# Open-sourcing a makerspace community

## A small wind turbine workshop at Kopli 93


BY THE **FAB CITY FOUNDATION**

Distributed Design

Co-funded by the European Union

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# Credits

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# Why open-sourcing a makerspace community?

Learning about makerspace communities in places that never had one is a challenging task. The closest makerspaces might be too far away to visit regularly. Moreover, the materials these communities post online provide little information on how to make it work [1]. It is hard to start a thriving makerspace community from scratch when you are on your own. That's the case of Tallinn, the capital city of Estonia.

Open source, with well-known cases such as Wikipedia or Linux, has proved how by making publicly accessible and reusable digital information, like code, anyone anywhere wanting to use or create a digital program is never starting from scratch. Like in the case of science, freely accessible knowledge accumulation provides a head start for newcomer scientists. This process is vital to avoiding repeating mistakes on something already figured out. Open, collaborative practices provide a jumpstart platform for everyone, so we do not have to reinvent the wheel.

Open source has proved to work well in digital environments [2]: Linux provides access to code that is only digital, and Wikipedia would never be possible if carried out in traditional paper and ink formats. A step beyond digitality, open-source hardware presents new challenges for providing such jumpstart platforms: the hardware has to be documented, and the process of building it has to be correctly described. [3] This requires non-digital actions in the material world. It requires inventing and digitizing material processes.

Makerspaces are more complex to digitise than hardware: they work not because of technical or mechanical processes. What makes a makerspace function is its community [4]. It is not clear, though, how to document a makerspace community. We know that 'open-source' doesn't have to be a yes/no category. Some authors are talking about 'open design' or 'open source product development' in the context of hardware as a gradual process of opening what it may not open by default. [5] It may take years and several iterations for a piece of hardware to be considered 'open source hardware'. Open design would be a way of making a material object replicable and modifiable by anyone by generating digitised documentation that allows understanding of the working and production of the material object.

We want to introduce the concept of 'open-sourcing' as the gradual process of documenting and making publicly available the inner workings of organizations, from governance models to conflict solving, or distribution of resources and responsibilities, along the lines observed and described in open-source software and hardware.

Some aspects of how a community operates a makerspace are more 'technical' or easy to capture than others. For instance, producing (open source) hardware in a makerspace involves following specific protocols often related to measurable actions. Our starting point is a workshop to build a piece of technology in a makerspace because open-source hardware is well documented and its production replicable in isolation.

Open-source hardware can be a jumpstart platform sustaining the tentative process of open-sourcing a makerspace community. In other words: an easy path to start open-sourcing a makerspace community begins with an open-source hardware project. In this context, we conceive 'open-sourcing' as infused by participatory action research methodologies [6], which we understand as 'communities that evolve by researching themselves'.

What we describe in the following pages is a case of Distributed Design, involving a community of makers and a makerspace. There are open-source materials of technology (a book, actually copyrighted) from their designers. 'Open-sourcing' in this case refers to everything that happens during the workshop: from bringing in a qualified workshop instructor, mobilising local stakeholders, finding the resources for the workshop, organising the activities, or involving the media, to understanding and communicating the value that has been produced and how to replicate it —and scale it.

Our goal is to showcase how a recently opened makerspace in Estonia is developing its community while trying to address an urgent national need, all during its first 'big' event: a workshop building a small wind turbine. Our focus is on something other than the technology or the workshop, as it has been adequately documented elsewhere. Instead, we would like to shed some light on the exciting and erratic process of a makerspace community 'under construction' organizing a four-day workshop with over 20 participants without the technical skills to build the machine or any experience organizing such events.

We aim to provide easily explained processes and activities supported by materials that inspire other emerging makerspace communities to understand themselves and take action. We refused to provide exhaustive technical or descriptive materials that only experts would use. This material is a tool to think, organise and take action together.

# The context

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# The context

## The local situation

Tallinn is the capital city of the small republic of Estonia, situated on the eastern side of the Baltic sea. The country adopted a u-turn direction in the 1990s, jumping' from the USSR to building a digital state from scratch [7]. Fully invested in the individual path to prosperity by increasing consumption capacities, Estonians have grown suspicious of any productive activity outside the markets during the last three decades, especially when involving communities or collaborative practices. As a result, the makerspace culture did not emerge here.

In the late summer of '22, the first community makerspace opened in an old cultural centre located in the northern district of Tallinn. The story of how this came to happen is not a typical one. It started with an EU project involving the local technical university (TalTech) and the municipality. The project aims to restore old urban industrial areas, and makerspaces are one of the primary mechanisms for articulating the restoration. So, the local partners in Tallinn had to create a makerspace first, using EU funding and city district resources. The community did not start at the makerspace. First, the local partners of the EU project started a community garden [8]. The makerspace community emerges from multiple partners with different interests, and it can be said to be a 'directed' process more than a natural one.

Also, Estonian is an 'energy poor' country, forced to import a significant amount of the energy it consumes. A historical client of Russian gas, Estonia, had tried to develop energy resilience by investing in the very contaminant shale oil found on the country's east side. Unfortunately, the EU considers shale oil a non-renewable resource unsuitable for the long term.

## War and energy crisis

The energy crisis caused by the war in Ukraine hit Estonia harder than other EU countries. Besides the increase in utility bill costs, all other products, especially food, are affected by high inflation. Inflation in Estonia reached a 2022 peak of 25% in August. This situation started a debate on how to get cheaper energy as the country cannot produce it.

Estonia also is one of the former USSR republics that Russia considers to somehow exist in what should be Russian territory. Of course, Estonians dutifully disagree, but they fully understand the risks involved after enduring many centuries of imperial 'occupations' (Russian, Prussian, Swedish...).

The war in Ukraine started on 24 February 2022. That's a holiday in Estonia. They celebrate the start of the First Estonian Republic (1918) and their independence from the newly founded Soviet Union. The coincidence of dates is generally accepted in Estonia as a clear message from their neighbours: 'you are next!'.

# The opportunity

After three decades of fully investing in a global free market model, Estonian society is starting to realize the perils of overdependency on the global markets for supplies. For Estonia, energy is the most critical of such supply dependence. In the middle of an energy crisis, without much energy alternatives to exploit in the country, and under the menace of a near-future military conflict, Estonians are reconsidering their chances of continuing to exist as a free and independent country.
How about (we intend to tell them) if you consider using the knowledge produced by a globally distributed network of designers and makers in a local network of makerspaces to produce what communities need? To start somewhere, let's say that within the first three months of the first community makerspace in the country, the knowledge of self-producing wind turbines for rural areas is transmitted to a group of Estonian pioneers. And what's more, let's say that such knowledge is replicable and scalable in a relatively short period of time. Then, would Estonians start to be interested in makerspaces and distributed design?
Could this country become a poster child for everyone to see the vast potential of applying distributed design on a national scale? Instead of designing from scratch, as too often happened in makerspaces producing protective gear during the Covid pandemic, starting from what others did, and adapt it to the local context.

We have three objectives:

1) telling how to hold a workshop or another significant event in a makerspace;
2) sharing our lessons learnt on how to create a community through such sort of events;
3) establishing a first draft towards a blueprint for communities open-sourcing know-how documentation.

# Our stakeholders

We involved nearly a dozen stakeholders in producing the Wind Turbine Workshop. As Kopli 93 makerspace opened only a few months before the workshop, this represented an exceptional occasion to activate our networks and generate a broader interest in our work. Generally, we can group our stakeholders in three geographical areas: Estonia, where most of the stakeholders are based; Greece, where the stakeholders that intermediated with the global wind turbine community, and our workshop provider, are based; the European and global networks supporting makerspaces, open energy technology, and new ways of connecting the local to the digital. But geographic boundaries are also permeable: as an example, the Fab City Foundation exists at all three levels coordinating a global network, having one of our Greek stakeholders as a founder, and being based in Estonia.

Our stakeholders represent multiple interwoven interests making the Wind Turbine Workshop a seed of something that could unlock positive feedback loops between them. The symbiotic relationship between public governmental and administrative bodies, research institutions, EU-level multi-country projects, research innovation agencies, community initiatives, and global networks, all looking into bringing new sustainable practices for local populations (referred, in this case, to energy empowerment), points out to new models of open, stable and dynamic 'public-private-community' collaborations. Broad informal consortiums that activate some of its members when needed, with access to varied resources. There is strength in such informal networks. We aim to replicate and expand this multistakeholder partnership model in the future.

| DDP WTW STAKEHOLDERS DATA GATHERING CATEGORIES | ROLE IN THE WORKSHOP | GOALS / MOTIVATION | RESOURCES PROVIDED | RESPONSIBILITIES |
|---|---|---|---|---|
| **KOPLI 93** | Host. | Organizing a project with local impact.<br>Bring activity to the makerspace. | Access to a makerspace.<br>A makerspace master.<br>Community Members probono work.<br>Participants recruiting process.<br>Media communication. | Hosting the workshop.<br>Providing workforce and learners.<br>Help coordinating the event. |
| **P2P LAB** | Initiator.<br>Intermediator. | Start energy discussion in Estonia.<br>Provide activity for makerspace.<br>Research pilot interest. | Underpinning ideas.<br>Open technology workshop experience.<br>Intermediate contact with the workshop provider. | Facilitating the contact with Wind Empowerment and Nea Guinea. |
| **WIND EMPOWERMENT** | IP & design provider. | Expanding their global network of energy communities. | Wind turbine design and manufacturing guide. | Providing quality resources for the workshop. |
| **NEA GUINEA** | Workshop provider. | Expanding EU network.<br>Delivering practical know-how. | A qualified instructor. | Workshop delivery. |
| **FAB CITY FOUNDATION** | Initiator.<br>Event producer.<br>Partner host. | Support like-minded initiatives.<br>Starting a local informal network. | Strategic vision.<br>Production and documentation.<br>One person part-time dedication.<br>Hosting the workshop instructor.<br>Hosting DDP. | Coordination of the stages prior to the workshop.<br>Coordinating the documentation of the workshop. |
| **DISTRIBUTED DESIGN PLATFORM**<br>(LOCAL PARTNER) | Event producer.<br>Workshop documentation. | Organize and promote DDP activities locally. | Covering instructor's travel costs.<br>Covering the workshop fee.<br>Provide meals for the participants.<br>Community member remuneration as cameraman. | Document and open-sourcing the workshop.<br>Create a high-quality deliverable. |
| **CENTRINNO**<br>(LOCAL PARTNER) | Event producer.<br>Workshop documentation. | Organize and promote CENTRINNO activities locally. | Tools and Materials.<br>Media communication, promotion and dissemination.<br>Workshop participation certificates. | Coordination of the stages prior to the workshop. |

| DDP WTW STAKEHOLDERS DATA GATHERING CATEGORIES | ROLE IN THE WORKSHOP | GOALS / MOTIVATION | RESOURCES PROVIDED | RESPONSIBILITIES |
|---|---|---|---|---|
| **TALTECH** | Partners host. | Supporting P2P Lab and Centrinno local partner interests. | Administrative support. Hosting Centrinno locally. | Facilitating production of the event. Procurement of materials and tools. |
| **NORTH-TALLINN CITY DISTRICT** | Supporting partner. | Supporting Centrinno and Kopli 93. | Administrative support. Centrinno partner. | Facilitating supply of tools & materials from North-Tallinn Vocational School. |
| **ESTONIAN ENVIRONMENTAL INVESTMENT CENTER** | Supporting partner. | Supporting Kopli 93. | Tools & machines procurement. Makerspace master's income. | Facilitating the presence of a Makerspace master during the workshop. |
| **WORKSHOP PARTICIPANTS** | Makers. Knowledge transfer vessels. | How-to hands-on learning & building of a small wind turbine. | Workforce. Practical skills. Avant garden role for new ideas. | Providing workforce. Knowledge dissemination after the workshop. |

# Kopli 93

### Role in the workshop

Host.

### Goals / Motivation

Organizing a project with local impact.
Bring activity to the makerspace.

### Resources provided

Access to a makerspace.
A makerspace master.
Community Members probono work.
Participants recruiting process.
Media communication.

### Responsibilities

Hosting the workshop.
Providing workforce and learners.
Help coordinating the event.

## About

Kopli 93 is a community centre dating from the 1930s and located in the Kopli Peninsula in Tallinn (Estonia). It is owned and managed by the North-Tallinn City District and Salme Cultural Centre.

The centre's activities include hosting an urban community garden, local beekeeping, and Estonia's first community-based makerspace. Kopli 93 is also responsible for organizing the Kopli Makers Festival, which brings together local makers and initiatives focused on local production, resilience and community self-sufficiency.

## Contact

FACEBOOK

YOUTUBE

INSTAGRAM

# P2P Lab

### Role in the workshop

Initiator.
Intermediator.

### Goals / Motivation

Start energy discussion in Estonia.
Provide activity for makerspace.
Research pilot interest.

### Resources provided

Underpinning ideas.
Open technology workshop experience.
Intermediate contact with the workshop provider.

### Responsibilities

Facilitating the contact with Wind Empowerment and Nea Guinea.

## About

The P2P Lab is an interdisciplinary research collective founded in 2013 and based in Ioannina (Greece). It is a spin-off of the Ragnar Nurkse Department of Innovation and Governance at TalTech (Tallinn) and the globally-oriented P2P Foundation.

It fosters the understanding and implementation of free and open-source technologies and peer-to-peer practices while also designing and executing projects using participatory and community-based methods and practices.

## Contact

WEBSITE

FACEBOOK

# Wind Empowerment

### Role in the workshop

IP & design provider.

### Goals / Motivation

Expanding their global network of energy communities.

### Resources provided

Wind turbine design and manufacturing guide.

### Responsibilities

Providing quality resources for the workshop.

## About

Wind Empowerment is a global network founded in 2011 at the World Social Forum in Dakar, Senegal. A diverse set of organizations, NGOs, social enterprises, universities, governmental institutions and hundreds of individual practitioners worldwide integrate the network.

It serves as a platform for knowledge exchange, conducting joint projects and interdisciplinary research to empower rural communities by manufacturing small wind turbines with local resources for sustainable rural electrification.

## Contact

WEBSITE

DISCORD

FACEBOOK

# Nea Guinea

### Role in the workshop

Workshop provider.

### Goals / Motivation

Expanding EU network.
Delivering practical know-how.

### Resources provided

A qualified instructor.

### Responsibilities

Workshop delivery.

## About

Nea Guinea is a Greek non-profit organization based on the outskirts of Athens and founded in 2009. It aims to the 'self-management of everyday life' regarding food, health, energy, shelter and clothing.

It runs projects developing alternative techniques and practices to increase Greece's human and community self-sufficiency and resilience to become less dependent on the goods and services of the global industrial market.

## Contact

WEBSITE

FACEBOOK

# Fab City Foundation

### Role in the workshop

Initiator.
Event producer.
Partner host.

### Goals / Motivation

Support like-minded initiatives.
Starting a local informal network.

### Resources provided

Strategic vision.
Production and documentation.
One person part-time dedication.
Hosting the workshop instructor.
Hosting DDP.

### Responsibilities

Coordination of the stages prior to the workshop.
Coordinating the documentation of the workshop.

## About

The Fab City Foundation is a non-profit organization established in 2020 in Estonia as a legal and organisational structure to support and coordinate the Fab City Global Initiative. Its founders are the Institute for Advanced Architecture of Catalonia (IAAC) from Spain, the Fab Foundation from the US, the P2P Lab from Greece, and Tomas Diez from Venezuela/Indonesia.

Fab City aims to develop a network of locally productive and globally connected self-sufficient cities. It has 49 cities, regions and countries..

## Contact

WEBSITE
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YOUTUBE

# Distributed Design Platform

Distributed Design

### Role in the workshop

Event producer.
Workshop documentation.

### Goals / Motivation

Organize and promote DDP activities locally.

### Resources provided

Covering instructor's travel costs.
Covering the workshop fee.
Provide meals for the participants.
Community member remuneration as cameraman.

### Responsibilities

Document and open-sourcing the workshop.
Create a high-quality deliverable.

## About

The Distributed Design Platform is a European network established in 2017 and co-funded by the Creative Europe program of the European Union. It brings together a diverse member base from cultural and creative institutions, including designers, cultural organisations, universities and makerspaces.

Emerging at the intersection of the Maker Movement and design sensibility, it provides a framework for designers, makers and creatives to innovate the design field towards more sustainable, open, inclusive and collaborative practices.

## Contact

WEBSITE
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YOUTUBE

# CENTRINNO

### Role in the workshop

Event producer.
Workshop documentation.

### Goals / Motivation

Organize and promote CENTRINNO activities locally.

### Resources provided

Tools and Materials.
Media communication, promotion and dissemination.
Workshop participation certificates.

### Responsibilities

Coordination of the stages prior to the workshop.

## About

CENTRINNO is a research project starting in 2020 and financed by the EU's research and innovation programme Horizon 2020. The project involves 9 European pilot cities: Amsterdam, Barcelona, Blönduós, Copenhagen, Geneva, Milan, Tallinn, Paris and Zagreb.

The project aims to develop and demonstrate strategies, approaches and solutions for regenerating historic industrial sites as creative, locally productive, and inclusive manufacturing hubs, also called Fab City Hubs.

## Contact

WEBSITE
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# TalTech

### Role in the workshop

Partners host.

### Goals / Motivation

Supporting P2P Lab and Centrinno local partner interests.

### Resources provided

Administrative support.
Hosting Centrinno locally.

### Responsibilities

Facilitating production of the event.
Procurement of materials and tools.

## About

TalTech, also known as Tallinn University of Technology, is a public research university founded in 1918 in Tallinn, Estonia. The only technical university in the country, it provides all higher education levels in engineering, information technology, economics, and maritime.

Its mission is to promote science, technology and innovation by being a leading provider of engineering education, ICT and economics in e-Estonia. It also aims to help develop the economy and industry of Estonia and the Baltic Sea region.

## Contact

WEBSITE
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# North-Tallinn City District

Tallinn

### Role in the workshop

Supporting partner.

### Goals / Motivation

Supporting Centrinno and Kopli 93.

### Resources provided

Administrative support. Centrinno partner.

### Responsibilities

Facilitating supply of tools & materials from North-Tallinn Vocational School.

## About

The North Tallinn City District is a unit within the territory and composition of Tallinn, formed by the Tallinn City Council and operating based on the District Statute established by it.

The Government of North Tallinn is responsible for social welfare labour and youth work, housing, waste management, spatial planning, culture and education, entrepreneurial support, data processing, and crisis management, among other areas of activity.

## Contact

WEBSITE

# Estonian Environmental Investment Center

KESKKONNAINVESTEERINGUTE KESKUS

### Role in the workshop

Supporting partner.

### Goals / Motivation

Supporting Kopli 93.

### Resources provided

Tools & machines procurement.
Makerspace master's income.

### Responsibilities

Facilitating the presence of a Makerspace master during the workshop.

## About

Founded in 2000, the Estonian Environmental Investment Center is Estonia's leading funder of environmental projects. Part of the Ministry of the Environment, it has supported more than 20,000 environmental projects with a total investment of more than 2 billion euros in grants.

It aims to reduce environmental nuisances, promote sustainable development, conserve and protect biodiversity, achieve a healthy environment and prevent and repair environmental damage.

## Contact

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YOUTUBE

# Workshop Participants

### Role in the workshop

Makers.
Knowledge transfer vessels.

### Goals / Motivation

How-to hands-on learning & building of a small wind turbine.

### Resources provided

Workforce.
Practical skills.
Avant garden role for new ideas.

### Responsibilities

Providing workforce.
Knowledge dissemination after the workshop.

## About

The workshop brought together 21 participants. Of these, many had skills and knowledge relevant to the workshop, and most had participated in similar projects and events. Moreover, most of them are part of the local community, coming from Tallinn and its surroundings.

They were the driving force behind the workshop, taking care of most of the turbine's fabrication work in collaboration with the instructor and the makerspace master. They are the first cohort of Estonian community-based small wind turbine manufacturers.

# Locally manufacturing, digitally organising

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# Getting an instructor involved

It was sometime in early September 2022. Surrounded by pines outside a Georgian restaurant near the technical university of Tallinn, two people sat talking about this and that. It was their first time together at the place. Eventually, they came up with the idea of organizing an open-source wind turbine workshop at Kopli 93 makerspace.

Who were they? Their names don't matter, but their roles and affiliations: they were wearing several different hats from some of our workshop stakeholders: TalTech, P2P Lab, CENTRINNO, Distributed Design Platform, and Fab City Foundation. Both were very interested in finding ways to activate the recently opened Kopli 93 makerspace that they had just visited early that week. They are the instigators of our story. So what did they do next?

One of them offered to act as a liaison with a greek organization connected to the global network of small wind turbine developers. That same day, he reached out by email to the person who they wanted to be the instructor for the workshop. Several more emails regarding all the technical and organizational questions followed the first. The wanted instructor was connected to one of our stakeholders, the P2P Lab, which facilitated the negotiations.

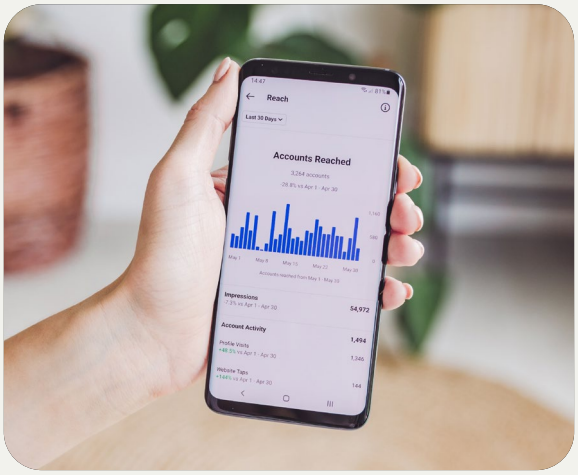
Despite a schedule conflict, that person agreed to come to Tallinn and be our workshop instructor. Part of the agreement was that a member of the workshop organizing team would host the workshop instructor at their place. That provided an opportunity for long, intensive conversations during the days the workshop instructor spent in Tallinn for the workshop. The workshop instructor was also familiar with and curious about what was happening in Estonia, especially regarding one

of the local stakeholders. Bounds were created between the workshop instructor and workshop organizers.

By the end of the workshop, Kostas (that's what the workshop instructor's called) was willing to come back for a second workshop if needed or to provide support via video call with his expertise. On the other hand, the workshop organizers and participants were grateful for having him as the wizard who appeared one snowy morning in November at Kopli 93 makerspace to help them all become something they could not become by themselves. Bounded by the experience, a new universe of opportunities was now open for Estonia after building the first small wind turbine in a makerspace in the country, accepting the challenge and opportunity that the local and global situation posed to them all.

# Channeling communication

Due to the need to work in a coordinated way, we created a Facebook group conversation for the team. We were two members of the Fab City Foundation, two of CENTRINNO and the master of the Makerspace. Through this group conversation, we carried out most of the coordination work related to obtaining the necessary materials and preparing the space for the workshop. Finally, the members of CENTRINNO were in charge of promoting the event, carrying out the open call and communication with the participants, using the Kopli 93 Facebook page, the group and email.




# Machines, tools and materials

Our workshop instructor, Kostas, emailed us a complete inventory of the machines, tools and materials needed to build our small wind turbine. He also enclosed the diagrams for the laser-cut components required. As this was our first time at Kopli 93 Makerspace doing a project of this scale, we started working as a team well in advance to get everything done on time. Two members of the CENTRINNO team, the Makerspace master and a member of the Fab City Foundation took on the job. We divide the work and distribute it among the team members to make it more comfortable and methodical.

The first task we carried out was to check the inventories that Kostas had sent us to determine what required machines, tools and materials we had in the makerspace. To do this, we went there and did a check-up together. The second task was to carry out one inventory in a spreadsheet with the machines, tools and materials we did have. We then emailed Kostas to ask if some of our machines and tools could replace others we needed. Once Kostas replied, we drew up one inventory of the machines, tools, and materials to be purchased. The local members of the team translated them into Estonian.

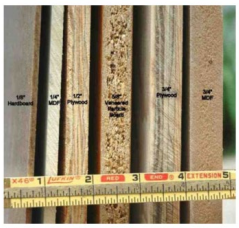
On the advice of André, the makerspace master, Ave and Karin, members of the local CENTRINNO team, used the inventory to request several quotations from different local distributors. The

selected distributors were Decora and ESPAK. The former took care of providing us with most of the goods we needed, including laser-cut parts. The second was responsible for providing us with the missing items. The magnets had to be imported from Poland, and to collect some of the metal parts we went to the Waste Management Center in Tallinn.

As Decora did not have all the goods, we made a list of the missing items. Ave took care of buying them directly from ESPAK. We received all the goods directly at the makerspace, the last items arriving the day before the start of the workshop. Two members of the Kopli 93 community came to help unload the goods. We unloaded the boxes into the workspace and stored the plywood boards in the storage area.

1

**1200 SWT plywood (birch) 6mm & 12mm thickness**



Tail:
20cm x 50cm @ 6mm – 1 piece

Hub:
circle - 20cm x 20cm @ 9mm – 1 piece
triangle - 26.8cm x 26.8cm @ 9mm – 1 piece

Blade template:
15cm x 60cm @ 6mm – 1 piece

Coil winder:
12cm x 12cm @ 12mm – 2 pieces
+ 10mm thick spacer

Magnet template:
23cm x 23cm @ 6mm – 1 piece

Rotor moulds:
base – 35cm x 35cm @ 12mm – 1 piece
middle – 35cm x 35cm @ 16mm – 1 piece
or in two pieces
middle 1 – 35cm x 35cm @ 12mm – 1 piece
and middle 2 – 35cm x 35cm @ 6mm – 1 piece
lid – 35cm x 35cm @ 6mm – 1 piece
island – 13cm x 13cm @ 12mm – 1 piece (should be 10 but can sand down)

Stator mould:

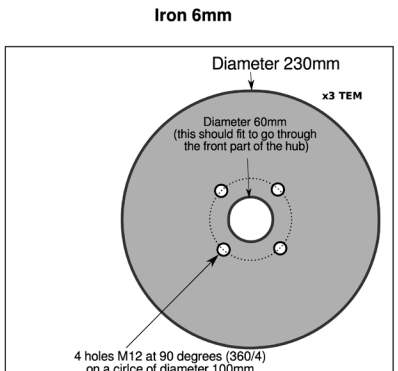
2

1. One of the listings provided by Kostas.
2. Diagram for a laser-cut part sent by Kostas.
3. Machines and tools available in the makerspace.
4. Decora Shopping Inventory.
5. Missing items to be purchased in ESPAK.

4

| Tool | Units |
|---|---|
| *Stable benches for wood working (ideally 110cm high)* | 3 |
| *Pencils* | 5 |
| *Pencil sharpener* | 1 |
| *Pencil erasers* | 2 |
| *Protractor (360 degrees or 180 degrees)* | 1 |
| *Carpenter square* | 2 |
| *Tape measures 2m long* | 2 |
| *Spirit level* | 1 |
| *10m extension lead for tools* | 1 |
| *Jigsaw* | 1 |
| *Set of wood jigsaw blades for curves (less wide)* | 1 |
| *Set of wood jigsaw blades for fast cut (wide)* | 1 |
| *Semi circular rasps (wood file)* | 2 |
| *Rectangular metal file* | 1 |
| *Carpenter clamps large* | 3 |
| *Carpenter clamps small* | 3 |
| *Hand saws* | 3 |
| *Carpenter chisels (2.5cm wide)* | 3 |
| *Wood hammers (mallet)* | 1 |
| *Block plane* | 1 |
| *Water sharpening stone for blades* | 1 |
| *Electric sander* | 1 |
| *Roll of 80 sand paper (1 m.)* | 1 |
| *Electric hand drill* | 1 |
| *Rechargeable hand drill* | 1 |
| *Drill press* | 1 |
| *Lubricant for drilling metal holes* | 1 |
| *Set of screw bits for electric hand drill* | 1 |
| *Set of cobalt drill bits for metal (5mm, 10mm)* | 1 |
| *Counter sink bit for drill* | 1 |
| *Wooden pallet* | 1 |
| *Bench vice attached on a stable bench (preferably with swivel base)* | 1 |
| *Wire cutter* | 1 |
| *5mm drill bit for wood + 12mm + 16mm* | 1 |
| *Safety goggles* | 3 |
| *Chemical masks* | 6 |
| *Saw dust maks* | 6 |
| *Sets of leather gloves* | 2 |
| *Electric soldering iron (100W or more)* | 1 |
| *Roll of welding wire (1mm thickness max)* | 1 |
| *Knife cutters* | 3 |
| *Set of combination pliers* | 1 |
| *Set of long nose pliers* | 1 |
| *Metal brush* | 1 |
| *Angle grinder* | 1 |
| *Grinding disk* | 1 |
| *Center punch for drilling holes* | 1 |
| *Small plastic containers of approx 1Lt* | 3 |
| *Metal spoon* | 1 |
| *Paint brush 5cm wide* | 1 |
| *Ratchet and socket set (socket for M12, M10 hexagonal bolts)* | 1 |
| *Set of spanners from No10 up to No22* | 1 |

3




5

| Tööriistade | Tool | Picture | Units to order (tk/kmpl ) |
|---|---|---|---|
| *Kobalt puuriotsad metallile 14mm* | *Set of cobalt drill bits for metal 14mm* | https://www.decora.ee/metallipuur-specialist-cobalt-12-0mm | 1 |
| *Suur sirkel (kuni 15-20cmm raadiuse joonistamiseks)* | *Compass (able to draw circle up to 15-20cm radius)* | https://www.bauhof.ee/et/p/587840/sirkel-pliiatsihoidjaga-max-150mm | 1 |
| *1mm paksused tinast lehed 3x10cm suurused, 10-15 tk* | *Small sheet of lead 1mm thick (we will need 10-15 pieces of 3x10cm)* | - | 1 |
| *Ühekordsed süstlad 5ml* | *Disposable syringes of 5ml* | - | 5 |
| *voolu alaldi* | *Rectifier* | - | 1 |

| Materjalid | Materials | Picture | Units to order (tk/kmpl) |
|---|---|---|---|
| ***Roostevabast terased detailid*** | ***Stainless steel parts*** | | |
| *Puidukruvid peitpeaga, 5mm x 25mm (25tk/pakk)* | *Woodscrews with conical head 5mm x 25mm* | https://espak.ee/epood/toode/puidukruvi-peitpeaga-zn-50-25-pz-25tk-pk/ | 5 |
| *Puukruvid peitpeaga, 5mm x 20mm (25tk/pk)* | *Woodscrews with conical head 5mm x 20mm* | https://espak.ee/epood/toode/puidukruvi-peitpeaga-zn-50-20-pz-25tk-pk/ | 5 |
| *Polt M10 (täiskeermega) x 65mm* | *Bolts M10 (all thread) x 65mm* | ww.decora.ee/polt-kk-m10x70-osakeere-5tk https://espak.ee/epood/toode/polt-kuuskant-ry-a4-m10-70-din931 | 5 |
| *Polt M10 (täiskeermega) x 30mm* | *Bolts M10 (all thread) x 30mm* | s://www.decora.ee/polt-kk-m10x30-10tk https://espak.ee/epood/toode/polt-kuuskant-ry-a4-m10-30-din933-49k | 3 |
| *Roostevabad mutrid M10* | *Stainless steel M10 nuts* | https://www.decora.ee/mutter-m10-50tk | 2 |
| *Polt M12 (poolkeermega) x 11cm* | *Bolts M12 (not all thread) x 11cm* | https://www.decora.ee/polt-kk-m12x110-osakeere-5tk | 2 |
| *M12 Mutter* | *M12 nuts* | https://www.decora.ee/mutter-m12-20tk | 2 |
| *M12 lai seib* | *M12 wide washers* | https://www.decora.ee/seib-lai-m12-zn-din-9021-100tk-karp | 1 |
| *Polt M5 x 15mm* | *Bolts M5 x 15mm* | https://www.decora.ee/polt-up-m5x16-25tk | 1 |
| *Roostevabad mutrid M5* | *Stainless steel M5 nut* | https://www.decora.ee/catalog/product/view/id/2860025/s/mutter-m5-25tk/ | 1 |
| ***Tsingitud kruvid ja poldid pooli kerimiseks*** | ***Galvanized Screws & bolts for coil winder*** | | |
| *10cm plastoru sisediameetriga 10mm või rohkem* | *10cm plastic pipe with internal diameter 10mm or more* | https://www.decora.ee/ventilatsioonitoru-plastikust-a100-o100mm-1-5m | 1 |
| ***Tsingitud kruvid ja poldid vormide jaoks*** | ***Galvanized Screws & bolts for moulds*** | | |
| *Mutrid M12* | *Rotor fastening nuts M12* | https://www.decora.ee/mutter-m12-200tk | 2 |
| ***Elektroonilised osad*** | ***Electrical parts*** | | |
| *Kõri kaablile OD20 x 1m* | *Electrical conduit OD20 x 1m* | https://www.decora.ee/valgustus-ja-elekter/elektrikaabad/installatsioonitarvikud/kori-kaablile-16-10-7mm-5m | 1 |
| *Elektrikaabel 1x4mm2 x 3m* | *Electrical cable 1x4mm2 x 3m* | https://www.decora.ee/6608-kaabel-kummi-4l5 | 1 |
| ***Valumaterjalid*** | ***Casting materials*** | | |
| *Katalüst 2kg epoksiidvaigu jaoks* | *Catalyst for 2kgr of resin – 70gr* | https://www.decora.ee/kovendi-capalac-pu-harter-0-5-l | 1 |

# The participants application and selection

The CENTRINNO team carried out a two-stage process for the application and selection of workshop participants.

As a first step, we sent the application to educational partners, such as Kopli vocational school and some communities. As a second step, we launched an open call posted both on the Kopli 93 Facebook page and the websites of these organisations. In doing so, it was aimed to get as many candidates as possible with the necessary skills to replicate the workshop without closing the doors to the general public.

The application included some questions about the candidates' skills. As a result, we obtained, on the one hand, a sample of participants with the necessary skills to carry out the work and with a clear vocation for teaching. This last part ios important, as we were not only looking for skilled workers, but also but people who could carry on teaching others what was learnt during the workshop, with the aim the initiative a replication strategy to be implemented in other communities with manufacturing capacities. On the other hand, there was valuable information for future events and workshops in Kopli 93 Makerspace.

**Kopli 93** Friday, 11 November 2022 at 10:03

**Wind generator workshop**

The workshop aims to build a wind generator for home use with a diverse group of limited number of participants. The workshop is led by a Greek scientist and practitioner, Mr Kostas Latoufis.

The workshop is free for the participants, the working language is English, and the workshop duration is four full workdays, starting in the morning and ending in the evening.

Please let us know about your wish to participate ASAP: https://forms.gle/D7oBat4Se4E9Tv7c9

The workshop is supported by Fabcity Foundation, Distributed Desing, Estonian Environmental Investment Centre and North-Tallinn City District. Creating of Kopli 93 community hub is possible thanks to Centrinno project supported by funding from the European Union's Horizon 2020 Research and Innovation programme under grant agreement number 869595. The project is coordinated by TalTech. Read more at https://centrinno.eu/ #Kopli 93 #centrinnoeu

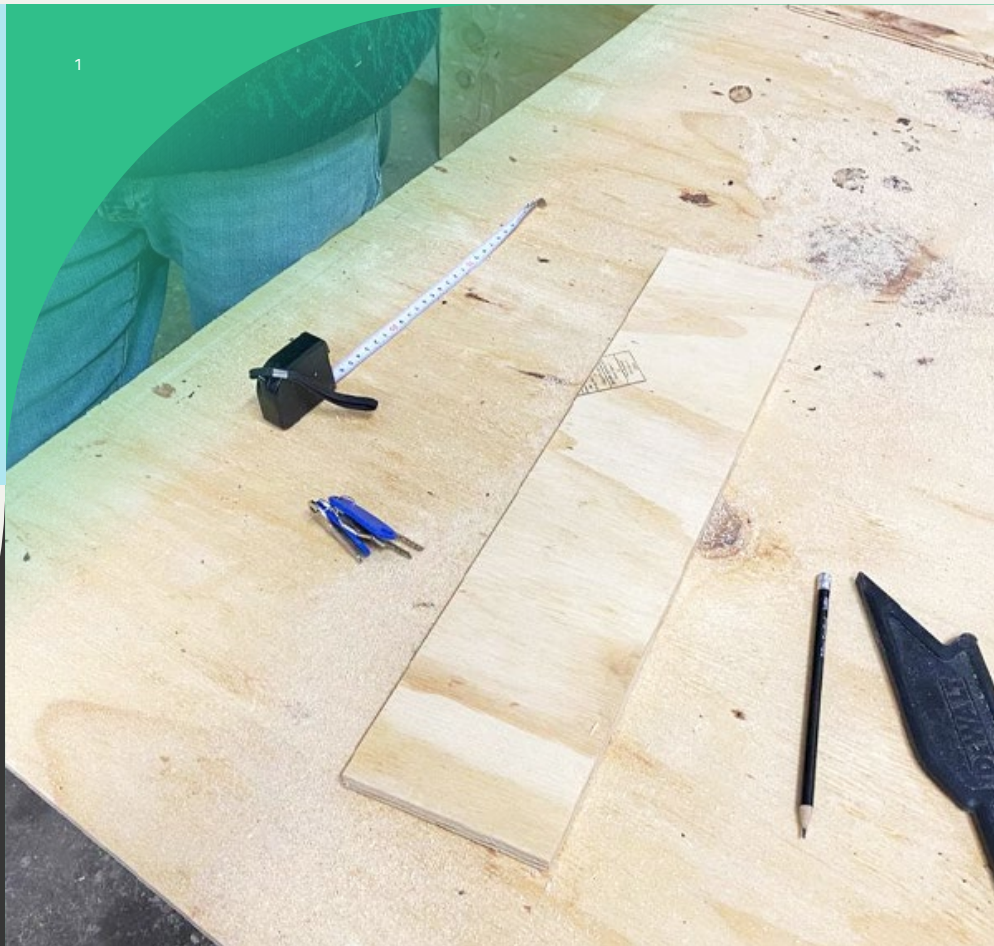
# Preparing the makerspace

Preparing the workspace to host the workshop required more teamwork. Therefore, we all met at the Makerspace the evening before to unpack the materials and tools received. Kostas, who had already arrived from Greece, helped us and made a first check of them. Once this was done, two volunteers from the Kopli 93 community cut the plywood sheets to make them handier for the workshop. Finally, the rest of us organised the new tools and the other materials on the makerspace shelves and tables.

Kopli 93's Makerspace has a lounge area that doubles for intimate discussions and meetings. After preparing the workspace, it was time to get this area ready. The CENTRINNO team members brought and set up the projector, and the rest set up about fifteen more chairs for the next day's gathering. After a cup of tea and an exchange of views on the challenges and opportunities of the days ahead, we said goodbye.

The next day we met at 9 a.m., an hour before the start of the workshop, to finalise the last details. First, Kostas distributed several copies of the turbine instruction book [9] on the workspace tables. Next, we prepared the coffee and snacks and checked that everything was in order. That done, we sat down for tea and waited for the participants to arrive.

1. Plywood Cutting.



# Getting the media involved

The momentum generated around the workshop attracted much interest from media outlets. The CENTRINNO team took it upon themselves to transform this initial interest into de facto coverage of the workshop. After meeting internally and talking to the media, we agreed that the best time for the press to attend would be Friday, 18 November, at noon. We decided on the presence of a few journalists, a reporter and a TV camera operator. The time to be covered was set at one hour, including recording the activities during the meeting and some interviews with participants and stakeholders present.

# How much does it cost?

Calculating the costs of a multi-stakeholder workshop is tricky, especially when this is the first one we organized in such a way. There are hidden -or non-monetary- costs that are usually left aside. In our case, for example, we did not pay for the space. That doesn't mean that using the makerspace for four days and 32 hours in total, not including the time setting up the space and preparing the materials, was for free. There is always a voided rent when none is paid. A proportional part of utility bills is never accounted for. Pro-bono work from the persons involved or paid-work time from some of the persons involved that are covered by a stakeholder that deems the use of its members' time as productive and valuable for the organization.

A workshop always has hidden costs. We will highlight the ones we paid for, knowing that the stakeholders provided work-time contributions from some of their members. Most charges were covered by three stakeholders that divided tasks and responsibilities among themselves.

The Fab City Foundation, also in its role of Distributed Design Platform project local partner, covered the instructor's travel and support fees for the instructor's organization to provide a reliable person along with the educational materials and experience. It also covered four-day meals for the 20-something participants and other people involved in the workshop and the reduced fee from a member of the makerspace community to shot, film and edit during and after the workshop. In addition, it had one person with part-time dedication for two months helping organize the workshop and one with occasional coordination tasks. CENTRINNO covered the tools and materials and realized the workshop participation certificates. Finally, the Estonian Environmental Investment Center provided funding for Kopli 93 makerspace,

including the building, acquisition of tools and machines, and part of the makerspace master's income.

In total, the stakeholders paid nearly 5,000 EUR in monetary costs, not including rent of space or machinery, neither the hours of work provided by their members involved. We consider it an investment.

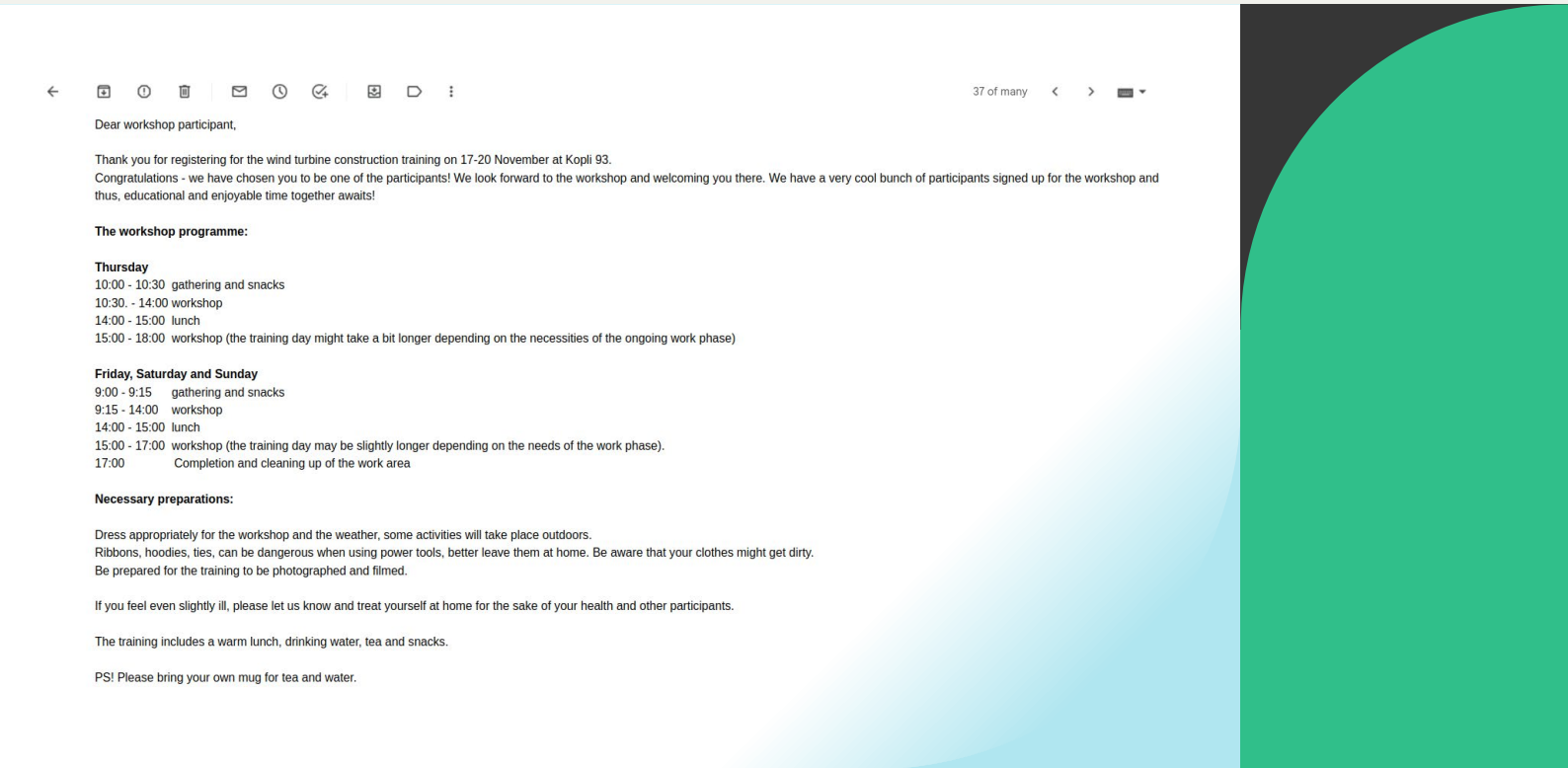
This is the cost for a first-time getting-everything-started in two months activity. Nevertheless, it opened a new array of possibilities for the future, especially knowing that many stakeholders needed to learn what a makerspace is, what open-source technology is, or how grassroots energy solutions are articulated. By late November, the local stakeholders had an idea of the potential of community makerspaces. And with Tallinn being European Green Capital in 2023 amid an energy crisis, this workshop put Kopli 93 makerspace on the radar of politicians, researchers, communities, and the creative economy hubs.

# Workshop scheduling

We held the Wind Turbine Workshop in the Makerspace of Kopli 93 between the 17th and 20th of November 2022. After consulting with Kostas and not knowing the number of registered participants who would eventually attend, we opted to be conservative, spreading the workload over four eight-hour days, including an hour for lunch and fifteen to half an hour a day devoted to gathering accompanied by snacks. In this way, we wanted to ensure that the work would be done while, at the same time, the pace of work would be smooth and allow us all to enjoy the journey.

1. Schedule mail sent by CENTRINNO.

1



37 of many

Dear workshop participant,

Thank you for registering for the wind turbine construction training on 17-20 November at Kopli 93.
Congratulations - we have chosen you to be one of the participants! We look forward to the workshop and welcoming you there. We have a very cool bunch of participants signed up for the workshop and thus, educational and enjoyable time together awaits!

**The workshop programme:**

**Thursday**
10:00 - 10:30 gathering and snacks
10:30. - 14:00 workshop
14:00 - 15:00 lunch
15:00 - 18:00 workshop (the training day might take a bit longer depending on the necessities of the ongoing work phase)

**Friday, Saturday and Sunday**
9:00 - 9:15 gathering and snacks
9:15 - 14:00 workshop
14:00 - 15:00 lunch
15:00 - 17:00 workshop (the training day may be slightly longer depending on the needs of the work phase).
17:00 Completion and cleaning up of the work area

**Necessary preparations:**

Dress appropriately for the workshop and the weather, some activities will take place outdoors.
Ribbons, hoodies, ties, can be dangerous when using power tools, better leave them at home. Be aware that your clothes might get dirty.
Be prepared for the training to be photographed and filmed.

If you feel even slightly ill, please let us know and treat yourself at home for the sake of your health and other participants.

The training includes a warm lunch, drinking water, tea and snacks.

PS! Please bring your own mug for tea and water.

We also decided to include two general presentations by Kostas in the schedule, which would open and close the workshop and give a better overview of the work to be done or done. We also set aside about fifteen minutes a day to clean the space and half an hour for a diploma award ceremony on the last day. The CENTRINNO team designed the diplomas and sent an email with the planned schedule for the workshop to all selected participants.

The workshop was designed to be delivered in communities and makerspaces, maximising interactions and creating shared experiences among participants. To do this, Kostas divided us participants into three working groups of about five people, known as workstations. We had three workstations: wood, metal and a generator. During the working day, we alternated the activities carried out at these workstations with activities performed altogether.

1. Workshop diploma by CENTRINNO.

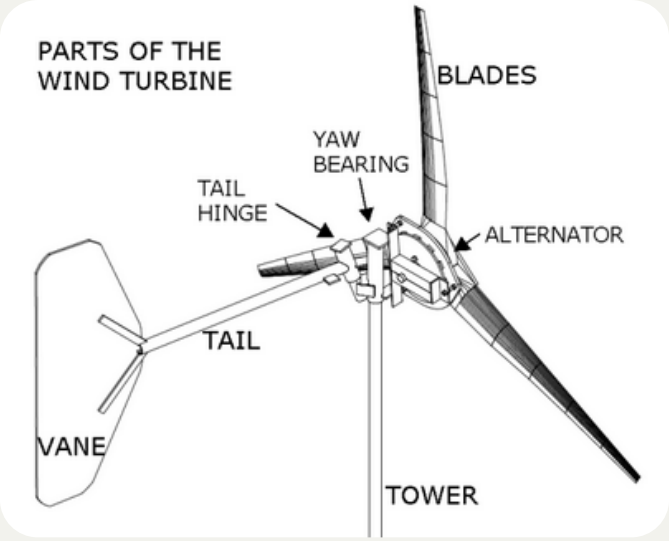


# Workshop activities

CONTENTS

# All-together

Many of the activities we carried out during the workshop were done by all of us together. During some of these activities, Kostas took a more central role, organising the work, instructing us, or helping us to manufacture parts of the turbine of particular difficulty. During many others, Kostas acted as one of us, enjoying leisure time with all the participants and collaborating on the everyday tasks.




© Hugh Piggott

## Organising

On the first day, after the initial welcome and introductions, Kostas explained how the work would be distributed during the workshop. He told us that we would divide the work into three workstations: wood, metal and generator. He also explained which parts of the turbine each workstation would be responsible for. He then asked for volunteers to join the first day's workstations and explained to us the first tasks to be carried out in each one.

Kostas repeated this distribution of work every morning, assigning the initial tasks of the day to each workstation. He also gave us a brief daily schedule each morning and, just before we said goodbye, a brief wrapping up of the milestones achieved that day.

As part of the organizational activities, Kostas and André, the Makerspace master, reminded us daily of the need to keep the workspace clean. We all collaborate on it, and we spend the last fifteen minutes of the day all together sorting the tools used and sweeping the floor of the workspace to return everything to its normal state.

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## Learning

### Instructing the participants

The seminar was mainly practical. However, we all attended together two short general presentations given by Kostas. He gave the first one on the first day, right after the presentations and before explaining the work in the workstations. We learned a bit more about small wind and open design technologies. Also, about the process of building a small turbine and the Wind Empowerment network and its work, of which Kostas is part. He gave the second one on the last day, as a closing of the workshop and before we all said our goodbyes. With our turbine up and running and more relieved, we delved deeper into the same topics. We also learned about the outdoor turbine installation process and other renewable energy systems, such as hydro and hybrid systems [10].

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1. General presentation.
2. Hands-on technical Instruction.
3. Diploma awarding ceremony.

In addition, Kostas provided us with hands-on technical instruction during the activities we did together to produce the generator. He also reminded us daily of the safety protocols for handling the machines and tools and the mandatory use of protective equipment before we got down to work.

### Acknowledgement

To thank all the participants for their effort and enthusiasm during the long working days of the workshop, on the last day we held in the workspace a brief diploma ceremony. Kostas and Karin, CENTRINNO member and Kopli 93 Project Coordinator, chaired the ceremony. Gathered around them, we all wait our turn to receive our diploma, shake their hands and exchange a few words of affection.

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# Producing

### Manufacturing the generator

We did a lot of the turbine generator manufacturing work together, mainly due to the unfamiliarity most of us had with electrical labour.

One of the parts we manufactured altogether was the stator. The stator is one of the two fundamental parts of the generator and consists of an assembly of coils. In the case of our turbine, six coils of 76 turns per coil and a copper wire of 1.4 mm. diameter. To build it, we fixed the six coils with an electric screwdriver to a hexagonal plywood mould we had prepared the day before. Then Kostas explained how to connect the coils in series, and we made the connections.

▶ VIDEO: The Stator Assembling

The second fundamental part of the generator is the magnet rotor, and we also manufactured it together. The magnetic rotor of our turbine is a single steel disc 230 mm in diameter and 6 mm thick with eight magnets glued around its perimeter at a constant distance. We use a thin

plywood jig with one hole per magnet to attach the magnets to the disc. First, Kostas taught us the differences between the types of magnets available on the market. Then, we practised placing them correctly before adding the glue.

▶ VIDEO: The Magnet Rotor Disc

Finally, as the last activity before finishing the turbine, we all gathered to watch Kostas install the electrical box that would house the cables from the stator. The cables will carry the electricity produced by converting mechanical energy into electrical energy by the turbine generator.

1

1. Installing the electrical box.

## The Wind Turbine Final Assembling

On 20 November, the fourth day of the workshop, at 1:44 pm, we finished our small wind turbine. Then, the final assembly was done together in the workspace. It was an emotional and touching moment, with all of us surrounding two of our colleagues, tightening the last nuts and putting the finishing touches to the electrical box. Many of us took pictures and videos. However, the work still needed to be done.

2. Final assembly of our small wind turbine.

| General Specs | |
|---|---|
| TURBINE DIAMETER | 1200 mm. |
| BATTERY VOLTAGE | 12 V. |
| POWER RATING | 200 W. |
| NUMBER OF MAGNETS | 8 on one disk |
| NUMBER OF COILS | 6 |

| Estimated monthly energy production | |
|---|---|
| MEAN 3 m/s | 5 kW h. |
| MEAN 4 m/s | 14 kW h. |
| MEAN 5 m/s | 23 kW h. |
| MEAN 6 m/s | 33 kW h. |
| MEAN 7 m/s | 41 kW h. |

Adapted from The Axial Flux Alternator Windmill Plans, Copyright by Hugh Piggott.

2

### The Blade Calibration

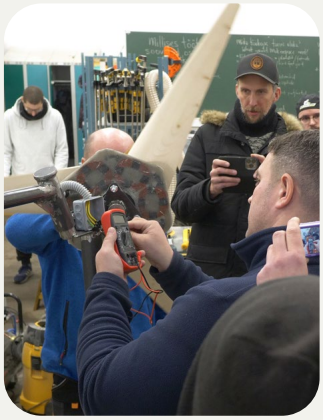
After the final assembly of the turbine, Kostas showed us how to check the blade's balance of the centre of mass. Since it was slightly displaced, we used tin and tape to strategically add some weight and balance it.

### Wind Turbine Testing

Once we balanced the blades' centre of mass, we performed two tests on the turbine. For the first one, we used a multimeter to test its values, and for the second one, we checked if the turbine could light an LED bulb. Both tests gave satisfactory results, but the second one was particularly moving. For the first time, we could truly perceive the potential of the technology we had built.

1. Calibrating the blades.
2. Testing the turbine with a multimeter.
3. Testing the turbine with LED.

1



2

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# Refueling

The working day to build our turbine was long and intensive, so we needed time to relax and unwind. The tea break came unexpectedly. It was not agreed upon in the initial schedule. Still, the availability of tea and snacks in the lounge area and the possibility to take a break and chat a bit made the difference. In this way, a small tradition was established. Work stopped every day around mid-morning, and we all enjoyed a fifteen-minute break.

The next break for refuelling was lunch. Lunch was prepared daily by a local caterer and brought to the makerspace. It was free for all of us, courtesy of the Fab City Foundation. We were allowed to request vegetarian and vegan options on the event registration form. Lunch was packed in containers made of recycled material, as was the cutlery. Every day, when we received the messenger from the caterer, we would clear one of the tables and dispose of the containers there. We also set up a small area to collect and sort the waste. Then, one by one, we would take ours to enjoy it all together, sitting as we could on the couches or chairs in the lounge area or using the furniture in the makerspace to make ourselves comfortable. Finally, we took our container and cutlery to the recycling area before returning to work.

4. Tea break.
5. Lunch break.

4

5

# Workstations

To build our wind turbine, we worked simultaneously in three areas: wood, metal and generator. Most of the work was done this way, and we organised ourselves into working groups called workstations. The number of members composing each workstation varied depending on our particular interests and the requirements of the task at hand.

## Workstation areas

### Wood Workstation

The work we carried out in the wood workstation followed a direction of increasing detail. First, we started with the larger grain tasks and progressed to the finer ones.

### Making the template

The first task Kostas gave us was the preparation of a template for drawing the blank blades, the pieces of wood we will carve to build the blades. Before we got down to it, we all consulted together one of the instruction books that Kostas had placed on the workspace benches that morning. Then, after a short deliberation, we set to work. The template dimensions were 600 mm long, 150 mm wide at the widest part or root and 38 mm wide at the narrowest part or tip. We draw it on thin plywood using a metal ruler and a pencil. Then we cut it on the table saw.

### The blank blades

Once the template was made, we started to draw the edge of the blank blades on the wood. To do this, we follow the contours with a pencil. We then used the hand saw, and the table saw to cut them and sand them with the electric sander.

### Making the tower

Another task we carried out at the wood workstation was constructing the turbine tower. To build it, we used the same wood as the blades. As the main mast, we used a piece of wood about two metres long, and to make it fit into the metal structure of the turbine, we carved it. To do this, we clamped it to a bench and used the hand planer and the spokeshaves to give a circular shape to one of the ends.

1

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1. Cutting the blank blades.
2. Making the turbine tower.

## The blades

The bulk of the work at the wood workstation consisted of transforming the blank blades into blades. To do this, we needed to create the blade's windward or front face and the blade's rear face on the one hand and give the blade an aerodynamic shape on the other. We worked on it for days and used many tools, mainly the trenchers, the manual and the electric planer. Finally, we did multiple polishing with the hand and power sanding.

We were very excited when we finished carving the blades. However, there was still a lot of work on them. On the one hand, to sandwich them. On the other hand, to prepare them to be assembled on the turbine.

▶ VIDEO: Carving the Blades

We used two pieces of plywood to sandwich the blades: a triangle on the front side and a circle on the backside. We prepared both pieces by drawing them on plywood and cutting them with the jigsaw.

The very first thing we did was to check that the measurements were correct. Kostas guided us closely to do so. First, we placed the circle on top of the blades and clamped the assembly to the bench. Then we measure the distance between the pairs of tips of the blades and the distance from the circle's centre to the tip of each blade with the meter and the metal rulers. Once we checked that the measurements were correct, we screwed the circle and the triangle to the blades with two parallel rows of small screws using an electric screwdriver.

With the blades sandwiched, all that remained was to prepare them for final assembly to the turbine structure. We used the table drill to perforate the circle and create four holes, which will be used to bolt the blades and the magnet rotor disc. Finally, we used the same drill with a hole saw to make the central hole for the trailer hub.

## The tail vane

The last task we undertook at the woodworking station was to make the tail vane: the part that directly receives the wind and articulates the tail. It was a relatively simple task and we all really enjoyed doing it because of the large creative component involved.

▶ VIDEO: Cutting the Tail Vane

After minimal deliberation we decided that the shape that would best capture the essence of our turbine would be a phoenix tail. We draw the shape freehand and cut it with the jigsaw. Then we printed it in white and used a black marker to give it the final details.

1. Assembling the triangle on the blades.
2. Attaching the tail vane.

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## Metal Workstation

The work at the metal workstation followed a direction of increasing difficulty. First, we familiarized ourselves with the welding technique, then we made the simpler metal parts, and finally we undertook the task of making the more difficult ones.

### Learning to weld

The main technique we used in the metal workstation was welding. Welding is a precision technique, and mastering it involves a lot of practice. Only two of us at the metal workstation had previous experience. Far from being a problem, the workshop considers this and sets aside the first two days to become familiar with the technique before starting work.

On the first day of the workshop, we set up a tent in the front yard to keep us warm enough to start the practice. With this, we also solved the lack of space and the poor ventilation of our makerspace, avoiding possible accidents. Together, we took the tent out of the storage area and set up all participants in the workstation. However, the cold Estonian winter and the -7 degrees Celsius in North Tallinn struck us hard enough to make us postpone the start of practice until the next day. Then, more mentally prepared, we set up a table and a stool under the tent the next day, installed the welding machine and started practising.

We spent the whole day practising joining pieces of scrap metal together. We used a lot of electrodes during the process, and we even made a small fire with the permission of the makerspace master to warm up our hands. Kostas and the two more experienced members of the workstation helped us by explaining the ins and outs and trying to prevent us from making the most common mistakes. As we only had one welding machine, one of us welded while the other watched. While we were not welding or observing, we all engaged in relaxed conversations.

### Making the yaw bearer and the tail

After the welding practising, we built the yaw bearer and the tail of our turbine.

The yaw bearer is the part that allows the turbine to rotate and acts as an interface between the turbine tower and the turbine. It is a relatively simple piece consisting of two pipes fitted inside each other.

The tail comprises two metal parts: the hinge and the boom. The tail hinge fitted into the yaw bearer and consisted simply of two tubes welded at an angle of 20 degrees. Finally, the tail boom is a steel tube welded to the outer tube of the tail hinge.

▶ VIDEO: Making the Tail Hinge

Kostas helped us set the hinge angle, and we cut the tubes with the radial saw and applied the welding, leaving the three parts done.

### Getting the trailer hub ready

The trailer hub is the core piece of the turbine. It is fitted inside the magnet disc rotor, the stator and the blades, holding the assembly and allowing it to rotate. Since it was a directly purchased part, we customised it to adapt it to our turbine. To do this, we welded a laser-cut metal triangle with holes for the central bolts to hold the assembly together. Finally, we used the radial saw to cut the trailer hub shaft to the correct size.

▶ VIDEO: Cutting the Trailer Hub Shaft

## Generator Workstation

The last workstation was the generator workstation. Here we made the moulds and templates, then the built the generator parts, and finally, we used resin to protect them.

### Making the magnet jig and the winder

The generator is, together with the blades, the part of the turbine that requires the most precision in its manufacture. Two processes are particularly challenging: the placement of the magnets on the rotor disc and the coil winding.

To place the magnets properly on the rotor disc, we made a magnet jig, which consists of a circle with eight slots to place the magnets at the right distance. We made it on thin plywood, using a pencil, a compass and metal rulers, and then cut it with a jigsaw. The work was delicate and obviously, time-consuming, and we took great care to give it a good polish with fine sandpaper.

To wind the coils we built a small winder, a relatively simple device that consists of two cheek pieces forming a sandwich, crossed by a small metal tube that inserted in a wooden base allows rotation. To make the cheek pieces we used a plywood template that Kostas had brought with him.  We talked a lot about the best way to make the base, and finally we opted to reuse a piece of wood left over from the blades.

### Building the moulds

In addition to precision manufacturing, the generator requires extra work to protect it during turbine operation. Two parts are particularly vulnerable: the stator and the magnetic rotor disc.

To protect them, we coated them with resin and glass fibre, so as a preliminary step, we had to make two moulds. We made both moulds in plywood, combining the different thicknesses of the boards we had bought.

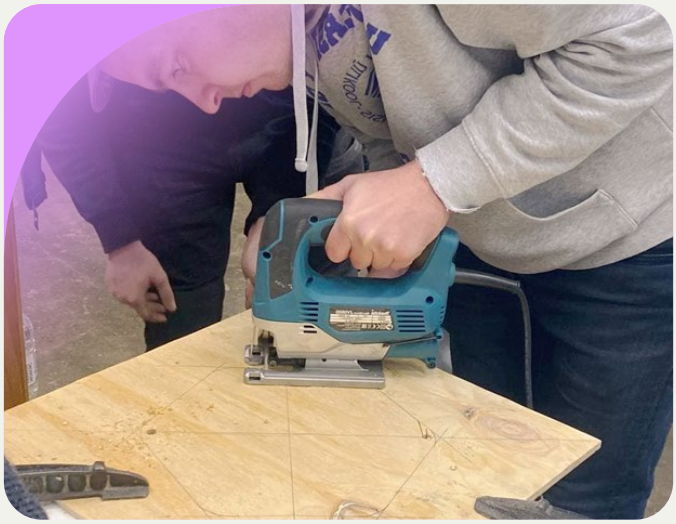
The magnet rotor disc mould was made from a solid base, an island and a lid. For the base and lid, we used two 350 mm squares we had cut out on plywood the previous evening. With the aid of a compass, we traced the 120 mm central circle of the lid and cut it with the jigsaw. Then we made the island by cutting out a 65 mm radius circle. We finally joined the three pieces with an electric screwdriver.

The stator mould manufacturing process was very similar. The mould is made of the same parts as the magnet rotor disc, but the cavity is hexagonal instead of round. As for the first one, we used the jigsaw to cut the plywood, and finally, we assembled the three parts with the electric screwdriver.

1. Drawing the coil winder.
2. The magnet jig.
3. Cutting the stator mould.

1

2



3

## Winding the coil and filling the moulds

We coiled the wire in pairs using the coil winder. One of us held the wire tightly while the other carefully turned the crank handle to wind it up and used a small screwdriver to seat it correctly. We counted the number of turns to ensure it was the 76 needed. It was a very organised process. However, despite our best efforts, one of the coils did not conduct electricity well when the stator was connected. We made another, this time with better luck.

▶ VIDEO: Winding the Coils

The process of filling the moulds was much more straightforward and much less clean. Before starting, we protected ourselves well to avoid the vapours emanating from the catalysed resin: safety goggles, latex gloves and a mask. We used one of the plastic containers we had bought to mix the resin with the catalyst. We stirred the mixture well with a small piece of plywood and poured it into the moulds. We added the small sheets of fibreglass that we had cut to the size of the moulds and used our fingers to soak them well in the mixture. We then closed the moulds with the electric screwdriver and let them sit flat until the next day.

▶ VIDEO: Filling the Moulds with Resin

## Opening the moulds and demoulding

The final step was to open the moulds and demould the parts. We opened the moulds after 24 hours. We removed the screws and used a small carving tool to separate the base and caps. Then, with the same tool, we carefully removed the excess resin adhering to the wood and used the wooden hammer to lightly tap and unmould the pieces. Now all that was left to do was to assemble.

▶ VIDEO: Demoulding the Magnet Rotor Disc

▶ VIDEO: Demoulding the Stator

# Consultation of technical materials

Although some of us had training and experience in similar projects, frequent consultation with the instruction books that Kosas had provided us was unavoidable to perform many tasks assigned to each workstation.

As the number of books available was limited, the most frequent form of consultation involved the joint observation of the book by all members of the workstation, followed by a short deliberation on specific processes or parts. At other times, the consultation was carried out individually by one of the members, who would then tell the others what he or she had learned.

1

# Interactions during surplus time

Sharing space, common interests and goals, and frequently being confronted with the need to solve problems as they arose creatively created a sense of momentary togetherness among the participants of the workstations that made it much easier for us to interact. This was especially noticeable on the last day, when, knowing that time was not scarce and the work was practically done, our conversations increased as we watched quietly as other colleagues worked or as we worked in a relaxed mood.

2

1. Consulting the recipe book.
2. Interacting during surplus time.

# Individually flowing

**The workshop balanced group work with individual creativity and autonomy, allowing flexibility and focus on individual interests. Individual flows are therefore also of interest to us.**

## Flow between workstations

Far from presenting a closed structure with well-defined boundaries, the design of the workstations was utterly permeable. Rather than hindering the work, this allowed Kostas to flow between workstations according to the needs that arose in the different tasks and to make the rhythm of the workshop more pleasant and natural, allowing participants to move guided by their interests and curiosity.

---

## Camera shooting

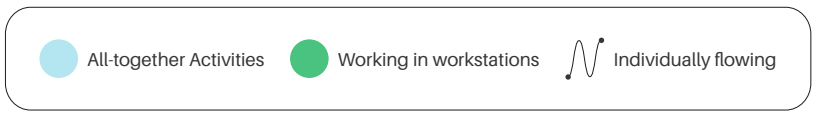
Most of the participants used their mobile phones at some point to immortalise some of the workshop activities. This was particularly noticeable during the most relevant activities, especially the final assembly of the turbine. It is worth noting that many of us were directly or indirectly related to one or more of the stakeholders, so we documented the event to generate social media content and spread the word.

---

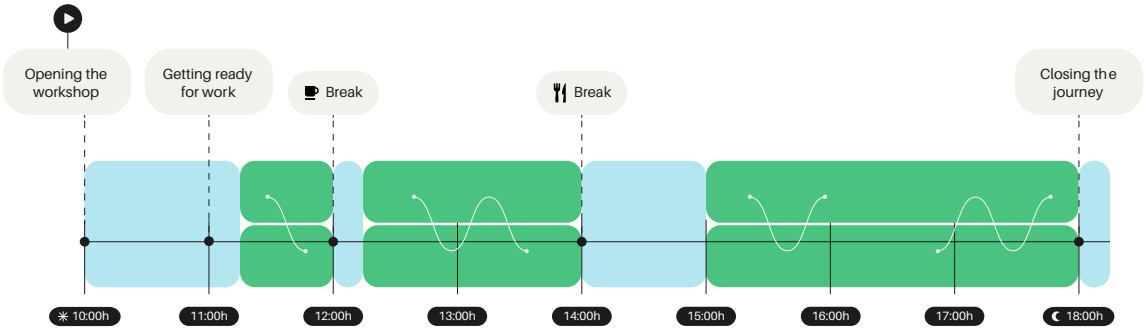
## Personal and remote-work time

We held the workshop during the week, so as the days went by and the work to be done was diminishing, it was not unusual to see some of us working on the laptop in the lounge area. Similarly, as the participants got to know each other more and more, sporadic small talk among ourselves became more common, interspersed with more group conversations.

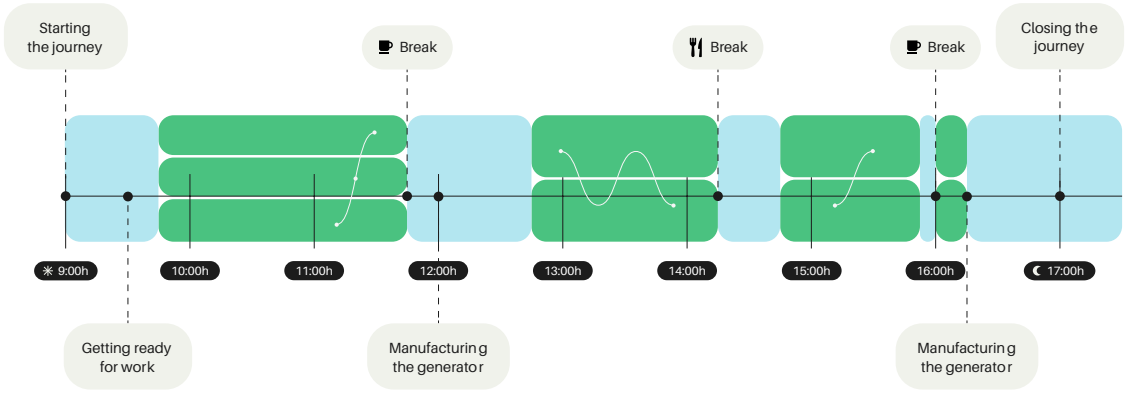
# Workshop activities daily flow
Infographic



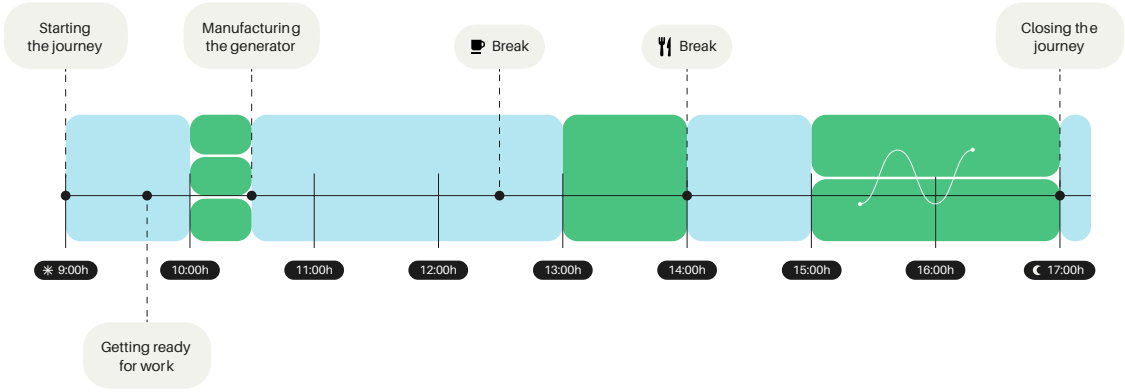

Day 1



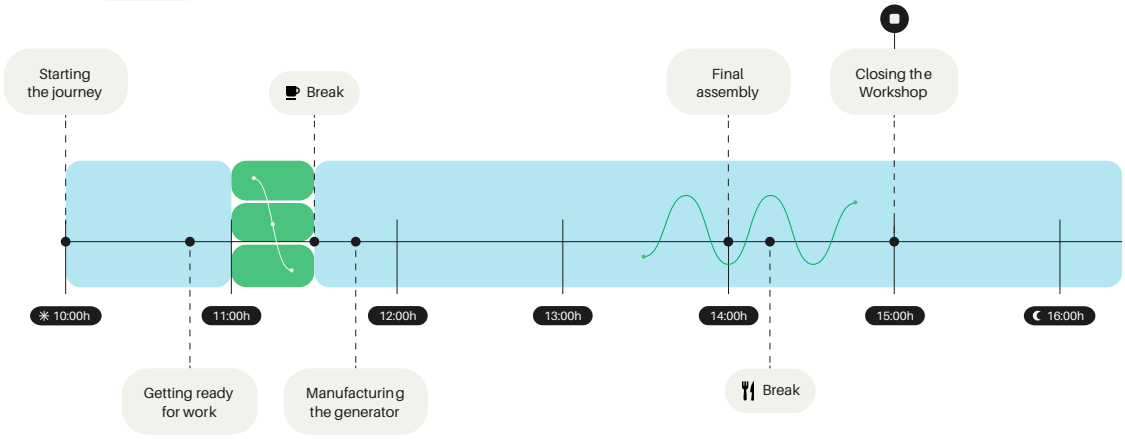

Day 2




Day 3




Day 4

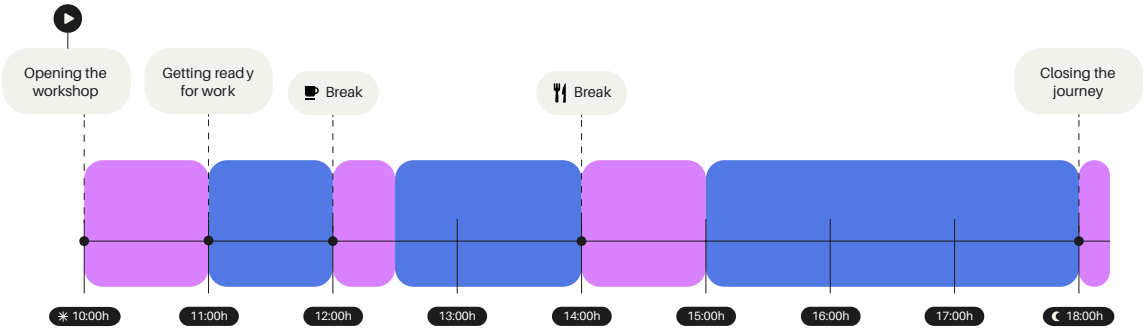


# Time manufacturing community / technology
Infographic

Community Building
Turbine Manufacturing

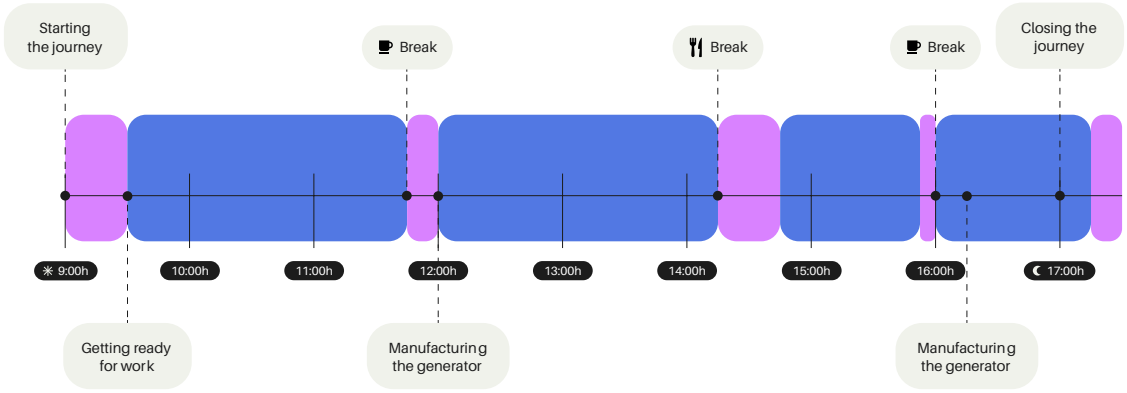
## Day 1

33% Community Building
67% Technology



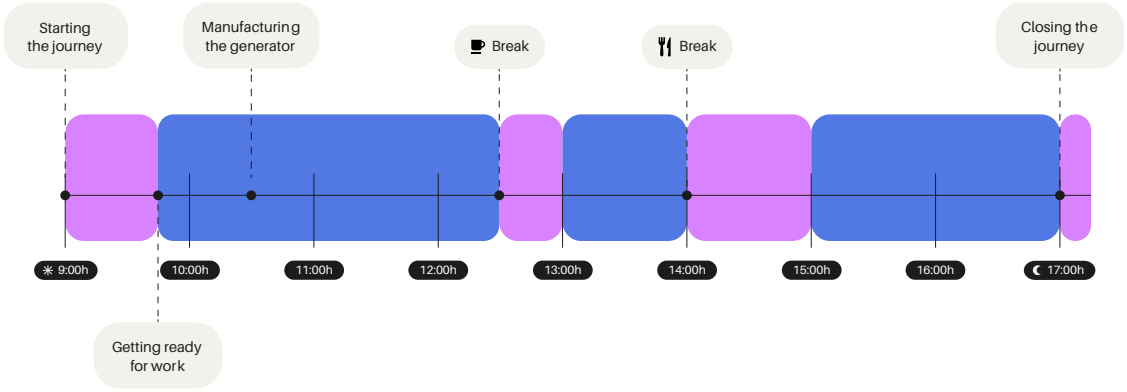

## Day 2

19% Community Building
81% Technology



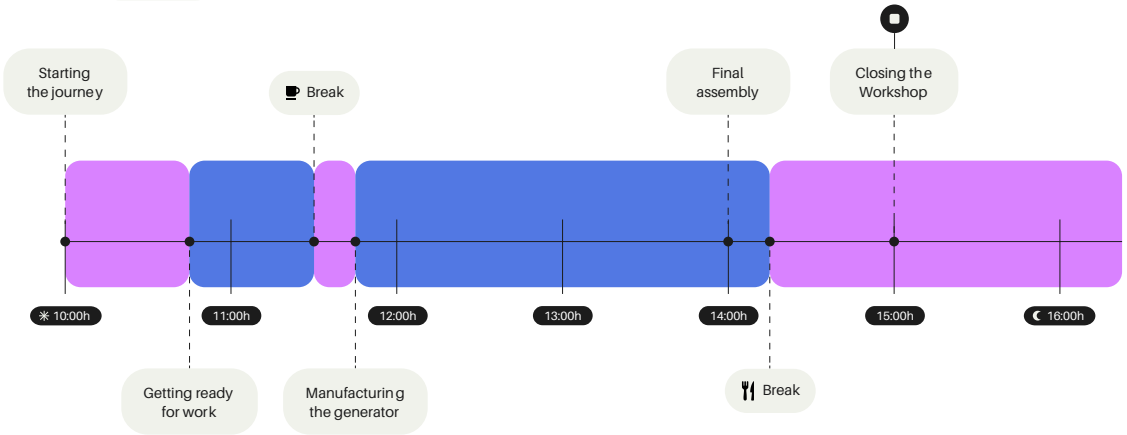

## Day 3

30% Community Building
70% Technology




## Day 4

49% Community Building
51% Technology



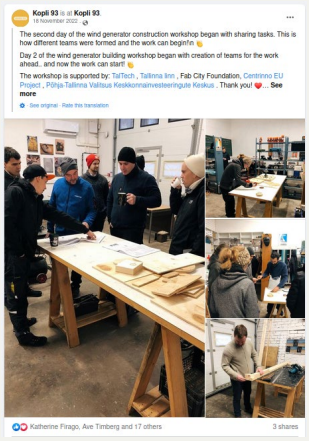
# Outcomes

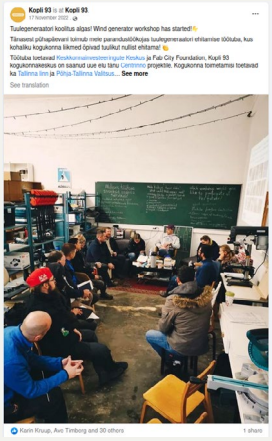
CONTENTS

# Digital media

During and after the workshop, some stakeholders used their social media to spread the word about the event. We came across five posts and a Facebook event by Kopli 93, Nea Guinea and the P2P Lab.

As host, Kopli 93 made three posts, one coinciding with the kick-off of the workshop, one to give a brief overview of the way of working, and one a week after the end of the workshop to wrap up what happened and thank the attendees for our participation. Finally, it made an event given by one of the participants about electrician basics. As an IP provider, Nea Guinea made a small appreciation post, reporting the event's occurrence to its network. Finally, as the ideator and one of the initiators of the workshop, the P2P Lab Facebook page made a longer post contextualising the workshop and its relevance to the community, as well as the twinning of Kopli 93 with similar





**Kopli 93** Thursday, 17 November 2022 at 11:33

**Wind generator training has begun! Wind generator workshop has started!**

From today until Sunday, our repair workshop is hosting a wind generator building workshop where local community members will learn to build a windmill from scratch!

The workshop is supported by Keskkonnainvesteeringute Keskus and Fab City Foundation, Kopli 93 community center has gotten a new life thanks to the Centrinno project. Community editors are also supported by Tallinna linn and Põhja-Tallinna Valitsus #centrinnoeu #Kopli 93

**Kopli 93** Friday, 18 November 2022 at 09:41

The second day of the wind generator construction workshop began with sharing tasks. This is how different teams were formed and the work can begin!
Day 2 of the wind generator building workshop began with creation of teams for the work ahead.. and now the work can start!

The workshop is supported by TalTech, Tallinna linn, Fab City Foundation, Centrinno EU Project, Põhja-Tallinna Valitsus Keskkonnainvesteeringute Keskus. Thank you! #Kopli 93 #centrinnoeu

**Kopli 93** Monday, 28 November 2022 at 19:11

We dreamed of our very own wind generator workshop for a really long time. The dream was made of ambition, belief, hope and a bit of fear also - will be manage to pull it off? Will we manage to finish the wind generator just in four days? Is it even possible?
As you can see from the photos, our dream came true. We got to try out metal and woodwork, and of course - learned a lot about electricity as well. We really hoped to learn something new and of course to finish the generator. And we came out of this process stronger and more resilient. As a community!
We are so-so happy about the feedback from the participants.. but we will make a separate post about it soon. Ja muidugi meie juhendajale ja osalejatele! Suur-suur aitäh! See kõik oli võimalik tänu/This all was possible thanks to: TalTech - Tallinna Tehnikaülikoolile Tallinna linna Strateegiakeskusele Põhja-Tallinna Valitsusele Keskkonnainvesteeringute Keskusele Salme Kultuurikeskusele Fab City Foundationile #Kopli 93 #CENTRINNOeu

projects such as the Tzoumakers makerspace in Tzoumerka.

All posts received a high number of likes if we take as a reference the usual number of likes on these Facebook pages, which indicates the interest of local communities in initiatives of this nature related to local energy resilience and self-sufficiency. The seminar was also well attended, with ten participants.

**Nea Guinea** Tuesday, 22 November at 10:43

Last week we had the pleasure to co-organize a small wind turbine building course in Tallinn, Estonia with the Kopli 93 maker space, along with a lovely group of about 20 enthusiastic people! We built a 1.2 meter rotor diameter small wind turbine in the course of 4 days, and got the chance to meet, share and learn from each other! Thank you all for a great workshop!

**P2P Lab** Tuesday, 22 November at 10:43

Kopli 93 is a young but already powerful sister of our Tzoumakers, situated in Tallinn, Estonia. A few days ago the local community, led by Karin Kruup, a P2P Lab affiliate, tried their hands with the manufacturing of a small-scale wind turbine, under the guidance of Kostas Latoufis and the Wind Empowerment network.
It is worth mentioning that a similar wind turbine has been manufactured in Kalentzi, Greece last summer, at our energy summer school. The open design of this technology allows adaptations that can cover vastly divergent conditions, from Ethiopia, to Greece, all the way to Estonia! For more details on how this is possible, read our latest piece here: https://www.mdpi.com/1996-1073/15/13/4659.

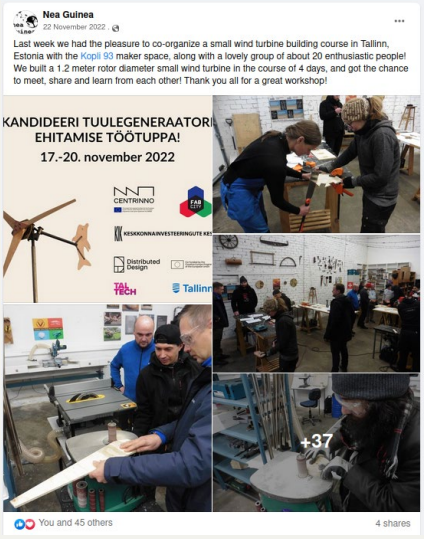
**Kopli 93** Monday, 12 December 2022

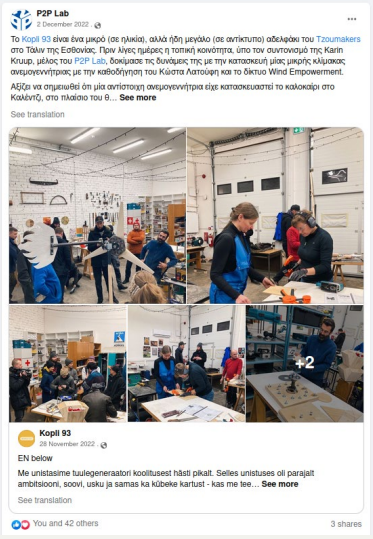
**Kopli 93 Event**

REGISTRATION COMPLETED!
On Friday, December 16, another workshop will be held in the Kopli 93 community Makerspace, where everybody can acquire knowledge and skills in the field of electrical work. Electricity is expensive, hiring an electrician even more. Wouldn't it be great if all domestic electrical work could be done by yourself without having to hire a specialist? Now is the opportunity to learn how electricity works and how to do electrical work. We will learn how to prepare the wires and how to connect them, how to choose the right tools and how to use them safely. We also create an imaginary apartment and install electrical wiring, put a switch and socket on the wall, put a light bulb in the ceiling and connect the wires using a junction box. We use different connection methods and we also measure electricity consumption of different devices.
The workshop will be conducted by Aleksei Amerhanov, specialist of Kopli Vocational School.
The workshop starts at 18:00.
Entrance from the back gate on Ketta Street.

P.S. The workshop is FREE!
P.P.S Due to the limited number of participants, advance registration is required.

Register here: https://docs.google.com/.../1gW0btuxXfJL...




In addition, thanks to the extensive media coverage we enjoyed from the beginning, two news items were published in two different Estonian digital media: Postimees and Pealinn. Postimees posted it the day before the workshop started. In contrast, Pealinn published it on November 18th, hours after the media covered the event in our makerspace, and included a video of almost two minutes in which, apart from briefly illustrating the work done, it also had a brief interview with some of the attendees. The video was also uploaded to the youtube channel Linnameedia, which is still available for viewing. As of February 6th 2023, it has 150 views, which gives us a rough idea of its impact on the local and Estonian community and makes us hopeful.



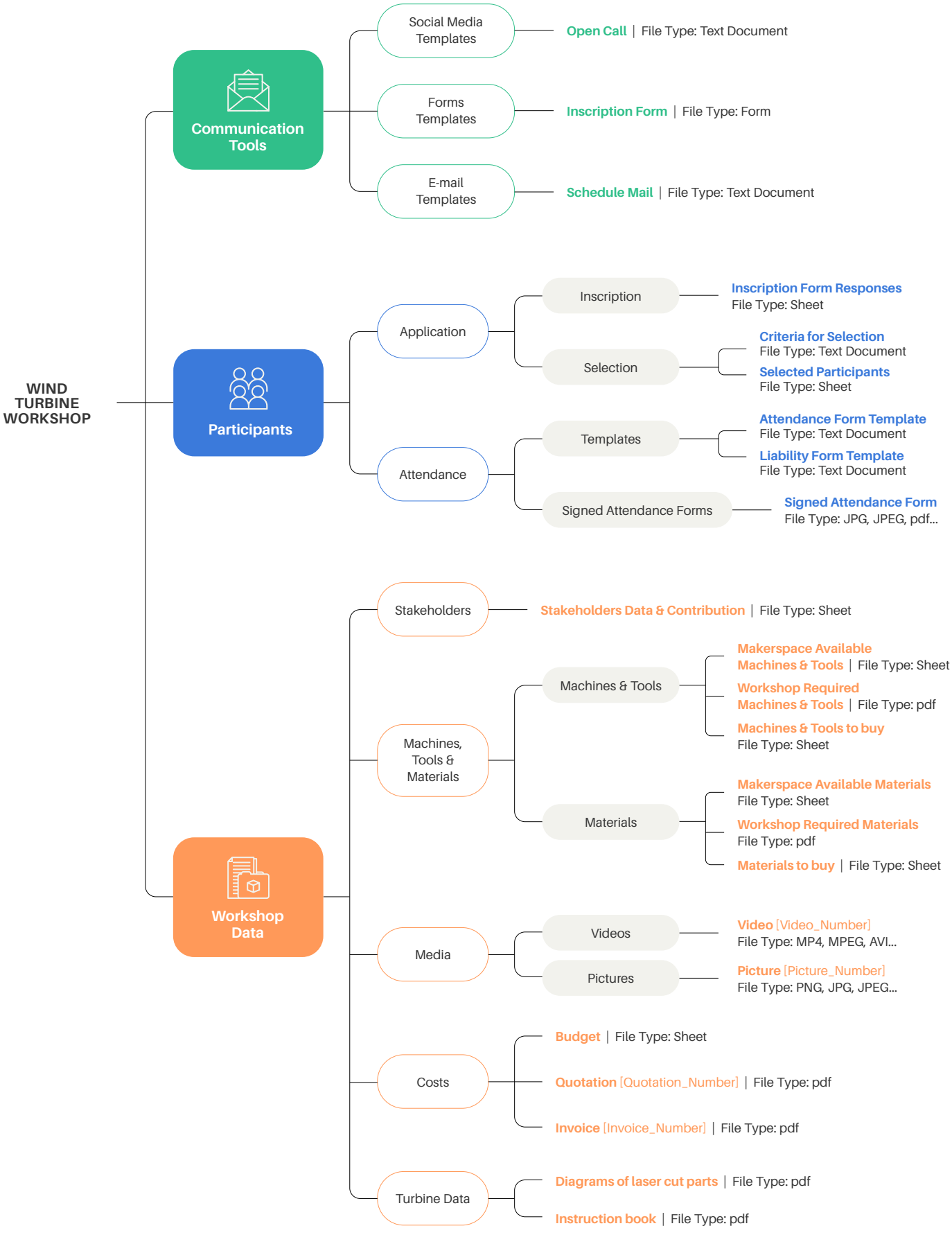
# Generating digital commons

As part of the stakeholders involved in the workshop, we created a cloud repository to clearly and securely store workshop and participant data. This repository also contained the materials for this deliverable. A closer look at this output leads us to propose an example of a repository that could be useful for future workshops. Ideally, this repository should be managed as a digital commons[1] [11], accessible to all stakeholders, with a set of rules for its management. These rules could be set out in a brief data management strategy agreed upon and subsequently also accessible to all stakeholders.

Organizing the repository in this way would help stakeholders work with consistent and up-to-date information and, in line with the spirit of the workshop, reduce negative environmental impact by avoiding duplicate information storage.

[1] The digital commons are commons in which resources are data, information, culture and/or knowledge created and stored online (De Rosnay & Stalder, 2020).

# Wind turbine workshop repository
## Infographics



# A small wind turbine

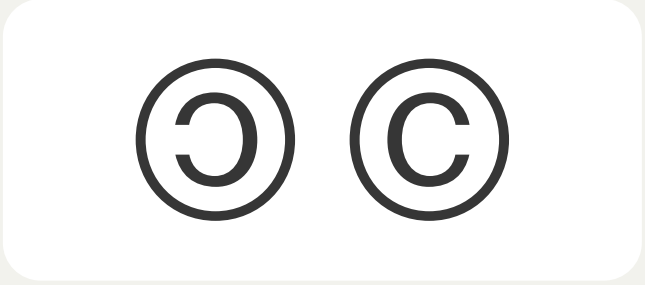
After four days of intense workshop work, we built our small wind turbine. The turbine is 1200 mm. in diameter with 600 mm. blades, 12 V. voltage, and mounts eight magnets in a single rotor disc and six coils in the stator. It is currently on display at the Kopli 93 Makerspace, mounted on a wooden tower of about 2 meters, built to support it temporarily. The turbine is customized, with small drawings on its front face and a phoenix-shaped tail that captures the feeling of the community at the time of its construction.

Following the workshop, we started discussions about its immediate future. Among the ideas we are considering is to make it functional by installing it on the roof of the Makerspace and, on the other hand, to tour Estonia's most meaningful events and festivals of a similar nature. Regardless of its immediate future, we strongly believe in its ability to inspire people and similar projects.

# Licensing and ownership

Who owns the wind turbine produced during the workshop? We are still figuring out the answer, so let's sketch some parts of an ongoing discussion here.

First, the design license of the small wind turbine model is copyrighted. The whole spectrum of elements to build the turbine is described in the book [10], and everything, including the technology's aim, seems to point towards open-source hardware.

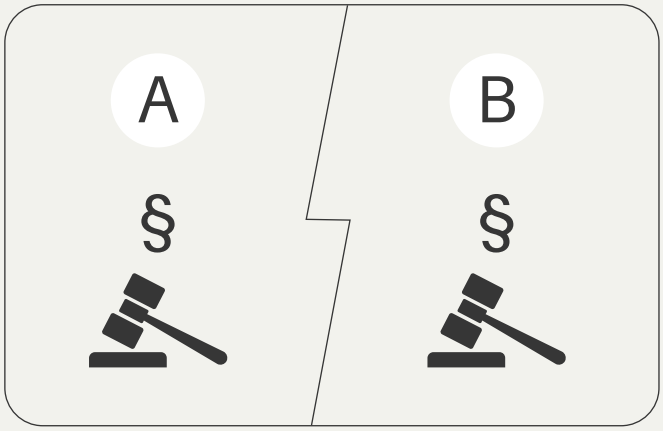


However, the design owner opted for a business model where selling the book brings needed income in a traditional fixed-price per-unit selling strategy. We learned that the intention is open-source, but the means to protect the technology are copyrighted. Ideally, each community building the wind turbines from the book would buy a book copy, and the community would 'acquire' the rights to make as many of those wind turbines as needed inside the community.

Second, needing a general agreement among our stakeholders on how to produce things at Kopli

93 makerspace; there is no way to determine who owns our small turbine.

The municipality was most interested in a repair shop service for the neighbours at the makerspace rather than producing new technology. It own the production space, part of the machinery used, and part of the materials. Therefore, it could claim a high stake in the material side of the turbine. However, it did not perform the work themselves.




The wind turbine was produced using their facilities and tools, but the space and the machines do not make anything alone. It is also covering the salary of the makerspace master, but the workshop's real wizard was the instructor from Nea Guinea, Kostas Latoufis.

The community-oriented stakeholders (CENTRINNO, Kopli 93, and Fab City Foundation) wanted the wind turbine to be owned by the Kopli 93 community. However, the community still needs to have a legal form (yet), so it cannot officially own the wind turbine. It was discussed that the turbine would be owned by the CENTRINNO local partner until the end of the project. It would be transferred to the Kopli 93 community after the community constituted itself as a non-profit organization. No steps have been taken yet.

Third, another part of the debate was about where the wind turbine would be installed.

The first option was Kopli 93 makerspace's roof. There it would be visible and functional. But installing it in a municipality-owned place would make a strong case for de-facto ownership of the wind turbine by the municipality. This is an ongoing debate. The wind turbine was produced in winter, and until the winter is over, the wind turbine will not be installed anywhere. For now, it stays inside Kopli 93 makerspace.

Fourth and last, let's examine the IP property claims over the ownership of our wind turbine.

The Fab City Foundation paid the workshop fee, which included a copy of the book, and it implies a concession over the property rights of the wind turbines produced by the community where the workshop took place.

Many of our stakeholders could claim some property rights over the produced wind turbine. Nevertheless, the goal is to transfer the property rights to the not-yet constituted non-profit organization of Kopli 93 makerspace. All other stakeholders with some sort of claim over the technologies produced at Kopli 93 should ideally waive any future ownership claims on the technologies made at the makerspace unless there is an agreement in place for the makerspace to build a technology for a stakeholder (or client).

This is crucial for empowering the local community of makers to feel supported instead of threatened by our stakeholders. No one wants to invest time and effort in endeavours that may be re-appropriated by someone else. The licensing and ownership issue should be solved before the makerspace community engages in further activities with a similar scope.

# What's coming next?

Next, Estonian elections to the parliament are coming in March. A general stakeholders' agreement with the municipality will be negotiated after the elections. For now, the makerspace master is on vacation in February, and everyone is busy with other things. Depending on the outcomes of next month's negotiations, more wind turbine workshops may be held, and maybe an informal group resembling a node of wind empowerment will start operating in Estonia with some of the workshop participants. Or the focus will shift to other aspects of building local energy resilience. One way or another, the makerspace community will maintain its own development. The community has been working for some months already in governance models with the aid of an expert wearing hats from two of our stakeholders. The possibility of establishing a non-profit organization for the community seems to be a solid idea. It is also important to determine the ownership rights of our small wind turbine. It is a symbol of something starting in Estonia. It should be kept and waved like a flag of 'the times are changing'.

# Open-sourcing Distributed Design practices

When we read that distributed design 'aims at developing and promoting the connection between designers, makers and the market', we may conclude that we are talking about connecting individual designers and makers to a market for selling their products or services. However, it may be too big a task for individual designers and makers to work within the parameters of the distributed design consistently.

To generate 'more sustainable, open, inclusive and collaborative practices, individual actions in markets ruled by giant global corporations may attain too little, too slow. We aim higher. We need new ways of working together: public-private-community multi-stakeholder networks with long-term ecosystemic business models. We need guidelines for emerging communities of designers and makers to associate among themselves and develop partnerships with local and global organizations.

We should start 'open-sourcing' our best practices, as good as we have them now, and collectively evolve them using global digital commons, peer-production collaborations, open licenses, and distributed innovation. We need to learn from each other, help solve each other's problems by showcasing ourselves to our network, making case studies on what happens to our circumstances and how we adapt to its limitations and opportunities.

Embracing an experimental attitude that rewards sharing the failures, the blocked and stalling situations, the trade-offs we face and our collective approach to breaking down, modularizing, and using an expert-based approach to solve our problems fragmented and recollected. Our governance models and decision-making processes. The tensions with public and private institutions, other communities, or within our own group.

We should start talking about our local worlds, who is there, and what are the situations at hand. Not worrying so much anymore to dutifully carry faultless EU-project-like reports on ourselves to avoid being questioned, maybe risking reaching objectives connected to funding. Stop being the 'reported shadow' of ourselves, for funders and clients, in social media and conferences and events, and accept that we are at the beginning, we have too much to learn. We have a long road ahead. And that we can only aspire to make a lasting impact in a world that needs feasible alternatives to what this-is-now if we work together, without whitewashing, without pretences, but by open-sourcing every local group, so we can become a truly empowered global network.

This document is a first attempt at open-sourcing a community during a workshop building copyrighted open-source hardware. We tried to connect an emerging group of local makers and a global community of small wind turbine designers. As the makerspace opened its gates barely three months before the workshop, and there are no makerspaces in the country, this experience can be considered as a 'too-many-first-times' condensed, while at the same time having an extended network of stakeholders with multiple capacities and converging interests. This represents an attempt to make sense of a chaotic emergent situation by using promising XXI century frameworks as distributed design. How does it look like where you are?

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