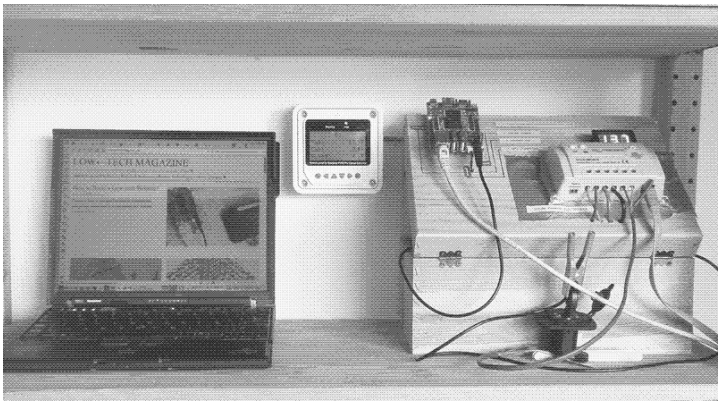
About this website

This website is a solar-powered, self-hosted version of Low-tech Magazine. It has been designed to radically reduce the energy use associated with accessing our content.



Second prototype of the solar powered server that runs this website.

Last update: January 28, 2020

Low-tech Magazine questions the belief in technological progress, and highlights the potential of past knowledge and technologies for designing a sustainable society. Because a web redesign was long overdue — and because we try to practice what we preach — we decided to build a low-tech website that meets our needs and abides by our principles.

To reduce energy use, we opted for a back to basics web design, using a static site instead of a database driven content management system. We further apply default typefaces, dithered images, off-line reading options, and other tricks to lower energy use far below that of the average website. In addition, the low resource requirements and open design help to keep the blog accessible for visitors with older computers and/or less reliable Internet connections.

Because it uses so little energy, this website can be run on a mini-computer with the processing power of a mobile phone. It needs 1 to 2.5 watts of power, which is supplied by a small, off-grid solar PV system on the balcony of the author's home. Typical for off-the-grid renewable power systems, energy storage is limited. This means that the website will go off-line during longer periods of cloudy weather.

The solar powered server in the media(https://solar.lowtechmagazine.com/media-links.html)

Page size: 397.41KB

Why a Low-tech Website ?

We were told that the Internet would "dematerialise" society and decrease energy use(https://www.bcg.com/publications/2012/energy-environment-technology-industries-smarter-2020-role-ict-driving-sustainable-future.aspx) . Contrary to this projection, it has become a large and rapidly growing consumer of energy itself. According to the latest estimates, the entire network already consumes 10% of global electricity production(https://solar.lowtechmagazine.com/2015/10/can-the-internet-run-on-renewable-energy/) , with data traffic doubling roughly every two years.

In order to offset the negative consequences associated with high energy consumption, renewable energy has been proposed as a means to lower emissions from powering data centers. For example, Greenpeace's yearly ClickClean report(http://www.greenpeace.org/usa/global-warming/click-clean/) ranks major Internet companies based on their use of renewable power sources.

However, running data centers on renewable power sources is not enough to address the growing energy use of the Internet. To start with, the Internet already uses three times more energy than all wind and solar power sources worldwide can provide. Furthermore, manufacturing, and regularly replacing, renewable power plants also requires energy(https://solar.lowtechmagazine.com/2015/04/how-sustainable-is-pv-solar-power/) , meaning that if data traffic keeps growing, so will the use of fossil fuels.

Finally, solar and wind power are not always available, which means that an Internet running on renewable power sources would require infrastructure for energy storage and/or transmission that is also dependent on fossil fuels for its manufacture and replacement(https://solar.lowtechmagazine.com/2017/09/how-to-run-modern-society-on-solar-and-wind-powe/) . Powering websites with renewable energy is not a bad idea. However, the trend towards growing energy use must also be addressed.

Websites are getting "fatter"

The growing energy use of the Internet is associated with two trends. First, content is becoming increasingly resource-intensive. This has a lot to do with the growing importance of video, but a similar trend can be observed among websites.

The size of the average web page(https://httparchive.org/reports/page-weight) (defined as the average page size of the 500,000 most popular websites) increased from 0.45 megabytes in 2010 to 1.7 megabytes in June 2018. For mobile websites, the average "page weight" rose tenfold from 0.15 MB in 2011 to 1.6 MB in 2018. Using

different measurement methods, other sources report average page sizes of up to 2.9 MB in 2018.

The size of the average web page increased at least threefold from 2010 to 2018.

The growth in data traffic surpasses the advances in energy efficiency(https://www.researchgate.net/publication/224224694/download) (the energy required to transfer 1 megabyte of data over the Internet), resulting in more and more energy use.

Over and above this, "heavier" or "larger" websites not only increase energy use in the network infrastructure, but they also shorten the lifetime of computers — larger websites require more powerful computers to access them. This means that more computers need to be manufactured, which is a very energy-intensive process(https://solar.lowtechmagazine.com/2009/06/embodied-energy-of-digital-technology/) .

Always online

A second reason for growing Internet energy consumption is that we spend more and more time on-line. Before the arrival of portable computing devices and wireless network access, we were only connected to the network when we had access to a desktop computer in the office, at home, or in the library. We now live in a world in which no matter where we are, we are always on-line, including, at times, via more than one device simultaneously.

Continuous network access doesn't combine well with renewable energy sources such as wind and solar power, which are not always available.

"Always-on" Internet access is accompanied by a cloud computing model – allowing more energy efficient user devices at the expense of increased energy use in data centers. Increasingly, activities that could perfectly happen off-line – such as writing a document, filling in a spreadsheet, or storing data – are now requiring continuous network access. This does not combine well with renewable energy sources such as wind and solar power, which are not always available.

Addressing both issues

Our new web design addresses both these issues. Thanks to a low-tech web design, we managed to decrease the average page size of the blog by a factor of five compared to the old design – all while making the website visually more attractive. Secondly, our new website runs 100% on solar power, not just in words, but in reality: it has its own energy storage and will go off-line during longer periods of cloudy weather.

The 50W solar PV panel in our original configuration. Since January 2019, we have been running the website on solar panels of 10W and 30W.

How is the website designed?

The Internet is not an autonomous being. Its growing energy use is the consequence of actual decisions(http://tonsky.me/blog/disenchantment/) made by software developers, web designers, marketing departments, publishers and internet users. With a lightweight, off-grid solar-powered website, we want to show that other decisions can be made.

The average page size of this website is below 0.5 MB — roughly a sixth of the average page size of the original website

With about 100 articles online, the average page weight on the solar powered website is now below 0.5 MB — roughly a fifth of the average page size of the previous design, and less than three times the average page size of the 500,000 most popular blogs in June 2018. The page weight for each article on this website is shown in the lower left corner of the screen.

Below are some of the design decisions we made to reduce energy use. We have published a separate document that focuses on the front-end efforts(https://github.com/lowtechmag/solar/wiki/Solar-Web-Design) , and one that focuses on the back-end(https://homebrewserver.club/low-tech-website-howto.html#software) . We have also released the source code for our website design(https://github.com/lowtechmag/solar) .

Static Site Generator

One of the fundamental choices we made was to build a static website. Most of today's websites use server side programming languages that generate the website on the fly by querying a database. This means that every time someone visits a web page, it is generated on demand.

On the other hand, a static website is generated once and exists as a simple set of documents on the server's hard disc(https://varia.zone/en/what-a-website-can-be.html) . It's always there — not just when someone visits the page. Static websites are thus based on file storage whereas dynamic websites depend on

recurrent computation. Static websites consequently require less processing power and thus less energy.

A static website requires less processing power because it is not dependent on recurrent computation

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The choice for a static site enables the possibility of serving the site in an economic manner from our home office in Barcelona. Doing the same with a database-driven website would be nearly impossible, because it would require too much energy. It would also be a big security risk. Although a web server with a static site can be hacked, there are significantly less attack routes and the damage is more easily repaired.

Dithered Images

The main challenge was to reduce page size without making the website less attractive. Because images take up most of the bandwidth, it would be easy to obtain very small page sizes and lower energy use by eliminating images, reducing their number, or making them much smaller. However, visuals are an important part of Low-tech Magazine's appeal, and the website would not be the same without them.

By dithering, we can make images ten times less resource-intensive, even though they are displayed much larger than on the old website.

Instead, we chose to apply an obsolete image compression technique called "dithering". The number of colours in an image, combined with its file format and resolution, contributes to the size of an image. Thus, instead of using full-colour high-resolution images, we chose to convert all images to black and white, with four levels of grey in-between. These black-and-white images are then coloured according to the pertaining content category via the browser's native image manipulation capacities.

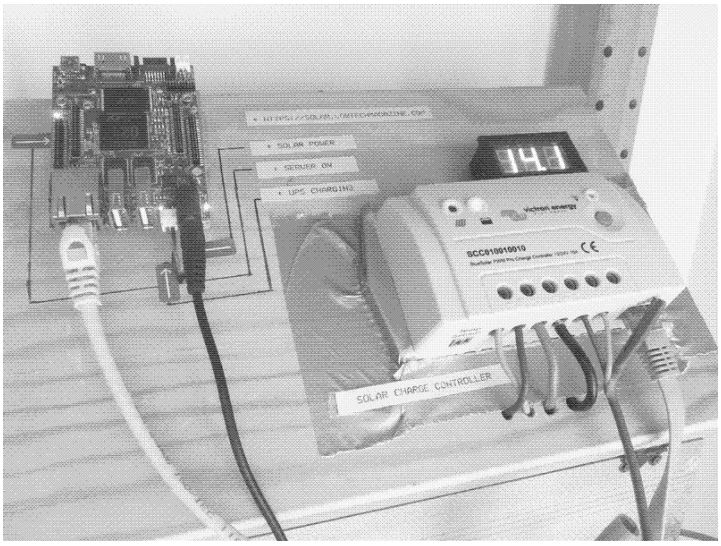


Image: The server and the solar charge controller.
Page size: 397.41KB

Compressed through this dithering plugin, images featured in the articles add much less load to the content: compared to the old website, the images are roughly ten times less resource-intensive.

Default typeface / No logo

All resources loaded, including typefaces and logos, are an additional request to the server, requiring storage space and energy use. Therefore, our new website does not load a custom typeface and removes the font-family declaration, meaning that visitors will see the default typeface of their browser. Only one weight (regular) of a font is used, demonstrating that content hierarchy can be communicated without loading multiple typefaces and weights.

Visitors will see the default typeface of their browser, eliminating the need to load a custom typeface.

We use a similar approach for the logo. In fact, Low-tech Magazine never had a real logo, just a banner image of a spear held as a low-tech weapon against prevailing high-tech claims. Instead of a designed logotype, which would require the production and distribution of custom typefaces and imagery, Low-tech Magazine's new identity consists of a single typographic move: to use the left-facing arrow in place of the hypen in the blog's name: LOW←TECH MAGAZINE. This pared-down identity drew inspiration from the past as well as the banner image of the previous design.

Why does it go offline?

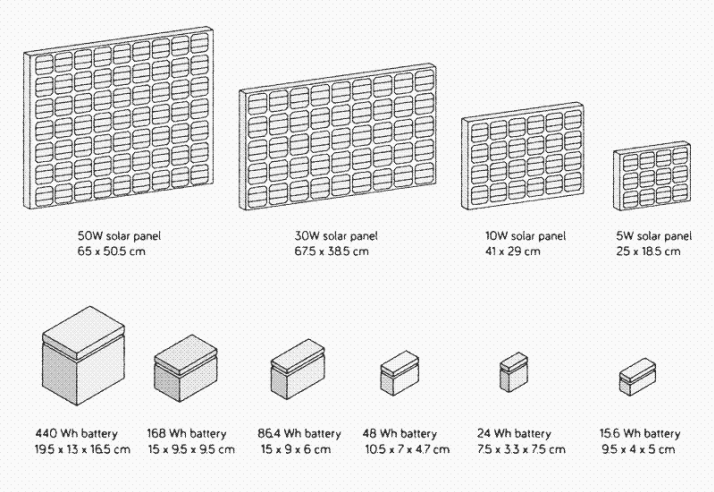
Quite a few web hosting companies claim that their servers are running on renewable energy. However, even when they actually generate solar power on-site, and do not merely "offset" fossil fuel power use by planting trees or the like, their websites are always online.

This means that either they have a giant battery storage system on-site (which makes their power system unsustainable), or that they are relying on grid power when there is a shortage of solar power (which means that they do not really run on 100% solar power).

Keeping the server on-line no matter what simply requires too many batteries, which makes the system unsustainable and expensive.

In contrast, this website runs on an off-the-grid solar power system with its own energy storage, and will go off-line during longer periods of cloudy weather. Less than 100% reliability is essential for the sustainability of an off-the-grid solar system(https://solar.lowtechmagazine.com/2020/01/how-sustainable-is-a-solar-powered-website.html) , because above a certain threshold the fossil fuel energy used for producing and replacing the batteries is higher than the fossil fuel energy saved by the solar panels.

Apart from sustainability (and costs), the author's home has limited space for installing solar panels and batteries. Keeping the server on-line no matter what — the standard business model of webhosting companies — simply requires too many batteries.



The sizing of battery and solar panel is a compromise between uptime and sustainability(https://solar.lowtechmagazine.com/2020/01/how-sustainable-is-a-solar-powered-website.html) . Illustration: Diego Marmolejo(https://www.instagram.com/ddidak/)

How often is it offline?

Over a period of roughly one year (351 days, from 12 December 2018 to 28 November 2019) the server was up for 95.26% of the time. This means that we were offline for 399 hours (which corresponds to 16.64 days).

These numbers don't tell the whole story, though. During the first ten months of this period, the server was online for 98.2% of the time. This means that it was offline for only 152 hours (6.4 days) – and this includes the winter months.

However, uptime from 1 October to 30 November 2019 plummeted to 80.17%. This was caused by a software upgrade of the Linux kernel, which increased the average power use of the server from 1.19 to 1.49 watts, and consequently brought the website down for at least a few hours every night.

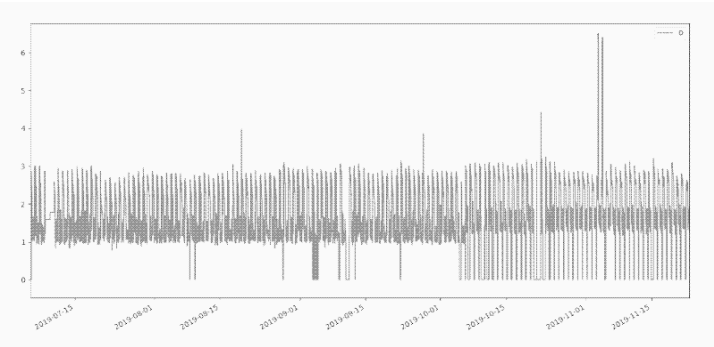


Image: In October 2019, average power use suddenly increases and the site goes down every night.

The graph above, which shows the power use of the server from 15 July to 15 November 2019, reveals the effect of the software upgrade. Power use is zero when the server is offline. Before the software upgrade, this happens only now and then, during longer periods of bad weather. From October onwards, it happens every night. The two peaks at the beginning of November show two intents to charge the battery with grid power, because we initially assumed the problem was caused by a deteriorating battery.

All the data above refer to a set-up consisting of a 50W solar panel with an energy storage capacity that is equivalent to that of an 86.4 Wh lead-acid battery. Since December 2019, we have been running the system on different sizes of solar panels and batteries(https://solar.lowtechmagazine.com/2020/01/how-sustainable-is-a-solar-powered-website.html) . The uptime of these configurations is not yet known. At the moment, the solar website is powered by a 30W panel and a 168 Wh lead-acid battery.

When is the best time to visit?

The accessibility of this website depends on the weather in Barcelona, Spain, where the solar-powered web server is located. Because it is solar powered, the website is most often online during the summer. To help visitors "plan" their visits to Low-tech Magazine, we provide them with several pointers.

A battery meter provides crucial information because it may tell the visitor that the blog is about to go down — or that it's "safe" to read it. The design features a background colour that indicates the capacity of the solar-charged battery that powers the website server. A decreasing height indicates that night has fallen or that the weather is bad.

To help visitors "plan" their visits to Low-tech Magazine, we provide them with several pointers such as a battery meter and a weather forecast.

In addition to the battery level, other information about the website server is visible with a statistics dashboard(https://solar.lowtechmagazine.com/power.html) . This includes contextual information of the server's location: time, current sky conditions, upcoming forecast, and the duration since the server last shut down due to insufficient power.

To access Low-tech Magazine no matter the weather, we have several offline reading options available(https://solar.lowtechmagazine.com/offline-reading.html) . We offer a 710-page perfect-bound paperback which contains 37 of the most recent articles from the website(http://www.lulu.com/shop/kris-de-decker/low-tech-magazine-20122018/paperback/product-24028679.html) (2012 to 2018), and a second volume, collecting articles published between 2007 and 2011(https://solar.lowtechmagazine.com/2019/12/the-printed-website-is-complete.html) .

The Printed Website.

Which hardware and software do you use?

We wrote three extra articles with more in-depth technical information:

- How to build a low-tech website: software and hardware(https://homebrewserver.club/low-tech-website-howto.html) , which focuses on the back-end.
- How to Build a Low-tech Website: Design Techniques and Process(https://github.com/lowtechmag/solar/wiki/Solar-Web-Design) , which focuses on the front-end.
- How sustainable is a solar powered website? (https://solar.lowtechmagazine.com/2020/01/how-sustainable-is-a-solar-powered-website.html) , which focuses on the sizing of the solar PV system and the optimal balance between uptime and sustainability.

SERVER: This website runs on an Olimex A20 computer(https://homebrewserver.club/low-tech-website-howto.html#server) . It has 2 Ghz of processing power, 1 GB of RAM, and 16 GB of storage. The server draws 1 - 2.5 watts of power.

SERVER SOFTWARE: The webserver runs Armbian Stretch, a Debian based operating system built around the SUNXI kernel. We wrote technical documentation for configuring the webserver(https://homebrewserver.club/low-tech-website-howto.html#configuring-the-webserver) .

DESIGN SOFTWARE: The website is built with Pelican(https://blog.getpelican.com/) , a static site generator. We have released the source code for 'solar', the Pelican theme we developed here(https://github.com/lowtechmag/solar) .

INTERNET CONNECTION. The server is connected to a 100 MBps fibre internet connection. Here's how we configured the router(https://homebrewserver.club/low-tech-website-howto.html#network) . For now, the router is powered by grid electricity and requires 10 watts of power. We are investigating how to replace the energy-hungry router with a more efficient one that can be solar-powered, too.

SOLAR PV SYSTEM. At the moment, the server runs on a 30W solar panel and a 168 Wh lead-acid battery. However, we keep experimenting with different setups(https://solar.lowtechmagazine.com/2020/01/how-sustainable-is-a-solar-powered-website.html) . The PV installation is managed by a 10A solar charge controller.

What happens to the old website?

The solar powered Low-tech Magazine is a work in progress. For now, the grid-powered Low-tech Magazine remains online. Readers will be encouraged to visit the solar powered website if it is available. What happens later, is not yet clear. There are several possibilities, but much will depend on the experience with the solar powered server.

Until we decide how to integrate the old and the new website, making and reading comments will only be possible on the grid-powered Low-tech Magazine, which is hosted at TypePad. If you want to send a comment related to the solar powered web server itself, you can do so by sending an e-mail to solar (at) lowtechmagazine (dot) com. Your comment will be published at the bottom of this page.

Who made this website?

Idea: Kris De Decker(http://www.krisdedecker.org)

Web design and development: Marie Otsuka(http://motsuka.com) , Roel Roscam Abbing(https://roelof.info) .

Computer hardware: Roel Roscam Abbing

Solar hardware: Kris De Decker

The printed website: Lauren Traugott-Campbell(http://squishysystems.com/) .

Content production: Kathy Vanhout

This project was funded in part by the Maharam Foundation(https://risdmaharamfellows.com/past-fellows/) .

Can I help?

Yes, you can.

On the one hand, we're looking for ideas and feedback to further improve the website and reduce its energy use. We will document the project extensively so that others can build low-tech websites too. Here are some specific technical questions that we have(https://homebrewserver.club/low-tech-website-howto.html#room-for-improvements) .

To make a comment, please send an e-mail to solar (at) lowtechmagazine (dot) com. Comments will be published at the bottom of this page.

On the other hand, we're hoping for people to support this project with a financial contribution. Advertising services, which have maintained Low-tech Magazine since its start in 2007, are not compatible with our lightweight web design. Therefore, we are searching for other ways to finance the website:

1. We offer print-on-demand copies of the website(https://solar.lowtechmagazine.com/offline-reading.html) . These publications allow you to read Low-tech Magazine on paper, on the

beach, in the sun, or whenever and where ever you want.

2. You can support us through PayPal(https://www.paypal.me/lowtechmagazine) , Patreon(https://www.patreon.com/lowtechmagazine) and LiberaPay(https://liberapay.com/lowtechmagazine/) .

Comments (131) +

To make a comment, please send an e-mail to solar (at) lowtechmagazine (dot) com.
