open solar cooker models. - The oven safe glass casserole creates a greenhouse effect that increases efficiency. Remember to use its lid. - If this is your first attempt at solar cooking, start with something easy like chicken, rice, courgette or quick bread like banana bread. Baking apples and potatoes is also easy, but don't wrap them in foil; just put them in a dark, covered pot without adding water.

	<ul style="list-style-type: none"> - The biggest advantage of solar cooking is the flexibility in cooking times. You can remove the food at any time after it is done. - Choose a black or dark colour pot to raise the temperature. Most foods, with the exception of cookies and open-faced cheese sandwiches, are cooked in containers with the lids on. - Some solar chefs use a rack instead of an oven safe glass pan, if the recipe does not need to reach the top temperature. - Use potholders when removing lids or pots. - Here are some typical cooking times for 4 pounds (2 kilograms) of food on a sunny day. (See the infographic)
Next steps	Food contests, energy efficiency contests, spread the word activities
Links and external resources	<p>Detailed instructions and tips on https://www.academia.edu/33131232/Solar_Cookers_Poor_Communitys_Parts1_2_3b</p> <p>More designs by Matteo Muccioli on www.youtube.com/@MatteoMuccioliStudioMUMALab (English and Italian)</p> <p>www.youtube.com/@solcocinero (Spanish)</p>
Insights, comments, reflections	Throughout the event, participants gained practical knowledge regarding solar cooking technology and were encouraged to reflect on the positive impact that sustainable practices can have on the environment and local communities.

Name of the activity	Thermal imaging demonstration workshop
Previous experience	Forest of Dean District Council and Centre for Sustainable Energy, United Kingdom. AURORA project.
Description	Thermographic surveys help to better understand what energy efficiency measures are appropriate in buildings and to improve the energy saving behaviour of residents.
Goals	To use thermal imaging cameras to identify heat loss in buildings.
Level of complexity	Low.
Budget	High. Between 200-600€ for a thermal imaging camera, and a small budget for office supplies.
Space	Public buildings, such as schools or leisure centres. The place should be heated throughout the day to maximise the temperature difference between outside and inside. Avoid walls that are exposed to sunlight. Thermal imaging cannot: see through bricks, metal, plastic, etc. – it can only show the surface temperature; detect anything when there is no temperature difference between the inside and the outside of the dwelling; measure the temperature of air or exhaust gases. Some features of building surfaces can lead to misleading results: reflective surfaces such as metal finishes; stored heat (on a sunny day, brick, block and concrete can store heat and take a long time to cool down).
Timing	In the morning, around 10 a.m., the activity guide should turn on the heating. Duration of the workshop: about three hours. It should take place after 5 p.m. on a cloudy and dry autumn or winter day <ul style="list-style-type: none"> - First hour: The guide explains how to use thermal imaging cameras. - Last two hours: The participants put the information received into practice with the help of the guide.
Materials and tools	<ul style="list-style-type: none"> - Thermal imaging interpretation guide - Thermal imaging cameras. There are many options for cameras available. It is possible to choose between cameras which attaches to a device (such as tablet or phone), or handheld thermographic cameras. In a previous experience of the AURORA project, the Flir One Edge Pro and the Flir C3-X were used. - Devices to plug thermal imaging cameras into (tablets or phones) - Presentation slides & projector. AURORA project provides an infographic that can be used for free. - Office supplies
Number of participants and guides	It is recommended to buy or rent one camera per group of 4-6 people. One guide can easily work with a group of 10 people.
Other requirements	There are special instructions regarding weather conditions and indoor temperature that must be followed.
How to proceed with groups of people	The common receiver is an adult who owns or rents a house and suspects something may be wrong. However, families with children are welcome to join as it is a great opportunity to prepare youth for adulthood. The ratio of participants to cameras is 4-6 to 1. <ol style="list-style-type: none"> 1. Start off by gathering workshop participants and showing them some slides to explain what thermal imaging is and how it's useful.

	<ol style="list-style-type: none"> 2. Then set up groups of people with a camera to go around the building and have an exploration taking images throughout the building –prompt them to look at typical cold spots such as window and door frames. 3. Bring the participants together and get them to share what they found – you can offer prompts for examples: “What was the coldest spot you found?”, “Was that surprising?”. 4. Show a presentation or outlining possible solutions to heat loss.
Instructions	<ol style="list-style-type: none"> 1. Book a suitable space to carry out the workshop. Make sure the weather conditions are convenient and the heating works. 2. To set up the one-hour class on thermography, consult the guides recommended by the AURORA project (1 & 2) and show them to the participants. A projector, some tablets and printouts of the guides can be very useful. 3. Two hours of practical research. Allow time to share what they have found. 4. After the workshop, you can set up a loan service where people can borrow one of the cameras to take to their own homes. It is recommended that you provide some guidance for people to take home with them.
Important information that should be included	<p><u>Weather conditions</u></p> <ul style="list-style-type: none"> - The best time of year to look for insulation problems is autumn-winter, but it is preferable to wait for warmer temperatures to carry out improvement works. - No rain or high winds during the survey. - No sun shining directly onto the external walls of the property during the survey. - No significant changes in external temperature during the 24 hours prior to the survey. - The temperature difference between the inside of the building and the outside should be at least 10 °C during the survey. - The external envelope of the dwelling should be at a relatively constant temperature and, in general, the interior surface should be above 18 °C. This temperature represents the dew point of the wall under normal atmospheric conditions, assuming the wall meets certain standards. <p>A look at the different palettes and scales.</p>
Next steps	Establish a loan service so that participants can take the camera home.
Links and external resources	https://www.nhbc.co.uk/binaries/content/assets/nhbc/foundation/thermal-imaging-report-guide.pdf (English) https://octopus.energy/blog/how-to-use-flir-thermal-camera/ (English)
Insights, comments, reflections	<p>The event was a great success, with the 12 people who attended reporting that it helped them to understand how this technology can highlight simple and budget friendly solutions to heat loss in buildings. The images that were taken uncovered numerous fixable issues impacting the building. It pinpointed a multitude of gaps around windows, easily fixed with draught proofing measures. The cameras also identified cold spots where insulation had been removed around light fittings. The budget-friendly fix? Loft insulation light covers that cost just £6.</p>

Name of the activity	Hidden energy problems thermal photography contest
Previous experience	Department of Mechanical and Production Engineering – Section of Fluids and Energy, Aarhus University, Denmark. AURORA project.
Description	<p>This thermal photography competition is an interesting pretext to think about one of the most serious problems in the use of energy, its loss, of which we are often unaware.</p> <p>The contest has three categories:</p> <ol style="list-style-type: none"> 1. Buildings. Participants are asked to use the thermal imaging cameras to find thermal bridges, that is, paths of least resistance for heat transfer. In the event organised by the AURORA project, all images were taken at the same location, Aarhus University, which can help the jury to compare them. 2. Solar panels. Participants are encouraged to take photographs of solar panel installations in and around Aarhus. This is to help participants understand thermal imaging as a diagnostic tool for fault detection (e.g. hotspot) in solar installations. 3. Others. In the free section of the contest, participants are invited to take photographs of objects that present loss of energy, for example a device that is still red-hot in standby mode. <p><u>Rules</u></p> <ul style="list-style-type: none"> - There is a period of time for taking the photographs and submitting them to the organisers. - Participants are allowed to participate in more than one category, and can submit up to one photo per category. - One winner from each category will be chosen and each winner will get an award. (In the AURORA project the prize was a gift card worth 500 DKK). - Every picture needs to be documented in order to communicate the thermal bridges to the building services. <p><u>Organisation</u></p> <ul style="list-style-type: none"> - The organiser should offer a camera loan service, as the price of thermal imaging cameras is high. - The names of the members of the judging panel must appear on the event announcement. - Provide a mail account to allow participants to ask questions and be updated. - Provide participants with a procedure for sharing images, such as Google Form.
Goals	<ul style="list-style-type: none"> - To look for insulation problems and loss of energy. - To learn by doing. - To encourage creativity in technical contexts.
Level of complexity	Low
Budget	Medium. The budget for setting up the contest is minimal, as only a few posters are needed and this can be arranged very easily using only photocopies. However, the camera loan service and prizes drastically increase the budget.

Space	<p>In a previous experience, all images were taken at the same location. This option is not mandatory, but it has a clear advantage: the building is open for observation and taking pictures is not a problem. It can also help the judging panel to compare the different images.</p> <p>Whether the activity takes place in a single building or outside, the observation area should be large and be accessible to all participants.</p>
Timing	One month is a reasonable period of time for participants to take photographs and submit them.
Materials and tools	<ul style="list-style-type: none"> - Text and image processors to design the announcements and dissemination channels. The guidelines should include: description of the activity, rules, deadline of submissions, name of the jury members and selection criteria. - A link or a QR code to a thermal imaging interpretation guide. - A mail account to allow participants to ask questions and contact the organisers. - A procedure to collect the images taken by the participants (mail account, Google Form, website functionalities...). - Thermographic cameras loan service (participants' personal details, contract...). - Prizes. - A channel to announce the winners and exhibit the images, online or in print. - An internal protocol to notify building staff of faults and loss of energy.
Number of participants and guides	There is no limitation on the number of participants. The number of participants depends on the number of available thermal cameras and the duration of the competition.
Other requirements	The AURORA project emphasises that both guides and participants should have some knowledge of thermography and cameras before celebrating the contest.
How to proceed with groups of people	The thermographic imaging contest is a perfect activity to complement the thermography demonstration workshop with a more playful and creative approach. It can be carried out in universities and other educational institutions, and can be used as an activity on special dates such as World Energy Saving Day.
Instructions	<ol style="list-style-type: none"> 1. Design the announcements and find the dissemination channels. The guidelines should include: <ol style="list-style-type: none"> a. Description of the activity. b. Rules. c. Information about how the camera's loan service works. d. Deadline for submission and information on the award ceremony. e. Names of the jury members. f. Selection criteria. g. A mail account to allow participants to ask questions and contact the organisers. h. A QR code, link or mail account for cameras loan service, submissions and announce the winners. i. A link or a QR code to a thermal imaging interpretation guide. 2. Prepare a stand for key dates, such as the opening and closing days and the award ceremony. The loan service should be available from the opening day. 3. Contact the owners of the buildings or areas where the photographs were taken to inform them of the condition of the facilities.

	4. It is highly recommended to display the images in a public exhibition and/or post them on a website to raise awareness of energy loss. They can also be used with didactic purposes.
Important information that should be included	All the information and resources contained in the guidelines.
Next steps	The images can be used to show the community the conditions of the surrounding facilities, which can also be the germ for a new workshop focusing on solutions to fix thermal bridges.
Links and external resources	Organisers should provide at least one guide that explains or refresh how to use thermal cameras. Here two options: https://www.nhbc.co.uk/binaries/content/assets/nhbc/foundation/thermal-imaging-report-guide.pdf (English) https://octopus.energy/blog/how-to-use-flir-thermal-camera/ (English) https://www.aurora-h2020.eu/2024/06/10/using-thermal-photography-to-highlight-energy-wastage/ (English)
Insights, comments, reflections	In the AURORA project, several models were used by different partners, and all of them achieved the quality standard. FLIR model (handheld camera used in the event organised by Forest of Dean, UK) is the best among them all in terms of research grade equipment, but it is not necessary to use FLIR for such engagement activities, especially if budget is a concern. Those mounted to smart phones are cheaper and works just fine for the purpose.

Name of the activity	Public discussion: preparing for the next winter and beyond
Previous experience	Department of Mechanical and Production Engineering – Section of Fluids and Energy, Aarhus University, Denmark. AURORA project.
Description	Organising a public debate focused on emerging issues related to energy use, bringing together academics, researchers and citizens. In a previous experience in the AURORA project, the discussion was focused on energy transition scenarios without Russian gas, followed by discussions on some Danish policy packages that came out around that time. The presentation is based on a research article available at https://doi.org/10.1016/j.joule.2022.06.023 . This example might be very specific to the Danish context. However, any issue related to energy use can be addressed under the name of public debate.
Goals	<ul style="list-style-type: none"> - To report on a specific topic in an understandable way. - To share ideas. - To listen to citizens' concerns.
Level of complexity	Medium. As an intellectual and didactic activity, organisers need to provide accurate and reliable information, which should also be of interest to the public and properly explained.
Budget	Low, assuming the organisers have background on the field and there is no need to hire an external advisor.
Space	A space suitable for assemblies and discussions. Tables and chairs on the same level. A projector may be necessary. After the presentation led by the speaker, the authoritarian figure should be avoided.
Timing	The activity itself may be done in 2 hours, but the preparation of the presentation may take days.
Materials and tools	<ul style="list-style-type: none"> - A comfortable room for assemblies and discussions, aired and illuminated, equipped with tables and chairs. - Office supplies to facilitate participants' note-taking. - Text and image processors to design the announcement and dissemination channels. The announcement should include general information about the activity: name of the activity, date and time, location, room capacity, name of the speaker, promoting institution. - Optional materials: Projector and a Power Point or Canva presentation, a whiteboard or a blackboard.
Number of participants and guides	The event is presented as open to the public in general, so the only restriction is the room capacity, which should be indicated in the announcement.
Other requirements	It is recommended to have an additional information and resources dossier for those participants who want a broader perspective or specific information. Some organisers prefer to offer a snack such as a cup of tea/coffee and a sandwich/cake to attract participants.
How to proceed with groups of people	Active participation works best in small groups, so the number of participants should not exceed 25 people, otherwise it would be necessary to work with smaller groups and one guide per group in the discussion time.

Instructions	<ol style="list-style-type: none"> 1. Research and create a presentation aimed at a heterogeneous group of people. As a general rule, be clear and offer the option to add information if the audience is knowledgeable or interested. 2. Design the announcement and find the dissemination channels. It should include: <ol style="list-style-type: none"> a. Main topic and description of the activity. b. Date and time. c. Location and capacity. d. Name of the speaker and promoting institution. e. A mail account to allow participants to ask questions and contact the organisers before and after the event. 3. When starting the activity, hand out some office supplies and explain the general goal and the two different sections: the presentation itself and the discussion. During the presentation, the speaker can use slides. In the discussion time, the group can be divided into smaller groups if the number of participants is large.
Important information that should be included	Add a list of sources for participants to explore in more depth.
Next steps	NA
Links and external resources	NA
Insights, comments, reflections	<ul style="list-style-type: none"> - It is recommended that the activity is focused on citizens' problems. In the previous experience of the AURORA project, the activity took place in Denmark, where there is great concern about the usage of Russian gas after the war started. - Make sure that the files and presentation created can be shared with others so that the activity can be repeated in the future or the materials reused.

Name of the activity	Solar driven car race
Previous experience	Department of Mechanical and Production Engineering – Section of Fluids and Energy, Aarhus University, Denmark. AURORA project.
Description	Children and their families are invited to assemble a solar toy car and participate in a car race. This activity can be launched in the context of the special dates across the calendar devoted to research, science, uses of energy, and so on.
Goals	To introduce the basics of solar energy to youth, as a family activity.
Level of complexity	Low. Every solar toy car kit should come with instructions.
Budget	Low – medium. The price range for a regular solar toy car kit is between 4€ and 20€.
Space	A science museum is an extraordinary location for this kind of activity, however, it can take place in educational institutions and leisure centres as well. The activity is ideal outdoors on sunny days, but for the assembly part it is preferable to have a well illuminated and covered space.
Timing	3 hours. In 3 hours the guide can receive and help different children or groups of children.
Materials and tools	<u>Assemblage</u> <ul style="list-style-type: none"> - A number of solar toy car kits. The idea is that each child will have a kit. - Tables and chairs. Some of them need to fit children's sizes so that they feel comfortable for at least one hour while preparing the car. <u>Race</u> <ul style="list-style-type: none"> - Masking tape or chalk to delimit the track.
Number of participants and guides	The number of participants is limited by how many toy car kits there are. For groups of more than ten children, it is recommended counting with another guide. Families are welcome to help if they wish to do so.
Other requirements	Ideally, this activity should be done on a sunny day to ensure the cars work.
How to proceed with groups of people	<p>The guide's tasks consist of preparing a working area for the children, reading the instructions aloud and making sure the children understand them, and organising a race in a suitable place.</p> <p>This activity is taught for children over 4 years old. Families are welcome to participate and help, but it is expected that the child will assemble the car by her/his own according to her/his abilities.</p>
Instructions	<ol style="list-style-type: none"> 1. Choose a solar toy car kit model, buy it and assemble it to make sure the instructions are correct and the design is functional. Here is an example of a very simple solar toy car kit https://www.aliexpress.com/item/1005004333337102.html? 2. Design the announcements and find the dissemination channels. It is recommended to print out pictures of toy solar cars and hang them on the stand to show the children what the activity is all about. If the organisers have chosen a museum or other public institution, use their dissemination channels. Include: <ol style="list-style-type: none"> a. Description of the activity. b. Date and time. c. Estimated duration. d. Location and capacity.

	<p>e. A mail account to allow participants to ask questions and contact the organisers.</p> <ol style="list-style-type: none"> 3. Bring the posters and solar toy car kits and set up a stand to invite families with children to assemble the toy cars. 4. There is no need to wait to have a group of children to start. Read the instructions aloud and make sure the children understand them. 5. If there are at least three children, organise a race and let them play.
Important information that should be included	<ol style="list-style-type: none"> 1. Contact people interested in and arrange a time. 2. Find and book a place to carry out the activity. 3. Bring and distribute the materials. 4. Show an example of the project finished and walk among participants offering assistance.
Next steps	NA
Links and external resources	<p>Example of a very simple solar toy car kit</p> <p>https://www.aliexpress.com/item/1005004333337102.html?</p>
Insights, comments, reflections	<ul style="list-style-type: none"> - There is the option of purchasing more than one model in order to have simpler and more complex cars to ride in order to adapt the activity to the age and ability of the participants. - Make sure the instructions are written in a language the guide can understand. If not, consider buying another model or translating the instructions and printing them out for the activity.

Name of the activity	Make a fun and thrifty draught excluder from scrap materials
Previous experience	Forest of Dean District Council and Centre for Sustainable Energy, United Kingdom. AURORA project.
Description	Making a weatherstrip from waste materials.
Goals	To stop the cold air under doors and through windows.
Level of complexity	Low
Budget	Low
Space	A comfortable space for working together, airy and illuminated, supplied with tables and chairs.
Timing	2 hours
Materials and tools	<ul style="list-style-type: none"> - Tape measure. - Something soft and tubelike to make the body of the snake/dog, such as tights, socks or sleeves of a jumper. - Stuffing - Scissors and wool (or string) - Needles of different sizes and yarns of different colours and thicknesses - Things to make the snake's eyes, tongue, hairs, etc.
Number of participants and guides	One guide for a group of 15 people is sufficient, but the right ratio really depends on the age and ability of the participants, so for children under the age of nine who have never sewn before, this activity can be challenging. For the same reason, older people with motor disabilities may have difficulties.
Other requirements	NA
How to proceed with groups of people	NA
Instructions	<ol style="list-style-type: none"> 1. Fill the tube with stuffing so it forms a sausage shape. Leave a bit unstuffed at the end. If your stuffing material is very light, add something with a bit of weight so that the draught doesn't blow it away. 2. Close up your sausage with wool or string. You could make this into a nose. 3. Use fabric, buttons, scraps, decorations to give your snake/dog/sausage a bit of character.
Important information that should be included	Never use a weatherstrip to block boiler flues, air bricks, or window trickle vents and avoid over draught-proofing windows in kitchens and bathrooms where the moist air needs to escape and where there is no mechanical ventilation like an extractor fan.
Next steps	NA
Links and external resources	Infographic created by the AURORA project.
Insights, comments, reflections	Organisers can ask participants to bring some waste material and decoration from home to personalize the work.

Name of the activity	Soldering and assembling of solar cells
Previous experience	Department of Mechanical and Production Engineering – Section of Fluids and Energy, Aarhus University, Denmark. AURORA project.
Description	This is an hands-on workshop developed by Marta Victoria and Zhe Zhang, part of the AURORA team in Aarhus University, for participants to understand the basics of solar cells, assemble their own solar panels by soldering the solar cells and measure their power production outdoors.
Goals	To help participants understand how solar cells work and gain hands-on experience assembling their own solar panels using soldering.
Level of complexity	Intermediate-level tasks
Budget	Medium-high. The price range for all the materials can be around 100€, but with shared tools/equipment it's about 30€ or 50€.
Space	The perfect space for this activity Lab room which has soldering stations.
Timing	3 hours. In 3 hours the guide can receive and help different groups of high school students and above it. It is recommended that the participants would have basic knowledge of series and parallel circuits.
Materials and tools	<ul style="list-style-type: none"> - Solar cells - Thin tab wires - Wide tab wires - Flux pen - Solder (tin) - Red and black external wires - Tape (e.g., masking tape or duct tape) - Glass frame or alternative non-conductive flat surface - Optional: wiring terminal - Soldering station (set to 480 °C) - Tweezers - Pliers - Precision driller (optional, for making holes in the frame) - Yellow sponge and metal sponge (for cleaning the soldering tip) - Ammeter (or multimeter used as ammeter) - Voltmeter (or multimeter used as voltmeter) <p>Optional:</p> <ul style="list-style-type: none"> - Resistor box - Irradiance sensor - Spectroradiometer (Broadcom Qmini) - Optical fiber with cosine corrector - Computer with Spectrometer Application Software (WAVES)
Number of participants and guides	The activity works best in smaller groups (5-10 people), so all participants get hands-on experience. If the group is big, participants can form smaller groups of 2-3 people per group. The number of participants is ultimately limited by the number of available soldering stations.
Other requirements	

How to proceed with groups of people	People can form small groups of 2-3 on the soldering tasks, so that each participant can get hands-on experience. We do not recommend forming groups of more than 3 people.
Instructions	<ol style="list-style-type: none"> 1. Prepare Your Materials Gather solar cells, tab wires (thin and wide), flux pen, solder, tape, tweezers, pliers, glass or other mounting surface. 2. Plan the Layout Draw the connection layout. Cells will be connected in series (front of one to the back of the next). Keep at least 5 mm between cells. 3. Measure and Cut Thin Tab Wires Cut thin tab wires long enough to connect the front of one cell to the back of the next. Use extra length for external connections. 4. Apply Flux Use the flux pen to clean both: <ul style="list-style-type: none"> o The tab wires o The bus bars (metal strips) on the solar cells 5. Solder Tab Wires to the Front of the Cells <ul style="list-style-type: none"> o Heat the soldering station to 480°C o Use tweezers to hold tab wire in place o Slowly solder the wire onto the front grid of each cell 6. Connect the Back Side of the Cells <ul style="list-style-type: none"> o Align two cells with a small gap (3–5 mm) o Use tape to hold them in place o Solder the wires from the front of one cell to the back of the next 7. Repeat for All Cells Solder all cells in a series chain using thin tab wires. Use wide tab wires for the final external connection points. 8. Fix Cells to the Mounting Surface <ul style="list-style-type: none"> o Use tape to attach the cells to a glass frame or other non-conductive flat surface o Be careful not to break the cells – they are fragile 9. Make the External Connections <ul style="list-style-type: none"> o Solder red (positive) and black (negative) wires to the ends of the wide tab wires o Optional: Drill a hole in the frame to run the wires through or bend tab wires around the frame.
Important information	NA

that should be included	
Next steps	Participants can use multimeters to measure the voltage and current after assembling.
Links and external resources	Here you can find all the information: https://zenodo.org/records/15083659
Insights, comments, reflections	<ul style="list-style-type: none"> - Even though soldering experience is not required for this activity, it works better if the participants have some knowledge on how soldering works and the safety rules about using soldering stations. - Participants need to have a basic understanding of series and parallel circuits.

Name of the activity	Wattoteka & Termoteka
Previous experience	Laboratory of photovoltaics and optoelectronics, Faculty of Electrical Engineering, University of Ljubljana, AURORA Project
Description	This is an hands-on workshop that allow thermographic cameras and electricity meters to be borrowed by students
Goals	To allow as many students as possible to borrow a thermal camera and/or an electricity meter free of charge. Allow students who do not live in Ljubljana to take the thermal camera and/or electricity meter home. Allow students time to test the thermal camera and/or electricity meter in their home environment.
Level of complexity	Low
Budget	WATTOTEKA: Prices for new electricity meters start at €3 and upwards. TERMOTEKA: Prices for thermal imaging cameras start from €300.
Space	At home
Timing	The WATTOTEKA part is suitable for all seasons, while the TERMOTEKA is particularly suitable for the cold/winter season.
Materials and tools	WATTOTEKA: A thermal camera that works as a stand-alone measuring instrument or as a mobile phone adapter that works via an android or apple mobile app. TERMOTEKA: An electricity meter is required. A very large number of very different electricity meters can be purchased on the market. The most convenient are those that connect to the network via wi-fi and can be monitored and analysed from anywhere via a mobile app
Number of participants and guides	WATTOTEKA: The number of students/persons who can borrow a thermal camera depends on the number of thermal cameras the institution has and the length of time for each loan. TERMOTEKA: The number of students/persons who can borrow electricity meters depends on the number of meters the institution has and the length of time the meters are on loan.
Other requirements	There is a particular claim only for TERMOTEKA. Cold weather / winter is required so that students/persons can thoroughly check the quality of the thermal insulation or any damage to the insulation. WATTOTEKA does not require any additional conditions.
How to proceed with groups of people	For both WATTOTEKA and TERMOTEKA, the service procedure is the same. The student borrowing a thermal camera or electricity meter is identified; the date of borrowing and the return date are recorded.
Instructions	There are no specific instructions on lending, as it works on the same principle as the libraries, except that the item being lent is an electricity meter or a thermal camera. There are also no instructions on how to use the thermal camera or the electricity meter, as it is very intuitive to use and it is assumed that students will easily learn how to use it (see instructions of each equipment)
Important information	NA

that should be included	
Next steps	WATTOTEKA & TERMOTEKA can be carried out indefinitely. Any worn-out electricity meters and thermal cameras should be replaced with new ones.
Links and external resources	Here you can find more information of the activity: https://www.aurora-h2020.eu/ul-news/thermography-workshop-2/
Insights, comments, reflections	The free rental of electricity meters and thermal cameras is an ideal opportunity for students to thoroughly check their own or their parents' energy consumption or potential waste.

Name of the activity	Guided thermal camera tour through the city
Previous experience	Laboratory of photovoltaics and optoelectronics, Faculty of Electrical Engineering, University of Ljubljana, AURORA Project
Description	Guided thermal camera tour through the city
Goals	View different buildings through a thermal camera; Comparison of the thermal insulation of different buildings; Evaluating retrofit thermal insulation performance of older buildings; Identifying and recognising insulation defects.
Level of complexity	Low
Budget	The guided thermal camera tour through the city does not require a special budget apart from a one-off purchase of a thermal camera (around 300€)
Space	Any built-up/developed area
Timing	This is a 2-3 hour walk through a compact built-up area in winter
Materials and tools	The only specific material needed for the Guided thermal camera tour through the city is a thermal camera.
Number of participants and guides	The appropriate number for the Guided thermal camera tour through the city is 5 people. More people are possible, up to a maximum of 10 participants. However, the quality of the knowledge given per person decreases as the number of participants increases.
Other requirements	It is extremely important that the Guided thermal camera tour through the city takes place in cold/winter weather. Otherwise it is not possible to detect heat loss from insulation on buildings.
How to proceed with groups of people	<ul style="list-style-type: none"> - The guided thermal camera tour through the city starts with a short introduction and an explanation of how the thermal camera works. - Participants are told what and how they will see through the camera. From here on, the subject can be very educational if a wide variety of buildings are chosen. - There are no differences between the Guided thermal camera tour through the city for different age groups.
Instructions	The guided thermal camera tour through the city starts with a short introduction and an explanation of how the thermal camera works. Participants are told what and how they will see through the camera. From here on, the subject can be very educational if a wide variety of buildings are chosen.
Important information that should be included	There is no relevant information on how to take the guided thermal camera tour through the city. The most important thing is to have a working thermal camera and to walk on routes that are safe for road users.
Next steps	Guided thermal camera tours around the city can be repeated every winter
Links and external resources	https://www.youtube.com/watch?v=gi9rAuF4IZk https://www.youtube.com/watch?v=hclXhtmR3CI https://www.aurora-h2020.eu/ul-news/thermography-workshop-2/
Insights, comments, reflections	The event provided participants with practical knowledge on how to use a thermal camera. More importantly, they discovered how to detect where the biggest heat leaks are from heated homes.

Name of the activity	Charge your phone while riding your bike
Previous experience	Universidad Politecnica de Madrid. AURORA Project
Description	The participants make an electric charger for USB devices (phones, tablets...) that uses the energy generated while riding a bike with a dynamo
Goals	Learn the basics of an AC/DC energy converter Use "free" energy for charging the phone or tablet while riding a bike
Level of complexity	Medium – Low
Budget	Aprox. 12,5 €/charger (tools not included, dynamo included)
Space	An open space with big tables where there is a lot of transit of students
Timing	The activity lasts around 3h
Materials and tools	<ol style="list-style-type: none"> 1. Panel with board featuring positioning lines and holes for the cables 2. 9 cells 3. 18 intercell connectors with pre-applied solder 4. 4 busbars cut to the appropriate length 5. DC/DC converter with soldered input cables + protective casing 6. Fixture for holding and positioning the cells for soldering 7. Soldering iron 8. Solder + flux 9. Multimeter + probes 10. Lamp 11. Gloves 12. Pencils and tweezers for holding the cells after soldering 13. Cables with alligator clips 14. Electric grinder with stand 15. Silicone with gun (common material) 16. 1 small perforated PCB 17. 1 dynamo 12 VAC / 5.5W 18. 1 full-wave bridge rectifier 1000V / 2^a 19. 1 electrolytic capacitor 2200 µF / 35V 20. 1 DC-DC voltage reducer with USB output 21. Wire for making electrical connections 22. 1 small plastic box

Number of participants and guides	Groups of 4/6 adults (mainly university students)
Other requirements	This activity is a lot of fun for the participants because they use manual tools like a welder and a drill, many of them for the first time. However, this also makes the activity suitable only for small groups, as a lot of supervision is needed.
How to proceed with groups of people	As a hands-on workshop for university students, the activity offers a practical introduction to sustainable energy conversion and DIY electronics. Ideally, organizers should collaborate with engineering departments or makerspaces to ensure technical guidance. The first step is to invite professors or researchers specializing in renewable energy systems to provide a short theoretical introduction. This activity is best conducted in open-air spaces, where passersby can observe and engage. To emphasize sustainability, include a discussion on "free energy" applications. Given the use of tools (welder, drill, soldering), keep groups small and assign trained supervisors to ensure safety.
Instructions	<p>Step 1: Connect the 12V/5.5W output of the dynamo with wires to the positive input of the bridge rectifier, and connect the dynamo's ground (any metallic point on its structure) to the negative input of the bridge rectifier.</p> <p>Step 2: Solder the electrolytic capacitor to the output of the bridge rectifier and to the input of the DC-DC step-down converter.</p> <p>Step 3: Make a small hole in the plastic box to allow the USB port of the converter to fit through.</p> <p>Step 4: Arrange everything so it fits inside the plastic box and apply hot glue with a glue gun to secure the DC-DC converter in a fixed position.</p> <p>Step 5: Use heat-shrink tubing on the wires to make everything more compact, and adjust the length of the cables to fit the size of your bicycle.</p> <p>Step 6: Mount the dynamo to your bicycle wheel and start enjoying your USB charger.</p>
Important information that should be included	<p><u>Description of the device</u></p> <p>A device will be created from scratch that is capable of charging the battery of any electronic device using the alternating current generated by a dynamo. After passing through several intermediate stages, the circuit will finally produce a stable 5V direct current output, just like any USB port provides.</p> <p>Alternating current (AC) and voltage are so named because they constantly alternate their polarity—meaning the positive and negative poles switch back and forth (as is the case with household power outlets). Since the vast majority of electronic devices use direct current (DC) rather than AC, they employ transformers to convert AC into DC. This process is called rectification, which means converting alternating current into direct current.</p> <p>The voltage output from the dynamo is a sinusoidal signal with a 12V amplitude and a frequency that depends on the rotational speed. This signal is passed through a full-wave rectifier bridge—a circuit made up of 4 diodes arranged in such a way that it provides two different paths for positive and negative current, depending on the polarity of the signal (since a sinusoidal signal has both positive and negative</p>

	<p>amplitudes). This circuit ensures that the current, which alternated polarity before passing through it, has only a positive polarity at the output.</p> <p>The issue with the signal coming out of the rectifier bridge is that it still has voltage drops. This is resolved by adding a capacitor to the circuit. The capacitor acts as a reservoir of electric charge, meaning it charges fully and then discharges, releasing the stored electrical energy to counteract those voltage drops, thereby achieving a much more stable DC voltage.</p> <p>Finally, after the filtering stage, the DC voltage is passed through a final stage called a DC-DC buck converter. This converter is an electronic device whose function is to reduce the voltage at its input and provide a lower, stable voltage at its output, regardless of the current demand. These types of circuits are especially useful when a regulated and stable output voltage is required from a higher input voltage. In our case, the circuit ends in a USB port that provides a stable 5V output to directly connect any charger.</p>
Next steps	<ul style="list-style-type: none"> - Ask for feedback (pictures, commentaries...) from the students after using the charger. From experience, we believe that sending feedback should be a condition for qualification (otherwise, most students do not collaborate). - The ideal would be that the same students participated in the "Build your own PV module" activity, so that they could use both the dynamo or the PV module for powering the charger.
Links and external resources	<p>You can find more information here:</p> <p>https://www.youtube.com/watch?v=ZMmP0_Qik6s (English)</p>
Insights, comments, reflections	<p>The project provides a concrete application of concepts such as rectification, filtering, and voltage regulation.</p>

Name of the activity	Carbon Sequestration Game
Previous experience	Universidad Politecnica de Madrid. AURORA Project
Description	The activity consists of pictures taken by the participants with their own cell phones of situations that relate to energy efficiency in a positive or negative way.
Goals	Learn to pay more attention to energy efficiency aspects of the daily life
Level of complexity	Low
Budget	NA
Space	Any location is possible
Timing	As much time as you need, 1h/2h it's enough
Materials and tools	Cellphone with camera Post-its Board/placard
Number of participants and guides	Groups of adults (mainly university students)
Other requirements	NA
How to proceed with groups of people	As a hands-on activity for university students, the activity offers a practical introduction to sustainable energy conversion.
Instructions	<ol style="list-style-type: none"> 1. The activity begins with a board where participants can post ideas on how to improve the sustainability of the place where the activity (e.g., city, building, etc.) is taking place. 2. After that, all participants are invited to walk around the area and take pictures of situations related to energy efficiency — both positive (e.g., public bike chargers) and negative (e.g., an open window while the heater is on).
Important information that should be included	NA
Next steps	NA
Links and external resources	NA
Insights, comments, reflections	A wide diffusion of the main results obtained from the activity could help changing some habits in the campus.

Name of the activity	Make your own PV module
Previous experience	Universidad Politecnica de Madrid. AURORA Project
Description	The activity consists in making a small PhotoVoltaic module from zero and keep it for powering small devices
Goals	Learn how a PV module works by manufacturing one from zero
Level of complexity	Medium-Low
Budget	Approx. 50 €/module (tools not included)
Space	An open space with big tables where there is a lot of transit of students
Timing	Two sessions of 2.5h each
Materials and tools	<ol style="list-style-type: none"> 1. All the materials that compose a PV module (PV cell, frame, wires...) and the tools for its construction (welder, drill...) 2. DC-DC Buck/Boost Converter (based on the XL6009) 3. 3D-printed case (to house the converter) 4. Cables (for connection to the solar panel) 5. Double-sided tape or glue (for securing the converter)
Number of participants and guides	Groups of adults (mainly university students)
Other requirements	This activity is a lot of fun for the participants because they use manual tools like a welder and a drill, many of them for the first time. However, this also makes the activity suitable only for small groups, as a lot of supervision is needed.
How to proceed with groups of people	Students can be divided into 2-3 people groups. The assembling of the solar cells is almost impossible for only one person, so it is recommended that at least two people work on the same PV module.
Instructions	See the document below: Make your own PV module (in Spanish)
Important information that should be included	The solar cells are extremely fragile, usually several of them are broken during the manufacturing process. It is recommended to buy extra units.
Next steps	NA
Links and external resources	NA
Insights, comments, reflections	This activity is a lot of fun for the participants because they use manual tools like a welder and a drill, many of them for the first time. However, this also makes the activity suitable only for small groups, as a lot of supervision is needed. The cost of the materials is high if compared to other activities.

Name of the activity	Bike Tour and Thematic Talks
Previous experience	Cátedra de Energias Renováveis, Universidade de Évora, Portugal. AURORA Project and SEYN (Sustainable Energy Youth Network)
Description	A bicycle tour was organized through the city of Évora with the aim of raising awareness about the use of sustainable means of transport and highlighting the importance of the energy transition. Over the course of the 14 km bicycle ride, participants stopped at key locations related to renewable energy initiatives, with a particular focus on solar energy. Highlights included a visit to Évora City Hall, which is part of the POCITYF project and is installing innovative solar tiles; a stop at a municipal department responsible for the project, where participants could see and learn about the solar tiles firsthand; and visits to the companies Decsis and Capwatt Évora, both involved in solar energy and sustainable energy solutions with solar power plants with different technologies. This activity provided participants with the opportunity to exercise while discovering the city's concrete actions towards a greener future.
Goals	Raise awareness of eco-friendly transportation; Promote knowledge of local energy transition projects; Encourage sustainable physical activity.
Level of complexity	Low to medium — accessible bike ride with some technical explanations at stops.
Budget	Very low — only basic logistical costs (guides, safety, potential insurance).
Space	Around the city/village
Timing	Ride duration: around 3 hours, including stops. Best scheduled during mornings or afternoons, depending on the weather
Materials and tools	Bicycles (provided by participants or made available by organizers). Safety helmets.
Number of participants and guides	Groups of adults (mainly university students and researchers)
Other requirements	Municipal authorization to use public roads. Safety support (e.g., police or civil protection presence might be necessary). Accident insurance coverage.
How to proceed with groups of people	Split into smaller groups if necessary. Prioritize road safety at all times. Ensure everyone can hear and engage during the information sessions.
Instructions	Confirm registration and bicycle conditions before the event. Follow guides' directions throughout the ride. Respect traffic rules and safety guidelines. Actively participate in the discussions at each stop.
Important information that should be included	NA
Next steps	Publicize new dates for future tours. Expand the route to include additional renewable energy projects. Create digital information materials to share with participants after the event.

Links and external resources	NA
Insights, comments, reflections	This kind of initiative successfully combines environmental education with physical wellness.

Name of the activity	Solar Sound System Workshop
Previous experience	Cátedra Energias Renováveis, Universidade de Évora, Portugal - AURORA Project and Sustainable Energy Youth Network (SEYN)
Description	Hands-on workshop to build a portable solar-powered sound system that also functions as a USB charging station.
Goals	Teach participants how to assemble a self-sufficient sound system powered by renewable energy, promoting sustainability, technological autonomy and practical skills in electronics and woodworking.
Level of complexity	Medium — requires basic knowledge of electronics and manual skills with tools.
Budget	Moderate — involves purchasing solar panels, battery, charge controllers, amplifier, speakers, wood materials, and tools (such as soldering iron).
Space	Workshop space or large room with access to workbenches, electricity and proper ventilation.
Timing	1 to 2 full days (depending on participants' experience), divided between wooden box assembly and electronics installation.
Materials and tools	<ul style="list-style-type: none"> - Solar panel 15W 12V - Battery 12V 17Ah - 10A 12/24V charge controller - Bluetooth sound amplifier 2x50W - 20W (10 RMS) marine speakers - 5V USB step-down (3A output) - AC/DC battery charger - 3-way ON-OFF-ON switch - On/Off switches (for amp and USB charger) - Cables (0.5–1.5mm diameter), connectors - 2x DC barrel jack adapters (male + female) - Plywood (5mm), wooden rods (1.5x1.5cm) - Screws, wood glue, hinges, handles - Tools: saw, ruler, drill, soldering iron, multimeter, insulation tape, gloves
Number of participants and guides	Ideally groups of 5 to 10 participants, with at least 1 or 2 facilitators with technical knowledge.
Other requirements	<ul style="list-style-type: none"> - Access to electricity for soldering and power tools - Safety equipment (gloves, eye protection) - Technical supervision during electronics assembly
How to proceed with groups of people	<ul style="list-style-type: none"> - Split into subgroups per task: wooden box construction, wiring and electronics assembly. - Rotate tasks to ensure all participants experience each step.
Instructions	See the document below: Solar Sound System & charging station
Important information that should be included	<ul style="list-style-type: none"> - Label all parts and components before beginning - Double-check polarity in electrical connections - Prevent short circuits or overloading - Ensure solar panel orientation allows effective charging
Next steps	<ul style="list-style-type: none"> - Test the system outdoors - Use the system at events or as a demonstration in future workshops

	- Explore expanding the system with additional outputs or modules
Links and external resources	NA
Insights, comments, reflections	This workshop is an excellent opportunity to explore renewable energy through practical application. It fosters teamwork, technical learning, and environmental awareness while producing a functional and creative outcome.

Name of the activity	Solar Food Dehydrator
Previous experience	Cátedra Energias Renováveis, Universidade de Évora, Portugal - AURORA Project and Sustainable Energy Youth Network (SEYN)
Description	A Solar Food Dehydrator designed to preserve food by drying fruits and vegetables using solar heat, built using wood, mesh and plexiglass.
Goals	To create a sustainable, solar-powered device that dehydrates food efficiently without the use of electricity.
Level of complexity	Medium – requires basic woodworking skills, ability to follow construction diagrams and use of tools like a drill, saw and staple gun.
Budget	Moderate – mainly depends on the local cost of materials such as plywood, wooden rods, plexiglass, inox mesh and fasteners.
Space	Sufficient space to work with large plywood sheets and assemble a unit roughly 104 cm x 54 cm in size. Also, space is needed for outdoor testing under sunlight.
Timing	A full day or weekend project, depending on the number of participants and available tools.
Materials and tools	<ul style="list-style-type: none"> - Plywood (15mm) - Wooden rods (various sizes) - Plexiglass (4mm) - Inox mesh - Screws - Hinges - Handle - Heat-resistant silicone - Wood glue - Wood varnish <p>Tools: Saw, drill, ruler, pencil, screwdriver, chisel, staple gun, clamps, thermometer (optional for testing).</p>
Number of participants and guides	2–4 participants recommended; 1 person with construction knowledge or for technical guidance is ideal.
Other requirements	<ul style="list-style-type: none"> - Outdoor space with direct sunlight for testing. - Safety precautions while using power tools. - Labels for each wooden piece for easier assembly.
How to proceed with groups of people	Split tasks: cutting, assembly, mesh application, and final adjustments. Collaborate on construction stages like framing, attaching legs and shelf installation. Assign quality control and safety monitoring roles.
Instructions	See the document below: Solar Food Dehydrator
Important information that should be included	<ul style="list-style-type: none"> - Maintain a 40° angle for proper airflow. - Ensure all mesh is tightly secured to prevent insects. - Use heat-resistant silicone to seal the plexiglass. - Apply varnish to protect against weathering
Next steps	<ul style="list-style-type: none"> - Field testing with various fruits/vegetables. - Monitor temperature and drying efficiency. - Consider adding a thermometer for precision.

	- Optionally scale design or replicate for community use.
Links and external resources	NA
Insights, comments, reflections	The project promotes sustainability, food preservation and DIY skills. It is ideal for educational workshops, community projects, or personal homesteading initiatives. Collaboration and careful labeling significantly ease the assembly process.

Name of the activity	Contest: Photography about energy transition
Previous experience	Cátedra Energias Renováveis, Universidade de Évora, Portugal - AURORA Project and Sustainable Energy Youth Network (SEYN)
Description	A photography contest inviting participants to capture images that represent or relate to the concept of the energy transition, emphasizing the theme of a just transition.
Goals	<ul style="list-style-type: none"> - Engage citizens in reflecting on and illustrating the energy transition. - Raise awareness about the concept of a just transition through visual storytelling. - Encourage community participation in discussions about sustainable energy practices.
Level of complexity	Low
Budget	It depends on the contest prizes
Space	Participants could choose any location that they felt represented the energy transition.
Timing	There is no specific time. It depends on the duration of the competition and the announcement of the winners.
Materials and tools	<ul style="list-style-type: none"> - Camera or smartphone for capturing photographs - Internet access for submitting entries
Number of participants and guides	Open to all interested individuals.
Other requirements	NA
How to proceed with groups of people	NA
Instructions	<ol style="list-style-type: none"> 1. Capture a photograph that represents or relates to the energy transition. 2. Submit the photograph by the specified deadline. 3. Await the announcement of winners.
Important information that should be included	Prizes were awarded to the top three entries and the top 10 photographs were selected for exhibition
Next steps	NA
Links and external resources	NA
Insights, comments, reflections	<p>The contest intends to make the participants question themselves about energy transition and how to frame it in a picture. Some approaches can be more abstract than others and therefore a short description is attached to the picture submitted.</p> <p>The final picture exposition served to engage with the public in discussion regarding energy transition giving the individuals the possibility of expressing their perspectives on sustainable energy practices and the importance of a just transition.</p>

Name of the activity	Build your own energy sensor
Previous experience	Universidad Politecnica de Madrid. AURORA Project
Description	This project involves constructing a DIY energy sensor using an ESP32 microcontroller and a current transformer (CT) sensor. The sensor measures real-time electricity consumption and transmits the data via Wi-Fi to platforms like Home Assistant for monitoring and analysis.
Goals	<ul style="list-style-type: none"> - Develop a non-invasive energy monitoring device. - Enable real-time tracking of electricity usage. - Facilitate data visualization and analysis through integration with smart home platforms
Level of complexity	Intermediate. Requires basic knowledge of electronics and microcontroller programming
Budget	Approximately €20–€30, depending on component sources and availability.
Space	A standard workspace with a table, access to power outlets and internet connectivity.
Timing	Estimated 4–6 hours for assembly and testing. It can be divided in two sessions
Materials and tools	<ul style="list-style-type: none"> - ESP32 microcontroller - CT sensor (e.g., YHDC SCT-013-030) - Breadboard for prototyping board - Resistors and capacitors as per circuit requirements - Jumper wires - USB cable for programming - Soldering iron and solder (if opting for a permanent setup) - Computer with Arduino IDE installed
Number of participants and guides	<p>Basic understanding of electrical safety.</p> <p>Familiarity with Arduino programming.</p> <p>Access to a Wi-Fi network for data transmission.</p>
Other requirements	<ul style="list-style-type: none"> - Basic understanding of electrical safety. - Familiarity with Arduino programming. - Access to a Wi-Fi network for data transmission.
How to proceed with groups of people	<ul style="list-style-type: none"> - Divide participants into small teams. - Assign specific roles: hardware assembly, software programming, testing, and documentation. - Encourage collaboration and knowledge sharing among teams.
Instructions	<ol style="list-style-type: none"> 1. Assemble the circuit by connecting the CT sensor to the ESP32 via the breadboard. 2. Program the ESP32 using the Arduino IDE with appropriate libraries to read sensor data. 3. Establish Wi-Fi connectivity for the ESP32 to transmit data. 4. Integrate the device with a platform like Home Assistant for data visualization. 5. Test the setup by monitoring the energy consumption of various appliances.
Important information	<ul style="list-style-type: none"> - Ensure the CT sensor is clamped around only one conductor (live or neutral) and not both. - Calibrate the sensor readings to match actual energy consumption values.

that should be included	<ul style="list-style-type: none"> - Implement safety measures to prevent electrical hazards during installation.
Next steps	<ul style="list-style-type: none"> - Enhance the device with additional sensors (e.g., voltage sensors) for more comprehensive monitoring. - Develop a custom enclosure for the hardware to ensure durability and safety. - Explore integration with other smart home systems or cloud platforms for advanced analytics
Links and external resources	https://www.youtube.com/watch?v=KQTjjz1AwQg See the document below: Build your own energy sensor (in Spanish)
Insights, comments, reflections	Building a DIY energy sensor not only provides insights into household energy consumption but also fosters a deeper understanding of electronics and programming. Such projects promote energy awareness and can lead to more sustainable habits. Additionally, integrating the sensor with smart home platforms can automate energy-saving actions, enhancing overall efficiency.

Name of the activity	Low-Cost Electronics Workshop with ESP32
Previous experience	Cátedra de Energias Renováveis, Universidade de Évora, Portugal - AURORA Project
Description	The workshop introduces participants to basic electronics and programming using the ESP32 microcontroller. It enables them to build circuits, write code in Arduino IDE, and implement practical projects involving environmental sensors and IoT concepts.
Goals	<ul style="list-style-type: none"> - Develop basic skills in electronics and programming - Build simple projects using the ESP32 microcontroller - Learn and apply PWM (Pulse Width Modulation), temperature, humidity, and light sensors - Raise awareness of energy efficiency and sustainable practices - Explore real-time monitoring with Arduino Cloud
Level of complexity	Intermediate. Requires basic knowledge of electronics and microcontroller programming
Budget	Low. Main cost is for the electronics kit (€20–€25 per participant)
Space	A computer lab or workshop space with desks for circuit assembly, natural lighting, and access to power outlets
Timing	Recommended 2–3 hours per session
Materials and tools	<p>Electronics Kit, including:</p> <ul style="list-style-type: none"> - 1 x ESP32 microcontroller - Breadboard, USB cable, jumper wires - Sensors: DHT11, LDR, SCT-013 (current sensor) - LEDs (red, green, yellow, white, RGB) - Resistors, push button, capacitor, potentiometer - Computer with Arduino IDE installed
Number of participants and guides	Maximum 15 participants per session. 1/2 instructor.
Other requirements	<ul style="list-style-type: none"> - Internet access (for Arduino Cloud) - Well-lit space, especially for light sensor exercises
How to proceed with groups of people	<p><u>Students</u>: Use as a hands-on introduction to IoT and energy sustainability.</p> <p><u>Young Adults</u>: Encourages logical thinking and tech interest.</p> <p><u>Seniors</u>: Can be simplified and supported with extra guidance and supervision.</p>
Instructions	<ol style="list-style-type: none"> 1. Install Arduino IDE and ESP32 drivers 2. Connect the ESP32 board via USB 3. Run example codes: “Hello World” via Serial Monitor 4. LED control with PWM 5. Sensor readings: temperature, humidity, light 6. Weather station via Arduino Cloud 7. Upload code and monitor output 8. Observe and analyze data

Important information that should be included	<p><u>Description of the device</u></p> <ul style="list-style-type: none"> - The ESP32 is a versatile microcontroller with Wi-Fi/Bluetooth, ideal for IoT projects. Activities help participants understand core concepts of digital communication, sensors, and sustainability through practical implementation. <p><u>General guidelines</u></p> <ul style="list-style-type: none"> - Double-check polarity and connections - Use proper resistors for LED protection - Avoid short circuits; handle components gently - Use Serial Monitor or Cloud for real-time readings <p><u>Last tips</u></p> <ul style="list-style-type: none"> - Always include Serial.begin(9600) in setup - Allow delays for sensor stabilization - Document progress with photos and screenshots - Encourage participants to modify code and experiment
Next steps	<ul style="list-style-type: none"> - Enhance the device with additional sensors (e.g., voltage sensors) for more comprehensive monitoring. - Develop a custom enclosure for the hardware to ensure durability and safety. - Explore integration with other smart home systems or cloud platforms for advanced analytics
Links and external resources	<p>Workshop ESP32 Presentacion, codes and guide Arduino IDE Arduino Cloud ESP32 Project Resources</p>
Insights, comments, reflections	<p>This workshop provided an engaging learning environment where participants explored the potential role of technology in sustainability. It fostered understanding of smart devices and their potential impact on energy-conscious living.</p>

Name of the activity	Solar Bugs - Experience for kids to build their own solar toy
Previous experience	Universidad Politecnica de Madrid. AURORA Project
Description	Workshop for children to build a solar bug (4 to 9 years old)
Goals	<ul style="list-style-type: none"> - To introduce the notion that electrical energy can be produced from light power - To get familiar with solar cells and manipulate them - To visualize electrical circuits and self-powered devices - To boost creativity through the personal design of toys
Level of complexity	Low
Budget	4-5 euros per bug total (including 2 euros per solar cell; cost of soldering irons and solar bug arena not included)
Space	You need a working surface (i.e. table) where you can comfortably lay out your materials and a space where an accompanying adult can safely solder wires. Access to outdoor space is ideal to see the solar bugs move.
Timing	Build the solar bug in the morning or early afternoon so that you can play with it in sunny hours.
Materials and tools	<ul style="list-style-type: none"> - Small solar cell (approximately 5x5 cm) - Small vibrating motor (i.e. the ones used in mobile phones) - 1 Soldering iron per 20 children - Soldering wire - Wire strippers - Thin colored insulated wires and pin connectors - Double-sided tape - Stiff wire - 3D printed structure (or hard cardboard if 3D printing not available) <p>For the decoration:</p> <ul style="list-style-type: none"> - Children safe scissors - Children safe glue - Cardstock in different colors - Adhesive plastic googly eyes (the kind with a black pupil that moves) - Pipe cleaners - Markers
Number of participants and guides	<p>1 volunteer per 5 children</p> <p>1 extra volunteer per 20 children to work with the soldering iron</p> <p>Guides are not required as the activity is designed to work with small children</p>

Other requirements	<ul style="list-style-type: none"> - It is recommended to 3D-print a simple bug structure beforehand. - If it is not possible to play with the solar bugs outdoors, prepare a “solar bug arena” with strong lamps and a black surface to avoid reflexions when the kids are playing.
How to proceed with groups of people	<ul style="list-style-type: none"> - For the youngest children, this may be one of their first encounters with the concept of solar energy. A brief, interactive introduction in the form of a dialogue can therefore be especially enriching and engaging. - Safety: Children must be clearly informed that the soldering station is a hazardous area, and they should approach it in an orderly and supervised manner when they need their bug to be soldered. Caution is also required when using scissors and glue. It is advisable to consult with families beforehand to determine whether any children need direct supervision when handling these tools. The size of the groups will depend on this factor. - If using a solar bug arena, the children should not look at the lamps directly and strong reflections should be avoided.
Instructions	<ol style="list-style-type: none"> 1. Cut four wires in a length of approximately 3 cm and strip the ends. 2. Bring the wires to the soldering station for connection. Two wires should be soldered to the solar cell at one end and to connectors at the other. The remaining two wires are connected to the motor on one end and to connectors on the opposite end. 3. Cut a piece of stiff wire of approximately 3 cm and glue the motor to it. 4. Attach the solar cell on the bug structure (if possible, 3D printed; if not, made of hard cardboard) using double-sided tape. Attach the stiff wire with the motor perpendicularly to the bottom of the bug structure so that it touches the floor. 5. Connect the motor to the solar cell 6. Attach four legs to the bug using stiff wire and/or pipe cleaners 7. Decorate your bug, maybe adding a face, a tail, antennae, wings, etc.
Important information that should be included	<p><u>Description of the device</u></p> <ul style="list-style-type: none"> - A solar bug is a toy that vibrates when the sunlight reaches it. The vibration on the wire that allocates the motor makes the bug move on the floor. <p><u>General guidelines</u></p> <ul style="list-style-type: none"> - The bugs require quite strong illumination to move. In the central day hours of a sunny day, the Sun provides much more power density than most available lamps. - If outdoor playing is not an option, build beforehand a well illuminated solar bug arena. Do not attempt to use flashlights because they will most likely not provide enough power and it's difficult to follow all bugs as they move.

	<ul style="list-style-type: none"> - The bug structure can be as simple as a cardboard rectangle, but ideally it will have a position for the motor wire and another one for the head, as in the example provided here. <p><u>Last tips</u></p> <ul style="list-style-type: none"> - When gluing the motor to the stiff wire, it's important to ensure the connection is as rigid as possible. If the wire is too flexible, it will absorb the motor's vibrations, and the bug's movement will be significantly reduced. - Organize the groups so that children are working on different steps at the same time. For example, some groups can prepare their decorations before completing steps 1 and 2. This will help prevent everyone from needing the soldering station at once.
Next steps	
Links and external resources	<p>Details on the 3D printing structure (gcode file and image file), photos of solar bugs and an example of solar bug arena on:</p> <p>https://doi.org/10.5281/zenodo.15535050</p>
Insights, comments, reflections	<p>The workshop fosters creativity by combining guided technical instructions with opportunities for children to make their own decisions during the creative, hands-on elements.</p>



**Escuela Técnica Superior de
Ingeniería y Sistemas de
Telecomunicación y Sistemas
Informáticos**



TALLER AURORA

**MEMORIA
MÓDULO FOTOVOLTAICO**

Apellidos y Nombre

Madrid Vega, María



Contenido

Contenido	2
1. Introducción	3
2. Materiales.....	5
2.1. Módulo solar.....	5
2.2. Protector USB.....	5
3. Procedimiento	6
3.1. Construcción módulo fotovoltaico.....	6
3.2. Montaje sistema eléctrico	6
3.2.1. Previo	6
3.2.2. Convertidor DC-DC	6
3.2.3. Construcción circuito de protección USB	7
4. Resultados y pruebas	9
4.1. Medidas realizadas	9
4.2. Pruebas funcionales.....	9
5. Parte eléctrica.....	10
5.1. Convertidor DC-DC.....	10
5.2. Protector USB.....	11
6. Tiendas donde adquirir los componentes.....	12

1. Introducción

El objetivo del taller es fabricar módulos solares con 9 celdas, con un sistema de regulación de voltaje (convertidor DC-DC) y un circuito de protección (protector USB), que permitan la carga de móviles o funcionamiento de pequeños dispositivos, como ventiladores.

A continuación, se explicará todo lo que hay que hacer paso a paso:

El taller se divide en 2 días. En el primer día se realiza el montaje de las 9 células y en el segundo día se hace el montaje eléctrico y las pruebas de funcionamiento.

Lo primero que tendrá que hacer el encargado del taller es la preparación para el primer día. Habrá que comprar los marcos para los módulos. Cada módulo tiene **9 células, 4 busbars y 12 conectores**. Los conectores son los de la imagen, y hay que ponerles una bolita de estaño en cada una de las 6 pestañitas.



Ilustración 1-1 Conector

Una vez estañados los conectores, hay que cortar los busbars para poder colocarlos entre las células; 2 de ellos serán más largos, para unirlos en serie, y los otros 2 serán los que salgan por lo extremos del cuadro (importante que sean un poco más largos del tamaño de una celda porque tienen que sobresalir por detrás).

Una vez hecho esto y después de una explicación sobre la física detrás de los módulos, el efecto fotovoltaico y curvas I-V, los alumnos pueden empezar con el taller. Como solo hay 15-18 alumnos y 5 módulos, se pondrán en grupos de 3 o 4. Cada grupo de alumnos debe tener: *cuadro, 9 células, 4 busbars, 12 conectores estañados, pinzas, lápiz, guantes, foco de luz, flux, multímetro, lamina de silicona, 2 cables, piezas para sujetar celdas impresas en 3D, reglas y un soldador.*

Lo primero que deberán hacer será poner 2 células juntas encima de la lamina de silicona, con la ayuda de las piezas en 3D. Uno de los alumnos sujetará el conector, otro el soldador y el otro las celdas. **Es muy importante que el alumno que manipule las células lo haga con guantes, ya que son muy sensibles.**

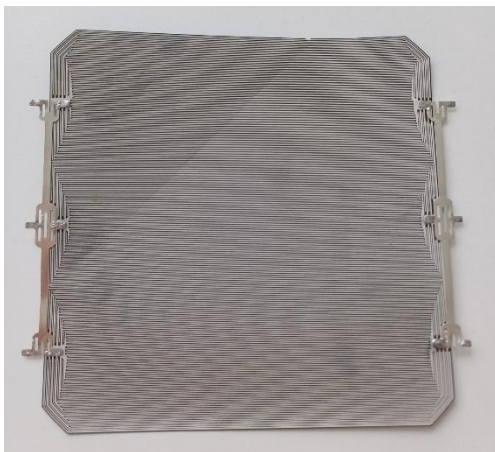


Ilustración 1-2 Célula con 2 conectores

Antes de pasar a la siguiente celda, es recomendable que vayan midiendo la tensión que tienen entre las celdas, para comprobar que no hay ningún cortocircuito o problema (*cada celda da más o menos 0.6V*). Esto lo harán colocando las celdas sobre el cristal con mucho cuidado y a la vez, un alumno enfocará con el foco directamente a las celdas y otro le dirá con el multímetro la tensión entre las celdas.

Deben ir soldando los conectores, habiendo echado flux previamente (para que la soldadura salga limpia), formando 3 filas de 3 células. Finalmente, soldarán los busbars para que las células queden en serie.

El segundo día comienza la parte del **montaje eléctrico**. Con la ayuda del lápiz y las reglas, los alumnos deberán hacer líneas horizontales y verticales sobre el cartón para que las células

queden simétricas. Después, con un taladro harán **2 agujeros en los extremos**, para que puedan sacar los extremos de los busbars y posteriormente soldar los 2 cables que tienen.

Una vez hechos los agujeros, sacados y soldados los cables, los alumnos tienen que aislar bien el cristal usando una silicona por todo el marco.

Como se puede observar en la imagen inferior (Ilustración 1-3), hay una caja impresa en 3D en una de las esquinas, en la cual se meterá el convertidor y el protector USB para que quede mejor estéticamente, y los cables sí atarán con cinta aislante.

Para probar si funcionan los ventiladores bastaría con conectar la salida del módulo a los cables del convertidor, y si se quiere probar para ver si se puede cargar el móvil, tenemos que conectar la salida del módulo al convertidor, y la salida del convertidor al protector USB.

Con uno de los focos, o incluso con la luz solar, para comprobar si funciona el panel solar se puede hacer de diferentes maneras. Una de ellas puede ser saliendo a la calle, y con la luz del Sol podemos alimentar el panel. Si funciona correctamente el ventilador debería empezar a moverse. Otra de las maneras para comprobarlo es apuntando con el foco directamente al panel y debería pasar lo mismo.



Ilustración 1-4 Conexión cableado convertidor DC-DC

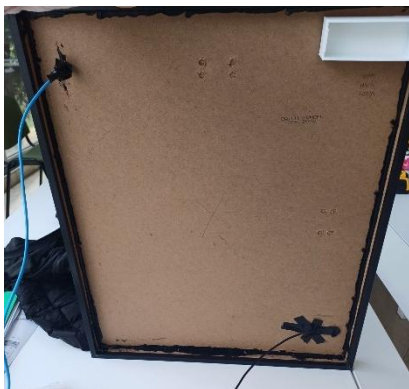


Ilustración 1-5 Módulo por detrás

Para comprobar si funciona como cargador de móvil tenemos que conectar el circuito de protección USB, que se habrá montado previamente como se explica en apartados posteriores. En este caso tenemos que conectar la salida del convertidor (la positiva) al positivo del protector, y lo mismo con el negativo. Ahora ya lo único que hay que hacer es conectar el USB del cargador de móvil a la salida del protector, que es un USB tipo A hembra, y debería empezar a cargarse el móvil.

Una vez hecho todas las medidas se da por finalizado el taller.

2. Materiales

La fabricación de los módulos consta del propio modulo solar, del convertidor DC-DC y del protector USB.

Los materiales que necesita cada alumno se han detallado en el apartado anterior y en éste se va a detallar lo que se necesita especialmente para el módulo solar y para el circuito de protección que se deberá montar previo al taller.

2.1. Módulo solar

Para 1 módulo solar completo necesitaremos:

- Células (9): [HTTPS://WWW.MRWATT.EU/ES/MONOCRISTALINAS/C%C3%A9LULA-SOLAR-MONOCRISTALINA-SUNPOWER-FLEXIBLE-ALTA-POTENCIA-5X5-PULGADAS-125X125MM-BIN-ME1-ULTRA-PEAK-PERFORMANCE-DE-3720MW.HTML?SEARCH_QUERY=BINME1SP5&RESULTS=1](https://www.mrwatt.eu/es/monocrystalinas/c%C3%A9lula-solar-monocrystalina-sunpower-flexible-alta-potencia-5x5-pulgadas-125x125mm-bin-me1-ultra-peak-performance-de-3720mw.html?search_query=binme1sp5&results=1)
- Convertidor DC-DC XL6009 (Buck/boost): debe tener 2 inductores; (Si el link caduca, buscando “Buck boost converter” en Amazon se puede volver a encontrar el mismo módulo) [HTTPS://WWW.AMAZON.ES/ANGEER-ADJUSTABLE-AUTOMATIC-CONVERTER-XL6009/DP/B07RNWWS4M/REF=SR_1_9?CRID=Z5BG9IU7CV1T&DIB=EYJ2IJOIMSJ9.2WDz0NS-9BGTMFH-RYFWSYFz9U7DL_6OLHE7QAA2P431UBAE6JI783UB5EH7-_XNXJLZZL4P8EZDC78Z9F1JGKARE970YTSTPT_9TY_3YQ9PWQUNWMYYFOWF2KTJW5sYWTHNVNELE3YMF7U4B9DBNE0NU4DY0JL3TUXKBJM3xFPHPKZ-FxRECMHRYGGNSt1CsZyTOBPJPHfSZzBYW9WK40JWSWx32ILE211JXLCCHYTK1QVMQ1WCXYDHUPLYK9FMVkJ2ILDAA00Q1W-DHRLCOJJQBWS29BJ_PLGHUCQO5CDs.09RRXCyGBy26Ik0IVZUNmFCOZYA3MC9FPHRYE7FMESA&DIB_TAG=SE&KEYWORDS=BUCK+BOOST+CONVERTER&QID=1715889687&SPREFIX=BUCK+BOOST+%2CAPS%2C103&SR=8-9](https://www.amazon.es/angeek-adjustable-automatic-converter-xl6009/dp/B07RNWWS4M/ref=sr_1_9?crid=Z5BG9IU7CV1T&dib=EYJ2IJOIMSJ9.2WDz0NS-9BGTMFH-RYFWSYFz9U7DL_6OLHE7QAA2P431UBAE6JI783UB5EH7-_XNXJLZZL4P8EZDC78Z9F1JGKARE970YTSTPT_9TY_3YQ9PWQUNWMYYFOWF2KTJW5sYWTHNVNELE3YMF7U4B9DBNE0NU4DY0JL3TUXKBJM3xFPHPKZ-FxRECMHRYGGNSt1CsZyTOBPJPHfSZzBYW9WK40JWSWx32ILE211JXLCCHYTK1QVMQ1WCXYDHUPLYK9FMVkJ2ILDAA00Q1W-DHRLCOJJQBWS29BJ_PLGHUCQO5CDs.09RRXCyGBy26Ik0IVZUNmFCOZYA3MC9FPHRYE7FMESA&dib_tag=se&keywords=BUCK+BOOST+CONVERTER&qid=1715889687&sprefix=BUCK+BOOST+%2CAPS%2C103&sr=8-9)
- Protector USB (montado por nosotros)
- Cables (para medir con el multímetro y para conectar el módulo con el convertidor)
- Conectores (12): [HTTPS://WWW.MRWATT.EU/ES/SOLDADURA/CONECTOR-ESPECIAL-PARA-CELULAS-SOLARES-SUNPOWER-C60.HTML?SEARCH_QUERY=SPDOGBONE&RESULTS=1](https://www.mrwatt.eu/es/soldadura/conector-especial-para-celulas-solares-sunpower-c60.html?search_query=spdogbone&results=1)
- Busbars (4): *2 del tamaño de 2 células y los otros 2 del tamaño de 1 célula + 5cm*
- Marco + cristal **40x50cm**: [HTTPS://WWW.LEROYMERLIN.ES/PRODUCTOS/MARCO-MILO-NEGRO-INSPIRE-40X50CM-19412792.HTML](https://www.leroymerlin.es/productos/marco-milo-negro-inspire-40x50cm-19412792.html)
- Aislante
- Cajita en 3D para el convertidor + circuito protección
- Flux: [HTTPS://WWW.MRWATT.EU/ES/SOLDADURA/STANNOL-FLUX-PEN-X32-10L-10ML.HTML?SEARCH_QUERY=FLUXPEN10&RESULTS=1](https://www.mrwatt.eu/es/soldadura/stannol-flux-pen-x32-10l-10ml.html?search_query=fluxpen10&results=1)
- Cinta de doble cara / pegamento (para pegar el convertidor a la caja y la caja al panel solar)

2.2. Protector USB

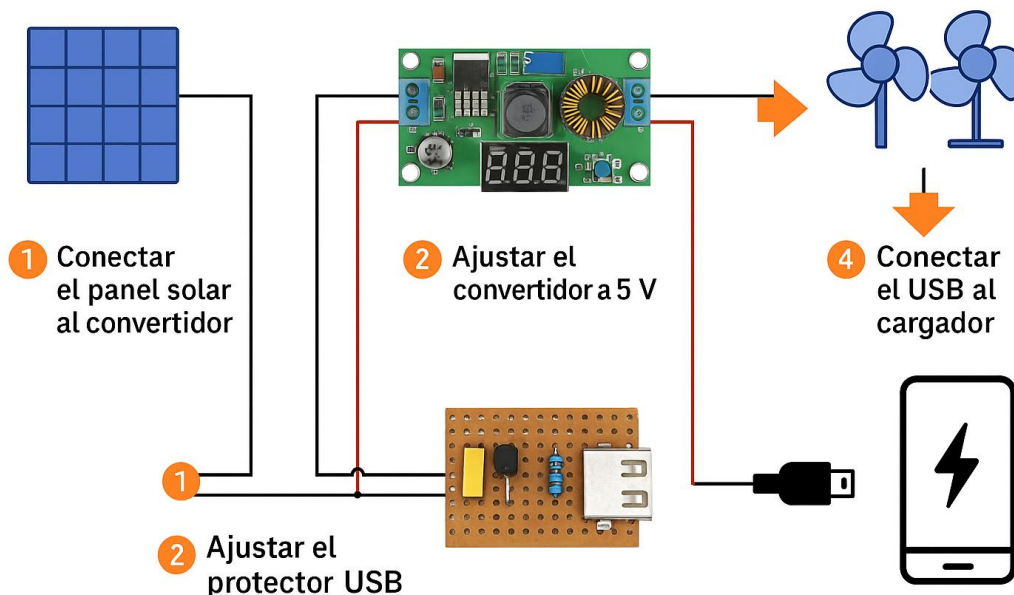
- Fusible PTC (autorrearmable) de 2.5–5A.
- Diodo Zener 5.1V 1.33W.
- Resistencia 200Ω.
- Tiristor BT151.
- Puerto USB tipo A hembra.
- PCB perforada.

3. Procedimiento

3.1. Construcción módulo fotovoltaico

El esquema del montaje es el siguiente:

ESQUEMA DE MONTAJE DEL MÓDULO SOLAR



3.2. Montaje sistema eléctrico

3.2.1. Previo

Antes de empezar el taller hay que hacer varias cosas. Lo que debe hacer la persona encargada del taller ya se ha detallado anteriormente, pero es básicamente estañar los 12 conectores y cortar los 4 busbars con la medida necesaria para poder conectar en serie las celdas. Es necesario poner el estaño en las 6 pestañitas de cada uno de los conectores, para que los alumnos a la hora de soldar las celdas solo tengan que ajustar conectores con las celdas presionando con el soldador suavemente.

Es necesario también hacer el circuito de protección del USB, el cual se explica más abajo.

Además, hay que diseñar unas cajas impresas en 3D para guardar cada bloque de convertidor+USB detrás del marco del módulo, y hacer un par de agujeros en cada marco para poder sacar los cables de negativo y positivo (esto también lo pueden hacer los alumnos).

3.2.2. Convertidor DC-DC

Antes de empezar con el taller se tienen que hacer un par de medidas con el convertidor para ajustar la salida a 5V. El panel tiene salida positiva y negativa. Hay que conectarlas a la entrada IN+ e IN- del convertidor.

Para ajustar la salida a 5V usaremos una fuente que le dé un poco más de 5V para alimentarlo. Tenemos que girar el tornillo del potenciómetro muy despacio hasta que el multímetro marque

5V a la salida. Es muy importante este paso, porque si no se ajusta bien el convertidor puede sacar más tensión y se corre el riesgo de que algo se estropee.

Procedimiento:

1. Conectar el panel al convertidor
 - a. Buscamos las entradas del convertidor: IN+ e IN-
 - b. Conectar los cables del panel solar en las entradas
 - i. IN+: positivo del panel
 - ii. IN-: negativo del panel
2. Ajustar el voltaje de salida a 5V
 - a. Conectar una fuente de alimentación de 5-6V.
 - b. Poner el multímetro en modo voltímetro (DC) y medir entre los pines de salida del convertidor OUT+ y OUT-
 - c. Girar el tornillo del potenciómetro muy despacio
 - d. Ajustar hasta que marque 5V o muy cerca

3.2.3. Construcción circuito de protección USB

Para la construcción del circuito de protección USB tenemos 2 versiones. En este caso vamos a elegir la versión 2, que es la más segura, aunque tiene más complicación. Como se ha explicado anteriormente necesitamos este circuito porque si por alguna razón el convertidor se pasa y da más de 5.1V. En ese caso, el Zener absorbe esa tensión, y el tiristor hace que el fusible corte la corriente más rápido para proteger cualquier dispositivo que hayamos conectado.

El circuito en cuestión es el siguiente:

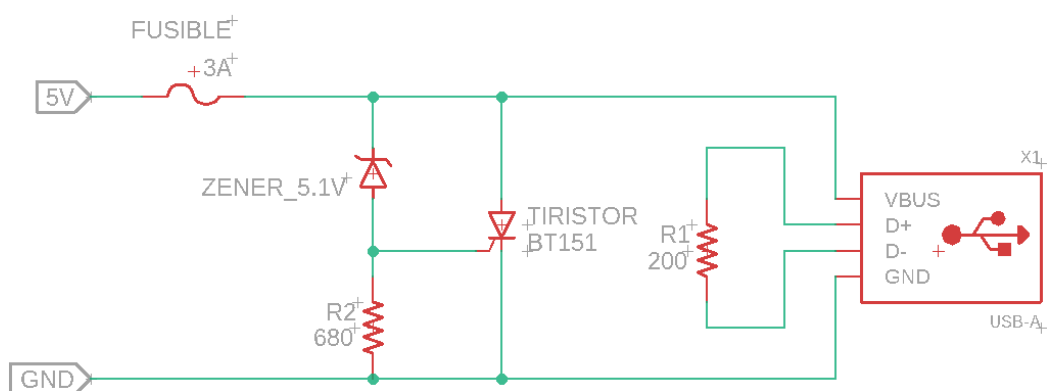
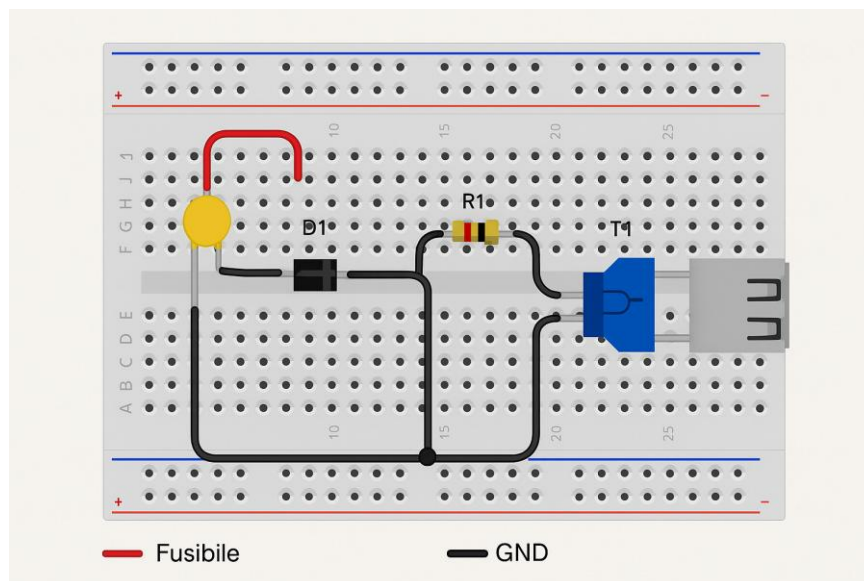


Ilustración 3-1 Circuito de protección USB

Componentes:

- Protoboard o PCB perforada
- Fusible autorrearmable PTC: si pasa más de 3A, corta la corriente y se reinicia solo.
- Diodo Zener de 5.1V: si la tensión se pasa, hace de barrera.
- Resistencia de 200Ω: para que el USB entre en modo carga.
- Tiristor BT151: detecta si sube de 5.1V y hace un cortocircuito controlado para que el fusible corte más rápido. Solo conduce cuando en su puerta (la pata extra) se alcanzan 0.7V.
- Puerto USB A (tipo hembra): para conectar el cable de carga del móvil.



4. Resultados y pruebas

4.1. Medidas realizadas

Las medidas que se deberán hacer serán mientras van soldando y poniendo en serie cada celda, ya que tendrán que comprobar que efectivamente tienen la tensión que deberían. Es decir, 1 celda tiene 0,6V, 2 celdas deberán tener 1,2V-1,3V y así con todo el panel (mínimo 5,4V, probablemente les saque unos 6V).

4.2. Pruebas funcionales

Como se ha dicho anteriormente, las pruebas que se van a hacer son: conectando el módulo al ventilador y conectando el módulo al convertidor y protector USB para cargar el móvil.

5. Parte eléctrica

En el taller hacemos 2 aplicaciones: poner en movimiento unos ventiladores y cargar el móvil. Para los ventiladores lo hacemos únicamente conectando los cables del módulo a los cables del ventilador. Para poder cargar el móvil necesitamos el convertidor DC-DC y también el circuito de protección USB.

5.1. Convertidor DC-DC

El módulo fotovoltaico genera electricidad, pero esa energía no es estable ni siempre está al mismo nivel que se necesita. Como necesitamos sacar una salida estable de 5V para alimentar, necesitamos del convertidor DC-DC.



Ilustración 5-1 Bloque Buck-boost

El convertidor da una salida constante. Dependiendo de la tensión que le llegue, subirá o bajara la tensión. Por ejemplo, si el panel da más de 5V, lo baja, y si da menos, lo sube. Si se ajusta bien siempre sacara 5V. El convertidor que utilizaremos es el de la imagen, basado en el circuito integrado XL6009.

Existen otros conversores muy parecidos basados en el mismo integrado, pero que sólo aumentan o disminuyen la tensión. Es importante no confundirse a la hora de adquirirlos. Para ello, hay que comprobar que la placa tenga dos inductores, que son los bloques de color negro:



Para ajustar la tensión de salida se hace girando el potenciómetro mientras se mide con un multímetro. Además, se deberá tener el convertidor alimentado a 5V mediante una fuente de alimentación.

Una vez ajustada, es recomendable comprobar que funciona correctamente, variando la tensión de entrada y comprobando que la tensión a la salida se mantiene constante.

Dado que el convertidor no es 100% eficiente, la corriente que consume, aun no teniendo conectada ninguna carga, puede variar en función de la tensión de entrada. También es posible que se produzcan algunos picos de corriente en el momento del arranque. Por ello, hay que ajustar también el límite de corriente de la fuente de alimentación; 1A es suficiente.

A la hora de comprar el convertidor, algunos vendedores ponen en las especificaciones que el rango de la tensión de entrada es 3.8V - 32V, mientras que otros dicen que es 5V – 32V. Se ha comprobado que funciona bien con una tensión de entrada de 3.5V, pero si bajamos de 3.5V, el ajuste del convertidor se pierde y empieza a elevar la tensión a más de 10V. Es por esto por lo que un circuito de protección para el puerto USB es necesario.

5.2. Protector USB

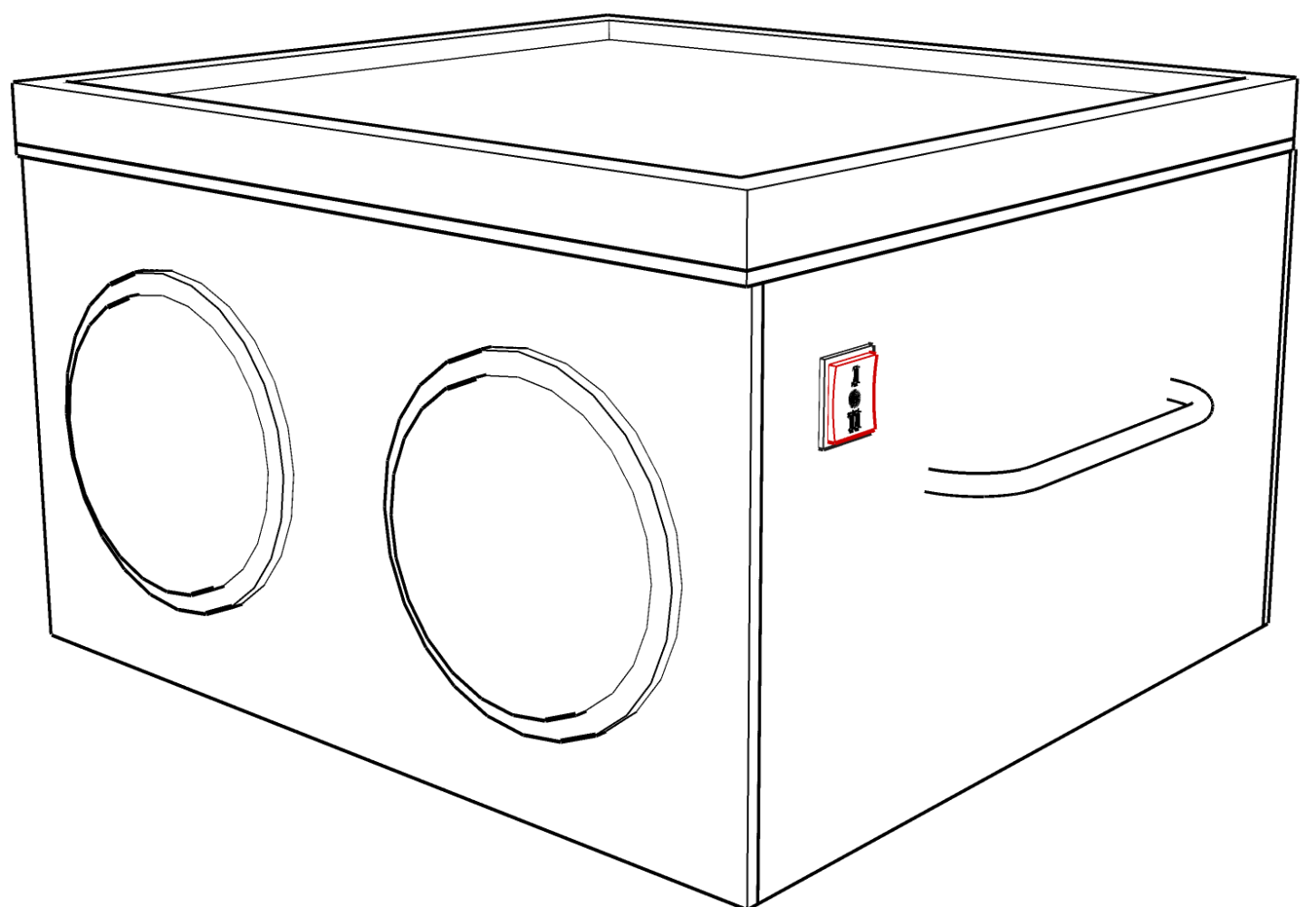
Como se ha mencionado anteriormente, se necesita un circuito de protección para implementar el puerto USB. No se vende fabricado ningún tipo de circuito de este estilo, por lo que hay que fabricarlo tal y como se ha explicado en apartados previos.

6. Tiendas donde adquirir los componentes

En caso de que algún componente sólo se venda en Rs Components en paquetes de muchas unidades, existen otras tiendas donde se pueden adquirir:

- Electrónica Praga: *es la única tienda física que vende el USB tipo A*
- Electrónica Embajadores: *es la tienda donde se compraron todos los componentes para el circuito de protección.*
- Conectrol: *en esta tienda no tenían fusibles*
- Electrónica Merchán
- Diotronic
- Para el marco: Leroy Merlin
- Para otros componentes: MrWatt

Solar Sound System & charging station



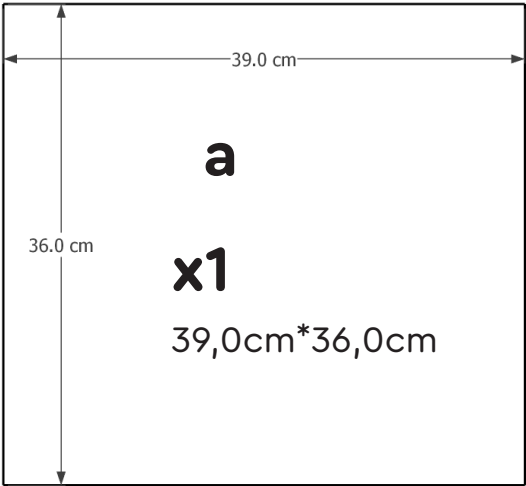
Box Enclosure

You will need:

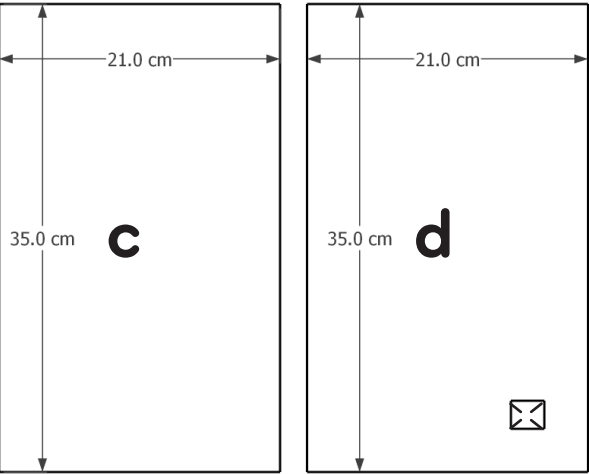
Plywood 5mm.

Box

Box Lid



Box Sides

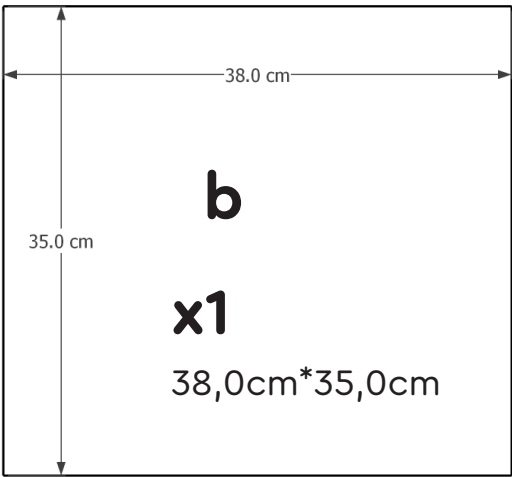


x2

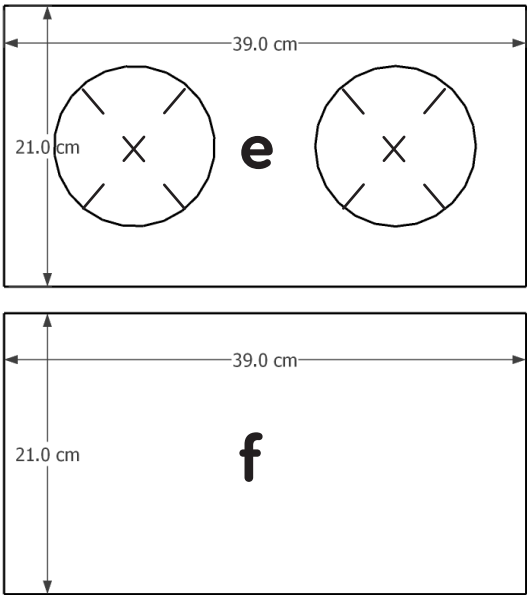
21,0cm * 35,0cm

hole: 2,5cm*2,0cm
only on one side!

Box Bottom



Box Front & Back



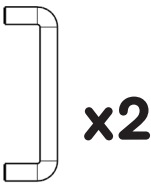
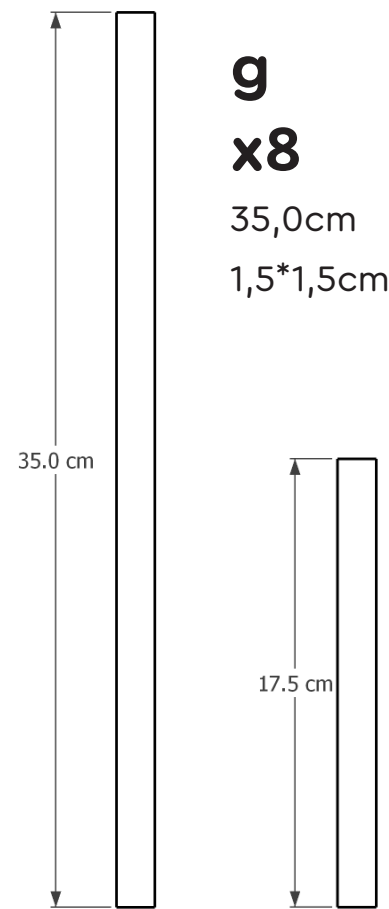
x2

39,0cm * 21,0cm

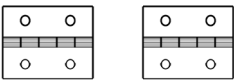
holes*2: d=12,0cm
only on the front side!

.....

Wooden rods (1,5cm*1,5cm)



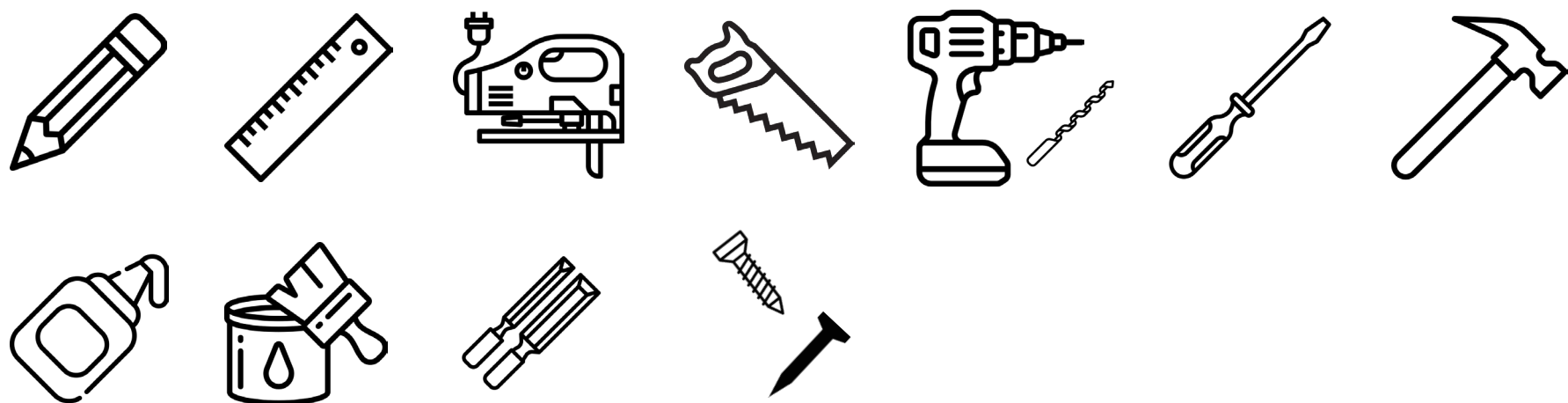
Handles



Hinges x2

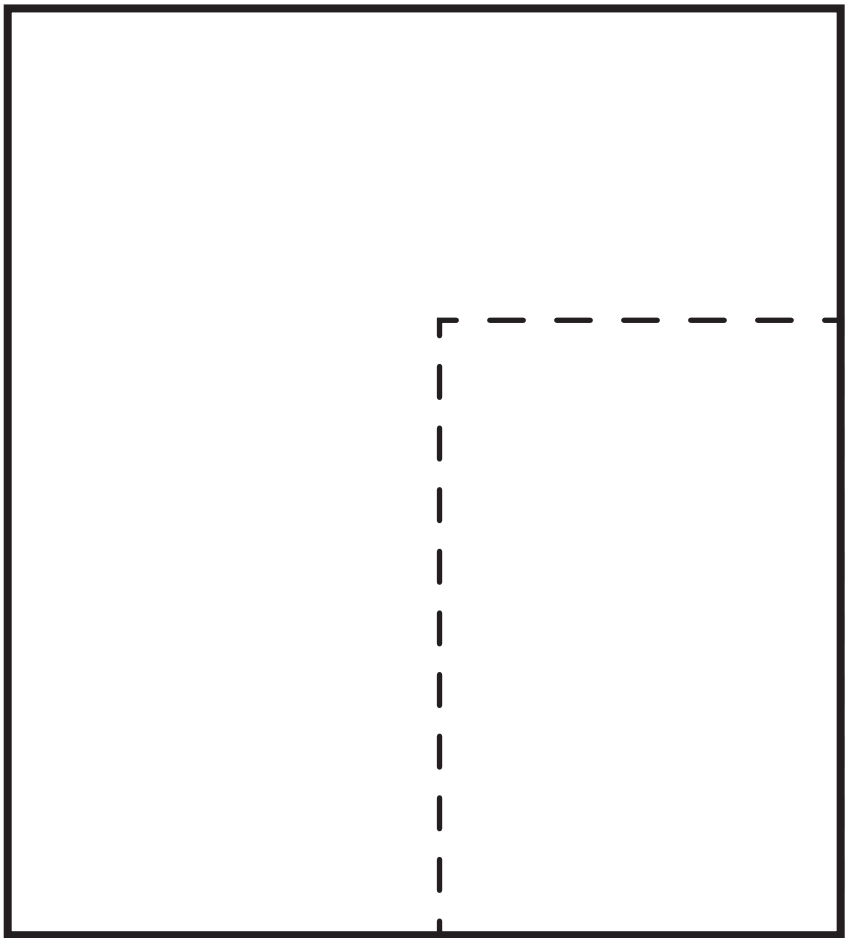
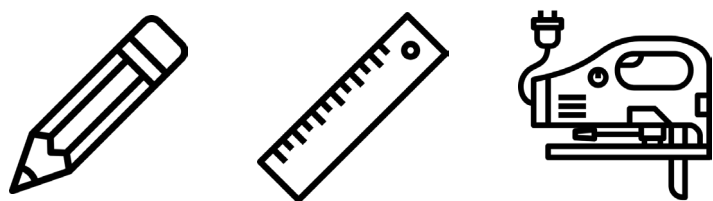


Tools



Step 0. Preparations

Cutting the plywood



Using pencils and rulers mark the plywood in the following dimensions:

Wooden box:

Box Lid **x1 (a)**
39,0cm * 36,0cm

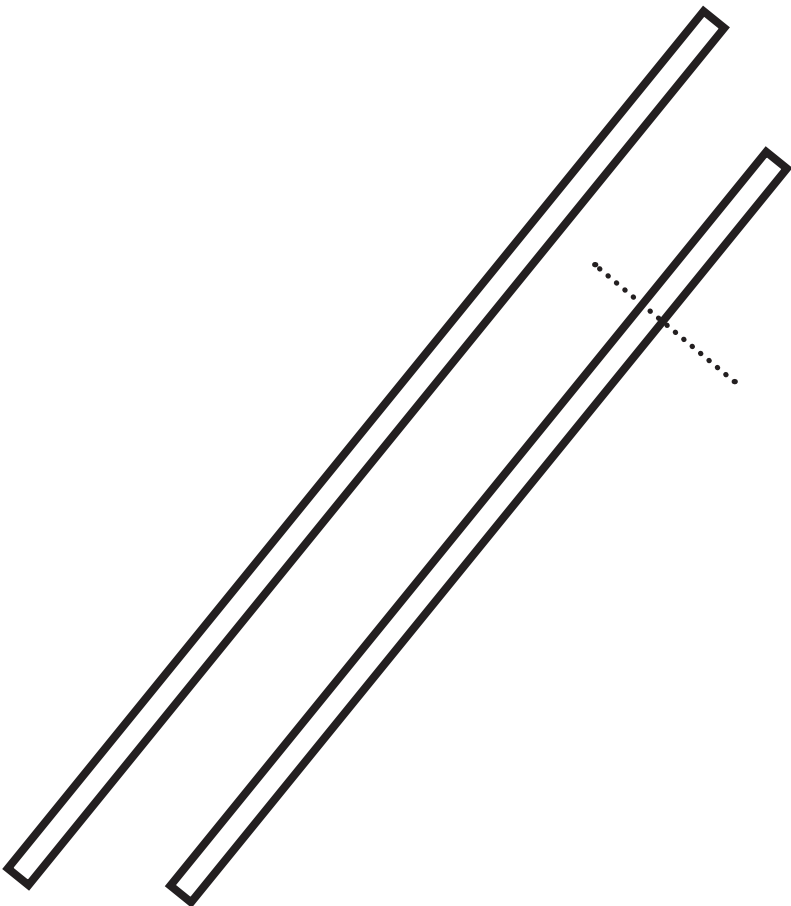
Bottom **x1 (b)**
38,0cm*35,0cm

Box Sides **x1 (c)** **x1 (d)**
21,0cm * 35,0cm 21,0cm * 35,0cm
hole: 2,5cm*2,0cm

Front & Back **x1 (e)** **x1 (f)**
39,0cm * 21,0cm 39,0cm * 21,0cm
holes*2: d=12,0cm



Cutting the wooden rods



Using pencils and the meter mark the wooden rods in the following lengths:

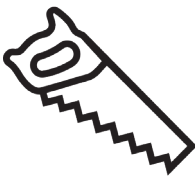
Wooden rods (1,5*1,5cm)

x8 (g)
35.0cm

x4 (e)
17.50cm

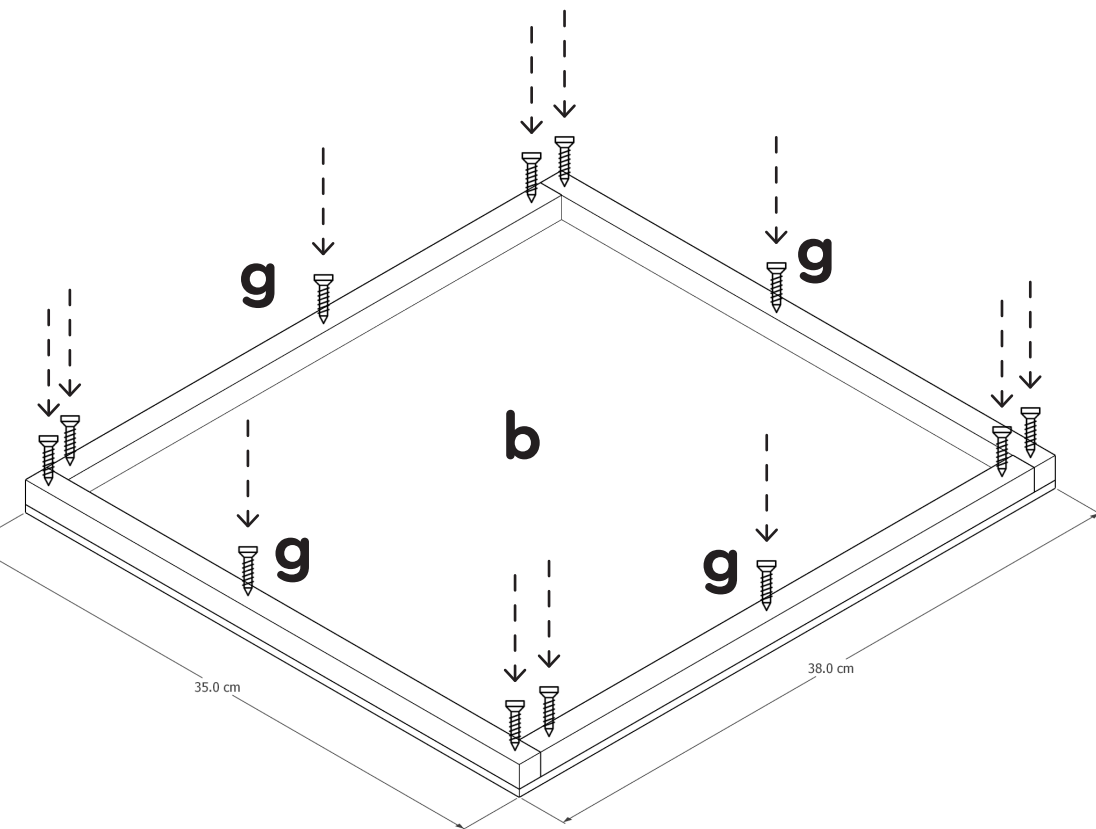
Note: Make sure to mark each piece of wood you cut with the corresponding letter. It will make the assembly much easier!

.....



Step 1. The Box

Starting with the base

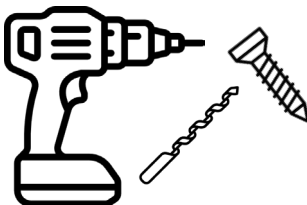


Take the base of the box enclosure (b) and frame its sides using the wooden rods (4*g) as indicated in the diagram

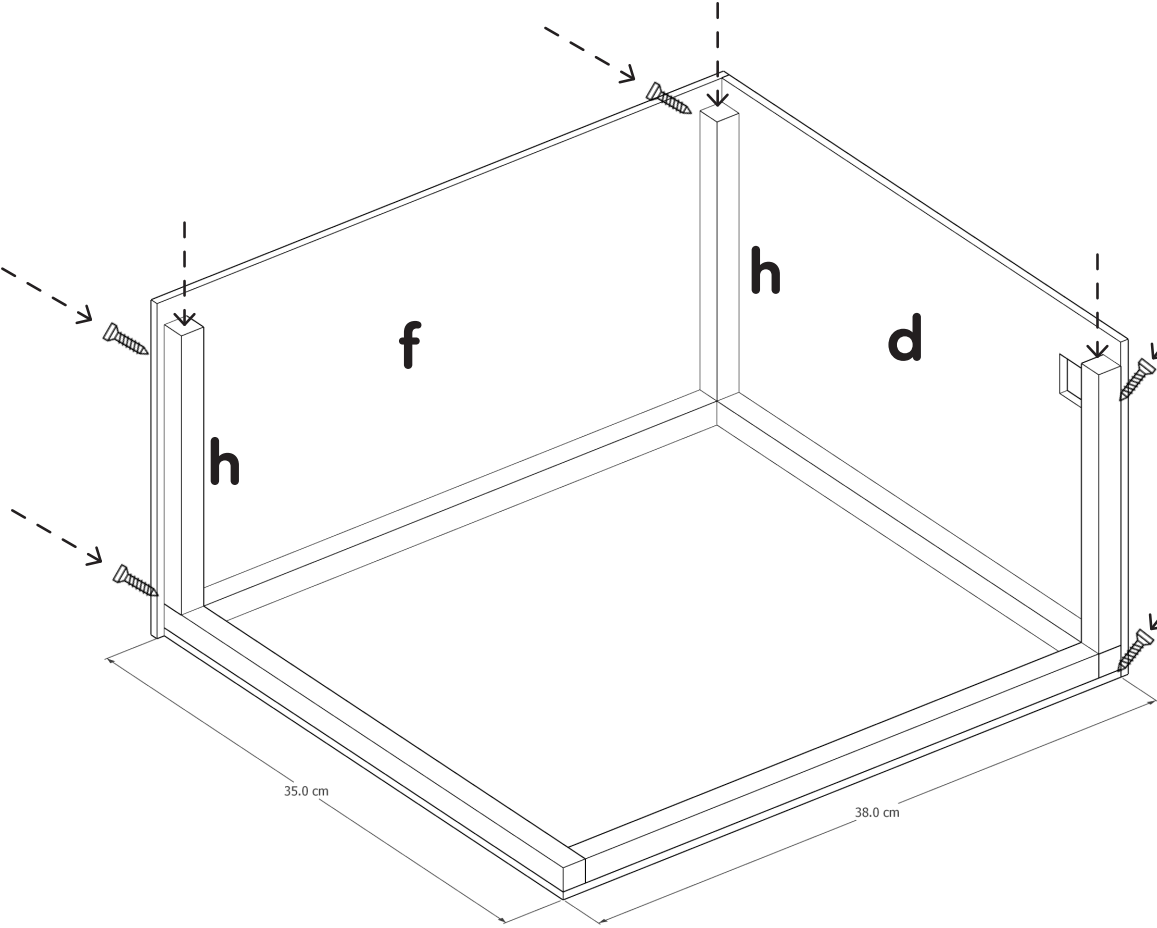
To secure the wood pieces use wood glue on every surface they come in contact with.

Then using a wood drill make small holes and then screw small screws as shown in the diagram.

.....



Continue with the sides



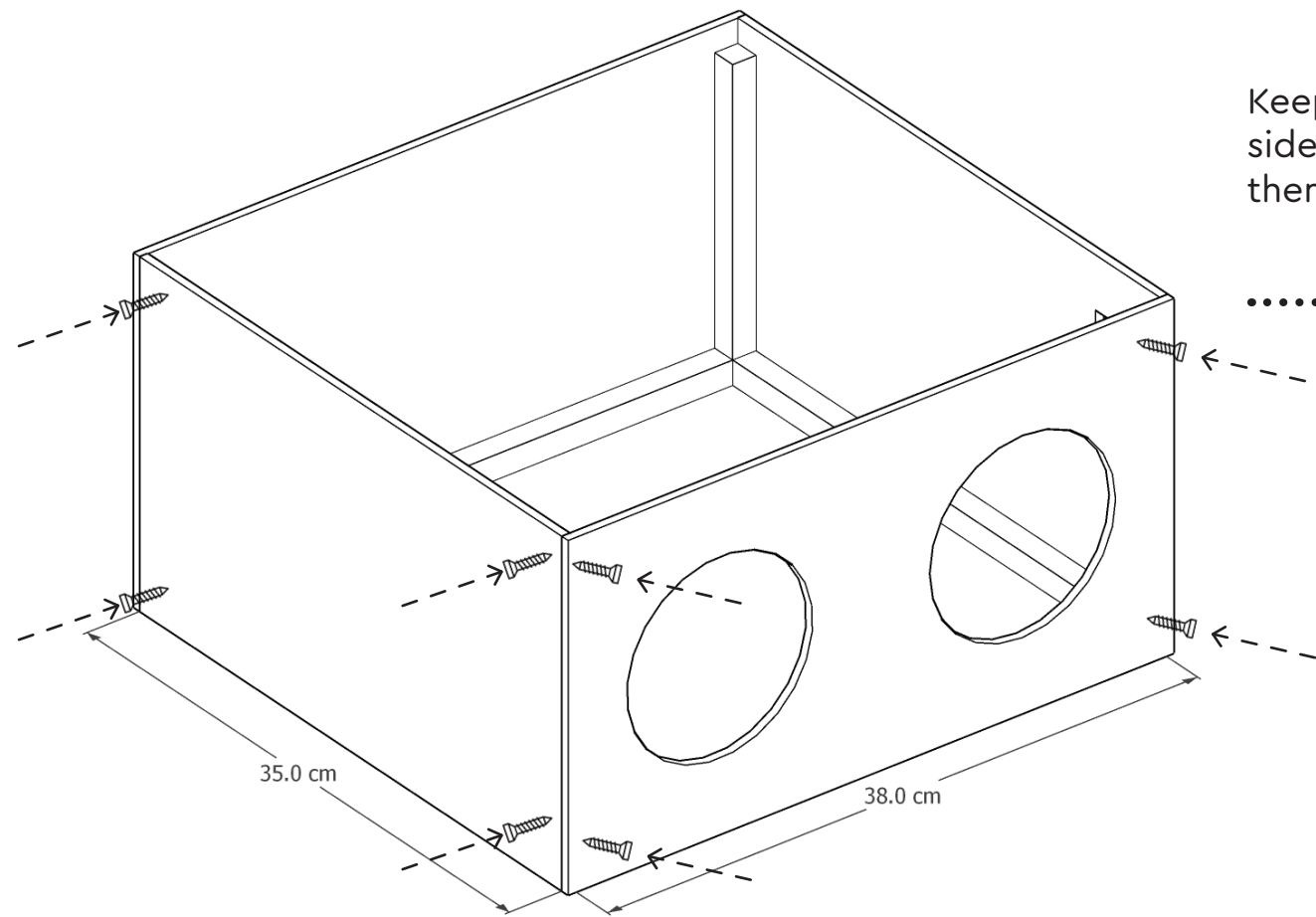
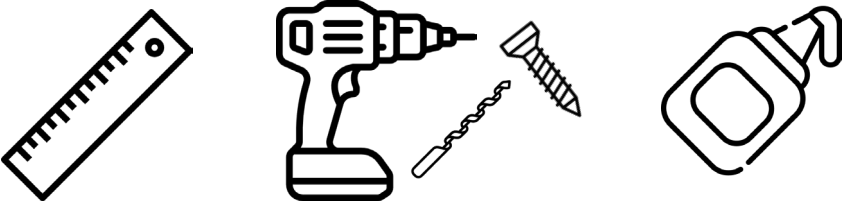
Place a the back side piece of plywood (f) on one of the long sides of the base. Make sure its bottom side sits nicely touching the side of the bottom plywood and the wooden rod you previously placed on that side.

Secure it on that side by using wood glue and screwing it on the side of the rod that you previously placed.

Continue by placing 2 rods (h), one on each vertical edge of the side you just placed (f). Secure them using wood glue and then screw them on the side's surface.

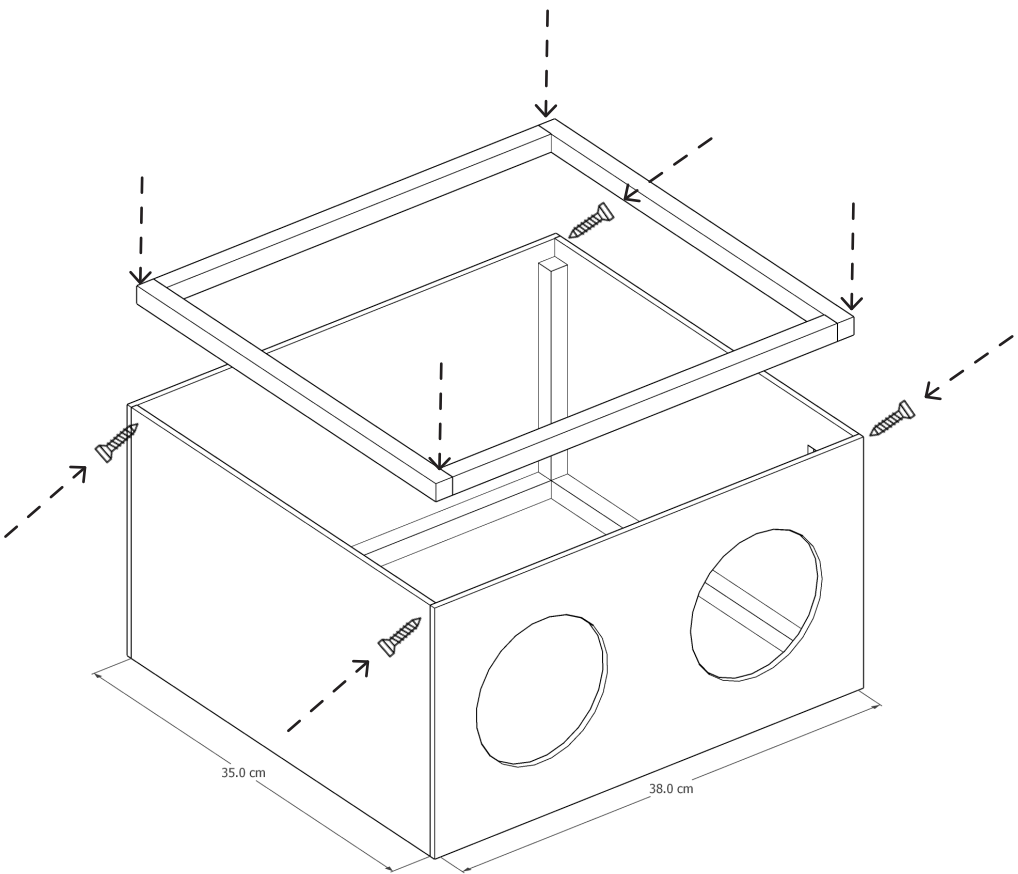
Continue by placing the next side (d) right next to the side you just secured. This piece of wood is shorter so make sure its side face is covered by side f.

Place the third rod (h) on the remaining side of the new panel.
.....

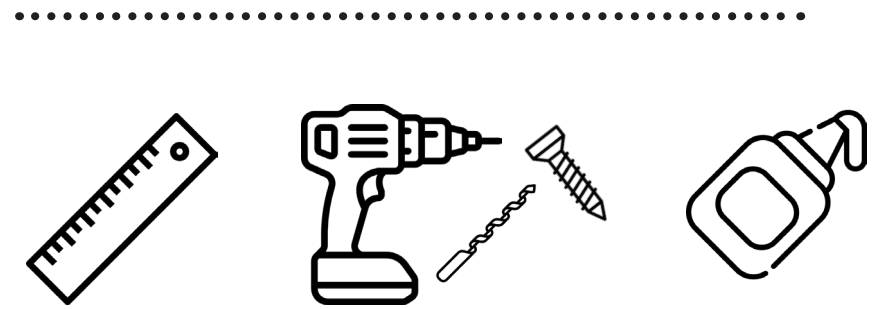


Keep going the same way adding the remaining side e and c and the last wooden rod (h) securing them with wood glue and screws/nails.
.....

Finishing the frame

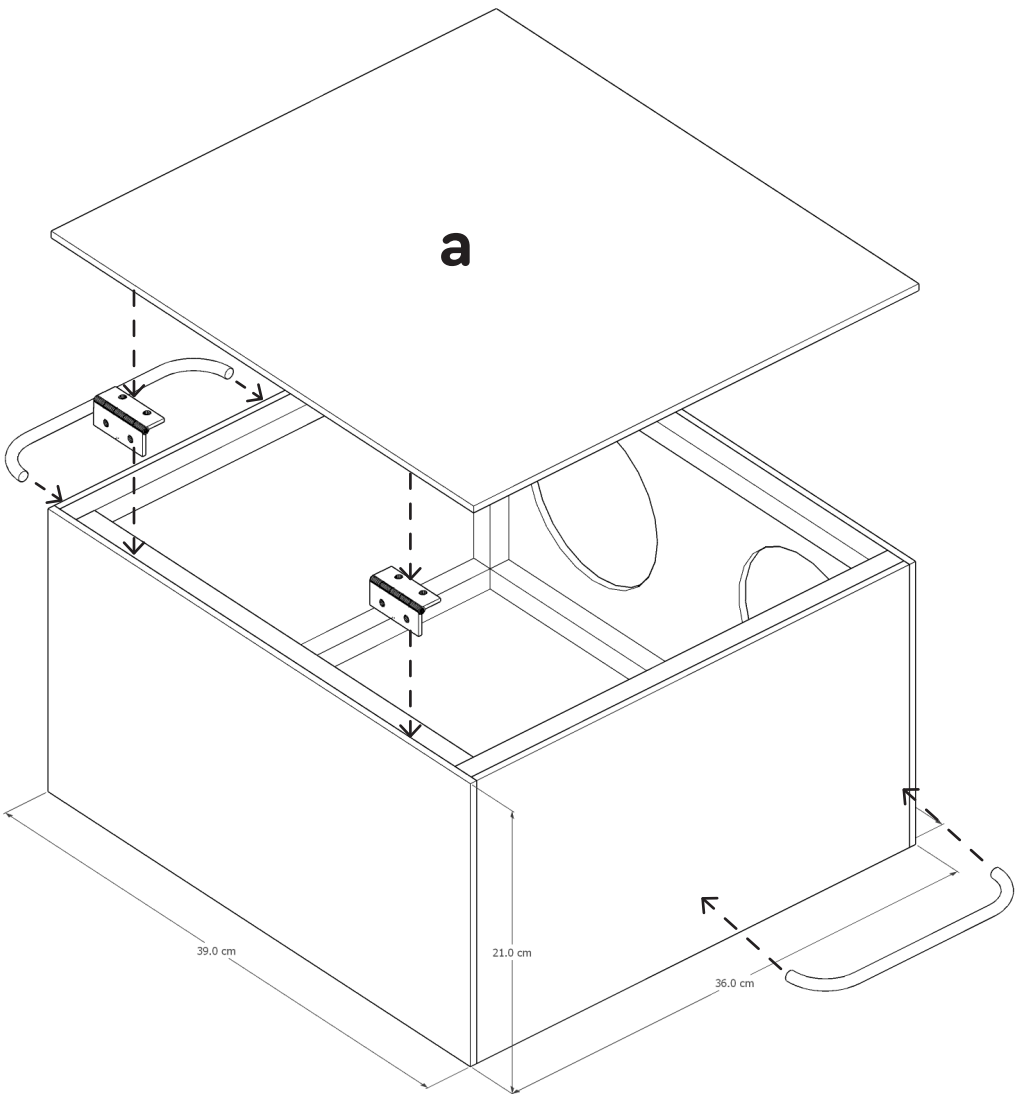


Add the last remaining rods (4*g) to finish the box's frame. Again, secure them using wood glue and screws/nails.



Step 2. Box Lid

Attach the lid



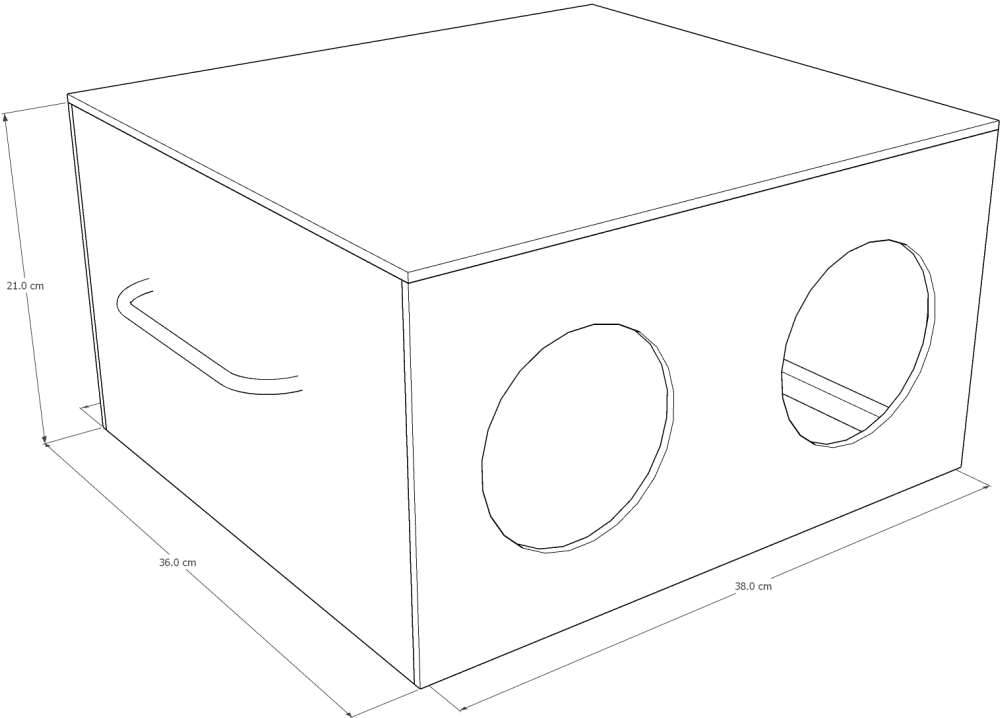
To attach the lid to the box enclosure, screw two hinges on the back long side.

Attach two handles on either of the 2 free sides.

To make the lid easier to open, you can attach a handle on the opposite side, or think of another way to do that ;)

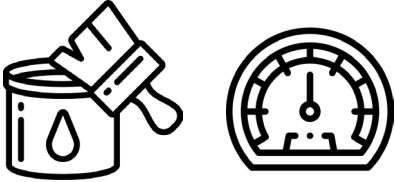


Step 5. Assembly



To protect the wooden surfaces you can paint the outside using wood varnish.

.....

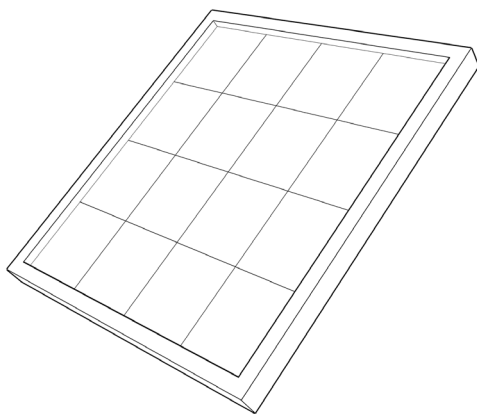


Enjoy!

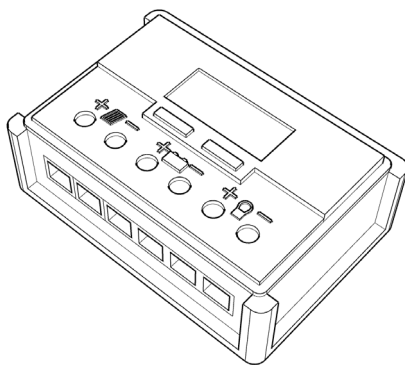


Electronics Assembly

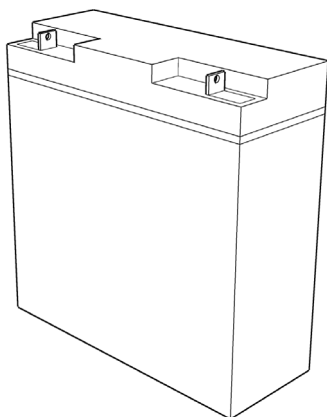
You will need:



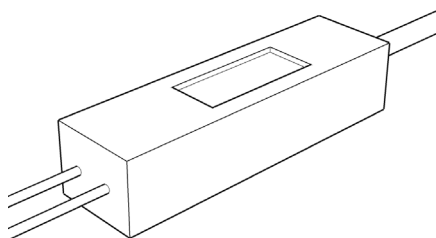
Solar panel
15W, 12V



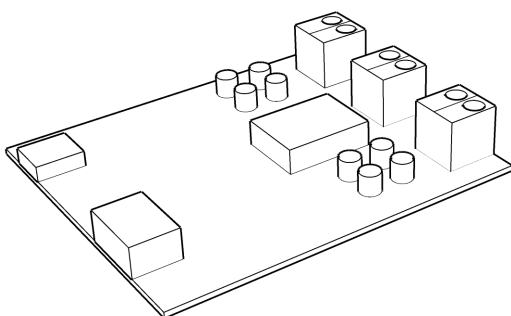
Charge Controller
10A 12/24V



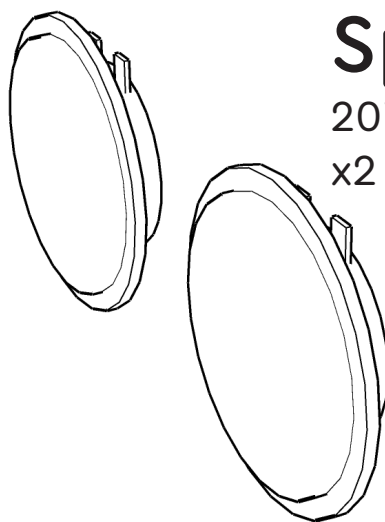
Battery Bank
12V, 17Ah



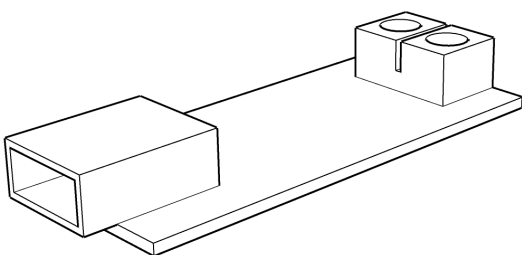
AC/DC Battery Charger
12V, 10A



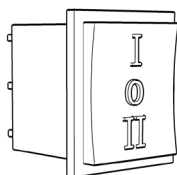
Sound Amplifier
DC, Bluetooth
2*50W RMS
12-24V



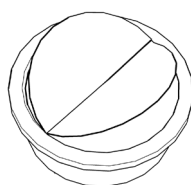
Speakers
20W (10RMS)
x2



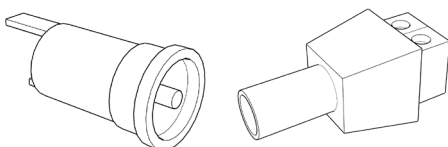
USB Charger
5V USB Step-down
3A max.output



3-Way Switch



On/Off Switch
x2



2.1mm Female & Male Jack mounts



Material you will need

Components

- Solar panel (PV):12V, 15W
 - Charge controller 10A 12/24V PWM
 - Battery 12V 17Ah
 - AC/DC battery charger
 - DC bluetooth sound amplifier 2*50W (Power Supply: 12–24V, Output Power: 50W*2)
 - 20W(10RMS) Marine type speakers (ϕ 120mm), 2*speakers max 50w RMS
 - 5V USB step down (2x output) Input Voltage Range: 8V-32V
 - 3 way ON-OFF-ON switch (with 6pins)
 - On/Off switch (1 for amp & one for Charging point)
 - cables 0.5–1.5mm diameter
 - 2* DC Barrel Jack Adapter Male 2.1mm
 - 2* DC Barrel Female 2.1mm
 - Cable connectors
-

Tools:

- Soldering iron
 - Soldering grease
 - Soldering wire
 - Wire cutter/ striper
 - Multimeter (measuring voltage, amperage, resistance)
-

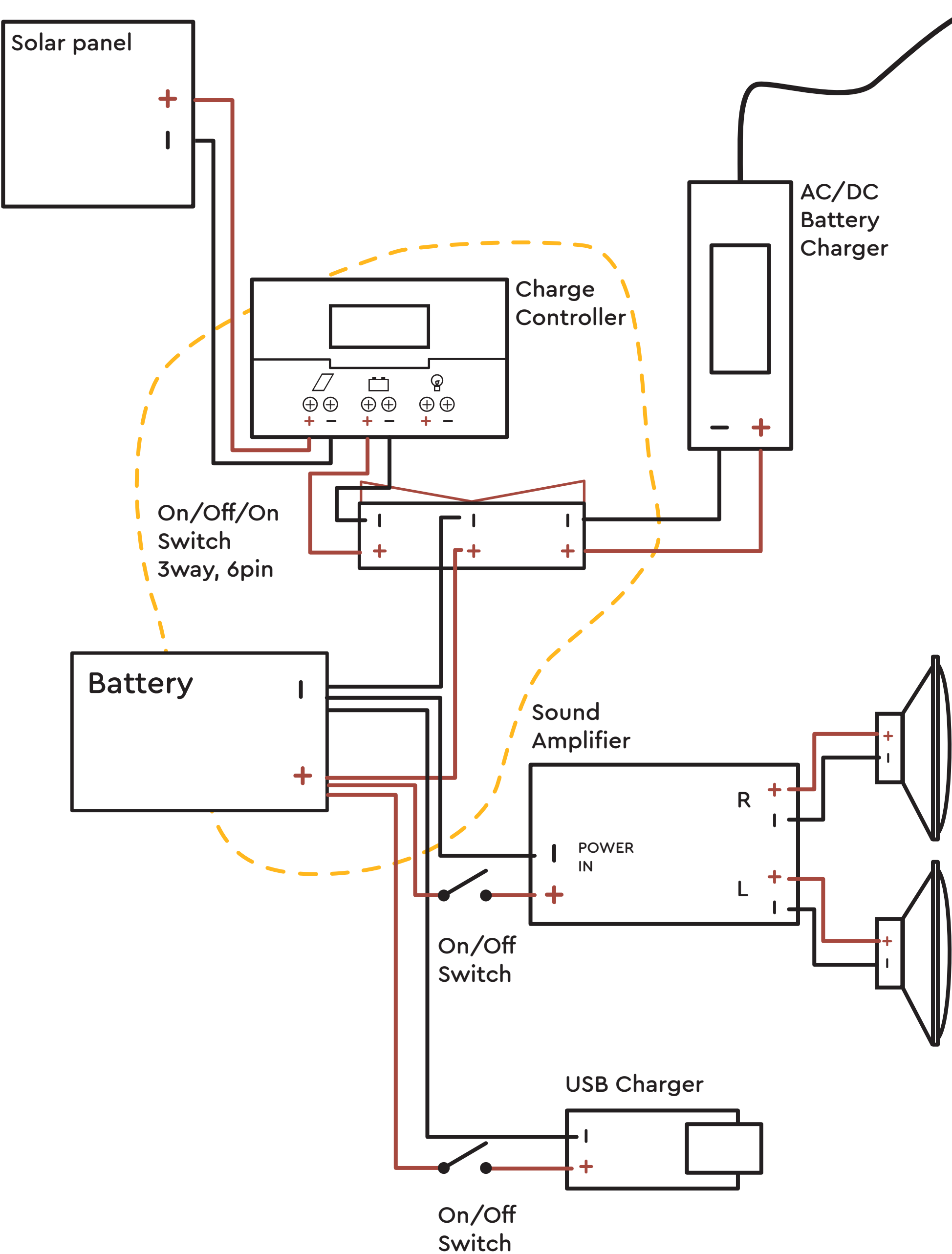
Extras:

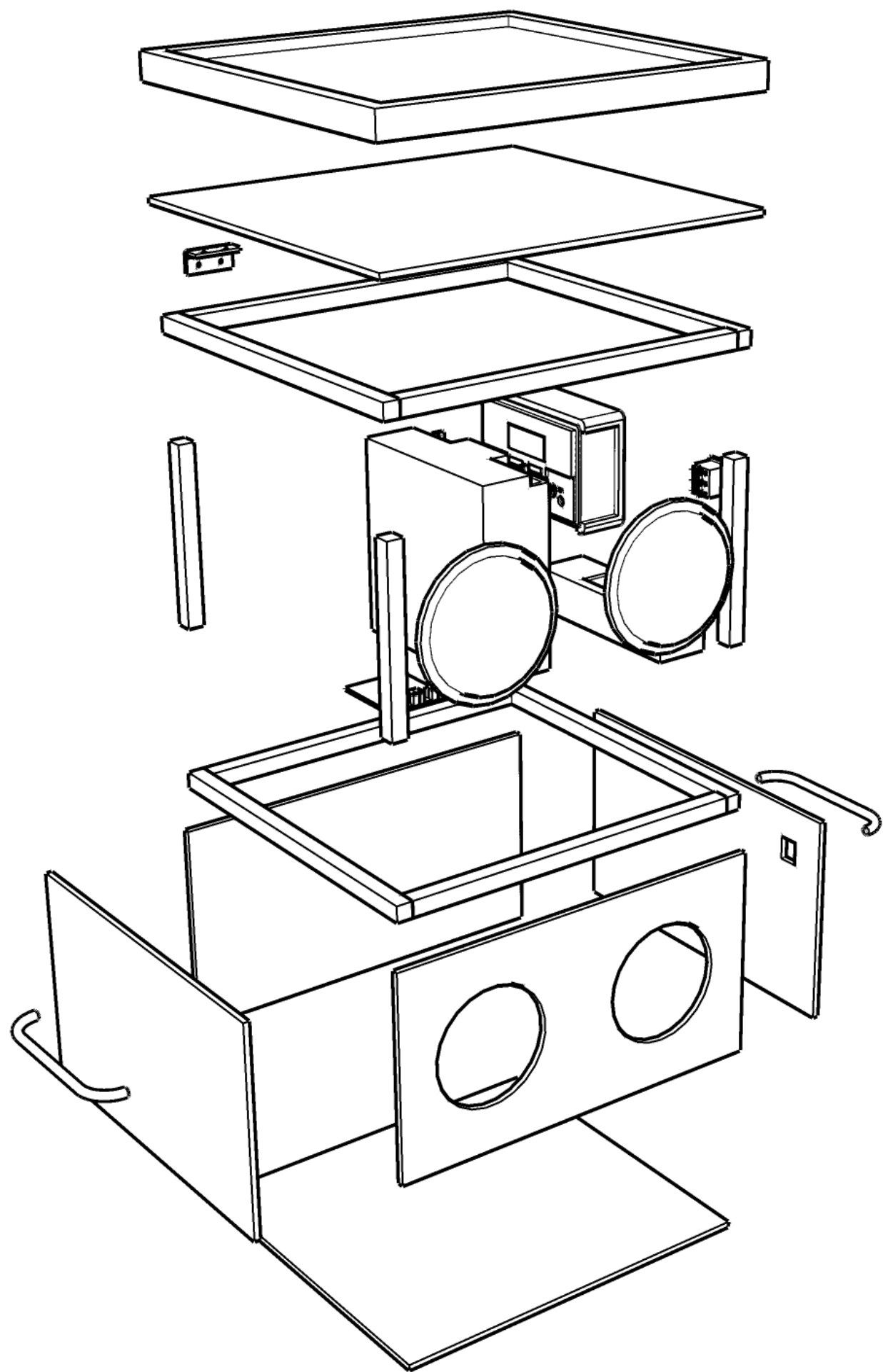
- Safety gloves
- Insulation tape



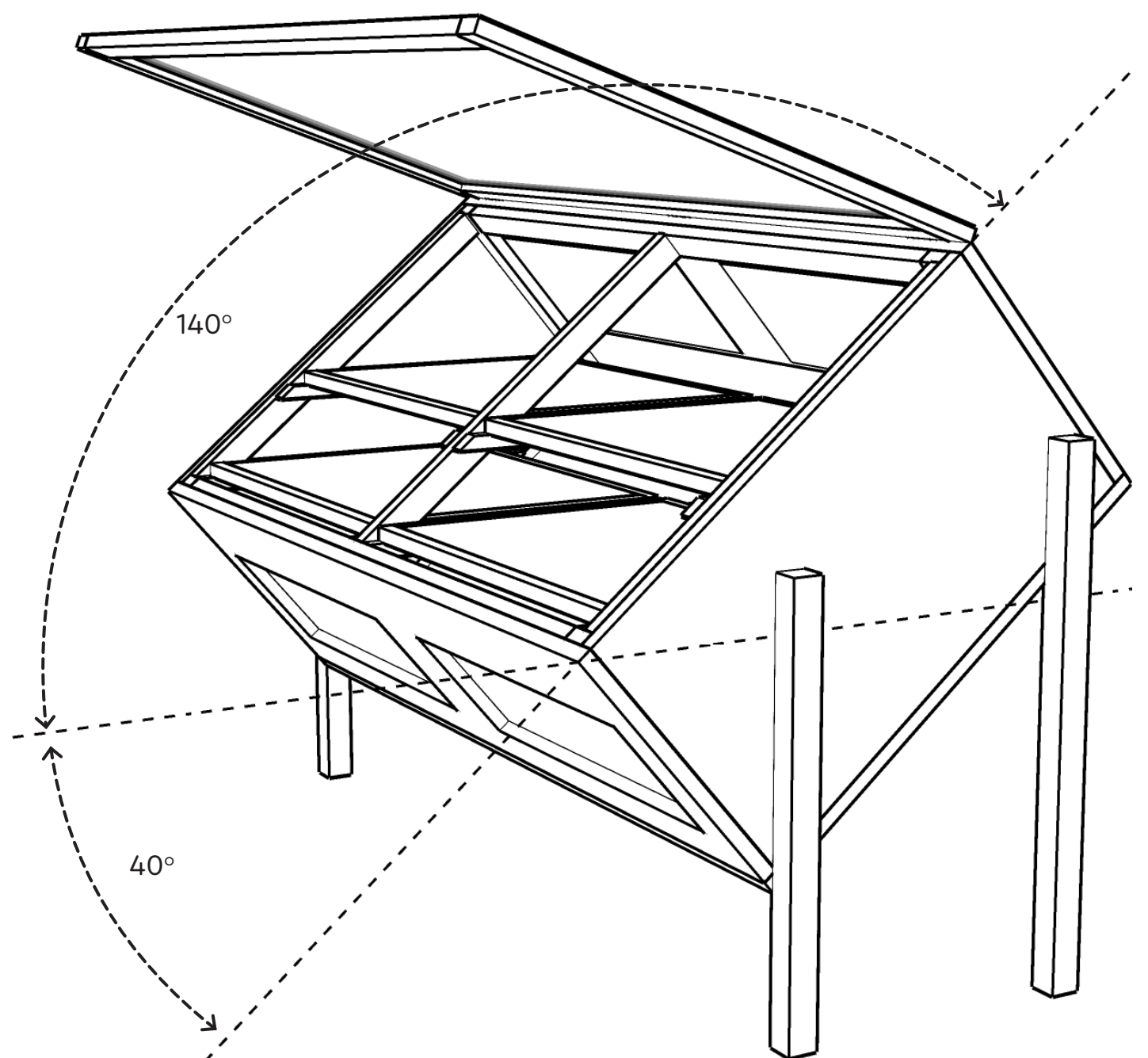
Solar Powered Sound System

Diagram





Solar Food Dehydrator

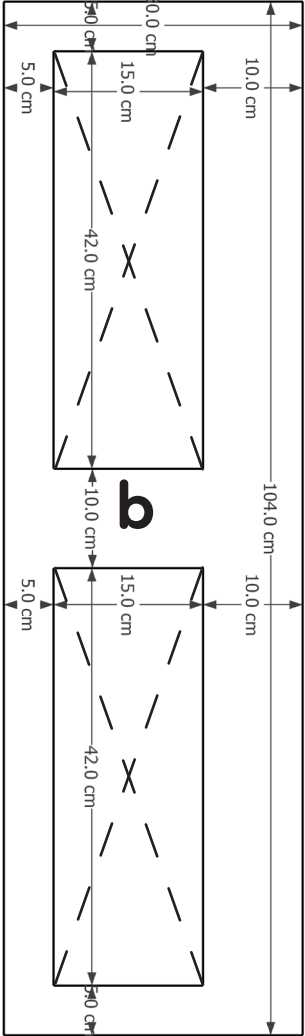
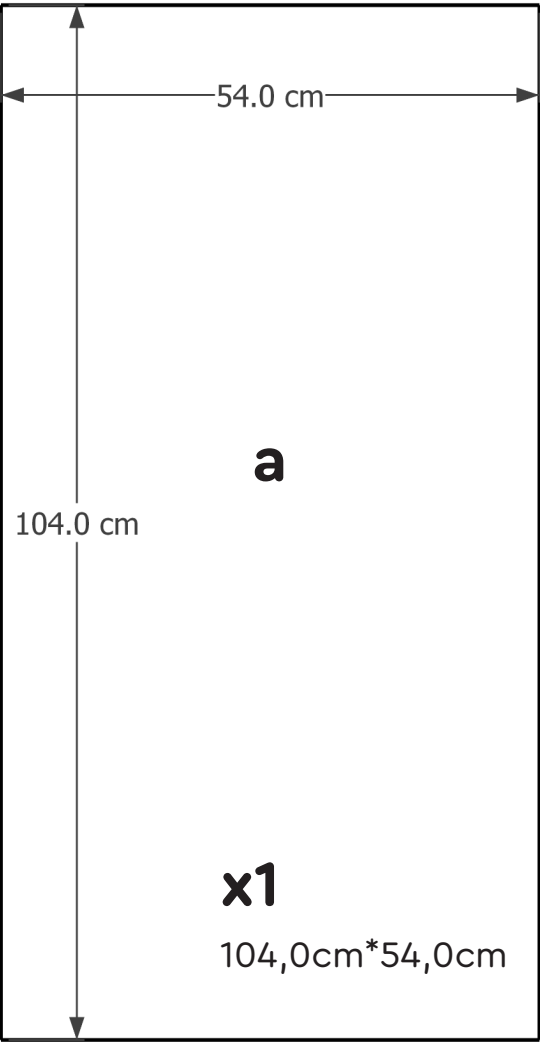


Wooden Box

You will need:

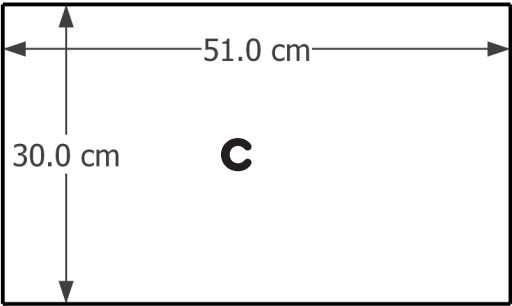
Plywood 15mm.

Box sides

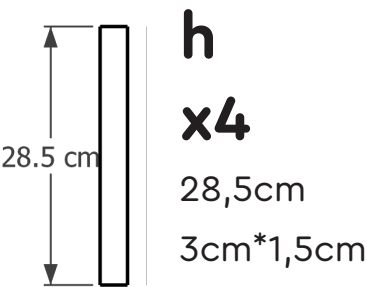
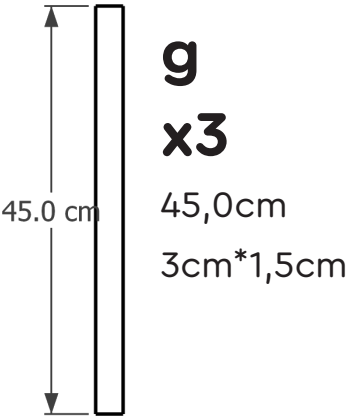
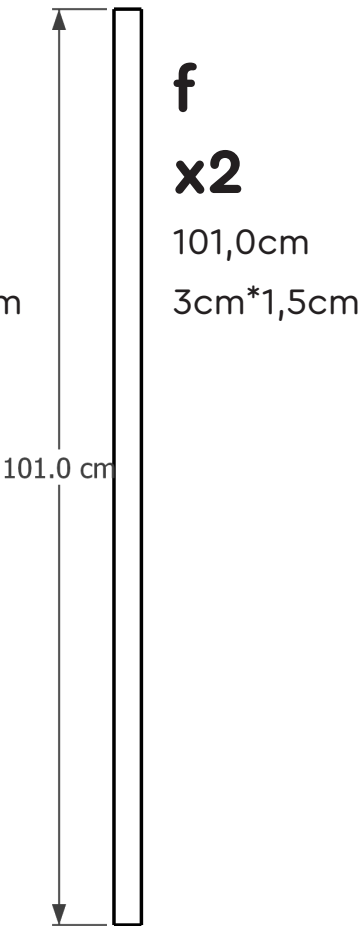
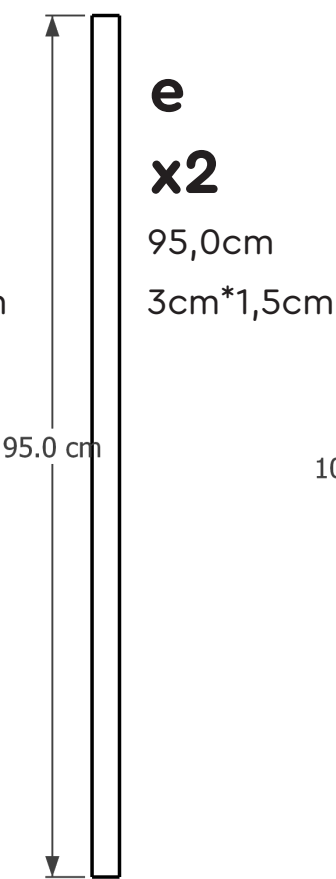
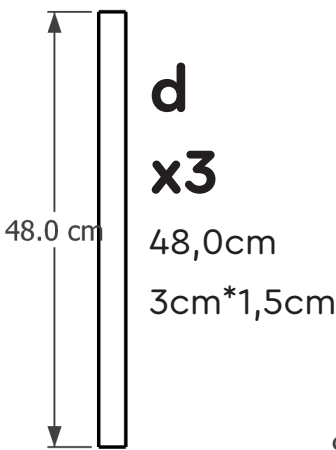


x2
104,0cm * 30,0cm
hole*2: 42,0cm*15,0cm

x2
51,0cm*30,0cm

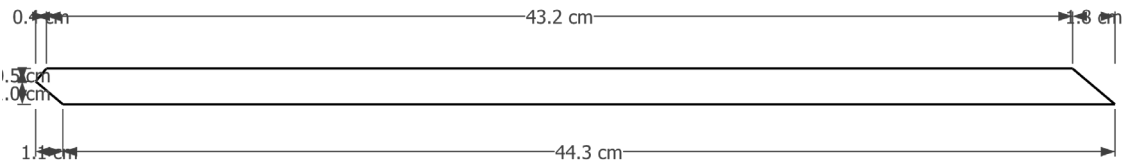


Wooden rods (3cm*1,5cm)



Wooden Box

Wooden rods (1,5cm*1,5cm)

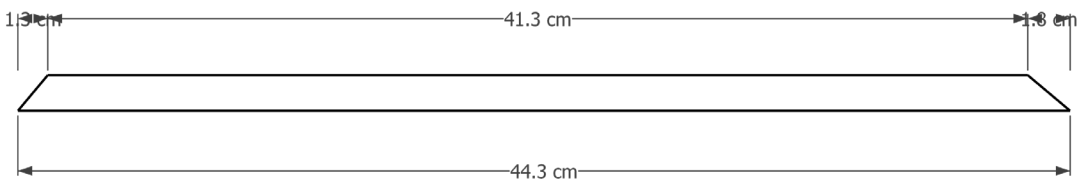


i

x2

44,3cm

1,5cm*1,5cm

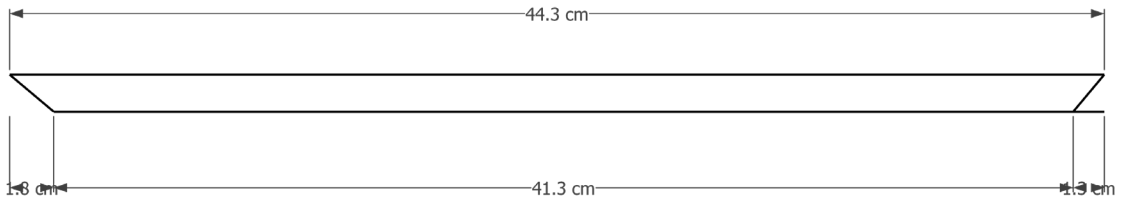


j

x2

44,3cm

1,5cm*1,5cm

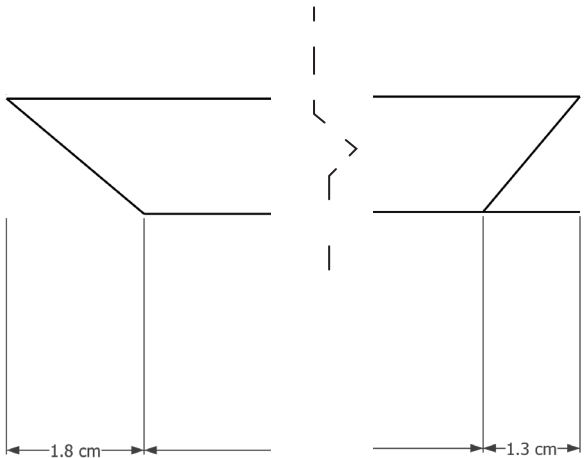
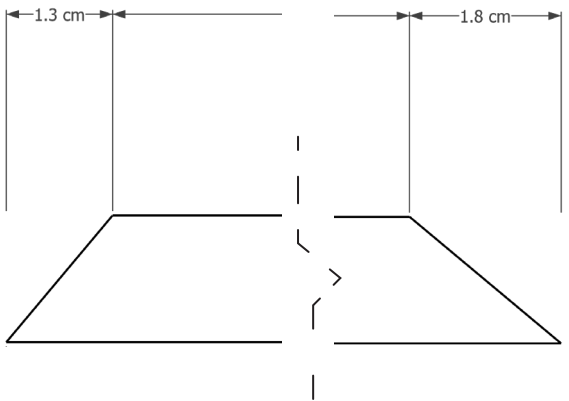
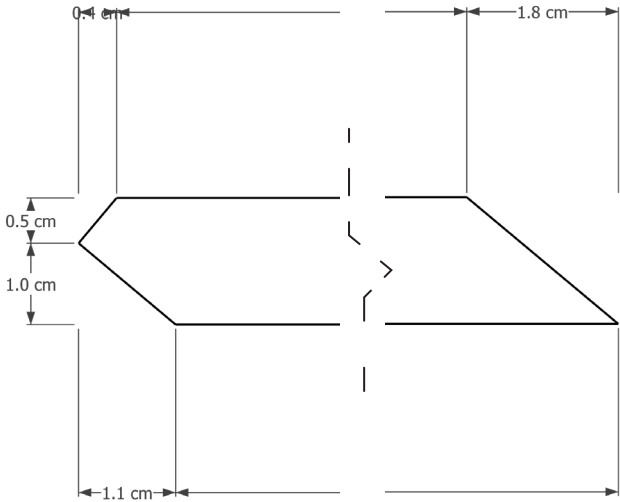


k

x4

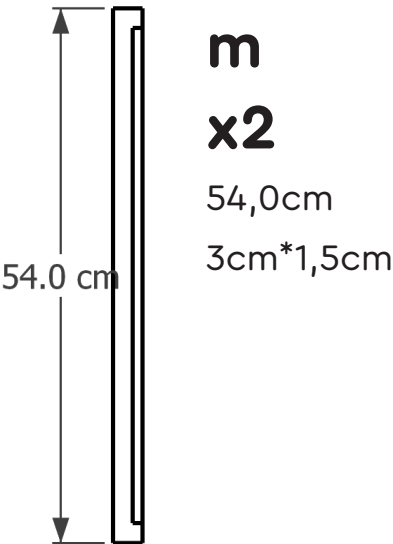
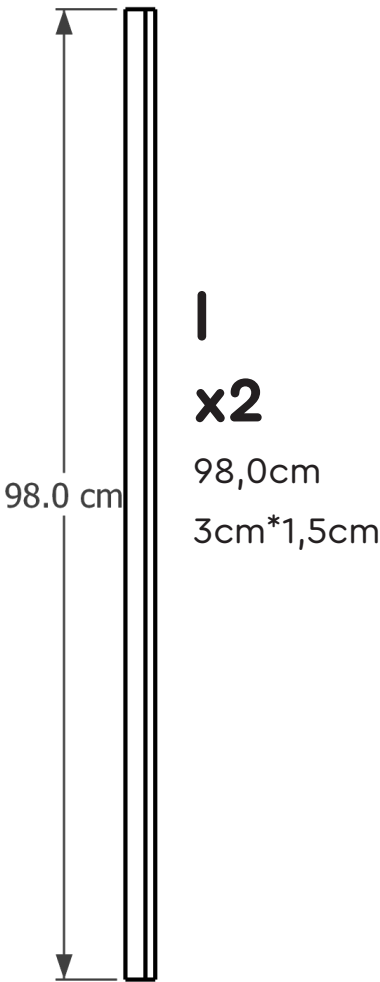
44,3cm

1,5cm*1,5cm

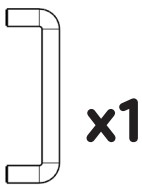
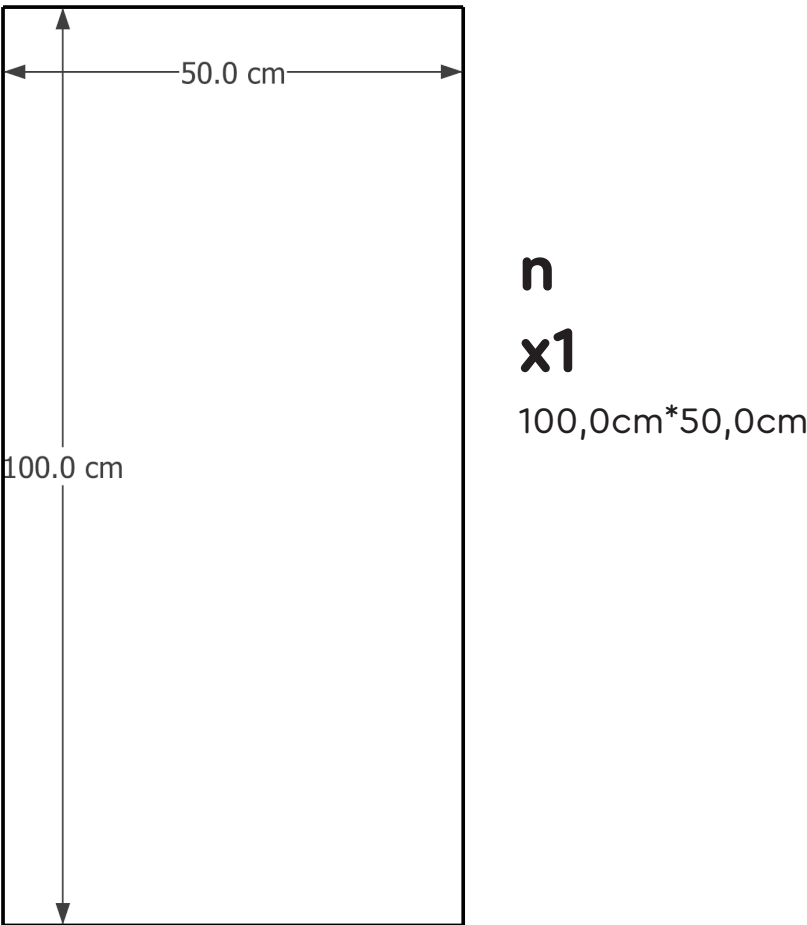


Box lid

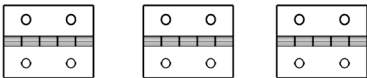
Wooden rods (3cm*1,5cm)



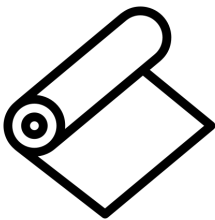
Glass/plexiglass (4mm.)



Handle



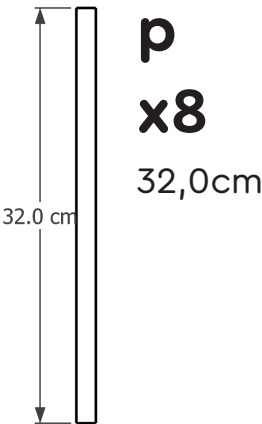
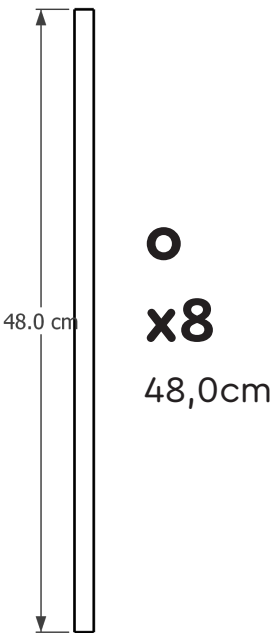
Hinges x3



Inox mesh

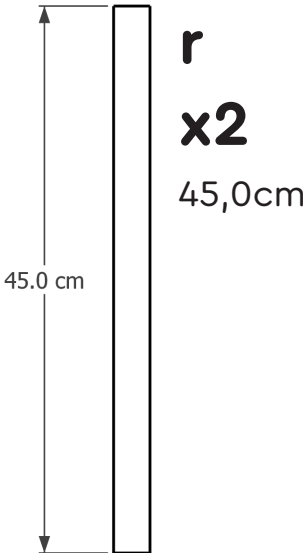
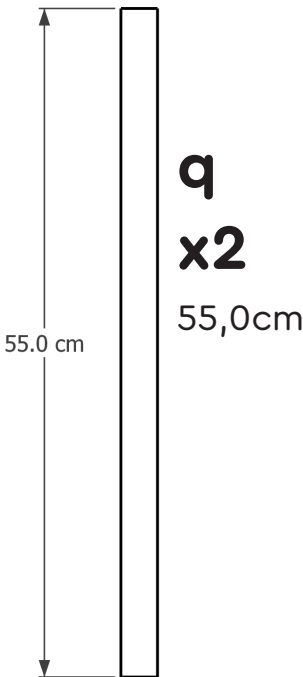
Shelves

Wooden rods (1,5cm*1,5cm)

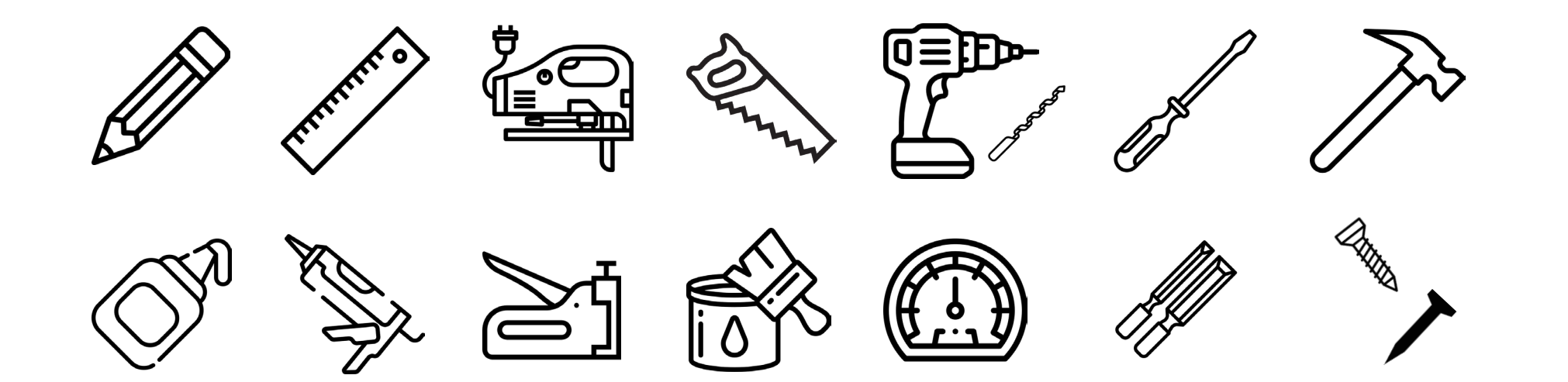


Legs

Wooden rods (3,0cm*3,0cm)

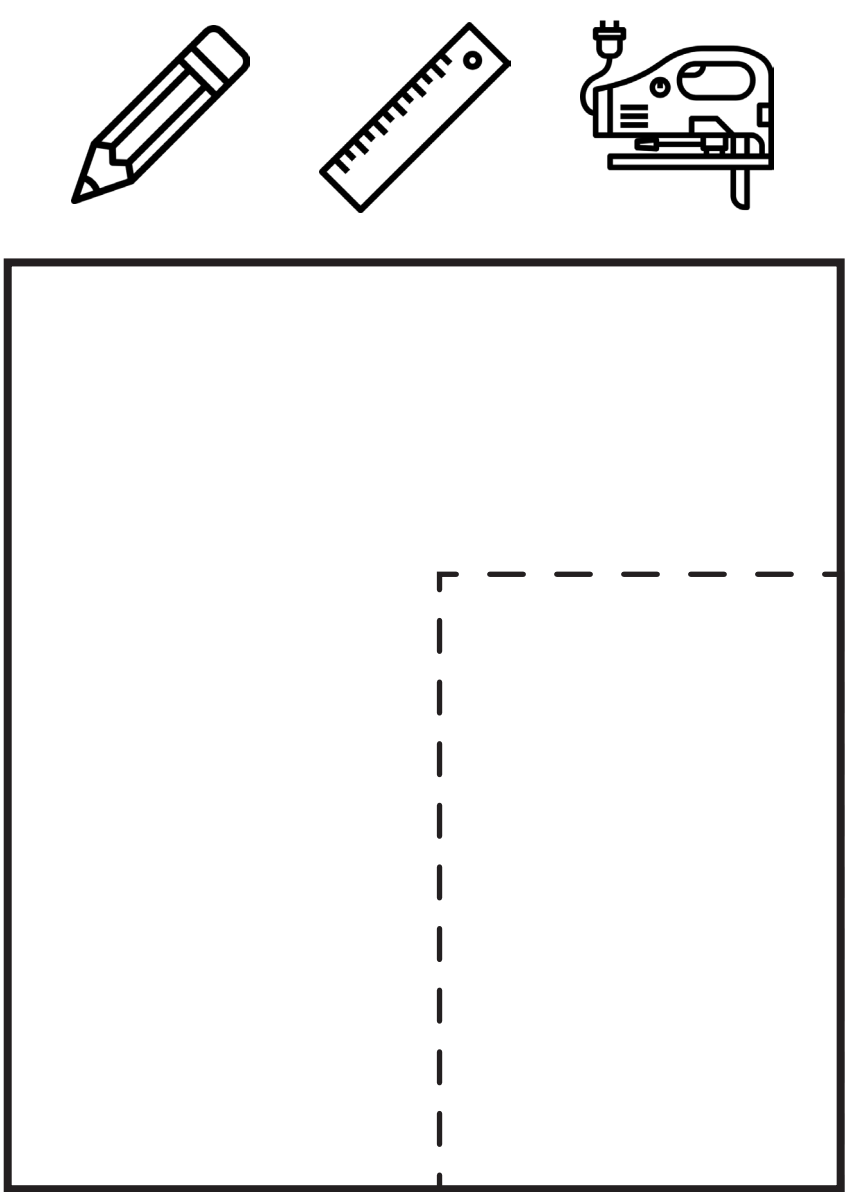


Tools



Step 0. Preparations

Cutting the plywood



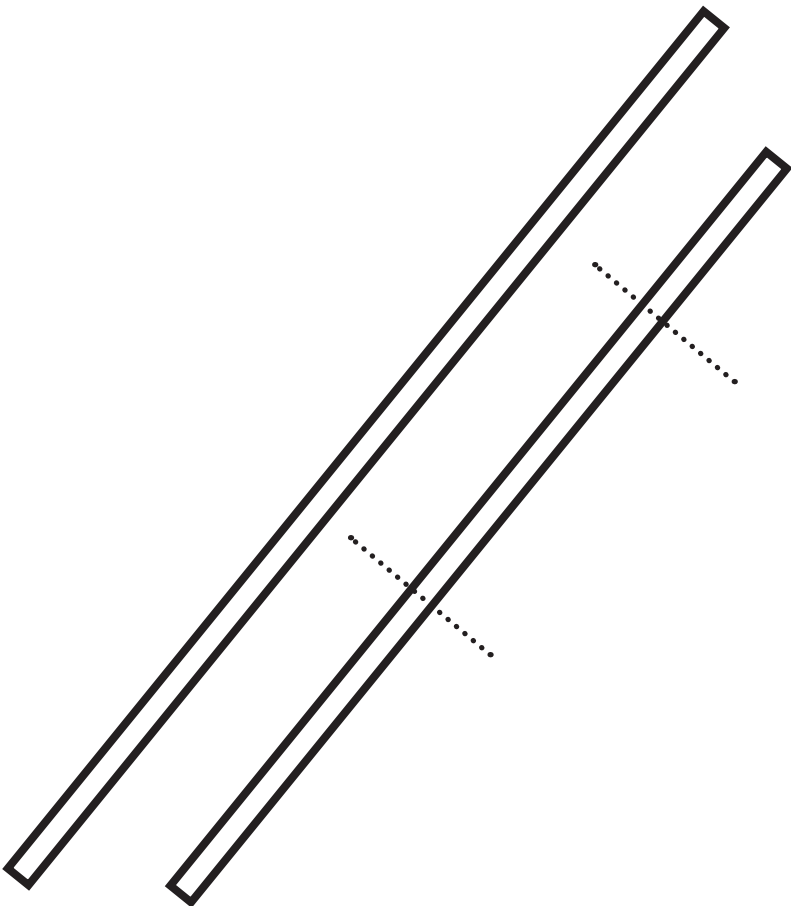
Using pencils and rulers mark the plywood in the following dimensions:

Wooden box:

Box Sides	x2 (b)	x2 (c)
	104,0cm * 30,0cm hole*2: 42,0cm*15,0cm	51,0cm*30,0cm

Bottom	x1 (a) 104,0cm*54,0cm
--------	---------------------------------

Cutting the wooden rods



Using pencils and the meter mark the wooden rods in the following lengths:

Wooden rods (3*1,5cm)

x3 (d)	x2 (e)	x2 (f)
48.0cm	95.0cm	101.0cm

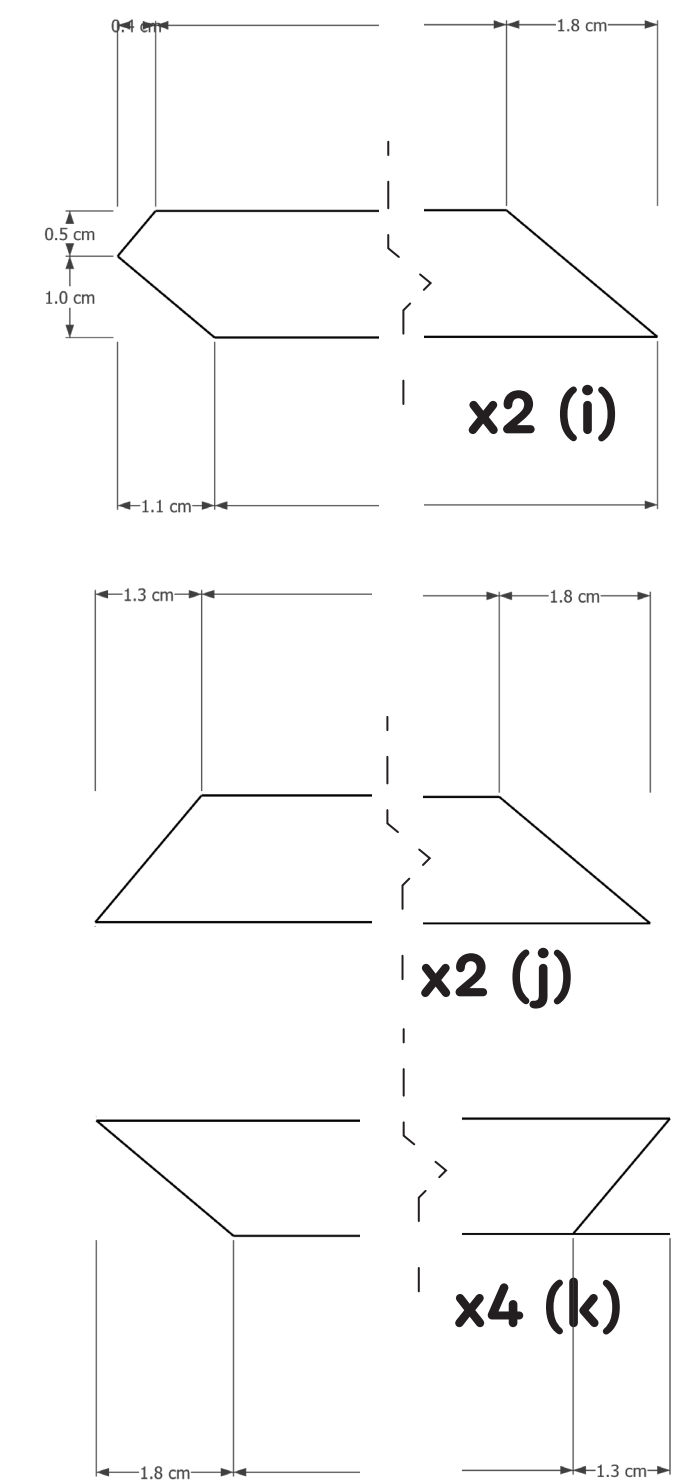
.....

x3 (g)	x4 (h)
45.0cm	28.5cm

Wooden rods (1,5*1,5cm)

x2 (i)	x2 (j)	x4 (k)
44.3cm	44.3cm	44.3cm

Cutting details for pieces i,j,k



Box lid (3,0*1,5cm)

x2 (l)	x2 (m)
98.0cm	54.0cm

Shelves (1,5*1,5cm)

x8 (o)	x8 (p)
48.0cm	32.0cm

Legs (3,0*3,0cm)

x2 (q)	x2 (r)
55.0cm	45.0cm

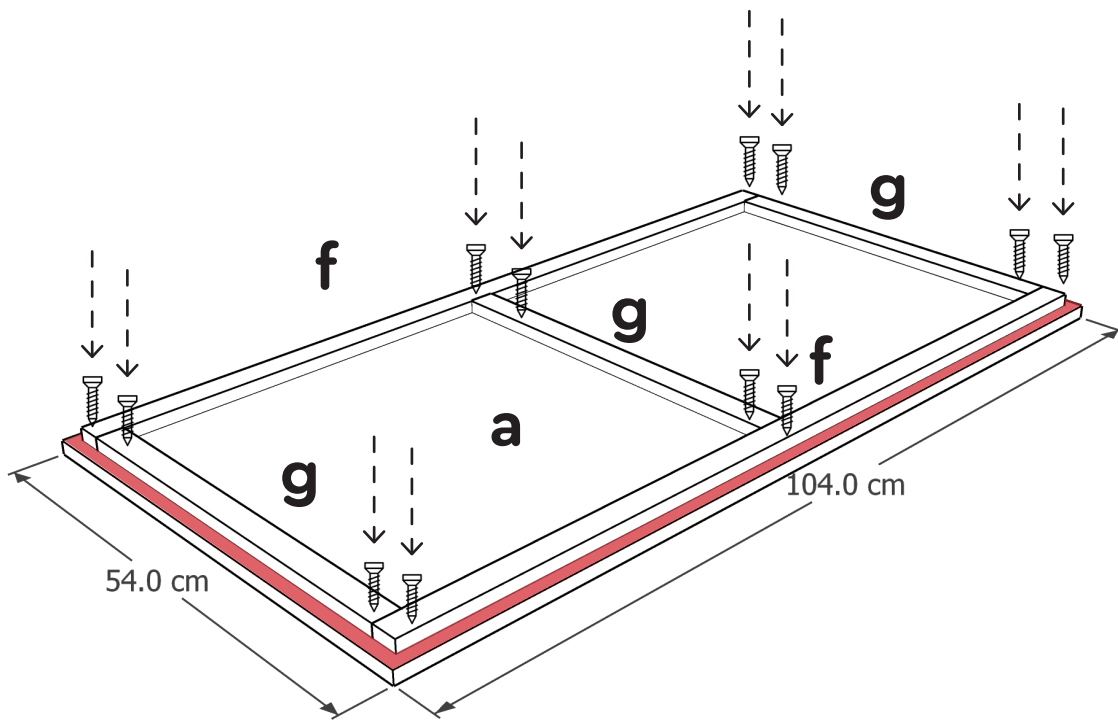
Note: Make sure to mark each piece of wood you cut with the corresponding letter. It will make the assembly much easier!

.....



Step 1. The Box

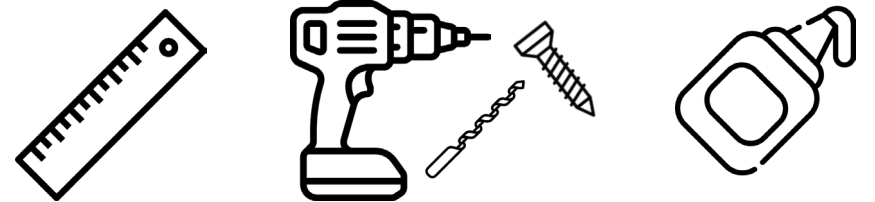
Starting with the base



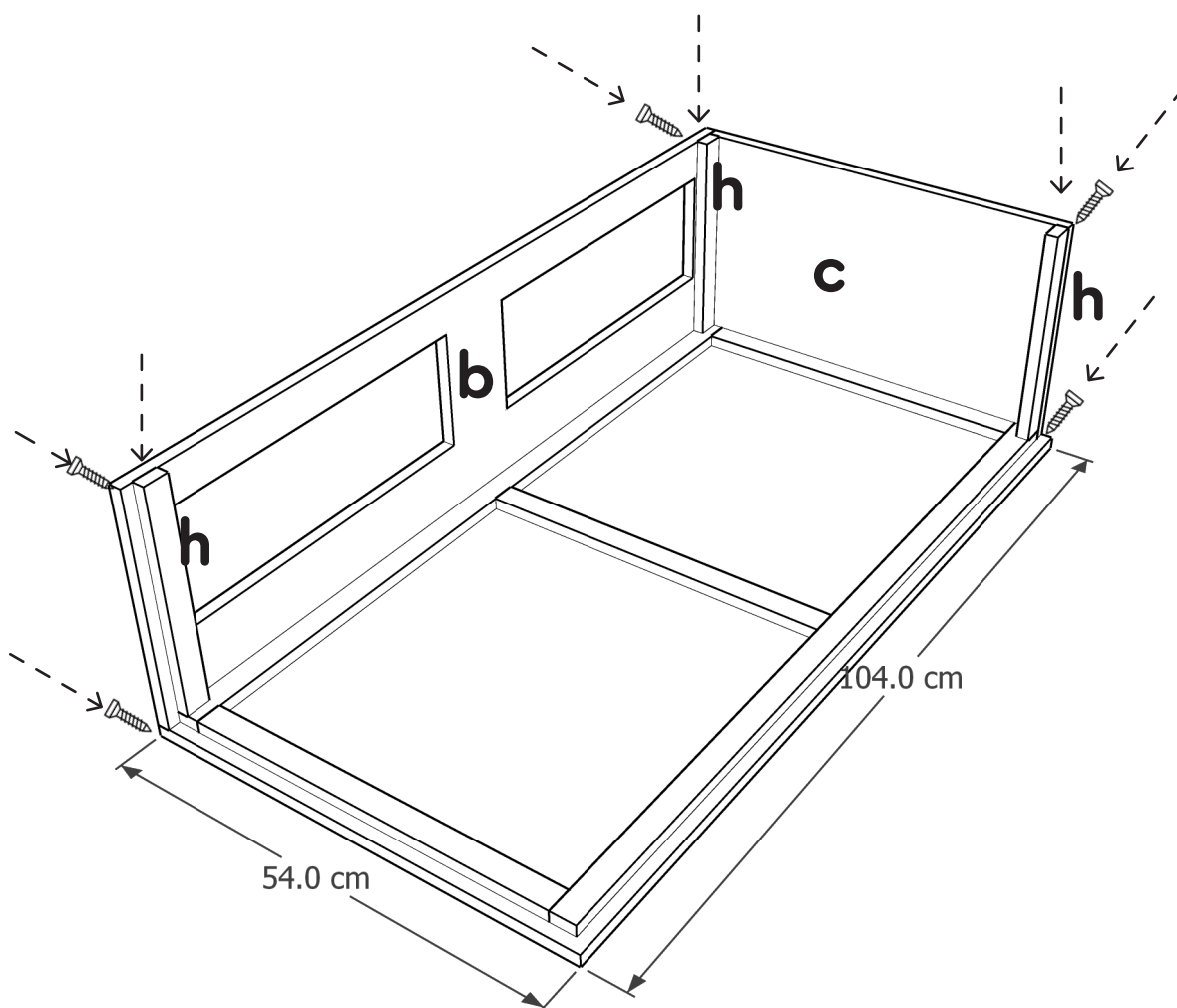
Take the base of the box enclosure (a) and frame its sides using the wooden rods (3*g & 2*f) as indicated in the diagram, leaving a 15mm offset in the bottom's perimeter (this is where the box's side pieces will sit).

To secure the wood pieces use wood glue on every surface they come in contact with.

Then using a wood drill make small holes and then screw small screws as shown in the diagram.



Continue with the sides



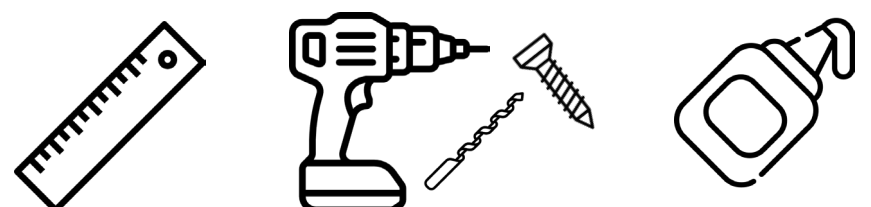
Place a long side piece of plywood (b) on one of the sides of the base. Make sure its bottom side sits nicely on the 15mm frame of the plywood that sits in the bottom.

Secure it on that side by using wood glue and screwing it on the side of the rod that you previously placed.

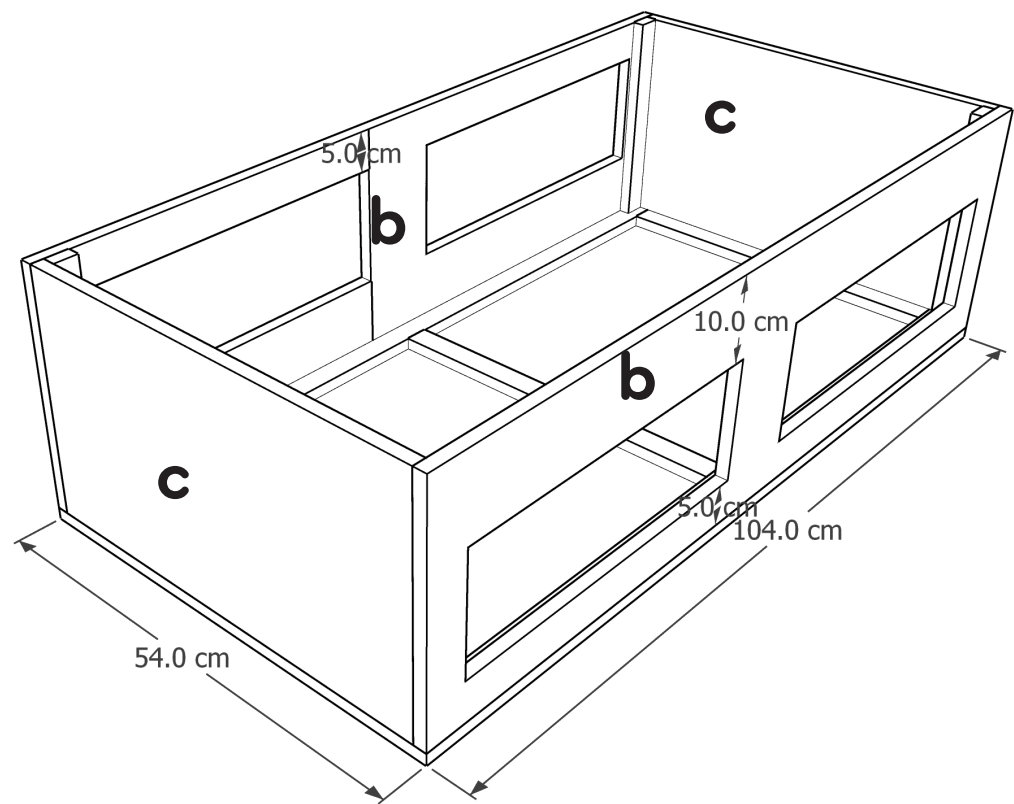
Continue by placing 2 rods (h), one on each vertical edge of the side you just placed (b). Secure them using wood glue and then screw them on the side's surface.

Continue by placing the next side (c) right next to the side you just secured. This piece of wood is shorter so make sure its side face is covered by side b.

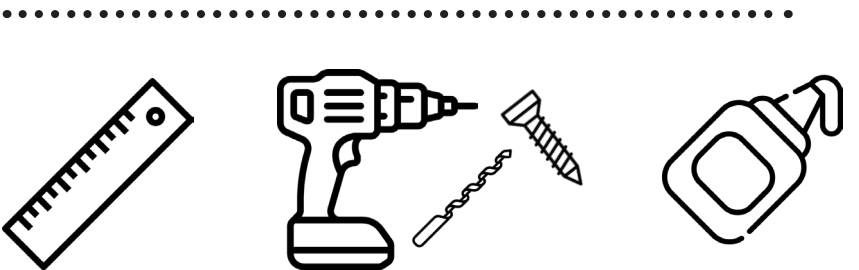
Place the third rod (h) on the remaining side of the new panel.



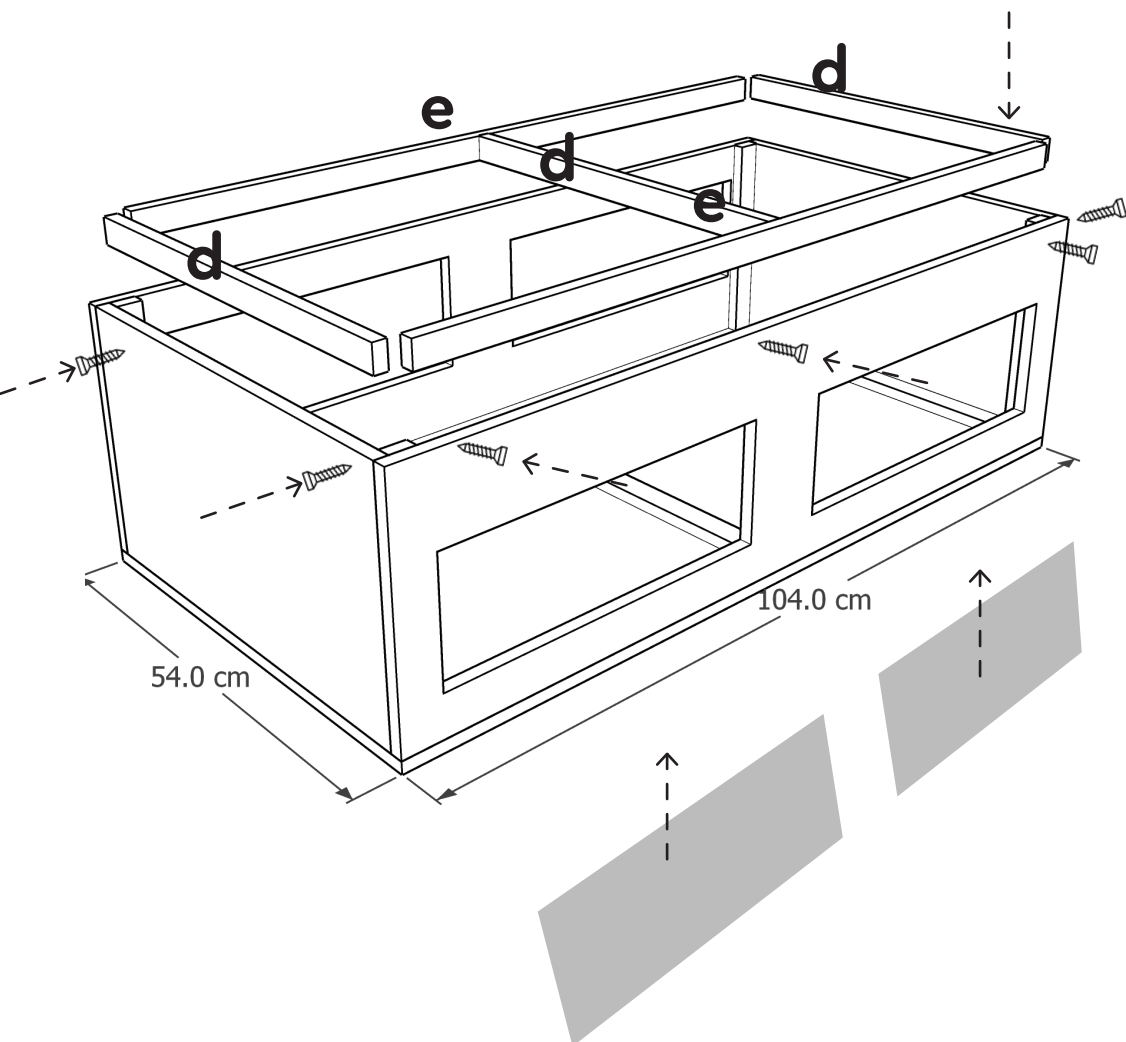
Continue with the sides



Keep going the same way adding the remaining side b and c and the last wooden rod (h) securing them with wood glue and screws/nails.

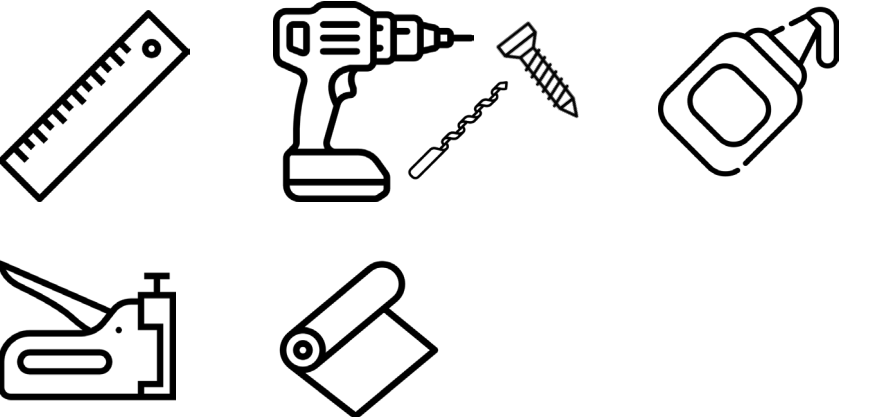


Finishing the frame

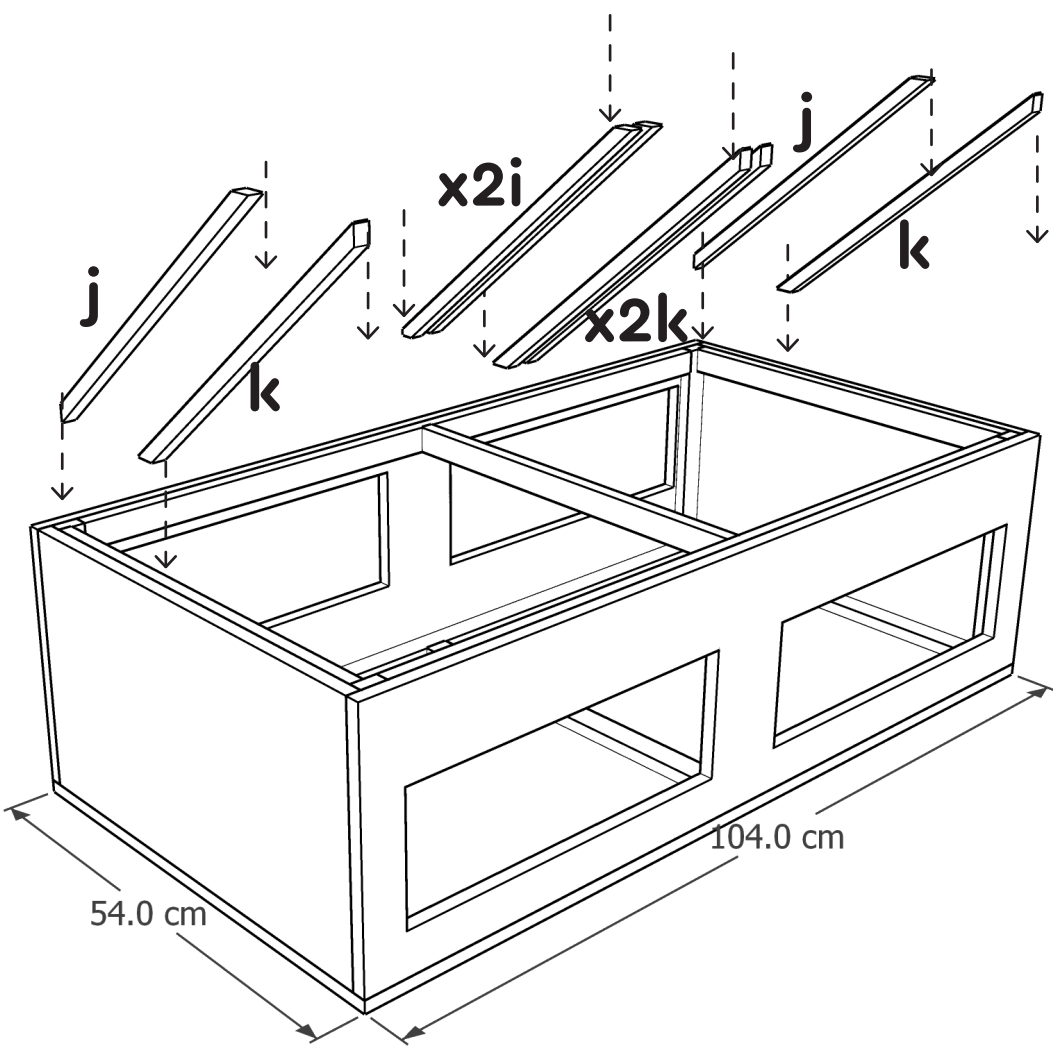


Add the last remaining rods (2*e & 3*d) to finish the box's frame. Again, secure them using wood glue and screws/nails.

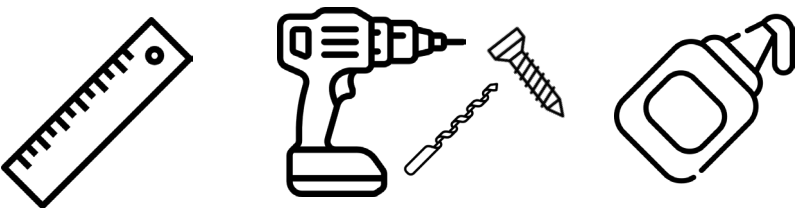
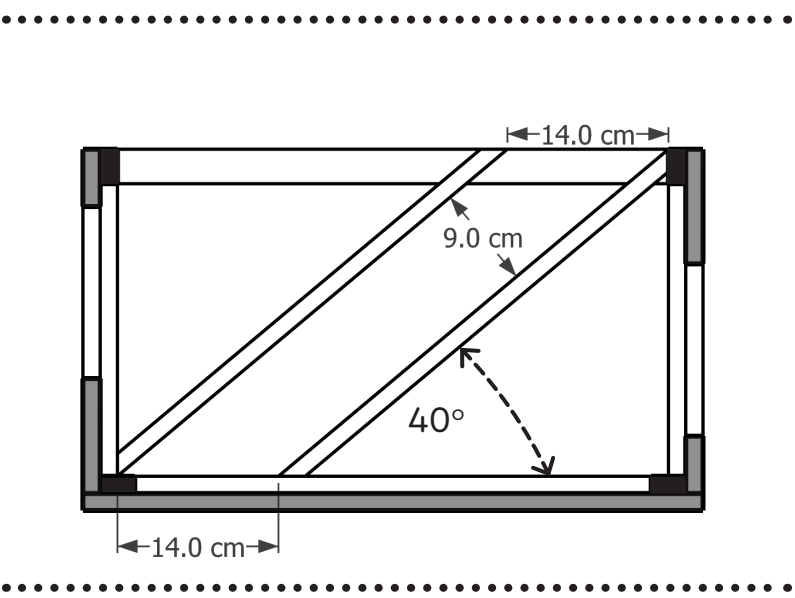
Now that the main frame and enclosure are finished, its time to line all side openings with the inox mesh so insects won't be able to enter the dehydrator. You can secure the mesh using a staple gun.



Shelf tracks

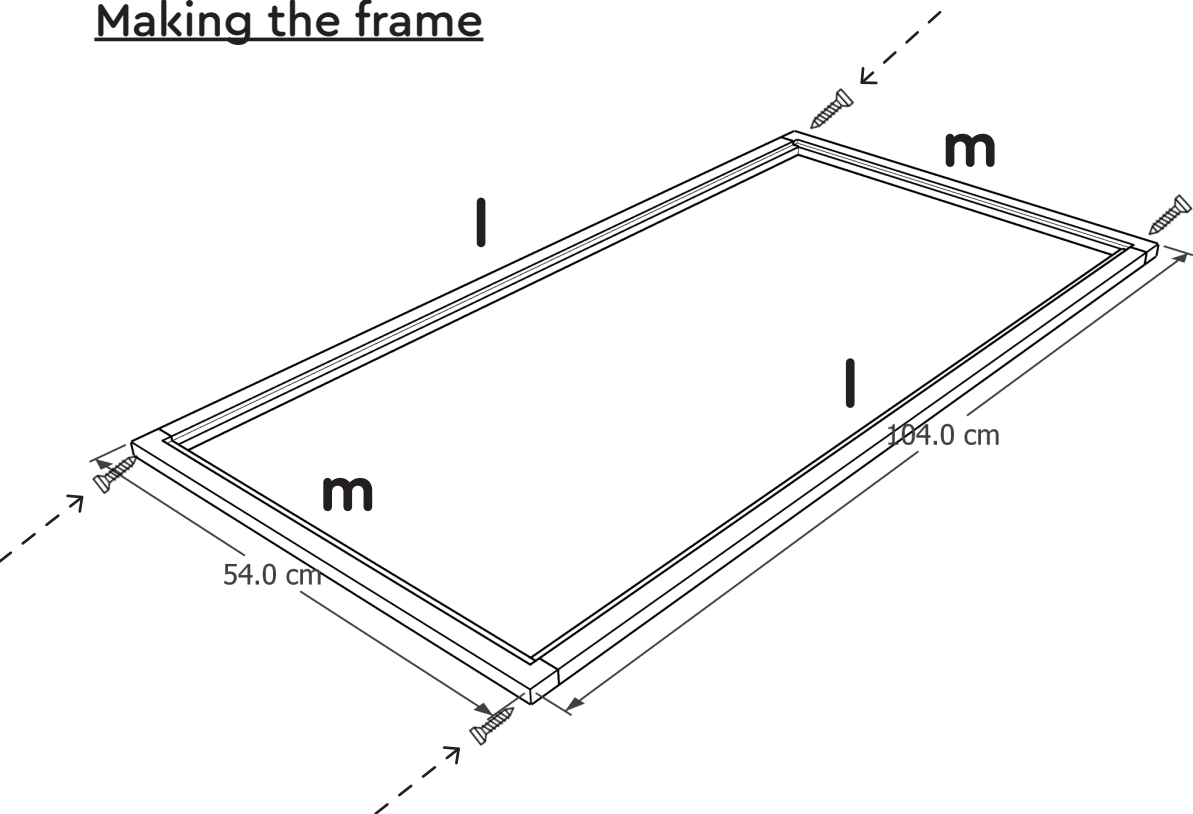


Continue by adding the tracks for where the shelves will be sitting on.
Add the tracks at an angle according to the diagram bellow so that they create a 40° angle with the back of the box.



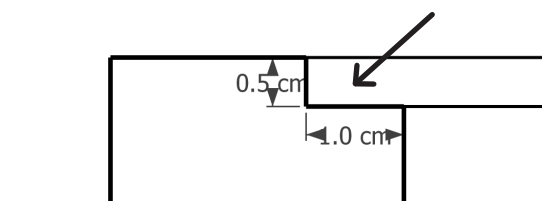
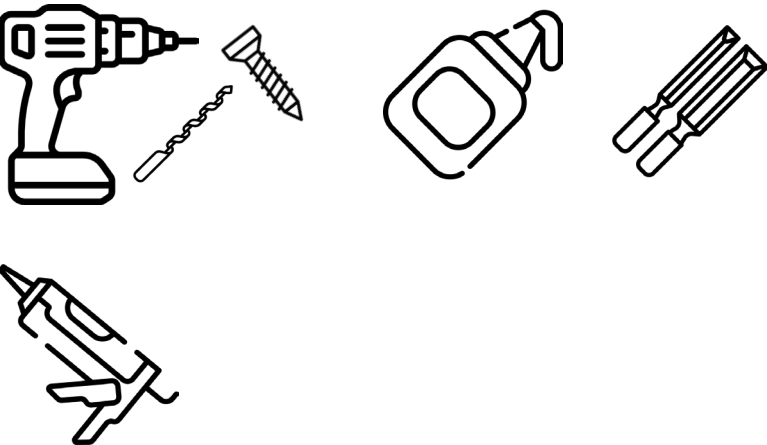
Step 2. Box Lid

Making the frame



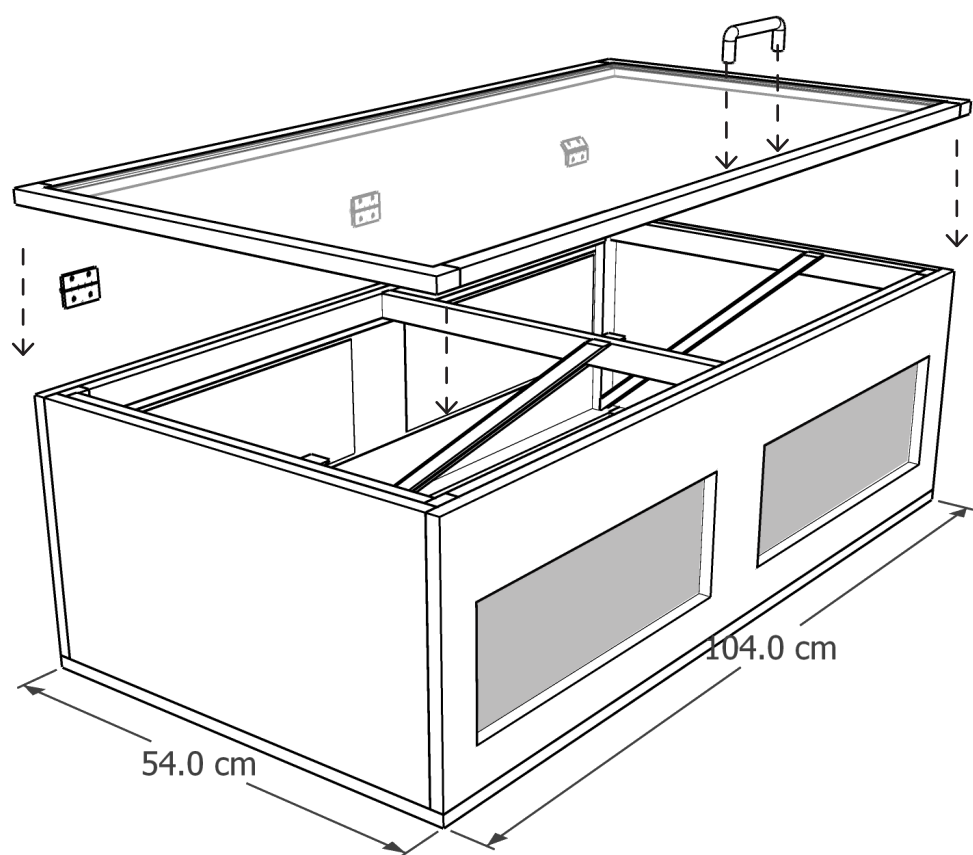
Using screws/nails and wood glue, connect the rods (2*l & 2*m) in order to make a rectangle frame for the plexiglass.
Using a chisel, curve a small crevice, about 5mm deep and 10mm wide according to the section diagram. This is where the plexiglass panel will sit.

Continue by adding heat resistant silicone in the crevice and then placing the plexiglass panel.



Section diagram

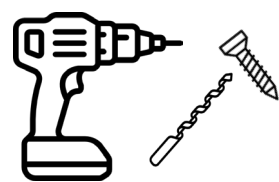
Attach the lid



To attach the lid to the dehydrator box by screwing three hinges on the top long side.

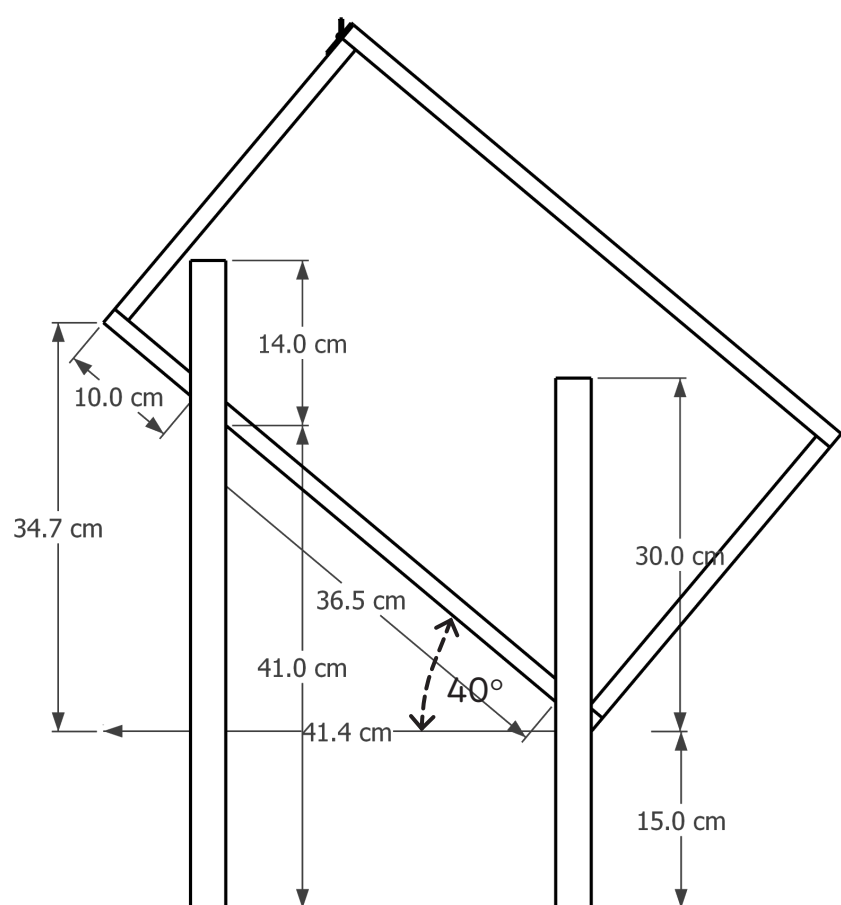
To make the door easier to open, attach a handle on the opposite side.

.....



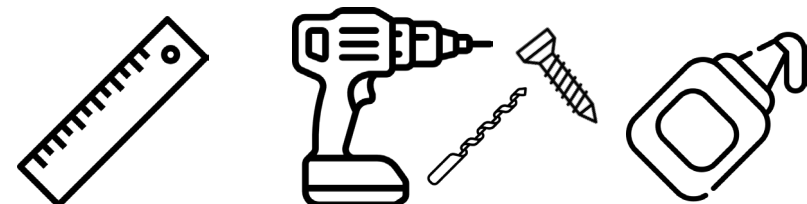
Step 3. Legs

Attach the legs



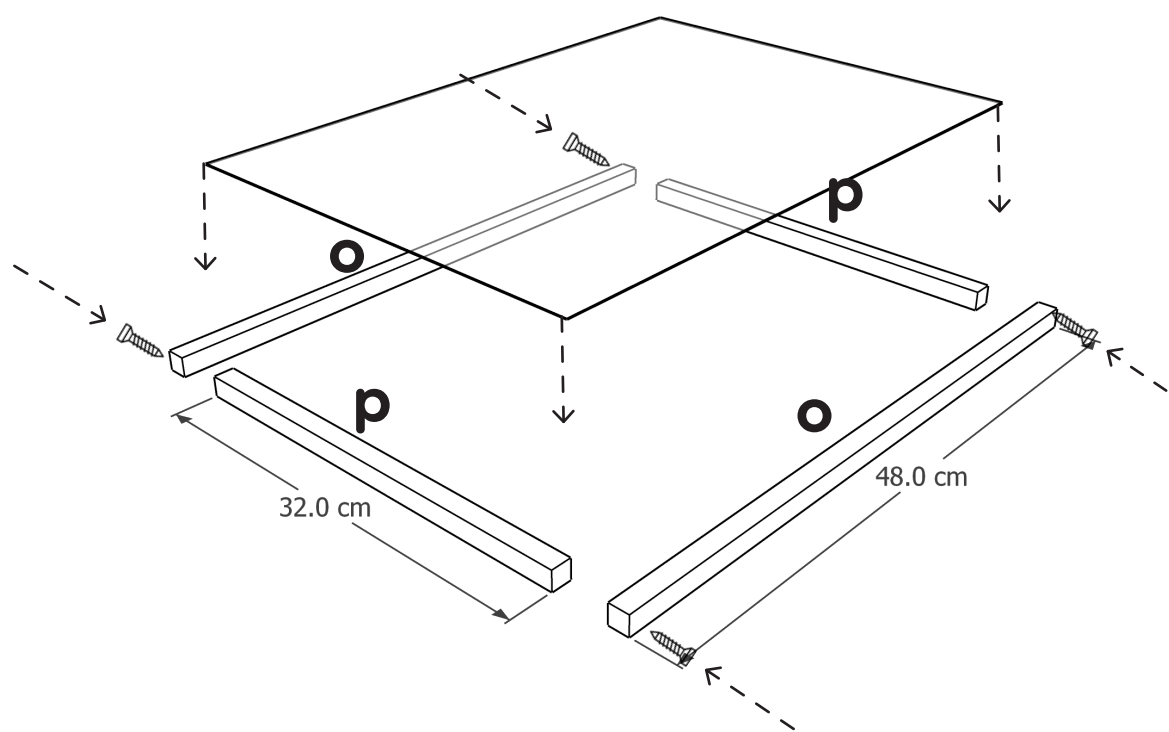
Attach the box's legs on the sides so that the back side off it creates a 40° angle with the ground surface. Allow for a minimum of 35cm height from the ground so that air can circulate and enter from the lower openings.

.....



Step 4. Shelves

Making the shelves



To make each shelf connect the rods (2*o & 2*p) to make the rectangle frame. Make sure that the longer side of the frame is equal to the length of the longer piece of wood (o=48cm).

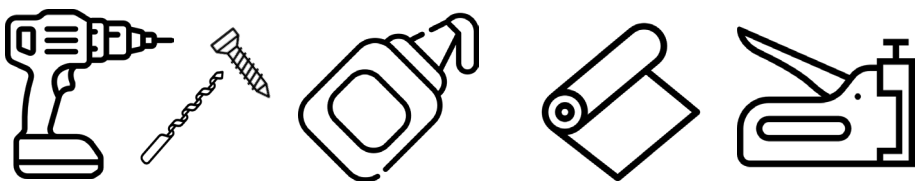
Secure the rods using wood glue and screws/nails.

.....
Continue by cutting pieces of inox mesh big enough to cover the top of the wooden frame.

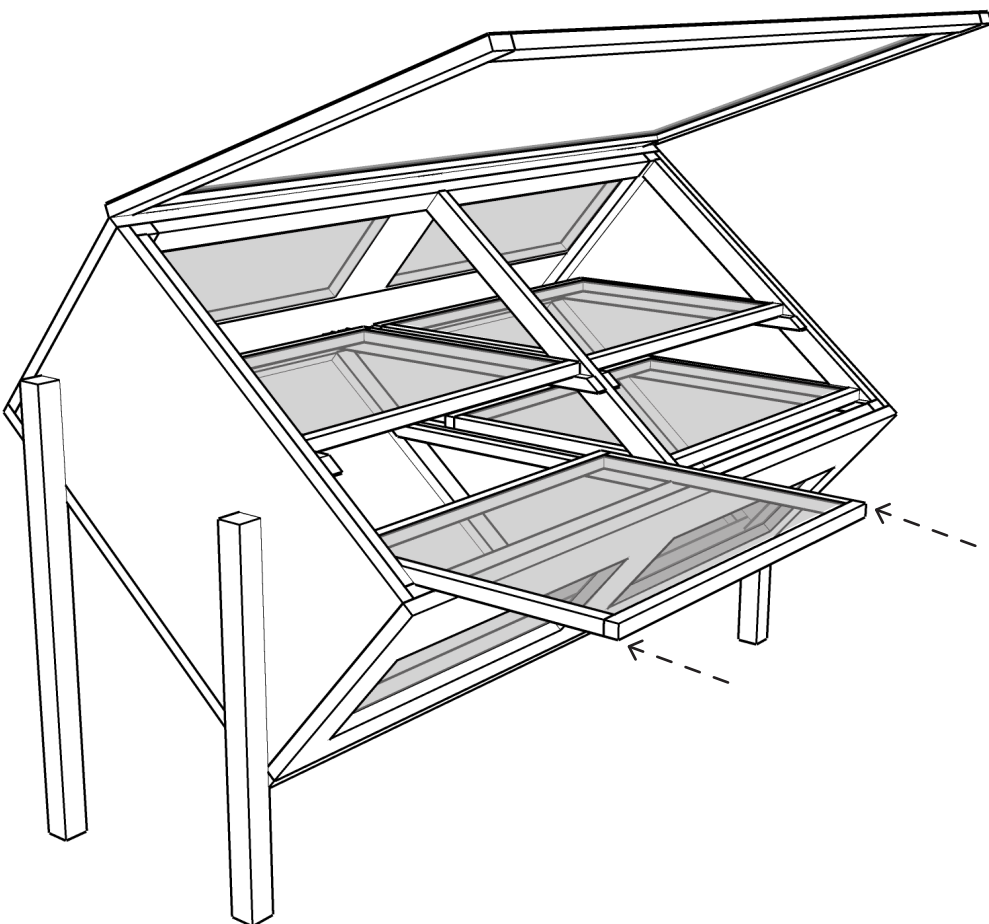
This is where the produce will be laid out for dehydration.

To attach the mesh to the frame use a staple gun.

.....
Repeat the process until you have 4 shelves of the same size.



Step 5. Assembly



To protect the wooden surfaces you can paint the outside using wood varnish.

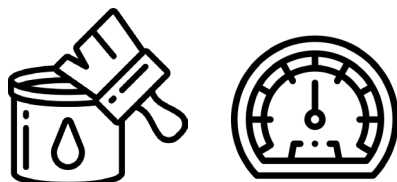
.....
Finish your dehydrator by sliding the shelves into position.

.....
To test the dehydrator, place it outside directly on sunlight & line the trays with slices of fruit or veggies.

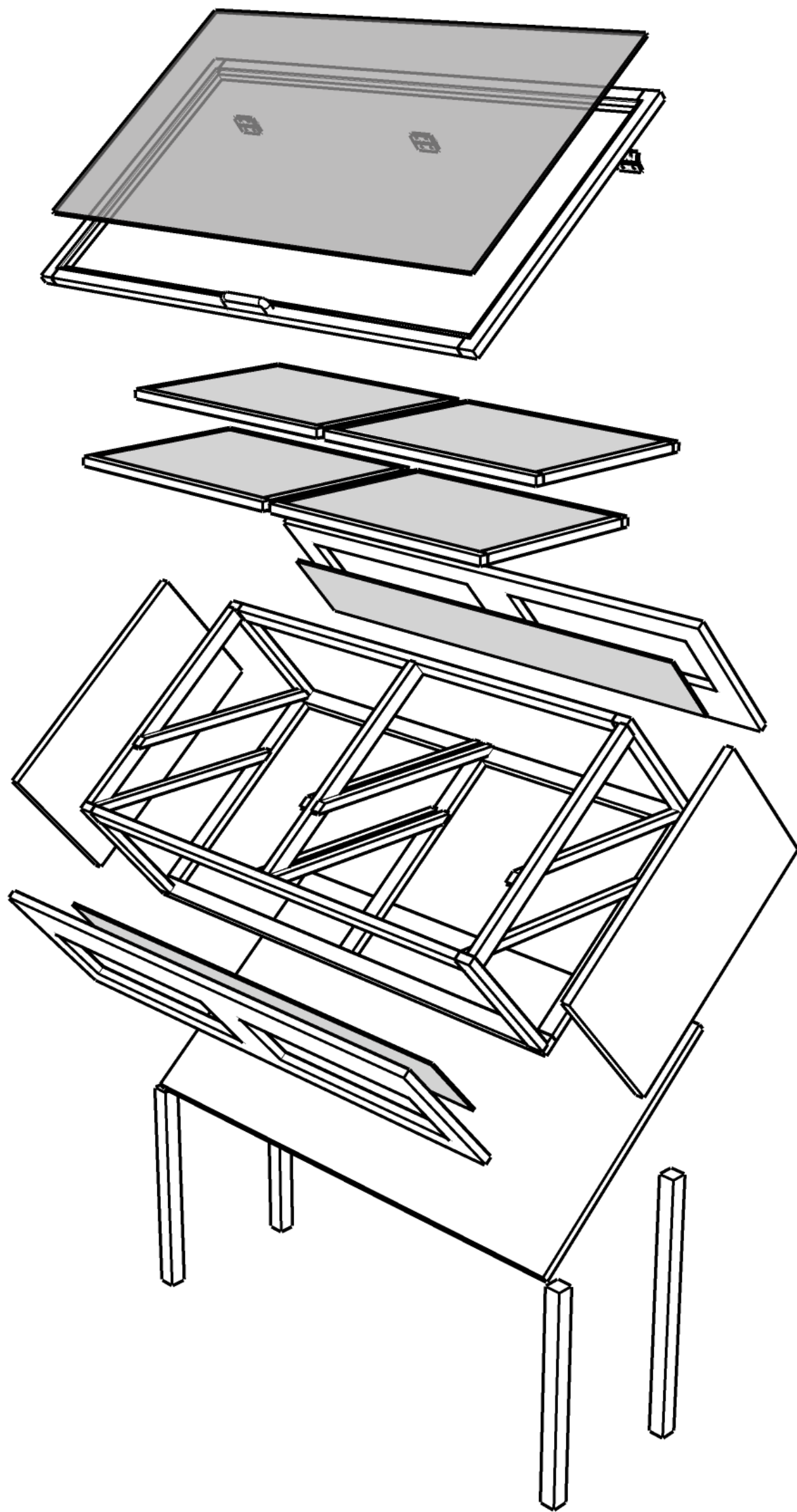
You can check the airflow by placing your hand on the top opening.

You can also monitor the dehydrator's inside temperature using an oven thermometer.

.....



Enjoy!



Sensor Energético

Arduino

Aurora

Índice:

Descripción general-----	3.
Hardware-----	4.
Funcionamiento-----	5.
Software-----	6.
Arduino-----	6.
Funcionalidades a destacar-----	7.
Python-----	8.
Funcionalidad-----	8.
Ejecución-----	9.
Posibles incidencias-----	10.

Descripción general

El objetivo del proyecto Arduino Aurora es el de concienciar de la importancia que tiene tomar medidas de eficiencia energética en nuestro día a día mediante diversos recursos didácticos. En este caso, mediante el diseño de un sensor energético que ayuda a inculcar este objetivo a la vez que se aprende sobre desarrollo hardware y Arduino.

El sensor se encarga de monitorizar los valores de temperatura y luz ambiental de la habitación o entorno en el que se encuentra.

El sensor se ha realizado con módulos compatibles con Arduino de manera sencilla y accesible para principiantes, debido a la naturaleza didáctica del proyecto. Como sensores principales se utilizan un sensor de temperatura y humedad y una fotorresistencia a modo de sensor lumínico además de una pantalla lcd para mostrar los datos recabados a tiempo real.

El sensor lleva implementados en código una serie de avisos a dar en casos determinados (baja temperatura, baja luminosidad, etc.) y mediante un script externo introduce la información recopilada en un archivo de texto cada hora.

Toda la funcionalidad del proyecto así como la documentación del hardware empleado están incluidos en esta carpeta.

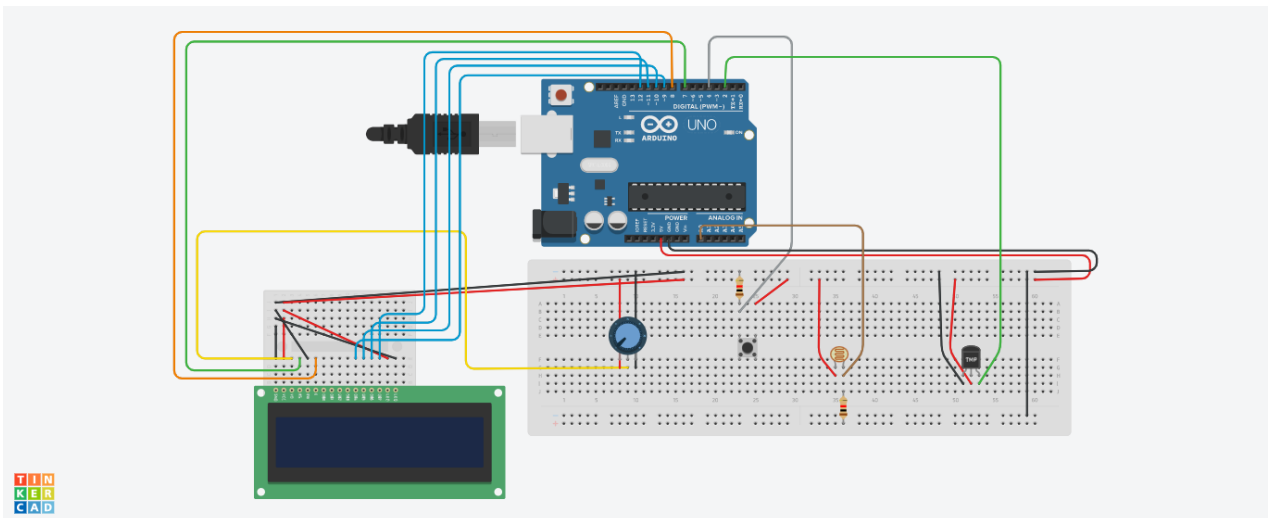
Hardware

Para la realización de este proyecto son necesarios los siguientes componentes hardware:

- Placa Arduino UNO x1.
- Elegoo 830 breadboard x1.
- Elegoo UNO expansion shield module x1.
- Sensor de temperatura y humedad DHT-11 x1.
- Pulsador x1.
- Pantalla LCD LCM1602A x1.
- Potenciómetro PT-15 x1.
- Fotorresistencia 10k x1.
- Resistencias de 10k x2.

Del módulo de expansión solo utilizaremos la breadboard de la que dispone el componente separándola de la placa.

Las conexiones del circuito vienen dadas en el siguiente diagrama:



El circuito se alimenta a 5V.

El sensor mostrado en el diagrama NO es el sensor DHT-11, es solo un esquemático de ejemplo.

El mismo caso ocurre con el potenciómetro.

El cableado que se muestra es el del sensor original.

-Funcionamiento:

La fotorresistencia y el sensor de temperatura recopilan la información de la luminiscencia y temperatura de la habitación respectivamente, dicha información es procesada por el controlador Arduino y mediante software se programan respuestas ante los siguientes escenarios:

1. Baja temperatura: se avisa al usuario que encienda la calefacción.
2. Alta temperatura: se avisa al usuario que encienda el aire acondicionado durante 1 hora (tiempo recomendado).
3. Baja luminosidad: se avisa al usuario que encienda la luz, se activa si la habitación tiene baja luminosidad o si anochece.
4. Innecesario exceso de luminosidad: se avisa a cierta hora de la noche (por defecto, las 0:00 am) que se apaguen las luces, ya no solo por el medio ambiente, sino por la salud del usuario.

Toda información incluyendo los avisos programados se muestran por la pantalla LCD a tiempo real. En condiciones normales, se muestra por un lado la temperatura, por otro lado, pulsando el botón, se pasa a mostrar la luminosidad. En cualquiera de los cuatro escenarios anteriormente descritos, se pasa a mostrar el aviso hasta que el usuario pulse el botón para regresar a la información habitual.

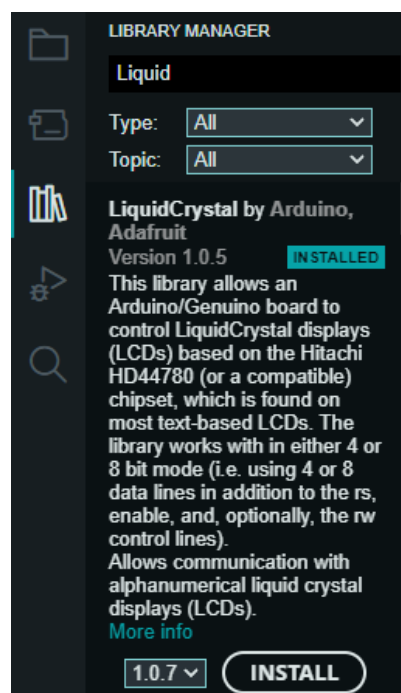
Software

El software del sensor se desarrolla en dos partes, la primera y más importante en Arduino y la restante en Python.

-Arduino

Para la realización de esta parte se necesita el IDE de Arduino instalado en el ordenador. En su defecto, también se puede utilizar entornos web o plugins en otros IDEs como Visual Studio o CLion, siempre que se tenga acceso al puerto serial, pero se recomienda encarecidamente utilizar el IDE de Arduino.

El código utiliza cuatro librerías, una de las cuales es nativa a Arduino (Time.h). Para el resto, se deberán instalar ya sea por el library manager como se muestra a continuación o mediante la descarga del archivo comprimido de la misma, en cuyo caso se añadirá en Sketch->Include Library->Add .Zip file buscando el archivo comprimido.



Posteriormente, incluimos las librerías:

```
#include <LiquidCrystal.h> //instalar LiquidCrystal by Arduino Adafruit
#include <DHT.h> //instalar DHT sensor library by Adafruit
#include <Time.h> //nativa a Arduino
#include <TimeLib.h> //instalar Time by Michael Margolis
```

--Funcionalidades a destacar

A diferencia de la fotorresistencia, las mediciones del sensor de temperatura se hacen mediante el uso de su librería dedicada. Esto significa que al imprimir el valor leído directamente del sensor, viene dado en Celsius. En el caso de la fotorresistencia, se deben realizar varias conversiones:

1. Longitud de onda a Voltios:

$$L_V = \text{valor inicial} * \left(\frac{V_{in}}{1023} \right) V$$

2. Voltios a Ohmios:

$$L_{\Omega} = \frac{10k * (V_{in} - L_V)}{L_V} \Omega$$

3. Ohmios a Lumens:

$$L = \frac{500}{\frac{L_{\Omega}}{1000}} \text{ Lumens}$$

Todo este proceso queda reflejado así:

```
float sensorRawToPhys(int raw){//conversión de onda analógica a lumens
    float Lv = float(raw) * (5/ float(1023));//Longitud de onda a Voltios
    float Lo = (10000 * (5 - Lv))/Lv;//Voltios a Ohmios
    float phys=500/(Lo/1000);//Ohmios a Lumens
    return phys;
}
```

También se dispone de una función que determina a través de la librería TimeLib.h si son horas de tener la luz encendida.

El resto del código implementa la funcionalidad del sensor además de imprimir los valores en el puerto serial.

-Python

Para la realización de esta parte es necesario tener Python instalado en el ordenador además de disponer de un IDE como Visual Studio o Pycharm.

Para instalar Python se puede utilizar la terminal del IDE, la del ordenador o la Microsoft store (si tu ordenador es Windows).

El código utiliza dos librerías, una de las cuales es nativa de Python (time). Para la librería serial, es necesario instalarla desde la terminal del IDE con el siguiente comando:

```
python -m pip install PySerial
```

Después se importan las librerías:

```
import serial #instalar  
import time #librería na
```

--Funcionalidad

El script coge los valores impresos en el puerto serial utilizado por el Arduino y los imprime a su vez en la terminal y en un archivo .txt

```
//imprimimos los datos por el puerto serial  
Serial.print(hour());  
Serial.print(":");  
Serial.print(minute());  
Serial.print(" Temperatura: ");  
Serial.print(t);  
Serial.print(" C, Luz: ");  
Serial.print(lumens);  
Serial.println(" Lumens");
```

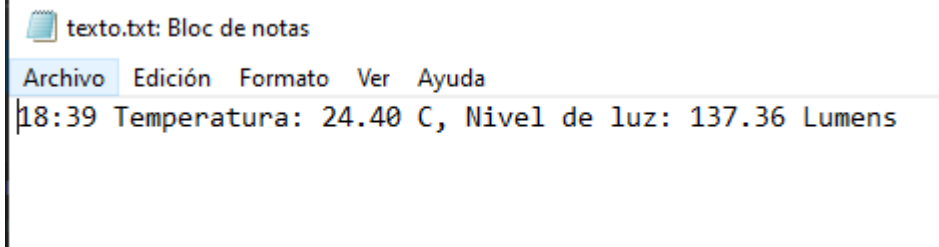
Código Arduino

```
time.sleep(3600)  
cad=serialArduino.readline().decode('ascii')  
print(cad)  
  
archivo.write(cad)
```

Script Python

Ejecución

1. Conectar la placa Arduino al puerto USB e indicar en ambos programas qué puerto serial se está utilizando (ej.: COM4).
2. Crear un archivo de texto vacío en la carpeta del proyecto (o utilizar el que ya viene).
3. Indicar en el script de Python la ruta del archivo de texto.
4. Indicar en el código de Arduino la fecha y hora desde la cual se comienza a monitorizar.
5. Subir el código Arduino a la placa SIN abrir el monitor serial.
6. Ejecutar el script de Python SIN desconectar la placa Arduino o terminar su ejecución
7. Deberías por un lado ver la actualización a tiempo real de los datos en la pantalla LCD y la información impresa cada hora en la terminal de Python.
8. Para terminar el programa, ve a la terminal de Python y escribe Ctrl+C para detener el script. Opcionalmente puedes desconectar el Arduino.
9. En la carpeta del proyecto actualiza pulsando F5 y abre el archivo de texto, deberías ver la información impresa con un formato parecido al siguiente:



Posibles incidencias:

- No se enciende el display LCD:
 - Puede que tengas uno o varios cables mal conectados, revisa el diagrama y compara con lo que tienes hecho y prueba otra vez.
- Los sensores solo leen el valor 0:
 - Puede que ocurra como en el caso anterior, para asegurarte, abre el Serial Monitor y mira la información que envían los sensores. Si persiste, reinicia Arduino.
- Me da el aviso de apagar las luces más pronto o más tarde de las doce:
 - Asegúrate de poner la fecha y hora ANTES de cada ejecución.
- El puerto serial está ocupado:
 - Si tienes un ordenador con Linux, Ubuntu o similares, puede que tengas que darle permisos al puerto.
 - Revisa que no haya otras aplicaciones utilizando el puerto serial, si es así, termina de utilizar la aplicación o cambia de puerto USB.
 - Si revisando parece que todo está correcto pero el error persiste, es muy posible que tu placa Arduino esté en mal estado.
 - Si el error te lo da el IDE de Python asegúrate de que el IDE de Arduino no tenga abierto el puerto serial.
- Termino el programa y no ha impreso nada en el archivo de texto:
 - Asegúrate de haber terminado el programa como se indica anteriormente y no de otra forma.
 - Asegúrate de haber escrito bien la ruta del archivo y/o el nombre del mismo.



SOLAR COOKING WORKSHOP

BUILD YOUR OWN
SOLAR COOKER

GOALS

- ② To acquire practical knowledge regarding solar cooking technologies
- ② To adhering to sustainable and alternative options
- ② To exploring hobbies outdoors
- ② To enhance teamwork skills

LEVEL OF COMPLEXITY - LOW

BUDGET - LOW

Materials and equipment are very cheap and easy to find at home.
The highest price is for kitchen utensils and food.

SPACE

Start by choosing a nice and safe area to place it.

TIMING

Build the solar cooker the day before you want to use, or very early in the morning of that day.

WEATHER

Wait for a sunny day and start cooking around 10 a.m.

DESCRIPTION OF THE DEVICE

A solar cooker is a device that transforms light into heat; it is a solar radiation concentrator.

Building a solar cooker can be a hobby and a way to pass the long sunny days, or a means to save money when cooking.

The temperature reached by a solar cooker (100 - 300°C) is not as high as that of a gas or electric oven, but it does allow food to be cooked safely.

GENERAL GUIDELINES

- ⌚ The best time to cook on a solar cooker is between 10 a.m. and 3 p.m. on sunny days.
- ⌚ Solar cooking means cooking outdoors.
- ⌚ Slow cooking preserves the flavour and nutritional value of food better.
- ⌚ It requires less attention because the food does not burn.
- ⌚ Cooking time is usually twice as long as in a conventional cooker.
- ⌚ The solar cooker may be located on the ground or on a suitable support. The container must be placed at the focal point formed by the panels.

HOW TO PROCEED WITH GROUPS OF PEOPLE

ELDERLY

Solar cooking can be one of the activities offered by community centres and nursery homes centres. Caregivers and volunteers can help, especially in physically demanding tasks.

STUDENTS

As a workshop for students, the solar cooker can become a very interesting approach to solar-powered household appliances.

Ideally, organizers should bring an academic perspective, so the first step is to contact experts from universities and other educational institutions.

It is advisable to do this activity in the context of a camping trip in rural areas, to show young adults how they can satisfy a vital need without using electricity and modern conveniences, as well as learning to live by the principle of near-zero emissions.

CHILDREN

In carrying out the activity, the young age of participants forces to increase safety measures, and it is mandatory to form small groups (3-5 children) assisted by adults to distribute tasks. Families can be also asked to join as volunteers, and sunny bank holidays can be a good opportunity.

Within this age group, building a solar cooker teaches two good lessons: working together to achieve a goal and thinking about how to do things differently.

NUMBER OF PARTICIPANTS AND GUIDES

ELDERLY AND YOUNG ADULTS

1 person to guide 5-8 participants

(+ 1 volunteer to help people with physical disabilities)

CHILDREN

1 guide per 5 children

(+ 1 volunteer)

MATERIALS AND TOOLS

Infographics to choose one of the three solar cooker models proposed

TO BUILD THE COOKER

- ⌚ Thick cardboard to cut out pieces of at least as big as 70x70cm
- ⌚ Aluminium foil roll
- ⌚ Tape measure and masking tape
- ⌚ Scissors and cutter
- ⌚ Glue and double sided tape
- ⌚ Small piece of metal

TO COOK

- ⌚ Oven thermometer
- ⌚ Dark pot
- ⌚ Oven safe glass casserole with lid

You can also print out the instructions of each link.

PICK A MODEL

There is a range of solar cookers models, and you should choose the one that suits you best.

We proposed three different structures below, but you can adapt to your necessities the design and measures provided.

We recommend you to have a look at all the links provided in this guide.

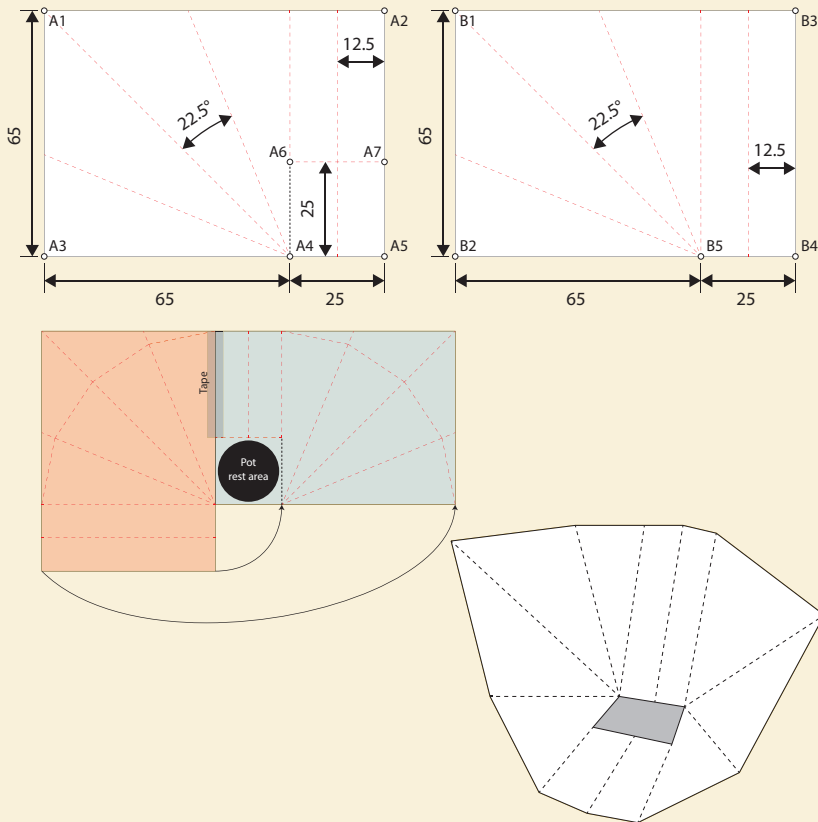
INSTRUCTIONS

1. Obtain some pieces of cardboard and cut them according to the dimensions indicated on the model.
2. Glue aluminium foil on the pieces of cardboard. Only apply glue on the matt side of the aluminium. The shiny side is preserved to capture and concentrate the sunlight. If you want a better result, use double sided tape, and a little of glue vertical lines (not spread). Press to adhere the foil to the cardboard. Trim the excess foil from the edges of the cardboard.
3. Draw the fold lines and fold with the help of a small piece of metal square, so that the folds are neat and deep.
4. Install the solar cooker as shown in the selected model in a safe area.

SATELLITE DISH MODEL SET UP BY AURORA

The structure resembles a satellite dish and its replication of Funil model DIY. It is recommendable to look up the article by professor Elmo Dutra (see the link below) for very detailed instructions and tips.

This design is made up of two large pieces of cardboard joined together. Several folds need to be made in the cardboard.

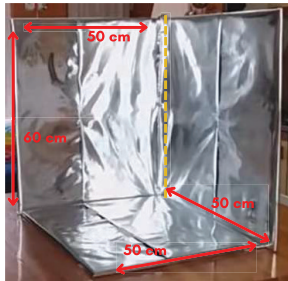


Detailed instructions and tips on
https://www.academia.edu/33131232/Solar_Cookers_Poor_Comunitys_Parts1_2_3b

OPEN BOX MODEL BY MATTEO MUCCIOLI

This efficient model is one of the simplest solar cookers.

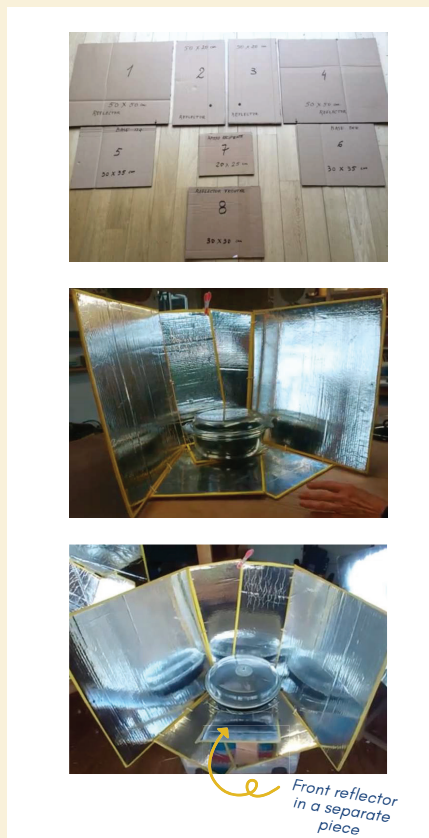
It has three mirrors forming a 90-degree angle and a small front reflector in a separate piece.



KIMONO MODEL BY MATTEO MUCCIOLI

This model requires cutting several pieces to join them together, but has the advantage that the structure is very easy to fold because the adhesive tape works as hinges.

It also has a front reflector in a separate piece that can be adjusted to try to reflect as much as possible of the whole pot.



More designs by Matteo Muccioli on www.youtube.com/@MatteoMuccioliStudioMUMAlab
Pictures from www.youtube.com/@solcocinero

LAST TIPS

- ② Only apply glue on the matt side of the aluminium. The shiny side is preserved to capture and concentrate the sunlight. If you want a better result, use double sided tape, and a little of glue vertical lines (not spread).
- ② To make the folds in the cardboards, use a small piece of metal, like a metal scalimeter.
- ② A peg or a metal binder clip may be needed to keep together some pieces.
- ② Align your solar cooker with the sun
- ② On windy days, you can use a thick thread to maintain the stability of the open solar cooker models.
- ② The oven safe glass casserole creates a greenhouse effect that increase the efficiency. Remember to use its lid.
- ② If this is your first attempt at solar cooking, start with something easy like chicken, rice, courgette or quick bread like banana bread. Baking apples and potatoes is also easy, but don't wrap them in foil; just put them in a dark, covered pot without adding water.
- ② The biggest advantage of solar cooking is the flexibility in cooking times. You can remove the food at any time after it is done.
- ② Choose a black or dark colour pot to raise the temperature. Most foods, with the exception of cookies and open-faced cheese sandwiches, are cooked in containers with the lids on.
- ② Some solar chefs use a rack instead of an oven safe glass pan, if the recipe does not need to reach the top temperature.
- ② Use potholders when removing lids or pots.

NEXT STEPS

Food contests, energy efficiency contests, spread the word activities...

LINKS AND EXTERNAL RESOURCES

Detailed instructions and tips on

https://www.academia.edu/33131232/Solar_Cookers_Poor_Comunitys_Parts1_2_3b

More designs by Matteo Muccioli on

www.youtube.com/@MatteoMuccioliStudioMUMAlab (English and Italian)

www.youtube.com/@solcocinero (Spanish)

INSIGHTS, COMMENTS, REFLECTIONS

Throughout the event, participants gained practical knowledge regarding solar cooking technology and were encouraged to reflect on the positive impact that sustainable practices can have on the environment and local communities.

PREVIOUS EXPERIENCE

Cátedra de Energias Renováveis, Universidade de Évora, Portugal. AURORA Project.

This guide is an educational resource created by



This work is funded by the European Union's Horizon 2020 research and innovation program under grant agreement no. 101036418.

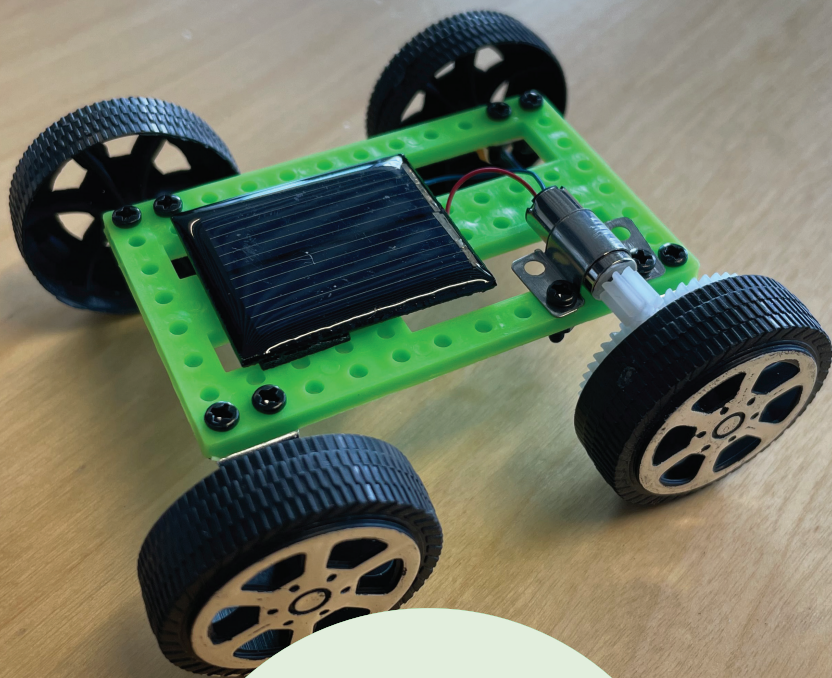
Idea

Cátedra Energias Renováveis, Universidade de Évora

Text and Design

Alejandra Remacha-Delgado, Universidad Politécnica de Madrid

Diogo Alexandre, Universidade de Évora



SOLAR DRIVEN CAR RACE

GOALS

To introduce the basics of solar energy to youth, as a family activity.

LEVEL OF COMPLEXITY - LOW

Every solar toy car kit should come with instructions.

BUDGET - LOW/MEDIUM

The price range for a regular solar toy car kit is between 4€ and 20€.

SPACE

A science museum is an extraordinary location for this kind of activity, however, it can take place in educational institutions and leisure centres as well. The activity can take place either indoors or outdoors, but for the assembly part it is preferable to have a well illuminated and covered space.

TIMING

In 3 hours the guide can receive and help different children or groups of children.

WEATHER

Ideally, this activity should be done on a sunny day to ensure the cars work.

HOW TO PROCEED WITH GROUPS OF PEOPLE

The guide's tasks consist of preparing a working area for the children, reading the instructions aloud and making sure the children understand them, and organising a race in a suitable place.

This activity is taught for children over 4 years old. Families are welcome to participate and help, but it is expected that the child will assemble the car by her/his own according to her/his abilities.

NUMBER OF PARTICIPANTS AND GUIDES

The number of participants is limited by how many toy car kits there are. For groups of more than ten children, it is recommended counting with another guide. Families are welcome to help if they wish to do so.

MATERIALS AND TOOLS

ASSEMBLAGE

- ② A number of solar toy car kits.
The idea is that each child will have a kit.
- ② Tables and chairs. Some of them need to fit children's sizes so that they feel comfortable for at least one hour while preparing the car.

RACE

- ② Masking tape or chalk to delimit the track.

DESCRIPTION

Children and their families are invited to assemble a solar toy car and participate in a car race. This activity can be launched in the context of the special dates across the calendar devoted to research, science, uses of energy, and so on.

INSTRUCTIONS

1. Choose a solar toy car kit model, buy it and assemble it to make sure the instructions are correct and the design is functional.
Here is an example of a very simple solar toy car kit:
<https://www.aliexpress.com/item/100500433337102.html?>
2. Design the announcements and find the dissemination channels.
It is recommended to print out pictures of toy solar cars and hang them on the stand to show the children what the activity is all about. If the organisers have chosen a museum or other public institution, use their dissemination channels. Include:
 - i. Description of the activity.
 - ii. Date and time.
 - iii. Estimated duration.
 - iv. Location and capacity.
 - v. A mail account to allow participants to ask questions and contact the organisers.
3. Bring the posters and solar toy car kits and set up a stand to invite families with children to assemble the toy cars.
4. There is no need to wait to have a group of children to start. Read the instructions aloud and make sure the children understand them.
5. If there are at least three children, organise a race and let them play.

LAST TIPS

- ⌚ Contact people interested in and arrange a time.
- ⌚ Find and book a place to carry out the activity.
- ⌚ Bring and distribute the materials.
- ⌚ Show an example of the project finished and walk among participants offering assistance.

LINKS AND EXTERNAL RESOURCES

Example of a very simple solar toy car kit:

<https://www.aliexpress.com/item/100500433337102.html>

INSIGHTS, COMMENTS, REFLECTIONS

- ⌚ There is the option of purchasing more than one model in order to have simpler and more complex cars to ride in order to adapt the activity to the age and ability of the participants.
- ⌚ Make sure the instructions are written in a language the guide can understand. If not, consider buying another model or translating the instructions and printing them out for the activity.

PREVIOUS EXPERIENCE

Department of Mechanical and Production Engineering – Section of Fluids and Energy, Aarhus University, Denmark. AURORA project.

This guide is an educational resource created by



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Idea

Department of Mechanical and Production Engineering – Section of Fluids and Energy, Aarhus University, Denmark

Design

Diogo Alexandre, Universidade de Évora



SNAKES

FUN AND THRIFTY
DRAUGHT EXCLUDER
FROM SCRAPS

GOALS

Making a weatherstrip from waste materials to stop the cold air under doors and through windows.

LEVEL OF COMPLEXITY - LOW

BUDGET - LOW

SPACE

A comfortable space for working together, airy and illuminated, supplied with tables and chairs.

TIMING - 2 HOURS

NUMBER OF PARTICIPANTS AND GUIDES

One guide for a group of 15 people is sufficient, but the right ratio really depends on the age and ability of the participants, so for children under the age of nine who have never sewn before, this activity can be challenging. For the same reason, older people with motor disabilities may have difficulties.

PREVIOUS EXPERIENCE

Forest of Dean District Council and Centre for Sustainable Energy, United Kingdom. AURORA project.

MATERIALS AND TOOLS

- ② Tape measure.
- ② Something soft and tubelike to make the body of the snake/dog, such as tights, socks or sleeves of a jumper.
- ② Stuffing
- ② Scissors and wool (or string)
- ② Needles of different sizes and yarns of different colours and thicknesses
- ② Things to make the snake's eyes, tongue, hairs, etc.

Organisers can ask participants to bring some waste material and decoration from home to personalize the work.

INSTRUCTIONS

1. Fill the tube with stuffing so it forms a sausage shape. Leave a bit unstuffed at the end. If your stuffing material is very light, add something with a bit of weight so that the draught doesn't blow it away.
2. Close up your sausage with wool or string. You could make this into a nose.
3. Use fabric, buttons, scraps, decorations to give your snake/dog/sausage a bit of character.

ATTENTION:

Never use a weatherstrip to block boiler flues, air bricks, or window trickle vents and avoid over draught-proofing windows in kitchens and bathrooms where the moist air needs to escape and where there is no mechanical ventilation like an extractor fan.

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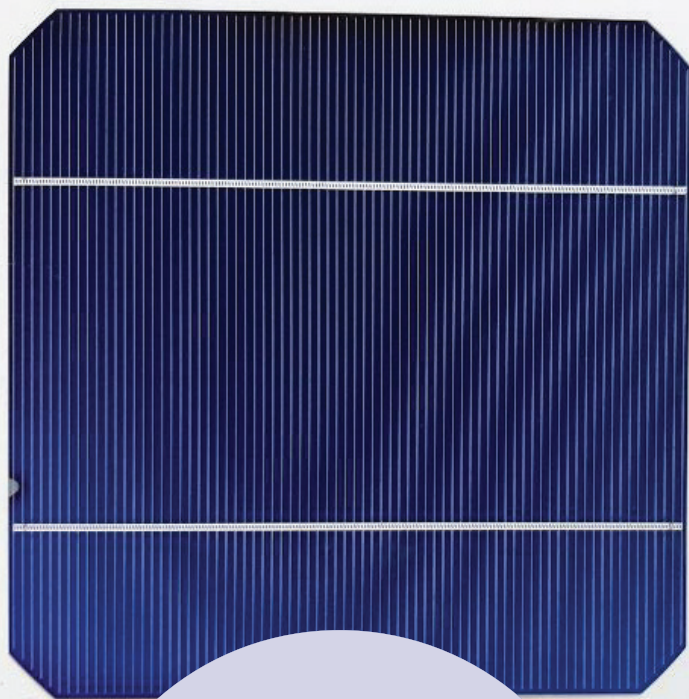
This work is funded by the European Union's Horizon 2020 research and innovation program under grant agreement no. 101036418.

Idea

Forest of Dean District Council and Centre for Sustainable Energy,
United Kingdom. AURORA project

Text and Design

Alejandra Remacha-Delgado, Universidad Politécnica de Madrid
Diogo Alexandre, Universidade de Évora



SOLDERING AND ASSEMBLING OF SOLAR CELLS

GOALS

To help participants understand how solar cells work and gain hands-on experience assembling their own solar panels using soldering.

LEVEL OF COMPLEXITY - MEDIUM

BUDGET - MEDIUM/HIGH

The price range for all the materials can be around 100€, but with shared tools/equipment it's about 30€ or 50€.

SPACE

The perfect space for this activity Lab room which has soldering stations.

TIMING

3 hours. In 3 hours the guide can receive and help different groups of high school students and above it. It is recommended that the participants would have basic knowledge of series and parallel circuits.

WEATHER

Ideally, this activity should be done on a sunny day so that participants can take the assembled solar cells outdoors to measure the voltage and current.

HOW TO PROCEED WITH GROUPS OF PEOPLE

People can form small groups of 2-3 on the soldering tasks, so that each participant can get hands-on experience. We do not recommend forming groups of more than 3 people.

NUMBER OF PARTICIPANTS AND GUIDES

The activity works best in smaller groups (5-10 people), so all participants get hands-on experience. If the group is big, participants can form smaller groups of 2-3 people per group. The number of participants is ultimately limited by the number of available soldering stations.

DESCRIPTION

This is an hands-on workshop developed by Marta Victoria and Zhe Zhang, part of the AURORA team in Aarhus University, for participants to understand the basics of solar cells, assemble their own solar panels by soldering the solar cells and measure their power production outdoors.

MATERIALS AND TOOLS

- ② Solar cells
- ② Thin tab wires
- ② Wide tab wires
- ② Flux pen
- ② Solder (tin)
- ② Red and black external wires
- ② Tape (e.g., masking tape or duct tape)
- ② Glass frame or alternative non-conductive flat surface
- ② Soldering station (set to 480 °C)
- ② Tweezers
- ② Pliers
- ② Precision drill (optional, for making holes in the frame)
- ② Yellow sponge and metal sponge (for cleaning the soldering tip)
- ② Ammeter (or multimeter used as ammeter)
- ② Voltmeter (or multimeter used as voltmeter)

OPTIONAL:

- ② Wiring terminal
- ② Resistor box
- ② Irradiance sensor
- ② Spectroradiometer (Broadcom Qmini)
- ② Optical fiber with cosine corrector
- ② Computer with Spectrometer Application Software (WAVES)

INSTRUCTIONS

1. Prepare Your Materials

Gather solar cells, tab wires (thin and wide), flux pen, solder, tape, tweezers, pliers, glass or other mounting surface.

2. Plan the Layout

Draw the connection layout. Cells will be connected in series (front of one to the back of the next). Keep at least 5 mm between cells.

3. Measure and Cut Thin Tab Wires

Cut thin tab wires long enough to connect the front of one cell to the back of the next. Use extra length for external connections.

4. Apply Flux

Use the flux pen to clean both:

- ⌚ The tab wires
- ⌚ The bus bars (metal strips) on the solar cells

5. Solder Tab Wires to the Front of the Cells

- ⌚ Heat the soldering station to 480°C
- ⌚ Use tweezers to hold tab wire in place
- ⌚ Slowly solder the wire onto the front grid of each cell

6. Connect the Back Side of the Cells

- ⌚ Align two cells with a small gap (3–5 mm)
- ⌚ Use tape to hold them in place
- ⌚ Solder the wires from the front of one cell to the back of the next

7. Repeat for All Cells

Solder all cells in a series chain using thin tab wires. Use wide tab wires for the final external connection points.

8. Fix Cells to the Mounting Surface

- ⌚ Use tape to attach the cells to a glass frame or other non-conductive flat surface
- ⌚ Be careful not to break the cells – they are fragile

9. Make the External Connections

- ⌚ Solder red (positive) and black (negative) wires to the ends of the wide tab wires
- ⌚ Optional: Drill a hole in the frame to run the wires through or bend tab wires around the frame.

LINKS AND EXTERNAL RESOURCES

Here you can find all the information:

<https://zenodo.org/records/15083659>

INSIGHTS, COMMENTS, REFLECTIONS

- ⌚ Even though soldering experience is not required for this activity, it works better if the participants have some knowledge on how soldering works and the safety rules about using soldering stations.
- ⌚ Participants need to have a basic understanding of series and parallel circuits.

PREVIOUS EXPERIENCE

Department of Mechanical and Production Engineering – Section of Fluids and Energy, Aarhus University, Denmark. AURORA project.

This guide is an educational resource created by



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Idea

Department of Mechanical and Production Engineering – Section of Fluids and Energy, Aarhus University, Denmark. AURORA project.

Design

Diogo Alexandre, Universidade de Évora



CHARGE YOUR
PHONE WHILE RIDING
YOUR BIKE

GOALS

- ② Learn the basics of an AC/DC energy converter
- ② Use “free” energy for charging the phone or tablet while riding a bike

LEVEL OF COMPLEXITY - LOW/MED

BUDGET

Aprox. 12,5 €/charger (tools not included, dynamo included)

SPACE

An open space with big tables where there is a lot of transit of students

TIMING

The activity lasts around 3h

OTHER REQUIREMENTS

This activity is a lot of fun for the participants because they use manual tools like a welder and a drill, many of them for the first time. However, this also makes the activity suitable only for small groups, as a lot of supervision is needed.

HOW TO PROCEED WITH GROUPS OF PEOPLE

As a hands-on workshop for university students, the activity offers a practical introduction to sustainable energy conversion and DIY electronics.

Ideally, organizers should collaborate with engineering departments or makerspaces to ensure technical guidance. The first step is to invite professors or researchers specializing in renewable energy systems to provide a short theoretical introduction.

This activity is best conducted in open-air spaces, where passersby can observe and engage. To emphasize sustainability, include a discussion on “free energy” applications. Given the use of tools (welder, drill, soldering), keep groups small and assign trained supervisors to ensure safety.

NUMBER OF PARTICIPANTS AND GUIDES

Groups of 4/6 adults (mainly university students)

DESCRIPTION

The participants make an electric charger for USB devices (phones, tablets...) that uses the energy generated while riding a bike with a dynamo.

MATERIALS AND TOOLS

- ⌚ Panel with board featuring positioning lines and holes for the cables
- ⌚ 9 cells
- ⌚ 18 intercell connectors with pre-applied solder
- ⌚ 4 busbars cut to the appropriate length
- ⌚ DC/DC converter with soldered input cables + protective casing
- ⌚ Fixture for holding and positioning the cells for soldering
- ⌚ Soldering iron
- ⌚ Solder + flux
- ⌚ Multimeter + probes
- ⌚ Lamp
- ⌚ Gloves
- ⌚ Pencils and tweezers for holding the cells after soldering
- ⌚ Cables with alligator clips
- ⌚ Electric grinder with stand
- ⌚ Silicone with gun (common material)
- ⌚ 1 small perforated PCB
- ⌚ 1 dynamo 12 VAC / 5.5W
- ⌚ 1 full-wave bridge rectifier 1000V / 2^a
- ⌚ 1 electrolytic capacitor 2200 μ F / 35V
- ⌚ 1 DC-DC voltage reducer with USB output
- ⌚ Wire for making electrical connections
- ⌚ 1 small plastic box

INSTRUCTIONS

1. Connect the 12V/5.5W output of the dynamo with wires to the positive input of the bridge rectifier, and connect the dynamo's ground (any metallic point on its structure) to the negative input of the bridge rectifier.
2. Solder the electrolytic capacitor to the output of the bridge rectifier and to the input of the DC-DC step-down converter.
3. Make a small hole in the plastic box to allow the USB port of the converter to fit through.
4. Arrange everything so it fits inside the plastic box and apply hot glue with a glue gun to secure the DC-DC converter in a fixed position.
5. Use heat-shrink tubing on the wires to make everything more compact, and adjust the length of the cables to fit the size of your bicycle.
6. Mount the dynamo to your bicycle wheel and start enjoying your USB charger.

DESCRIPTION OF THE DEVICE

A device will be created from scratch that is capable of charging the battery of any electronic device using the alternating current generated by a dynamo. After passing through several intermediate stages, the circuit will finally produce a stable 5V direct current output, just like any USB port provides.

IMPORTANT INFORMATION

Alternating current (AC) and voltage are so named because they constantly alternate their polarity—meaning the positive and negative poles switch back and forth (as is the case with household power outlets). Since the vast majority of electronic devices use direct current (DC) rather than AC, they employ transformers to convert AC into DC. This process is called rectification, which means converting alternating current into direct current.

The voltage output from the dynamo is a sinusoidal signal with a 12V amplitude and a frequency that depends on the rotational speed. This signal is passed through a full-wave rectifier bridge—a circuit made up of 4 diodes arranged in such a way that it provides two different paths for positive and negative current, depending on the polarity of the signal (since a sinusoidal signal has both positive and negative amplitudes). This circuit ensures that the current, which alternated polarity before passing through it, has only a positive polarity at the output.

The issue with the signal coming out of the rectifier bridge is that it still has voltage drops. This is resolved by adding a capacitor to the circuit. The capacitor acts as a reservoir of electric charge, meaning it charges fully and then discharges, releasing the stored electrical energy to counteract those voltage drops, thereby achieving a much more stable DC voltage.

Finally, after the filtering stage, the DC voltage is passed through a final stage called a DC-DC buck converter. This converter is an electronic device whose function is to reduce the voltage at its input and provide a lower, stable voltage at its output, regardless of the current demand. These types of circuits are especially useful when a regulated and stable output voltage is required from a higher input voltage. In our case, the circuit ends in a USB port that provides a stable 5V output to directly connect any charger.

NEXT STEPS

- ② Ask for feedback (pictures, commentaries...) from the students after using the charger. From experience, we believe that sending feedback should be a condition for qualification (otherwise, most students do not collaborate).
- ② The ideal would be that the same students participated in the “Build your own PV module” activity, so that they could use both the dynamo or the PV module for powering the charger.

LINKS AND EXTERNAL RESOURCES

You can find more information here:

https://www.youtube.com/watch?v=ZMmP0_Qik6s (English)

INSIGHTS, COMMENTS, REFLECTIONS

The project provides a concrete application of concepts such as rectification, filtering, and voltage regulation.

PREVIOUS EXPERIENCE

Universidad Politecnica de Madrid. AURORA Project.

This guide is an educational resource created by




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Idea

Universidad Politecnica de Madrid. AURORA Project

Design

Diogo Alexandre, Universidade de Évora



The background of the top half of the image is a whiteboard covered with several colorful sticky notes in shades of yellow, orange, and pink. Some of the visible text on the notes includes "To go", "Eldge", "YOU NEED", "SHOUT OUTS", and "Share it with your friends!".

CARBON SEQUESTRATION GAME

GOALS

Learn to pay more attention to energy efficiency aspects of the daily life

LEVEL OF COMPLEXITY - LOW

SPACE & TIMING

- ⌚ Any location is possible
- ⌚ As much time as you need, 1h/2h it's enough

MATERIALS AND TOOLS

- ⌚ Cellphone with camera
- ⌚ Post-its
- ⌚ Board/placard

HOW TO PROCEED WITH GROUPS OF PEOPLE

As a hands-on activity for university students, the activity offers a practical introduction to sustainable energy conversion.

NUMBER OF PARTICIPANTS AND GUIDES

Groups of adults (mainly university students)

DESCRIPTION

The activity consists of pictures taken by the participants with their own cell phones of situations that relate to energy efficiency in a positive or negative way.

INSTRUCTIONS

1. The activity begins with a board where participants can post ideas on how to improve the sustainability of the place where the activity (e.g., city, building, etc.) is taking place.
2. After that, all participants are invited to walk around the area and take pictures of situations related to energy efficiency — both positive (e.g., public bike chargers) and negative (e.g., an open window while the heater is on).

INSIGHTS, COMMENTS, REFLECTIONS

A wide diffusion of the main results obtained from the activity could help changing some habits in the campus.

PREVIOUS EXPERIENCE

Universidad Politecnica de Madrid. AURORA Project

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This work is funded by the European Union's Horizon 2020 research and innovation program under grant agreement no. 101036418.

Idea

Universidad Politecnica de Madrid. AURORA Project

Design

Diogo Alexandre, Universidade de Évora



MAKE YOUR OWN PV MODULE

GOALS

Learn how a PV module works by manufacturing one from zero

LEVEL OF COMPLEXITY - LOW/MED

BUDGET

Approx. 50 €/module (tools not included)

SPACE

An open space with big tables where there is a lot of transit of students

TIMING

Two sessions of 2.5h each

OTHER REQUIREMENTS

This activity is a lot of fun for the participants because they use manual tools like a welder and a drill, many of them for the first time. However, this also makes the activity suitable only for small groups, as a lot of supervision is needed.

DESCRIPTION

The activity consists in making a small PhotoVoltaic module from zero and keep it for powering small devices

HOW TO PROCEED WITH GROUPS OF PEOPLE

Students can be divided into 2-3 people groups. The assembling of the solar cells is almost impossible for only one person, so it is recommended that at least two people work on the same PV module.

NUMBER OF PARTICIPANTS AND GUIDES

Groups of adults (mainly university students)

MATERIALS AND TOOLS

- ⌚ All the materials that compose a PV module (PV cell, frame, wires...) and the tools for its construction (welder, drill...)
- ⌚ DC-DC Buck/Boost Converter (based on the XL6009)
- ⌚ 3D-printed case (to house the converter)
- ⌚ Cables (for connection to the solar panel)
- ⌚ Double-sided tape or glue (for securing the converter)

The solar cells are extremely fragile, usually several of them are broken during the manufacturing process. It is recommended to buy extra units.

INSIGHTS, COMMENTS, REFLECTIONS

This activity is a lot of fun for the participants because they use manual tools like a welder and a drill, many of them for the first time. However, this also makes the activity suitable only for small groups, as a lot of supervision is needed. The cost of the materials is high if compared to other activities.

PREVIOUS EXPERIENCE

Universidad Politecnica de Madrid. AURORA Project

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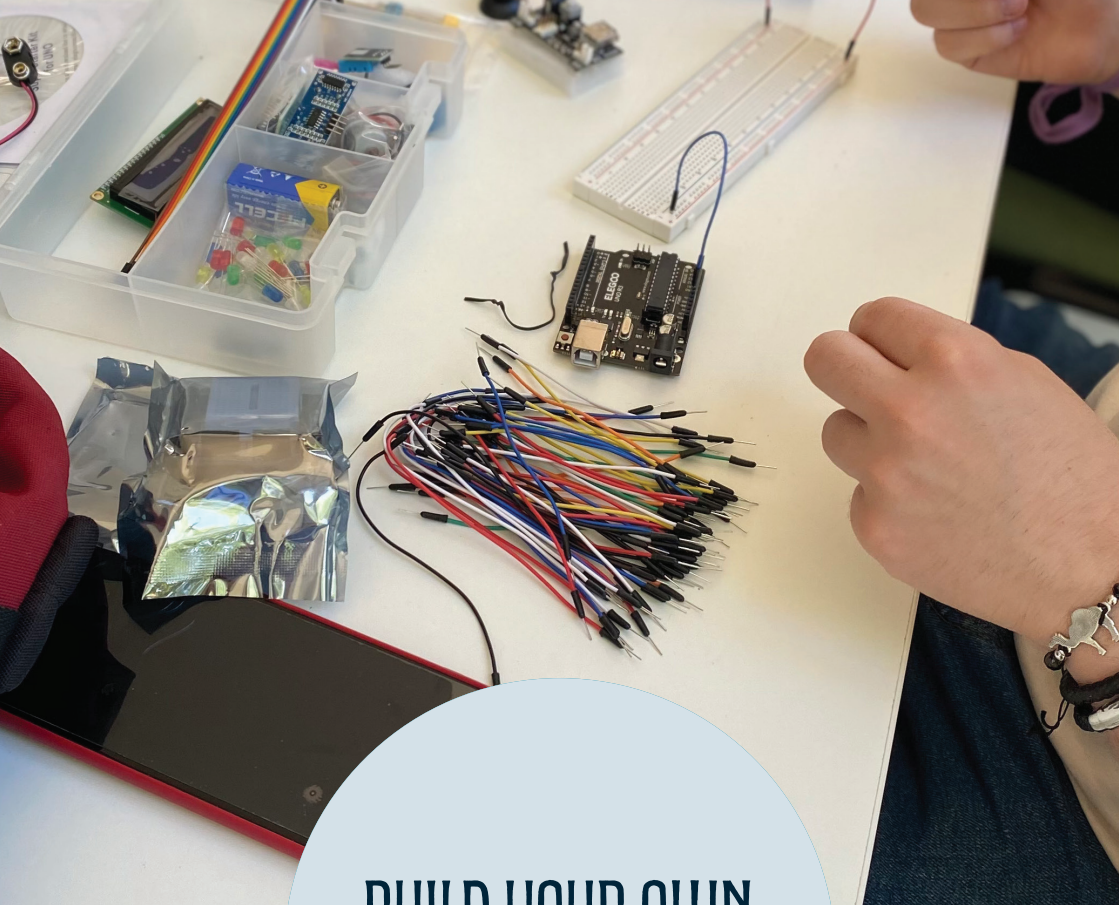
This work is funded by the European Union's Horizon 2020 research and innovation program under grant agreement no. 101036418.

Idea

Universidad Politecnica de Madrid. AURORA Project

Design

Diogo Alexandre, Universidade de Évora



BUILD YOUR OWN ENERGY SENSOR

GOALS

- ⌚ Develop a non-invasive energy monitoring device.
- ⌚ Enable real-time tracking of electricity usage.
- ⌚ Facilitate data visualization and analysis through integration with smart home platforms

LEVEL OF COMPLEXITY - MED

Requires basic knowledge of electronics and microcontroller programming

BUDGET

Approximately €20–€30, depending on component sources and availability.

SPACE & TIMING

- ⌚ A standard workspace with a table, access to power outlets and internet connectivity.
- ⌚ Estimated 4–6 hours for assembly and testing. It can be divided in two sessions

DESCRIPTION

This project involves constructing a DIY energy sensor using an ESP32 microcontroller and a current transformer (CT) sensor. The sensor measures real-time electricity consumption and transmits the data via Wi-Fi to platforms like Home Assistant for monitoring and analysis.

HOW TO PROCEED WITH GROUPS OF PEOPLE

- ② Divide participants into small teams.
- ② Assign specific roles: hardware assembly, software programming, testing, and documentation.
- ② Encourage collaboration and knowledge sharing among teams.

NUMBER OF PARTICIPANTS AND GUIDES

- ② Basic understanding of electrical safety.
- ② Familiarity with Arduino programming.
- ② Access to a Wi-Fi network for data transmission.

MATERIALS AND TOOLS

- ② ESP32 microcontroller
- ② CT sensor (e.g., YHDC SCT-013-030)
- ② Breadboard for prototyping board
- ② Resistors and capacitors as per circuit requirements
- ② Jumper wires
- ② USB cable for programming
- ② Soldering iron and solder (if opting for a permanent setup)
- ② Computer with Arduino IDE installed

OTHER REQUIREMENTS

- ⌚ Basic understanding of electrical safety.
- ⌚ Familiarity with Arduino programming.
- ⌚ Access to a Wi-Fi network for data transmission.

INSTRUCTIONS

1. Assemble the circuit by connecting the CT sensor to the ESP32 via the breadboard.
2. Program the ESP32 using the Arduino IDE with appropriate libraries to read sensor data.
3. Establish Wi-Fi connectivity for the ESP32 to transmit data.
4. Integrate the device with a platform like Home Assistant for data visualization.
5. Test the setup by monitoring the energy consumption of various appliances.

TIPS

- ⌚ Ensure the CT sensor is clamped around only one conductor (live or neutral) and not both.
- ⌚ Calibrate the sensor readings to match actual energy consumption values.
- ⌚ Implement safety measures to prevent electrical hazards during installation.

NEXT STEPS

- ② Enhance the device with additional sensors (e.g., voltage sensors) for more comprehensive monitoring.
- ② Develop a custom enclosure for the hardware to ensure durability and safety.
- ② Explore integration with other smart home systems or cloud platforms for advanced analytics

LINKS AND EXTERNAL RESOURCES

<https://www.youtube.com/watch?v=KQTjjz1AwQg>

PREVIOUS EXPERIENCE

Universidad Politecnica de Madrid. AURORA Project.

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Idea

Universidad Politecnica de Madrid. AURORA Project

Design

Diogo Alexandre, Universidade de Évora



LOW-COST ELECTRONICS WORKSHOP WITH ESP32

GOALS

- 🕒 Develop basic skills in electronics and programming
- 🕒 Build simple projects using the ESP32 microcontroller
- 🕒 Learn and apply PWM (Pulse Width Modulation), temperature, humidity, and light sensors
- 🕒 Raise awareness of energy efficiency and sustainable practices
- 🕒 Explore real-time monitoring with Arduino Cloud

LEVEL OF COMPLEXITY - MED

Requires basic knowledge of electronics and microcontroller programming

BUDGET - LOW

Main cost is for the electronics kit (€20–€25 per participant)

SPACE

A computer lab or workshop space with desks for circuit assembly, natural lighting, and access to power outlets

TIMING

Recommended 2–3 hours per session

DESCRIPTION

The workshop introduces participants to basic electronics and programming using the ESP32 microcontroller. It enables them to build circuits, write code in Arduino IDE, and implement practical projects involving environmental sensors and IoT concepts.

HOW TO PROCEED WITH GROUPS OF PEOPLE

- ⌚ Students: Use as a hands-on introduction to IoT and energy sustainability.
- ⌚ Young Adults: Encourages logical thinking and tech interest.
- ⌚ Seniors: Can be simplified and supported with extra guidance and supervision.

NUMBER OF PARTICIPANTS AND GUIDES

Maximum 15 participants per session. 1/2 instructor.

MATERIALS AND TOOLS

Electronics Kit, including:

- ⌚ 1 x ESP32 microcontroller
- ⌚ Breadboard, USB cable, jumper wires
- ⌚ Sensors: DHT11, LDR, SCT-013 (current sensor)
- ⌚ LEDs (red, green, yellow, white, RGB)
- ⌚ Resistors, push button, capacitor, potentiometer
- ⌚ Computer with Arduino IDE installed

OTHER REQUIREMENTS

- ⌚ Internet access (for Arduino Cloud)
- ⌚ Well-lit space, especially for light sensor exercises

DESCRIPTION OF THE DEVICE

- ⌚ - The ESP32 is a versatile microcontroller with Wi-Fi/Bluetooth, ideal for IoT projects. Activities help participants understand core concepts of digital communication, sensors, and sustainability through practical implementation.

INSTRUCTIONS

1. Install Arduino IDE and ESP32 drivers
2. Connect the ESP32 board via USB
3. Run example codes: “Hello World” via Serial Monitor
4. LED control with PWM
5. Sensor readings: temperature, humidity, light
6. Weather station via Arduino Cloud
7. Upload code and monitor output
8. Observe and analyze data

GENERAL GUIDELINES

- ⌚ Double-check polarity and connections
- ⌚ Use proper resistors for LED protection
- ⌚ Avoid short circuits; handle components gently
- ⌚ Use Serial Monitor or Cloud for real-time readings

LAST TIPS

- ⌚ Always include `Serial.begin(9600)` in setup
- ⌚ Allow delays for sensor stabilization
- ⌚ Document progress with photos and screenshots
- ⌚ Encourage participants to modify code and experiment

NEXT STEPS

- 🔗 Enhance the device with additional sensors (e.g., voltage sensors) for more comprehensive monitoring.
- 🔗 Develop a custom enclosure for the hardware to ensure durability and safety.
- 🔗 Explore integration with other smart home systems or cloud platforms for advanced analytics

LINKS AND EXTERNAL RESOURCES

- 🔗 Workshop ESP32 Presentacion, codes and guide
- 🔗 Arduino IDE
- 🔗 Arduino Cloud
- 🔗 ESP32 Project Resources

INSIGHTS, COMMENTS, REFLECTIONS

This workshop provided an engaging learning environment where participants explored the potential role of technology in sustainability. It fostered understanding of smart devices and their potential impact on energy-conscious living.

PREVIOUS EXPERIENCE

Cátedra de Energias Renováveis, Universidade de Évora, Portugal -
AURORA Project

This guide is an educational resource created by



This work is funded by the European Union's Horizon 2020 research and innovation program under grant agreement no. 101036418.

Idea

Cátedra de Energias Renováveis, Universidade de Évora, Portugal
AURORA Project

Design

Diogo Alexandre, Universidade de Évora



SOLAR BUGS

DESCRIPTION

Workshop for children to build a solar bug (4 to 9 years old)

GOALS

- ⌚ To introduce the notion that electrical energy can be produced from light power
- ⌚ To get familiar with solar cells and manipulate them
- ⌚ To visualize electrical circuits and self-powered devices
- ⌚ To boost creativity through the personal design of toys

BUDGET - LOW

4-5 euros per bug total (including 2 euros per solar cell; cost of soldering irons and solar bug arena not included)

SPACE

You need a working surface (i.e. table) where you can comfortably lay out your materials and a space where an accompanying adult can safely solder wires. Access to outdoor space is ideal to see the solar bugs move.

If it is not possible to play with the solar bugs outdoors, prepare a “solar bug arena” with strong lamps and a black surface to avoid reflexions when the kids are playing.

TIMING

Build the solar bug in the morning or early afternoon so that you can play with it in sunny hours.

DESCRIPTION OF THE DEVICE

A solar bug is a toy that vibrates when the sunlight reaches it. The vibration on the wire that allocates the motor makes the bug move on the floor.

GENERAL GUIDELINES

- ② The bugs require quite strong illumination to move. In the central day hours of a sunny day, the Sun provides much more power density than most available lamps.
- ② If outdoor playing is not an option, build beforehand a well illuminated solar bug arena. Do not attempt to use flashlights because they will most likely not provide enough power and it's difficult to follow all bugs as they move.
- ② The bug structure can be as simple as a cardboard rectangle, but ideally it will have a position for the motor wire and another one for the head, as in the example provided here.

LAST TIPS

- ② When gluing the motor to the stiff wire, it's important to ensure the connection is as rigid as possible. If the wire is too flexible, it will absorb the motor's vibrations, and the bug's movement will be significantly reduced.
- ② Organize the groups so that children are working on different steps at the same time. For example, some groups can prepare their decorations before completing steps 1 and 2. This will help prevent everyone from needing the soldering station at once.

HOW TO PROCEED WITH GROUPS OF PEOPLE

For the youngest children, this may be one of their first encounters with the concept of solar energy. A brief, interactive introduction in the form of a dialogue can therefore be especially enriching and engaging.

SAFETY

Children must be clearly informed that the soldering station is a hazardous area, and they should approach it in an orderly and supervised manner when they need their bug to be soldered. Caution is also required when using scissors and glue. It is advisable to consult with families beforehand to determine whether any children need direct supervision when handling these tools. The size of the groups will depend on this factor.

If using a solar bug arena, the children should not look at the lamps directly and strong reflections should be avoided.

NUMBER OF PARTICIPANTS AND GUIDES

- ② 1 volunteer per 5 children
- ② 1 extra volunteer per 20 children to work with the soldering iron
- ② Guides are not required as the activity is designed to work with small children

MATERIALS AND TOOLS

- ⌚ Small solar cell (approximately 5x5 cm)
- ⌚ Small vibrating motor (i.e. the ones used in mobile phones)
- ⌚ 1 Soldering iron per 20 children
- ⌚ Soldering wire
- ⌚ Wire strippers
- ⌚ Thin colored insulated wires and pin connectors
- ⌚ Double-sided tape
- ⌚ Stiff wire
- ⌚ 3D printed structure (or hard cardboard if 3D printing not available)

FOR THE DECORATION:

- ⌚ Children safe scissors
- ⌚ Children safe glue
- ⌚ Cardstock in different colors
- ⌚ Adhesive plastic googly eyes (the kind with a black pupil that moves)
- ⌚ Pipe cleaners
- ⌚ Markers

It is recommended to 3D-print a simple bug structure beforehand.

INSTRUCTIONS

1. Cut four wires in a length of approximately 3 cm and strip the ends.
2. Bring the wires to the soldering station for connection. Two wires should be soldered to the solar cell at one end and to connectors at the other. The remaining two wires are connected to the motor on one end and to connectors on the opposite end.
3. Cut a piece of stiff wire of approximately 3 cm and glue the motor to it.
4. Attach the solar cell on the bug structure (if possible, 3D printed; if not, made of hard cardboard) using double-sided tape. Attach the stiff wire with the motor perpendicularly to the bottom of the bug structure so that it touches the floor.
5. Connect the motor to the solar cell
6. Attach four legs to the bug using stiff wire and/or pipe cleaners
7. Decorate your bug, maybe adding a face, a tail, antennae, wings, etc.

LINKS AND EXTERNAL RESOURCES

Details on the 3D printing structure (gcode file and image file), photos of solar bugs and an example of solar bug arena on:

<https://doi.org/10.5281/zenodo.15535050>

INSIGHTS, COMMENTS, REFLECTIONS

The workshop fosters creativity by combining guided technical instructions with opportunities for children to make their own decisions during the creative, hands-on elements..

PREVIOUS EXPERIENCE

Universidad Politécnica de Madrid. AURORA Project

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Idea

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