# Eco Sailing

Ultimate Freedom on 100% Renewable Resources

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August 27, 2025

# Contents

# Intro

## 0.1 What is Eco Sailing?

the Sailing flavour of Eco Travel:

Using a sailboat for habitation, recreation, or transportation without polluting the environment and without consuming resources beyond a fair share.

Eco Sailing means moving at sea and near the shore in such a way that is environmentally friendly, socially responsible, and economically sustainable.

### 0.1.1 Sustainability

*Sustainable* means lasting a long time, like *going forever* without harming the environment, society or yourself. It is a way of living and traveling that does not deplete resources while consuming only a *fair share*.

Most readers of this book have sorted their residential life already in a sustainable way. You separate your waste, you recycle, you compost, you eat less meat, you buy local products, you use more public transportation, you avoid plastic and so on. You have established a budget which balances income and expenses. You are already living a sustainable life at home.

In financial terms, sustainability means that I can travel longer or infinite if I do not spend more than I earn. Travelling on a low budget is not a choice or a goal by itself but a consequence of the choice to travel longer or indefinitely.

### 0.1.2 Systemic approach

Eco Travel is a system. A system of needs, choices, habits, procedures and equipment. A system within a geographical, climatic and cultural context.

Typically the system will evolve, based on changing opportunities and constraints, new priorities in needs, revisited choices, adjusted procedures and upgraded equipment. Habits will both begin the evolution (begin with what you like to do), and some changed or new habits will be the result of the evolution. Often the result will tend towards a simpler and happier version of your life.

### 0.1.3 Habits

Eco Sailing is different from a typical residential life, and different from mainstream yacht sailing. The biggest difference is the choice for sustainable resources at very limited capacity.

You may be living a very sustainable life on land, yet you have virtually unlimited supplies of water, electricity and food at home. Plus more space and the chance to grow your own food. The difference here is capacity.

Or you may be a seasoned sailor, used to a yacht with a big engine, large fuel tanks, a watermaker, a generator, air conditioning and a freezer. The difference here is the priority for sustainability.

Old habits are hard to break. I do not expect many readers from the established sailing community to give up their high standard of comfort and convenience. On my personal sailing journey, it was mostly eco-friendly people on land, and sailors on very small boats, whe were interested in the Eco solutions that I am using.

From whatever background you come, Eco Sailing likely requires new habits. Living with limited resources, slower, simpler. These habits are related to a more conscious every-day life, more connected to nature and on a smaller budget, which could be considered motiviations on their own, or intermediate steps towards a happier life in greater freedom.

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Whatever perspective you have on sailing: in this book I will tell you everything about the hacks and systems that I have successfully applied on two sailboats. By Eco Sailing I have travelled from the Baltic Sea to Gibraltar. I heard that my story inspires people, so I want to inspire and encourage you all to get on board and live your dreams.

## 0.2 Book Structure

Sailing, ecology and sustainability go together hand in hand.

> Not necessarily sailing a modern, overpowered yacht that offers 4-star comfort and hops from marina to marina, refilling fuel and water tanks and connecting to shore power as soon as they can. Here I am writing about a sailing lifestyle which is closer to camping in terms of comfort, and similar to living in an offgrid tiny house.

Many aspects of Eco Sailing remind me of Permaculture, which is why the first four chapters of this book are based on major permaculture principles:

1. Use Renewable Resources
2. Catch Resources
3. Store Resources *and*

4. Store Food

These chapters list procedures and equipment which are tightly related with each other and form a logical group.

The chapter Cooking and Eating is dedicated to fulfilling the basic human need, ideally not only to survive, but to enjoy as well. Chapters 1-4 build the foundation that culminates, on one side, in cooking and eating.

On the other side, chapters 1-3 are the foundation for mechanical and electric energy, which pushes the boat and powers vital equipment. The electrical side I cover in chapter Electro Backbone.

The mechanical and procedural aspects I cover in the two chapters on Sailing and Anchoring.

Finally, autonomy can reach a limit. The chapter on Infrastructure discusses how we connect to zivilization, from time to time, for supplies, repairs, social contacts and so on.

Remaining chapters mainly list in tabular form and reference all Eco Sailing components by type. Because Equipment, Choices, Procedures and Habits are discussed and dispersed throughout the book, these lists give you summarized overviews.

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I don't find it easy to present a larger system of interrelated topics in a linear way, like in this book.

Most concepts form shorter or longer causal chains, such as:

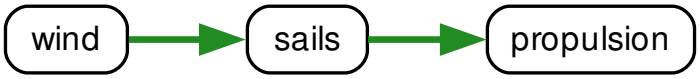


Figure 1: sails catch wind, generate propulsion

And also at other times:

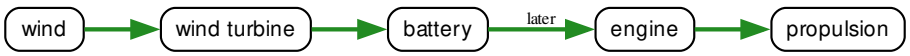


Figure 2: turbine catches wind...

The bigger, more accurate picture is:

So I chose to list Wind in chapter 1, Sails and the Wind Turbine (and all the other resource catchers) in chapter 2, the battery in chapter 3 and Propulsion in the Sailing chapter.

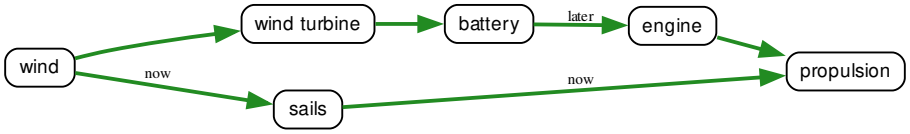


Figure 3: turbine and sails catch wind...

I am using many cross-references in the electronic versions of this book. They represent the green lines in the diagrams above. This way you can follow a causal chain from Wind, Turbine, Battery... (and back) if you want to. Otherwise you just keep reading chapter by chapter.

> Please let me know how this book structure works for your reading experience!

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## 0.3 About the author

Rock climber, paragliding pilot, sailor and engineer. Converted sailboats to 100% green energy for sustainable, autonomous life.

Full-time traveller since 2020, between the Arctic circle and the Sahara desert, in an electric car or on electric sailboats - producing "zero emissions".

Loves people, dogs and nature.

Believes in freedom and peace.

Figure 4: Portrait of Boran

# Chapter 1

# Use Renewable Resources

This section is directly derived from Permaculture principle #5.

It is what sets apart Eco Sailing from mainstream yachting: using the sea, wind and sun instead of diesel, marinas and shore power.

## 1.1 Wind

## 1.2 Rainwater

## 1.3 Seawater

## 1.4 Seaweed

## 1.5 Fish

## 1.6 Sunlight

*renewable resource*

A highly available resource which we often connect to electric energy. While solar panels are a great application for catching sunlight and converting it to electric energy. I value and use it a lot.

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If the goal of a particular activity is heating / boiling / cooking, however, then the most efficient way to use sunlight is to catch its infrared component, and use that as heat directly.

For me the most impressive way of doing that are solar stoves. I use hot water daily (2 liters estimated). When the batteries are not 100% full, I heat all water in solar stoves and keep it in thermos cans.

In theory, cooking on solar follows the same logic: heat food with sunlight. I do that frequently but I must admit: it is a different kind of cooking. Not all recipes work equally well, it is generally slower than a pan or a pot, and you need to learn new techniques. More on that in its own chapter.

The greatest advantage of solar cooking is that it consumes no fuel and no battery capacity.

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Another elegant yet luxury application of heat from sunlight is the solar shower. Downside: it consumes water. But if you would use that anyway for skincare, then catching the desired heat from sunlight is certainly clever.

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The most natural way of enjoying sunlight is certainly just letting it shine on your skin. Boatlife gives you plently opportunities for doing so.

# Chapter 2

# Catch Resources

Space and weight on a boat is limited. Catching resources from the environment is essential.

## 2.1 Catch Wind Energy

- Wind Turbine

## 2.2 Catch Solar Energy

- Solar Panels -> electric energy
- Solar Stoves -> heat for water and cooking
- Solar Shower -> heat for water

## 2.3 Catch Freshwater

- collect from public sources

## 2.4 Catch Rainwater

- from cabin roofs
- from deck
- from sails

## 2.5 Catch Saltwater

- for washing

- for flushing
- for desalination

## 2.6 Catch Food

- sea weed
- fish

## 2.7 Solar Panels

A great opportunity on a boat, even better on a catamaran, is the available space for mounting solar panels.

They catch sunlight, an endless renewable resource, and follow the Permaculture principle #2 (Catch and Store Resources).

Together with a modern charge controller, solar panels also implement the principle of self-regulation. If configured correctly, they will never over-charge your battery or overload your DC circuit.

# Chapter 3

# Store Resources

This section is derived from Permaculture principle #2 Catch and Store Resources.

It follows logically from the need to use resources (food, water, energy) not in the same moment when you catch or produce them.

In this book I am dividing storage of *food* from all other resources (water and energy).

This section here is about the "other" resources.

## 3.1 Hot Water

Fundamental for drinks and food: having hot water available is at the core of the Eco Travel kitchen.

With hot water, you can prepare tea and coffee. You can also prepare (I don't want to say "cook") porridge, instant noodles, instant soup, boiled eggs, taboule and other instant meals. You can also use it to wash dishes and to wash your hair.

You can prepare and carry hot water in a any mode of transportation: on foot, and even easier in a vehicle.

Boiling water requires quite some energy (200 Wh per liter, see chapter on Energy). Therefore it is best to keep hot water, that you do not use immediately, in a thermos.

Three liters of hot water contain the same amount of energy which is equivalent to half of a standard car battery. Imagine that: boiling 3 liters of water will empty half of your car battery.

Or in other words: keeping 3 liters of hot water is like installing an additional half car battery. It is the cheapest way of extending your energy storage capacity.

### 3.1.1 related Equipment

**always**

1. Thermos (to store hot water until you need it)

and **one or more of the following** for heating (in order of sustainability):

1. solar stove (mainly in car or boat, also possible for hiking)
2. 12 Volt immersion heater (in car or boat)
3. wood stove (solo stove, or similar) mostly for hiking or camping
4. compact gas stove (fossil but fast and versatile, perhaps as backup)

My favourite combination is the immersion heater in a thermos can. I use it almost every morning to -re-heat yesterday's hot water, and every afternoon to catch the last sunlight for heating tomorrow's hot water.

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Clearly the most elegant solution for heating water is with direct sunlight, using a solar stove. It works best when you are stationary. While driving, sailing or swinging around an anchor it might be impossible.

A solar stove takes time to boil water - approximately 40 to 80 minutes in direct sunlight for heating all of its content, which is depending on the stove size 0.4 to 3 liters. When you are stationary you can place the solar stove in the evening so that it will catch the morning sun, and you can harvest the hot water once to slip out of your sleeping bag.

During the day I boil several rounds of water in the solar stove and keep it in a thermos. This way you always have quick access to hot water, and still require no electricity, wood or gas. Bingo.

For bicycle travel, I find the solar stove the best possible heating option.

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The second most efficient way to boil water is with a 12 Volt immersion heater directly in your thermos bottle (car and boat only).

This will work in a car, but please be aware that it will drain your car battery quickly. In an electric car this is less of a problem. Otherwise use the immersion heater carefully while you are driving and the engine is running anyway. In stationary use with your car, and if you have solar panels to charge your 12 V system, then you can still dedicate electric energy for boiling water (relatively quickly) and replenish the battery with the help of the solar panel.

On a boat you are likely less limited in electric energy, and as an Eco Traveller you also have enough solar panels installed. When the batteries on my boat are fully charged then I use the immersion heater as my first choice, otherwise the solar stove.

You can shorten the time to boil water by starting with warm water that you kept from the previous day. On the sailboat I routinely boil water in the 2 liter thermos in the afternoon, and use (perhaps re-heat) that for the rest of the day and the next morning.

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A small and efficient wood stove, like a Solo Stove, uses a renewable fuel that comes for free. Plus the wood stove can not only boil water but also cook a real meal. It is great for hiking and for bicycle travel. Obviously it requires careful handling, it produces smoke and requires cleaning after use. The total manual time to boil water (or cook a meal) is larger than in the other options.

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A compact and efficient gas stove, such as the Primus Lite, is the fastest and most universal way to boil water or even cook. The biggest drawback is that it uses a fossil fuel that is not renewable. I am listing it here anyway because of its great utility.

When electric capacity was limited and sunlight not available, then I would use the gas stove as a backup. If we look at it from a *Fair Share* perspective, I would say that it is acceptable to use a gas stove after the other options have been exhausted.

On my current sailboat setup this is not an issue anymore, and now I have not used the gas stove since a year.

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Even when you don't have the means to heat water yourself, you can still bring hot water with you. You can buy or get hot water for free in many places, such as cafes, restaurants, hotels or from your couchsurfing hosts.

## 3.2 Batteries

On a sustainable and autonomous boat, batteries play a larger role. Obviously to store energy between the time you can harvest it (from sun and wind), and the time when you need it (for engines, cooking, lights, instruments and you-name-it).

By definition and by their nature as an energy-storage-system (ESS), batteries support the Permaculture Princicple #2: Catch and **Store** Energy.

> A completely alternative approch for storing electrical energy would be **fuel cells**. I had only researched but never worked with them.

> Please contact me if you want more information about fuel cells, then I will be happy to elaborate about my research results.

Typical electrical devices on a sailboat use 12 Volts as their input voltage. Therefore, it makes sense to have a 12 V battery system (so-called bank) on board.

On an all-electric boat there are typically some electrical loads which require a lot of power. Most notbably the engine(s), consuming several kW, and the inverter. The inverter in turn powers our convenient solution for cooking: the induction stove, with a max power consumption of 2 kW.

It simplifies wiring and improves efficiency if we supply those high-power loads from a higher voltage than 12 Volts. 48 Volts is a convenient voltage with a large market of batteries and appliances.

So our complete battery landscape is a combination of some 12 Volt batteries and some more 48 Volt batteries. On Love & Liberty, for example, has about 2.5 kWh in 12 Volt batteries and about 9 kWh of installed 48V battery capacity.

I am planning most of the capacity needs to be served from 48V for best efficiency, and a basic level of capacity in the 12 V battery banks. The 12 V bank should be large enough to power the boat over night (including the navigation mode, lights and autopilot).

### 3.2.1 Voltage Conversion

Should the 12 Volt batteries run out of energy, then I have a step-down solution in place which feeds the 12 Volt system from the 48 V batteries.

Also in the other direction we typically need to convert voltage. As much as I wanted all power generation to happen on the 48 V level, most solar panels and wind turbines deliver in 12 Volt. So we have to work with that. Step-up converters are taking care of that. In a perfect system, all electric power generation would directly feed into the 48 V system. But I have not found a complete solution for that, yet.

More on voltage conversion (12 V <-> 48 V -> 230 V) in the detailed chapter. I am mentioning it here in the battery chapter just to let you know that the 12 V batteries are not totally isolated from the 48 V batteries. You do not need to get the proportion between both banks exactly right, because we can always convert energy between them, at the expense of some conversion losses.

> A different battery architecture could use midpoint voltages not as a burden but as a chance. You could design a battery bank with 12 V batteries in serial connection, use the total of 48 V for specific loads (engines, inverter) and use the intermediate 12 V potential(s) for your 12 V bus of loads. This way, you eliminate conversion losses but you add losses from voltage drops in the diodes that you will inevitably need. All your 12 V loads (and chargers) must necessarily go through

at least 2 diodes - which will add 0.6 V to 1.4 V of voltage drops - which is a lot. While certainly viable, I had decided against such a solution. Therefore I do not introduce this architecture as a solution here, because I am writing only about tested and proven solutions. But if you are interested in that option, then please contact me and we can dive deeper into this subject. Perhaps I will build a prototype.

Yet another alternative is to operate just one 48 V battery bank, and supply your 12 V loads from a step-down converter (or better: redundant parallel converters, in order to eliminate a critical single-point-of-failure). This would also imply that all electric power generation must go to the 48 V system. If you have 12 V generators (solar panels or wind turbines), then you would step-up convert their output, just to step-down for 12 V loads. The total (system) efficiency for 12 V loads would be pretty poor. The efficiency for 48 V would not be affected. I did not choose this approach, but it is a viable one.

### 3.2.2 Chemistry

You have certainly heard of lithium batteries as an alternative to lead-acid batteries. For the 48 V battery bank, which you will likely install as a new one, there is no reasonable alternative to Lithium batteries. Yes in theory you could wire old (or new) 12 V lead-acid batteries in series, to produce a total of 48 V bank voltage. But then you must take care of midpoint voltages (at 12V, 24V and 36 V) and balance the batteries yourself. It is possible but unnecessarily complicated. Every quality lithium battery will take care of cell balancing internally (and very good ones will report on the internal cell voltages, for safety).

If you have sufficient capacity in your existing lead-acid 12 V batteries, then you can perfectly continue using those until their end of life.

You can also swap them out one-by-one, or expand your existing lead-acid batteries with lithium batteries in parallel. In this case you just need to set the charging voltages (float and absorption) in your 12 V charge controller(s) to a safe level for all your existing 12 V batteries.

I advise you to invest in lithium batteries whenever you buy new ones, and to avoid complicated serial battery banks where you need to manage and balance midpoint voltages.

When you compare the price of Lithium batteries to their usable capacity, they are not as expensive as they look at first glance. 12 V batteries are offered with a certain specified capacity but actually you can only use 50% of that without deep-discharging and permanently damaging them. With lithium chemistry, in contrast, you can use 80% of the rated enery without damage.

# Chapter 4

# Store Food

This section is derived from Permaculture principle #2 Catch and Store Resources.

In this book I am dividing storage of *food* from all other resources (water and energy).

This section here is about the *food* resources: your pantry.

My logic for storing food is:

1. most of my food shall keep for a long time without refrigeration
2. meals from stored food shall be easy or quick to prepare
3. preparing these meals shall be efficient in the usage of water and energy
4. most stored food items shall be useful in a larger number of recipes

The longer food keeps, the less frequently you need to stop sailing and re-stock your supplies. This increases autonomy.

Quick and easy preparation is fundamental when you are sailing short-handed or in high seas.

Efficient use of energy and water also increases autonomy because it does not deplete these resources as quickly. Cooking pasta and wasting liters of hot water is contrary to my logic. You can fix that by substituting pasta with rice (absorbs all water), or by cooking one-pot-pasta (no excess water).

Mostly I avoid one-trick-ponys in my pantry. This way I can create a larger variety of dishes from a smaller number of different ingredients. This increases diversity in my menu.

Of course the food shall be healthy, responsibly sourced and delicious. These properties are somewhat subject to opinion or personal taste, so the composition

of your pantry will be a different one. The purpose of my compilation is to demonstrate a system, or logic, between the catch / store and cook / eat topics.

I further separate my food inventory list into long-term storage (keeps for years) and mid-term storage (keeps for weeks).

On top, short-term storage is always improvised and a matter of availability (shops at land). Short-term storage is not strategic for the planning and for the goals of Eco Sailing. So yes, I do enjoy bread, butter and cheese - I just don't count on it. That's why I don't cover it in the storage section.

## 4.1 Mid Term Storage

Items in mid-term storage I can re-stock every week or two. Ideally sourced from local farmers, otherwise from groceries.

### 4.1.1 Potatoes

Offers a wide range of different end results (recipes). Surprisingly low in calories.

Used raw in: Rösti, Tortilla Espanol and Tajine. Used as boiled potatoes in: Fried Potatoes and Potatoe Salad

Also as the side dish for a million of other recipes (which I don't cook).

I boil them in seawater in a solar stove, for example on a sunny afternoon. Then I can decide later on the meal that I want to prepare quickly from boiled potatoes.

### 4.1.2 Onions

High in vitamin C. Depending on preparation, can taste soft, crisp, crunchy, sour, sweet or roasted.

I like to fry them quickly in a pan, then add them to many salads or meals.

Used in: Tortilla Espanol, Rice Tika Masala and Fried Potatoes, and optionally in Omelette, One-Pot-Pasta, Potatoe Salad and Tajine.

### 4.1.3 Garlic

The little brother of onions. Keeps even longer, but not as versatile as onions in its use in recipes. Somewhere between *ingredient* and *spice* that you can add to almost anything. Special appearance in Pasta Alio & Olio.

### 4.1.4 Eggs

Depending on climate somewhere between short-term and mid-term storage.

Used in: Omelette, Tortilla Espanol and Tamago.

## 4.2 Long Term Storage

Items in long-term storage I can store in bulk sizes (packs of kilograms or larger), and I need to re-stock only once per year, in theory. Typically I rotate my stock and re-supply smaller quantities after I consumed them.

### 4.2.1 Oatmeal

Used in: Porridge mainly. Can substitue wheat flour to a certain degree, and added to Omelette surprisingly.

### 4.2.2 Sunflower Seeds

Used in: Porridge, and for the quickest snacks (without cooking) together with raisins, or just plain.

### 4.2.3 Raisins

My main source for (culinary) sweetness.

Used in: Porridge, and for the quickest snacks (without cooking) together with sunflower seeds or peanut butter.

### 4.2.4 Peanut Butter

Admittedly not the highest quality of vegetable oil, but so versatile and easy to process (mostly without coooking).

I use it as the quickest snack with raisins, for example when sailing single-handed.

Can serve as spread on bread, can be added to Porridge, Salad, and almost any other recipe.

### 4.2.5 Mustard

Solid basis for vinaigrette (salad dressing) and an allround addition to many dishes. Special appearance in Seaweed Salad. Also keeps relatively well when opened.

### 4.2.6 Vinager

The standard for vinaigrette (salad dressing). Indispensable for (Cole) Slaw.

Can also be used for general cleaning and sterilization, and for removing corrosion from copper cable (mix with salt).

### 4.2.7 Mung Beans

For sprouting. Creates a fresh and green plant from long-term storage dry beans, within 24 hours. Ingenious trick of nature. I sprout them every day and add them to almost any meal, including Porridge.

### 4.2.8 Rice

The fundamental cereal, and the "more sustainable" alternative to pasta because rice naturally absorbs all and exactly the water that you cook it in.

Used in Rice Tika Masala, and in the Japanese Tamago for a fast and delicious snack.

And of course as the side dish for a million of other recipes (which I don't cook).

### 4.2.9 Pasta

Well, the standard. I suggest to cook only as One-Pot-Pasta, not to waste water and energy. See Rice as the more efficient alternative.

### 4.2.10 Ramen Kit

Somewhere between rice, pasta and soup.

### 4.2.11 Mayonnaise

An amazingly fresh tasting, long keeping food (while closed of course).

Used in Potato Salad as the second main ingredient. Also can substitute butter as a spread on bread.

### 4.2.12 Olive Oil

My main and only vegetable oil for cooking.

### 4.2.13 Falafel Mix

I admit, this is a one-trick pony. Can only produce Falafel. Mentioned here as an example and proxy for other ready mixes that I can cook or fry in the pan.

### 4.2.14 Soy Sauce

Alternative to vinaigrette, or as a dip for fresh vegetables (cucumber, carrots, zucchini/courgette).

Easiest sauce to eat with rice, or more sophisticated as Tamago.

# Chapter 5

# Cooking and Eating

or: my Nomadic Cookbook

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## 5.1 No Cooking At All

### 5.1.1 Trail Mix

also known as: Mélange Montagnarde (fr) / Studentenfutter (de)

Sunflower Seeds + Raisins

Extend or replace your favourite fruits, seeds and nuts. I find the above the most versatile also for other recipes.

Time to prepare: just go to the galley.

### 5.1.2 Energy Snack

Peanut Butter + Raisins

### 5.1.3 Seaweed Salad

Highly depends on seewead availability. I never plan this dish but prepare it when I happen to catch seaweed, typically on the anhor chain.

Seaweed + soy sauce, or mustard + olive oil

10 minutes for cleaning (from sand) and cutting / ripping to pieces +
5 minutes for the vinaigrette

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## 5.2 Just add Hot Water

Based on hot water, which I recommend to have always ready on the Eco Sailboat, these are very quick meals to prepare:

### 5.2.1 Ramen

The classic, no comment...

5 minutes

### 5.2.2 Porridge

Pour hot water over oatmeal and raisins. Let both soak (raisins will inflate and get soft). Add sunflower seeds, peanut butter and sprouts. Diced apple goes well with it, if you have. Add instant coffee or cacao for the taste, if you like.

Sometimes I eat it as a breakfast, sometimes as a desert, or just as a quick meal.

5 minutes to mix, 5 minutes to soak

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## 5.3 Proper Dishes

### 5.3.1 Falafel

Falafel mix + hot water, let soak, form patties, then fry with oil in a pan or in solar stove

5 minutes for mixing and forming, 10 minutes for soaking, 10 minutes and 0.2 kWh for frying (pan) or 60 minutes in solar stove

### 5.3.2 Potato Salad

Mix boiled potatoes with onion or pickled cucumber and mayonnaise

10 minutes for cutting and mixing, if you have (sun-) boiled potatoes, 20 more minutes and 0.5kWh if you need to (pot-) boil them first

### 5.3.3 Tortilla Espanol

1. fry half onion rings in a pan, then keep separate
2. boil diced raw potatoes in 50% olive oil and (hot) water; add some salt
3. while potatoes are boiling, add eggs to the fried onions and mix
4. when potatoes are done (cutting edges getting soft), add onions and eggs and fry everything for 5 minutes
5. cut in 6 or 8 pieces while still in the pan, and turn pieces around (saves a plate and a mess)

45 minutes total

0.5 kWh energy (no solar option)

# Chapter 6

# Electro Backbone

# Chapter 7

# Sailing

# Chapter 8

# Anchoring

# Chapter 9

# Infrastructure

# Chapter 10

# Equipment (summary)

everything that we carry or install on the boat, I call *equipment*.

Equipment is always a means to an end, such as Catching or Storing Resources or Cooking. Therefore I have sorted the detailed description of most pieces of equipment into those sections.

Here is a complete list of equipment from this book.

| Section | Item | Use | Principles |
|---|---|---|---|
| Catch R | Solar Panels | sunlight to el. energy | |
| Store R | Thermos | storing hot water | 2 . . . Store |
| Store R | 12 V immersion heater | boiling water | 6 No Waste, 9 Small |
| Store R | Batteries | storing el. energy | |
| Cook/Eat | Silicone Spoon | cleaning dishes | 2 Catch . . . , 6 No Waste |

## 10.1 Silicone Spoon (or Spatula)

For those who have been using it for a while, this is a fundamental helper in the kitchen - be it on a travel or at home.

Most of us know the silicone spoon as a one-trick-pony, but it can do so much more than just remove dough from a bowl. In Eco Travel, we use the silicone spoon after every single meal to clean the dishes as much as possible. It serves two purposes: preventing food waste and saving water.

When fresh water is limited, certainly while hiking, perhaps also in your car or boat, then you want to avoid wasting it. Using these techniques, I could travel the Moroccan Sahara for 2 weeks with only 1 liter of water per day.

**How to Use**

Adopting the silicone spoon requires a change of your habits. Instead of rinsing your plate with soap and lots of water, you use the silicone spoon to scrape off any remaining food - especially oily or sticky substances. After this pre-cleaning, you can wash the dishes with a minimal amount of water.

You can even go further and drink the water which you just used for final cleaning.

> Wait - you drink your dishwater?

Yes I do. Just 5 minutes earlier this has been my meal. A healthy one I might add. Here is another change in habits: when you wash dishes a long time after your meal, then yes, they will begin to stick and perhaps smell. This is where we learned, correctly, that used dishes are not exactly hygienic. Quite differently immediately after a meal. Scraping dishes, finishing with a little water and then drinking it is perfectly fine. A liquid version of the meal which you had 5 minutes ago.

**Where to avoid**

Avoid very sharp edges, like the opening of a tin can, or a knife obviously. They will cut the silicone.

**Which to buy**

You can find silicone spoons in most supermarkets, in various sizes and shapes. The perfect shape is very flexible. Sometimes the handle stick makes it stiffer than it should be - avoid that shape.

The best size is a bit larger than a tea spoon - small enough to fit in your mouth. This fits personal dishes perfectly. It requires a bit more work to clean pots and pans. If you can have two, then I recommend a larger one for pots and pans, and a smaller one for personal dishes. If you can only have one (hiking), then the smaller one is the most versatile.

# Appendix A

# Permaculture

While invented in a farming context, the principles of permaculture can be applied to many areas of life, including Eco Travel. In fact, Eco Tavel and Permaculture align with each other very well.

Below is a table that outlines the 12 principles of permaculture and how they can be adapted for travelling.

Our thoughts here are not designed to teach permaculture. If you are familiar with permaculture already, you may find these principles useful for thinking about how to travel in a more sustainable way.

## A.1 Classic Permaculture Principles

| # | Principle | *explanation (classic)* | in this book |
|---|---|---|---|
| 1 | Observe and Interact | Take time to observe natural systems and interact with the environment to better understand how it functions and to make decisions that work in harmony with nature. | |
| 2 | Catch and Store Resources | Capture resources like sunlight, water and wind when they are abundant to make them available during times of need. | Ch.2, Ch.3, Ch.4 |
| 3 | Obtain a Yield | Design systems that produce useful outputs, whether food, energy, or materials, to support sustainability and self-reliance. | |

| # | Principle | *explanation (classic)* | in this book |
|---|---|---|---|
| 4 | Apply Self-Regulation | Create systems with built-in checks and balances that respond to feedback, helping to avoid resource depletion and maintain balance. | |
| 5 | Use Renewable Resources | Prioritize renewable materials and energy to reduce dependency on finite resources. | Ch.1 |
| 6 | Produce No Waste | Design systems where all outputs are reused or recycled, minimizing waste. | |
| 7 | Design from Patterns to Details | Use natural patterns (e.g., water flow, seasons) to guide farm design before focusing on specifics. | |
| 8 | Integrate Rather than Segregate | Create systems where elements work together, like plants and animals, for mutual benefit. | |
| 9 | Use Small and Slow Solutions | Start with small, manageable systems that evolve naturally over time. | |
| 10 | Use and Value Diversity | Incorporate diverse plants, animals, and methods to build resilient systems. | |
| 11 | Use Edges and Value the Marginal | Leverage boundaries (e.g., forest edges) where diverse ecosystems create unique opportunities. | |
| 12 | Creatively Use and Respond to Change | Adapt to environmental or social changes with creative, flexible solutions. | |

Mapping the Permaculture Principles to Eco Travel

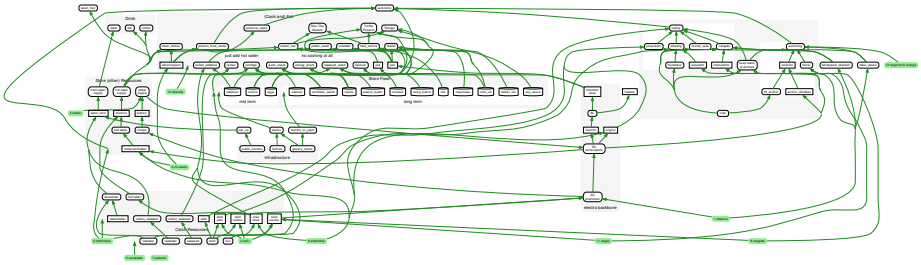
| # | Principle | transfer to Eco Travel | transfer to Boat |
|---|---|---|---|
| 1 | Observe and Interact | Watch the weather. Choose local food. | Sail with the wind *but* Hide from the storm |
| 2 | Catch and Store Resources | Bottle water when you find a source. Cook while it is sunny. Boil water while it is sunny. Keep hot water in a thermos. Shop groceries while you are in civilization. Find local organic shops. Eat pizza while you can. | Sail with the wind *or* Rest in a calm |

| # | Principle | transfer to Eco Travel | transfer to Boat |
|---|---|---|---|
| 3 | Obtain a Yield | Store excess energy in batteries. Share water, food and energy with others. Offer coffee. Offer help and advice. Take hitchhikers. Learn from locals. | Share the boat and offer a guest cabin |
| 4 | Apply Self-Regulation | travelling inhererently limits resources that you carry, making you constantly aware of supply and usage | |
| 5 | Use Renewable Resources | *(this is why we focus on foot / bicycle / sailboat and not airplane or cruise ship)* Take 'a shower' in natural bodies of water. | Boil potatoes in sea water. Clean dishes with sea water (after saving food with silicone spoon) |
| 6 | Produce No Waste | Carry paper bags for re-use in wrap-free groceries (sections). Clean dishes with silicone spoon. | |
| 7 | Design from Patterns to Details | Follow the sun (seasonal migration) to eliminate the need for heating. | Plan sailing routes also based on availability of usable moorings in the destination area. |
| 8 | Integrate Rather than Segregate | | Install walkable, flexible solar panels on horizontal surfaces (no davits which add weight, windage and torque) |
| 9 | Use Small and Slow Solutions | | |
| 10 | Use and Value Diversity | | |
| 11 | Use Edges and Value the Marginal | | |

| # | Principle | transfer to Eco Travel | transfer to Boat |
|---|---|---|---|
| 12 | Creatively Use and Respond to Change | Be flexible with travel plans. Embrace spontaneity. Rest while you can. Make eye contact, meet strangers, offer coffee. Choose hobbies or work which complement travelling (e.g. indoors while raining). | Sail no matter how low the windspeed (but respect hard weather). Let the boat drift in low wind (and no obstacles). |

# Appendix B

# Book Architecture



# Appendix C

# a little science of Energy

If we want to manage and conserve energy, we need to develop an understanding of energy amounts.

How much energy to move a car for a mile? How much energy to cook pasta for two? How much energy to heat a room for an hour? To boil a liter of water?

| what | how much | notes |
|---|---|---|
| boil water | 10 liters | from 20° to 100° Celsius |
| drive an electric car | 5 kilometers | *at about 100 km/h, depends on the car of course* |
| move a boat (slowly) | 10 nautical miles | *at about 2-3 knots, depends a lot on the boat, wind and current* |

To be honest: before I began driving an electric car, I did not have a clue how much energy is stored in a tank of gasoline, and how much energy is needed for cooking pasta. These things did not have to do anything with each other. They did not seem to have a common unit. I topped up my car and paid for the gasoline per liter. I cooked pasta, and while I knew roughly the price of electricity, but I certainly did not calculate the amount of energy or its price for a pasta meal.

For me this behaviour of passive energy consumption changed when I installed the cables and planned for the daily charging need of my first electric car. I charged it at home, so the car's energy consumption and the domestic energy consumption were now related. I estimated the total daily, monthly and annual consumptions. Also I changed the electricity provider to an 100% renewable one, because now energy consumption was part of my active decision making.

This topic is somewhat scientific and mathematical in nature. After all, we need to calculate power and energy when we make decisions about how many solar panels to install, and how large a battery to buy.

But I will keep everything simple and practical. My explanation format here is hybrid: I will explain the mathematical facts so that we will be able to actually calculate, and I will give intuitive analgies that you will mostl likely recognize from your daily life.

> There is no need to be frustrated if you do not find the mathematics intuitive. I must admit: I still do not find it intuitive myself. But I have learned to use it, and now it is almost second nature to me. It is a bit like using a computer: you do not need to understand how it works inside. As long as you can start it up, use the browser or a text editor or an email program, it is a success.

### C.0.1 Energy, Power and Time

Hiking up a hill requires a certain amount of energy for my body. The energy is transmitted to the muscles as blood sugar. Sooner or later I replentisch the energy by eating food.

Hiking up a in 30 minutes requires twice the power than hiking up the same hill in one hour. My body can clearly feel the difference. I need to breathe harder and my face may turn red. The total consumed energy is the same, but the time and power is different.

Here is the abstract formula which relates energy (E), power (P) and time (t):

$$E = P \cdot t$$

### C.0.2 Energy Units

A typical unit of power is the Watt (W).

Some examples: a smartphone operates at a few Watts. A laptop computer around 30 Watts. An electric cooking stove operates between 800 and 2000 Watts.

A car that accelerates or drives as high speed operates perhaps at 100 “Horse Powers” (HP), which is about 70 Kilowatts (70 thousand Watts).

The human brain operates at 30 Watts - what a mighty and efficient computer we have there!

Now, Energy is Power multiplied by Time. So, if we use the unit Watt for Power, we can express Energy in Watt hours (Wh).

A practical unit for the amount of energy is the kilowatt hour (kWh) [1]. It is the amount of energy that *something* with a power of 1 kW consumes in one hour.

[1] actually the official scientific unit is Watt Seconds (Ws), or Joule, but this is not very practical for daily use. 1 kWh = 3.6 megajoule.

# Appendix D

# Fundamentals (WIP)

No matter which type of transportation, a few topics are always relevant:

1. clothes
2. drinks
3. food
4. shelter
5. energy
6. communication

These topics are related. For example, hot water requires energy input and supports both the preparation of drinks (tea, coffee) and food (porridge, instant soup, ramen noodles, rice, pasta, potatoes).

When weight or space is limited, I find it a good compromise to heat water and prepare simple meals, instead of cooking fancy dishes.