Carbon Hack 22

GreenCharge project

Helping the planet by charging green

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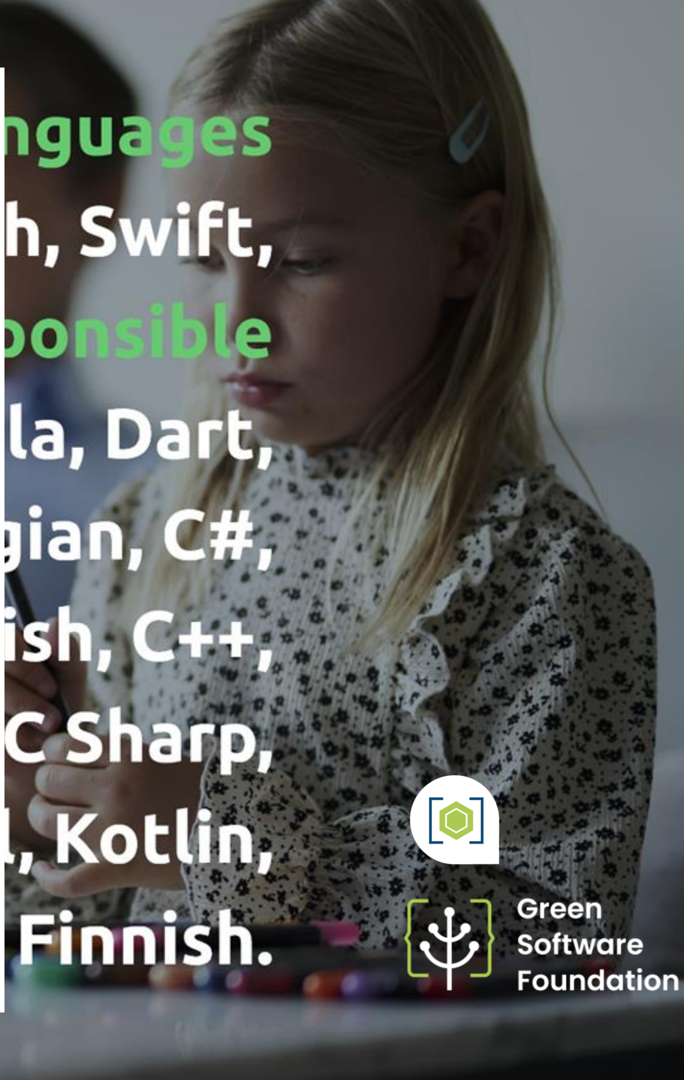

Project GreenCharge introduction

GreenCharge

Charge or operate any device with a battery in a green way using a smart plug. Disconnect and run on battery when electricity is dirty, connect and charge when it's clean.

1. What problem does your idea solve? (1 of 2)

The carbon intensity of the electricity grid varies over time, depending on the types and proportion of renewable sources used and the intermittency experienced in their electricity production.

Charging battery-powered devices when the marginal carbon intensity of the grid is low reduces CO_2 emissions.

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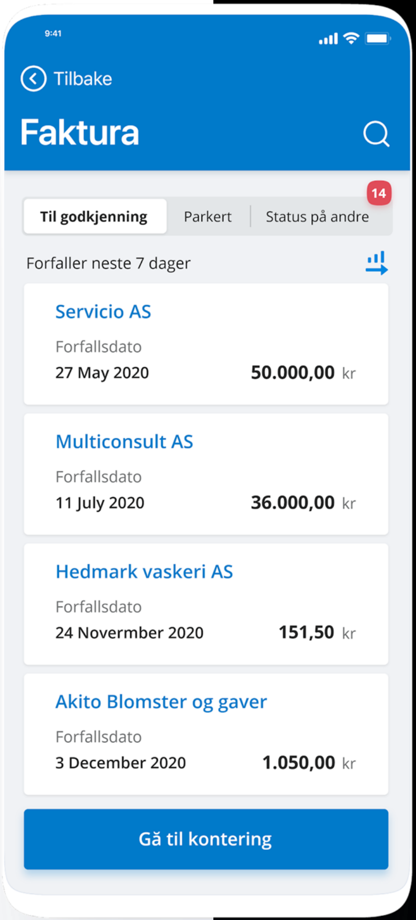
1. What problem does your idea solve? (2 of 2)

A few modern battery-powered devices are “smart” and can charge or operate on battery depending on the carbon intensity of the grid. An example is the latest Apple update, iOS 16.1, with a clean energy charging option.



Unfortunately, the majority of battery-powered devices used today are not “smart”. ***Helping devices get “smart” is a more sustainable option for CO_2 reduction than replacing them with “smart” devices before their end-of-life. We aim to make that possible.***

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2. What does your solution do? (1 of 3)

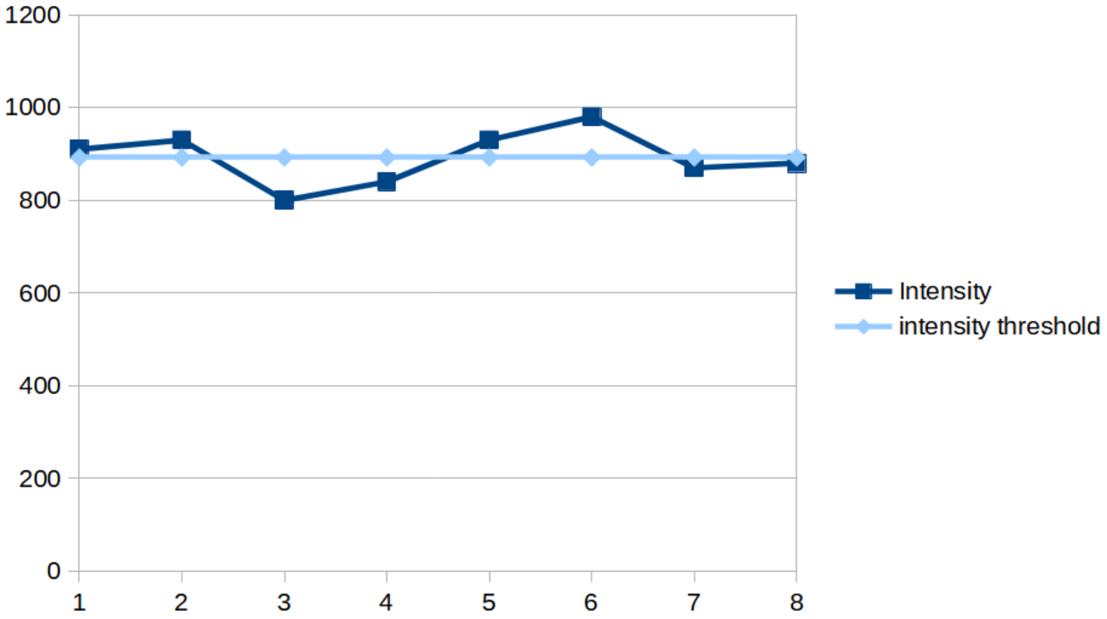
GreenCharge lets everyone charge all their devices in a green way.

- In the GreenCharge app, you set per device when the battery should be fully charged.
- GreenCharge knows how long it takes for each device to charge.
- GreenCharge will always use the cleanest electricity available, saving CO_2 emissions, when charging your battery-powered devices.

2. What does your solution do? (2 of 3)

It does so by looking at the intensity forecast and using those time frames where intensity is lowest.

Therefore even during high intensity periods, it is still possible to reduce your charging emissions.



2. What does your solution do? (3 of 3)

The end result is a charged device, generating lower emissions than charging in the usual way. So you're contributing to emitting less CO_2 by charging with GreenCharge.

The actual switching is done using a smart plug like this one, which is controlled by the GreenCharge app.

3. How does your solution use the API / SDK?

GreenCharge periodically requests the current carbon intensity in the region the device is located. The current intensity is then compared to the forecasted carbon intensity for the charging window. Receiving this data in real-time is made possible by using the **Carbon Aware API.**

GET `/emissions/forecasts/current` Retrieves the most recent forecasted data and calculates the optimal marginal carbon intensity window.

By utilizing the current and forecasted intensity, it is possible to make an informed decision about *when* to charge a device for the greenest possible result.

4. What is the impact of your solution? (1 of 4)

Nowadays, there are more and more devices that have rechargeable batteries in them. To quantify the impact of GreenCharge, we've calculated the avoided emissions of one such device: a mobile phone.

We have limited the calculations in our example to the Netherlands. GreenCharge is suitable for any country, any device, so the impact will depend on consumer willingness to adopt and the supply of smart plugs.

4. What is the impact of your solution? (2 of 4)

1 device,
1 country,
1 year

Charging a single phone: ~ 23.5 Wh per full charge cycle. Per year that's ~ 4.3 kWh.

Population: ~ 18 million; 97% have a mobile phone, therefore 17,5 million devices in total.

Let's assume the phones will be charged every other day on average.

For all phones in the Netherlands, that's 74.834 MWh per year.

The average historical MOER value in the Netherlands is 368 CO_2 kg/MWh.

The average historical emission reduction that can be achieved using GreenCharge is 12%.

That amounts to avoided emissions of **3307 tons CO_2eq.**

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4. What is the impact of your solution? (3 of 4)

In the Netherlands, charging mobile phones with GreenCharge can save as much CO_2 per year as the CO_2 absorbed by **132.300 trees**!

4. What is the impact of your solution? (4 of 4)

GreenCharge is suitable for **any country, any device** so the emissions savings will rise as adoption rises.

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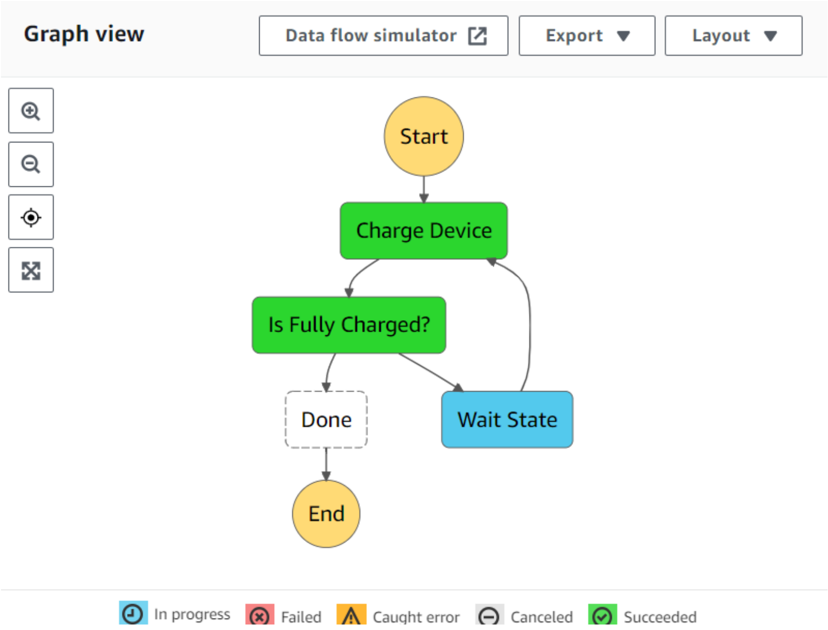
5. Describe your solution's feasibility? (1 of 4)

Backend application

The backend is implemented on AWS cloud. The application is a serverless application and it can be run at minimal costs as it is based on lambda functions. Infrastructure-as-code scripts are provided to easily deploy on any AWS account.

As time was limited, we focused on functionality and haven't paid much attention to other things that are important to a production-ready application. One of these is security. Security needs to be upgraded to protect the system and its users from abuse.

The app prototype has features that are not yet implemented in the backend.



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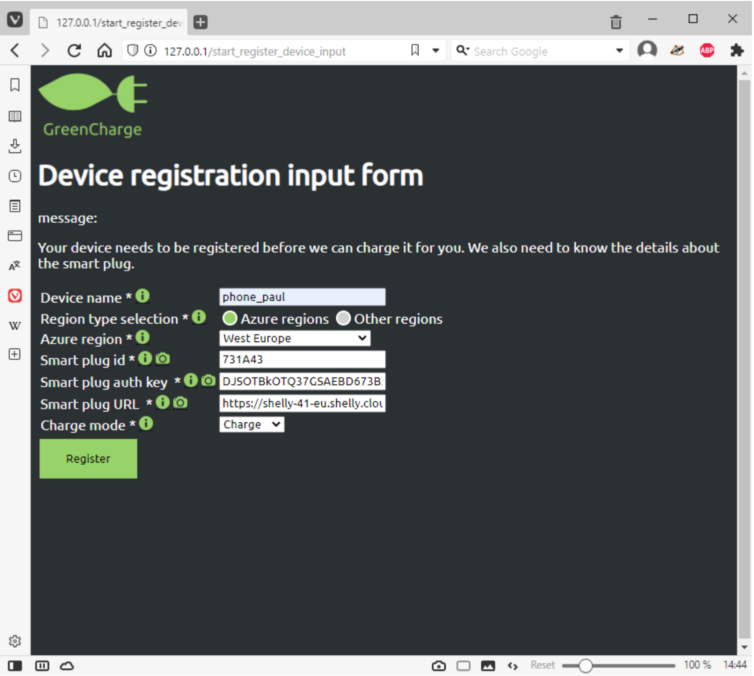
5. Describe your solution's feasibility? (2 of 4)



Front end application

The frontend is currently a simple web application that we host on AWS ECS. We envision a mobile app with which the end user can control the smart plug and we've created a design prototype for that. Implementing the prototype takes time and energy to build, but it is feasible. The prototype for the app shows what the UI would look like and what interactions are possible. As end users would run the app on their own devices, no additional hosting costs would be incurred by the supplier.

5. Describe your solution’s feasibility? (3 of 4)

Smart plug integrations

For this hackathon, we used the Shelly Plug S as a smart plug. It would be nice to integrate other smart plugs as well. Any smart plug which has an API that allows GreenCharge to switch it on and off and measure the power will do. However, each integration takes time. We could create an architecture that is generic, allowing other people to add new smart plug systems - provided they can fulfill the basic functionality of switching and measuring power.

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5. Describe your solution's feasibility? (4 of 4)

Intensity data provider

Carbon Aware SDK is the provider of the intensity data. The solution needs a license for this data.

Business feasibility

Creating a minimal viable product that can be brought to market would take us about 1000 programming hours, depending on the feedback on the mobile app design. This effort is mainly for refining the user experience.

We published the back-end of our project, as part of Carbon Hack 22, for others to use together with the necessary documentation and services. We view the user functionality as a distinguishing feature of our future product, aimed at consumers and their home environment.

We are open to suggestions for improvements in the business rules and logic that could result in even more CO_2 reduction.

6. Describe the vision for your solution.

We envision a world where consumers are empowered to use the greenest energy. Everyone knows how much green energy is available and when. All devices are smart and can plan their activities accordingly. Everyone has an overview of their consumption history and predicted needs, allowing them to make informed decisions on when to plan and execute certain tasks.

That world would require data, models and logic, but also “smart” devices. During the transition, older devices that have yet to reach end-of-life will still be operational. Simply replacing these is not necessarily the most sustainable choice for CO_2 emissions reduction.

With GreenCharge, any battery-powered device, anywhere in the world, can reduce its’ CO_2 emissions by using the greenest electricity available when charging or operating via smart plug.

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7. Solution links

Design for a mobile application (not implemented yet):

https://www.figma.com/proto/NqZSwmRP07PH6cssMDScBz/GreenCharge?page-id=3448%3A2689&node-id=3448%3A2697&viewport=295%2C-623%2C0.25&scaling=scale-down&starting-point-node-id=3479%3A3462

Code repository: https://github.com/vismaconnect/carbon-hack-22-green-charge.git

Frontend Proof of concept: http://16.170.226.10

Architecture: https://storage.googleapis.com/taikai-storage/images/d3362b60-5c38-11ed-9628-c58ba00aadffarchitecture.png

Impact calculations example: https://storage.googleapis.com/taikai-storage/others/449d7580-5c37-11ed-9f80-d9196df4c039avoided_emissions_calculation.xlsx

8. Link to YouTube video

https://www.youtube.com/watch?v=_gCH5JpKMFI

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Green Software Foundation

Learn more at

- grnsft.org/hack22
- grnsft.org/hack22/sdk
- grnsft.org/hack22/api

Special thanks to the following people for the use of their photos as published on unplash.com

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