CONGESTIEMANAGEMENT IN EEN DC-KEUKEN

ALEXANDER SPAANS

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DC LAB

THE HAGUE
UNIVERSITY OF
APPLIED SCIENCES

POWER ELECTRONICS 2022
Power Electronics & Energy Storage event
14 juni 2022 | 1931 Congrescentrum 's-Hertogenbosch
ENERGY STORAGE EVENT 2022

ALEXANDER SPAANS

- 25 Jaar
- Den Haag
- Elektrotechniek student bij THUAS TIS Delft
- Afstudeerder bij ATAG Benelux
- DC-Lab

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Power Electronics & Energy Storage event

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INHOUD

- ATAG Benelux
- Probleembeschrijving
- De gekozen aanpak
- Powerlogger
- Congestie manager
- Keuken

WAAROM WERKT ATAG AAN DC?

- De energie transisitie
- Slimme oplossingen om het piekvermogen te reduceren in de keuken
- De keuken is de hoofdverbruiker in een huishouden
- Klaar zijn voor het toekomstige net
- Een oplossing kunnen bieden voor huishoudens met een laag aansluitvermogen

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WISSELSPANNING IN MIJN KEUKEN

- Bereiden van een gerecht
  - Piekvermogen van 5,6kW
- Een enkele 230Vac groep kan 16A leveren (3600W)
- Smart maken van deze AC applicaties is niet mogelijk

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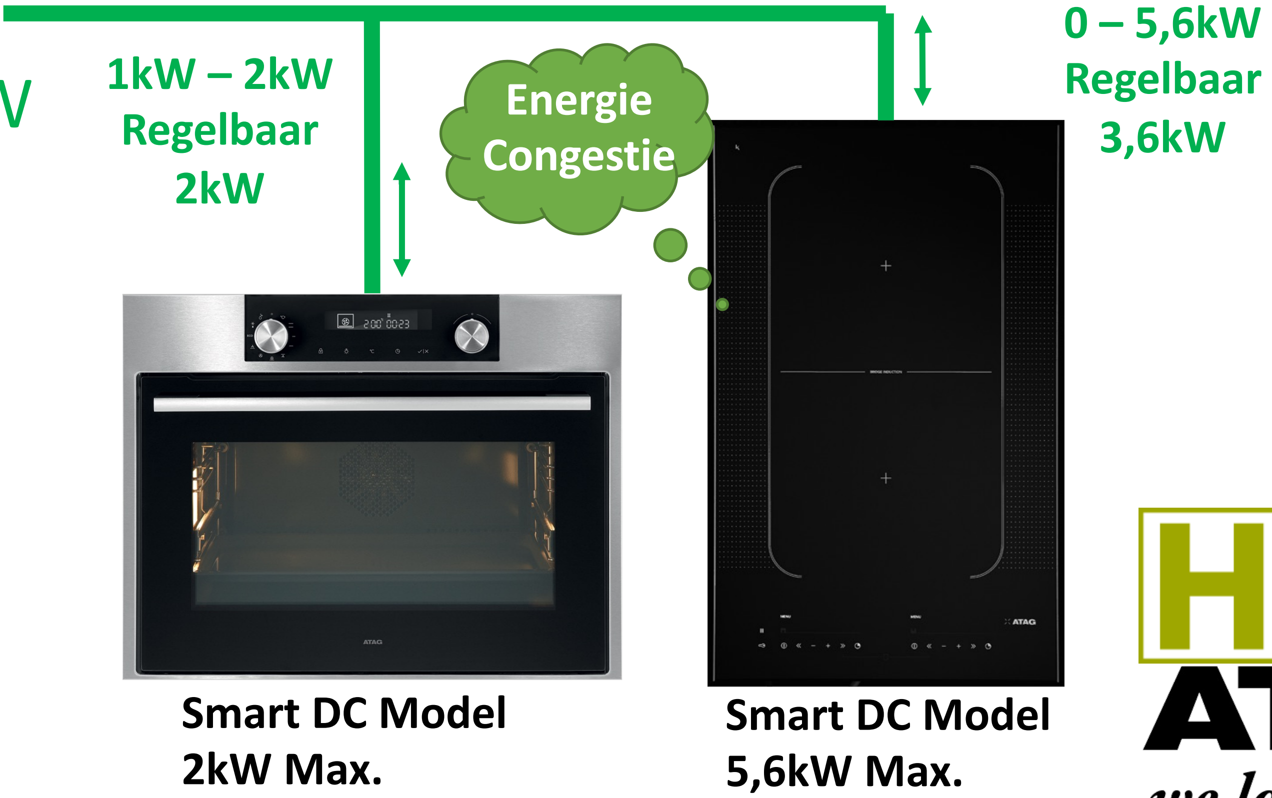
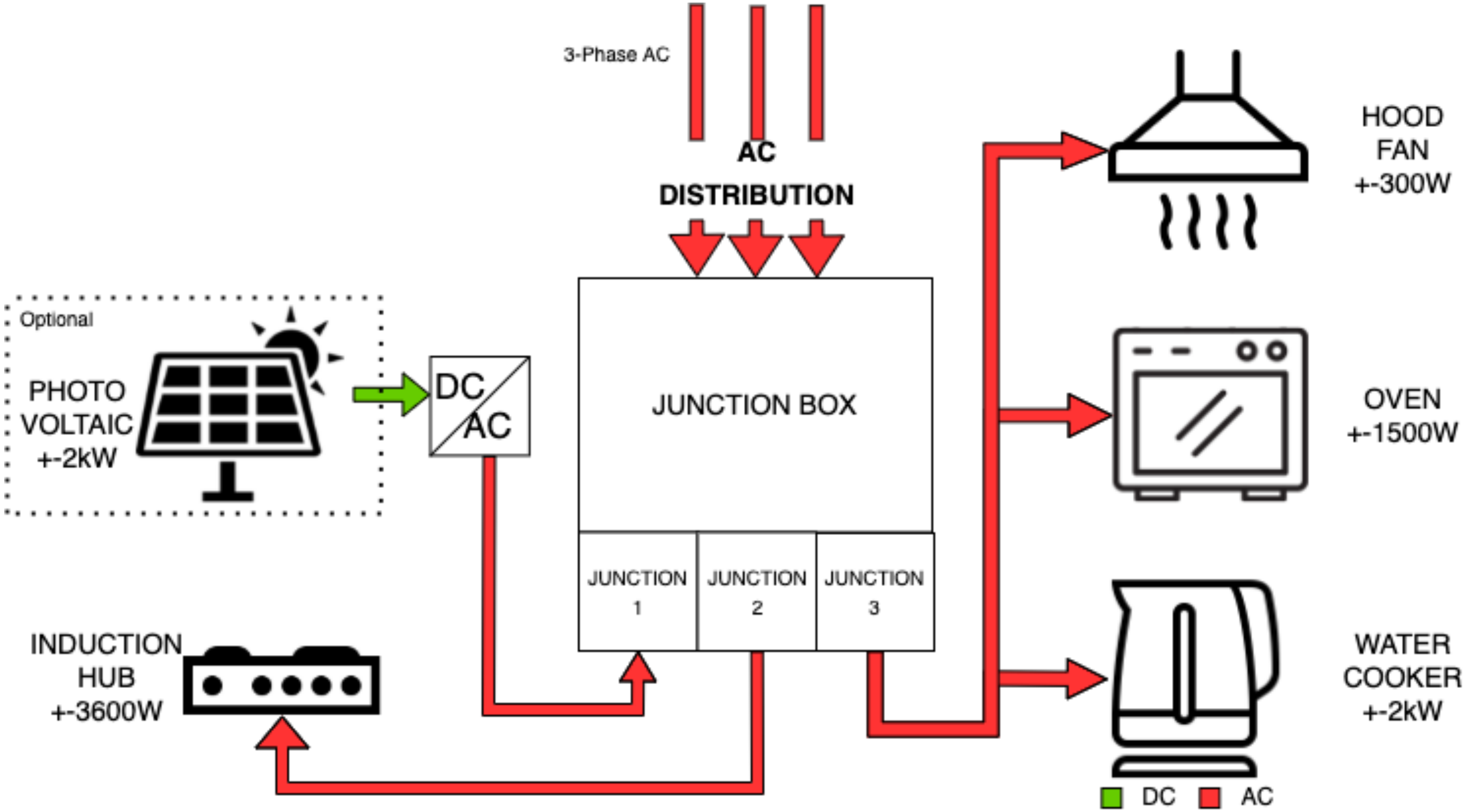
GELIJKSPANNING IN MIJN KEUKEN

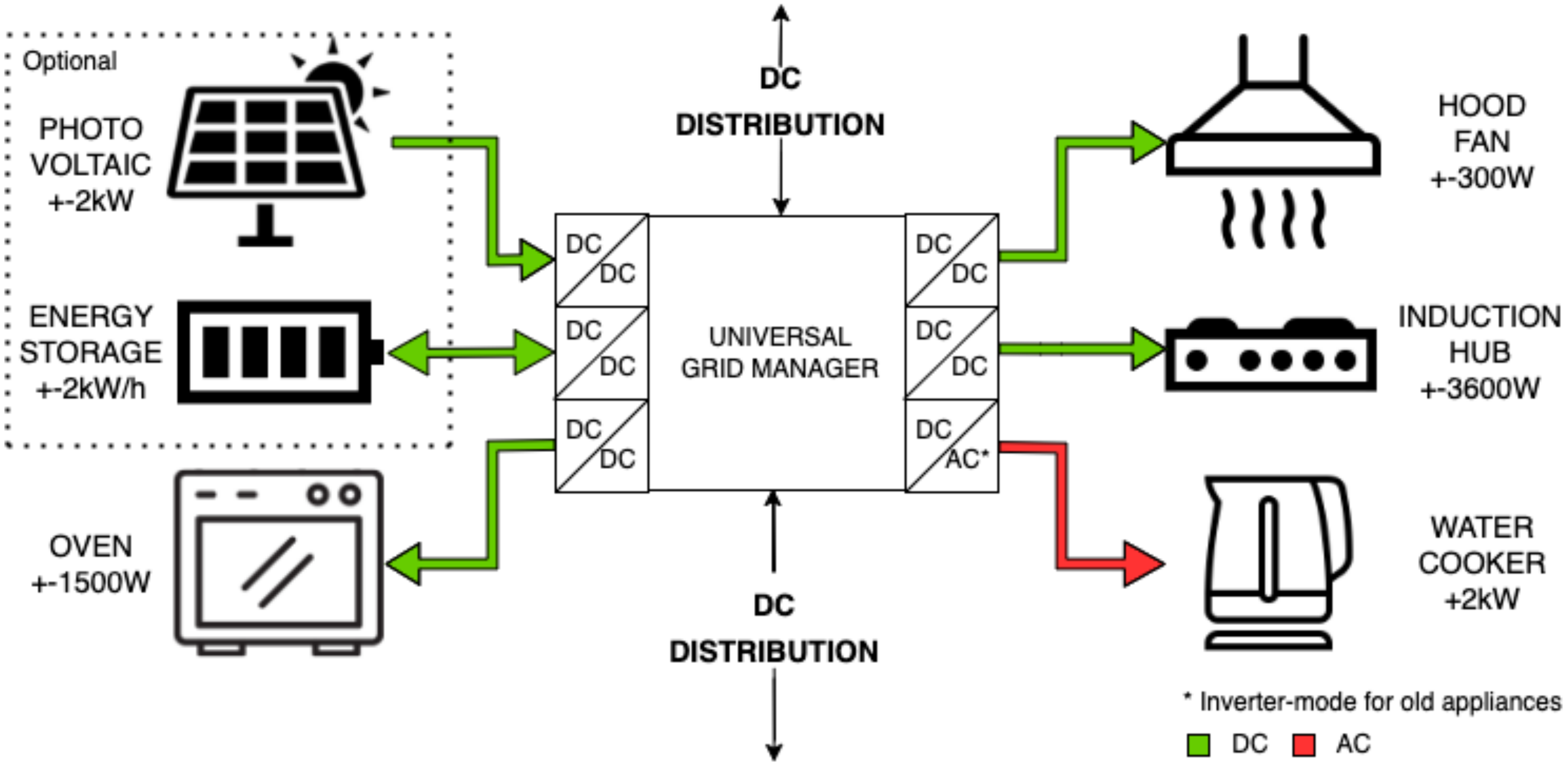
- Bereiden van een gerecht
  - Piekvermogen van 5,6kW
- Een enkele 350Vdc groep kan 16A leveren (5600W)
- Smart DC-grid controller maakt het DC-Grid stabieler en beter regelbaar



TYPISCHE AC KEUKEN SETUP

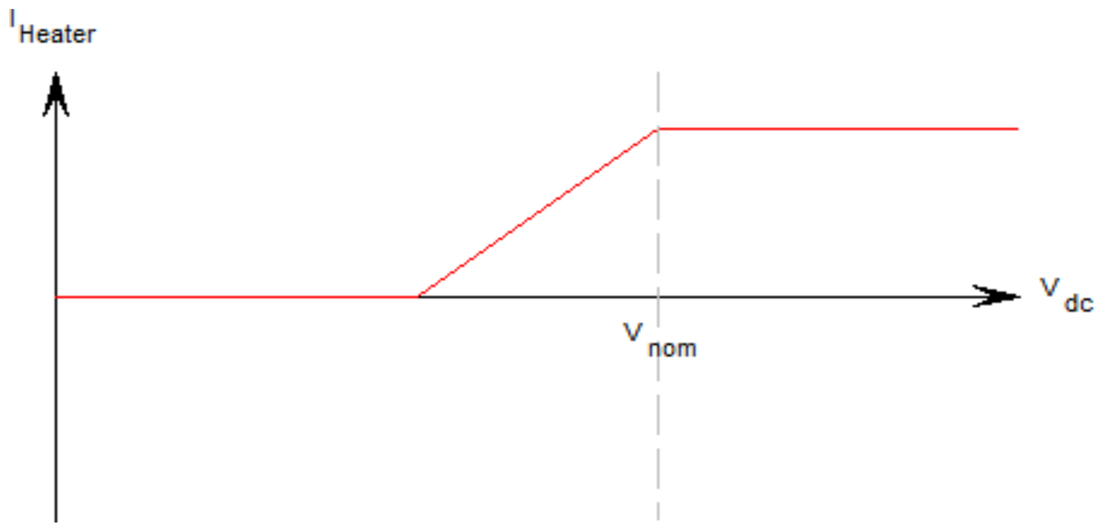


VOORBEELD DC KEUKEN



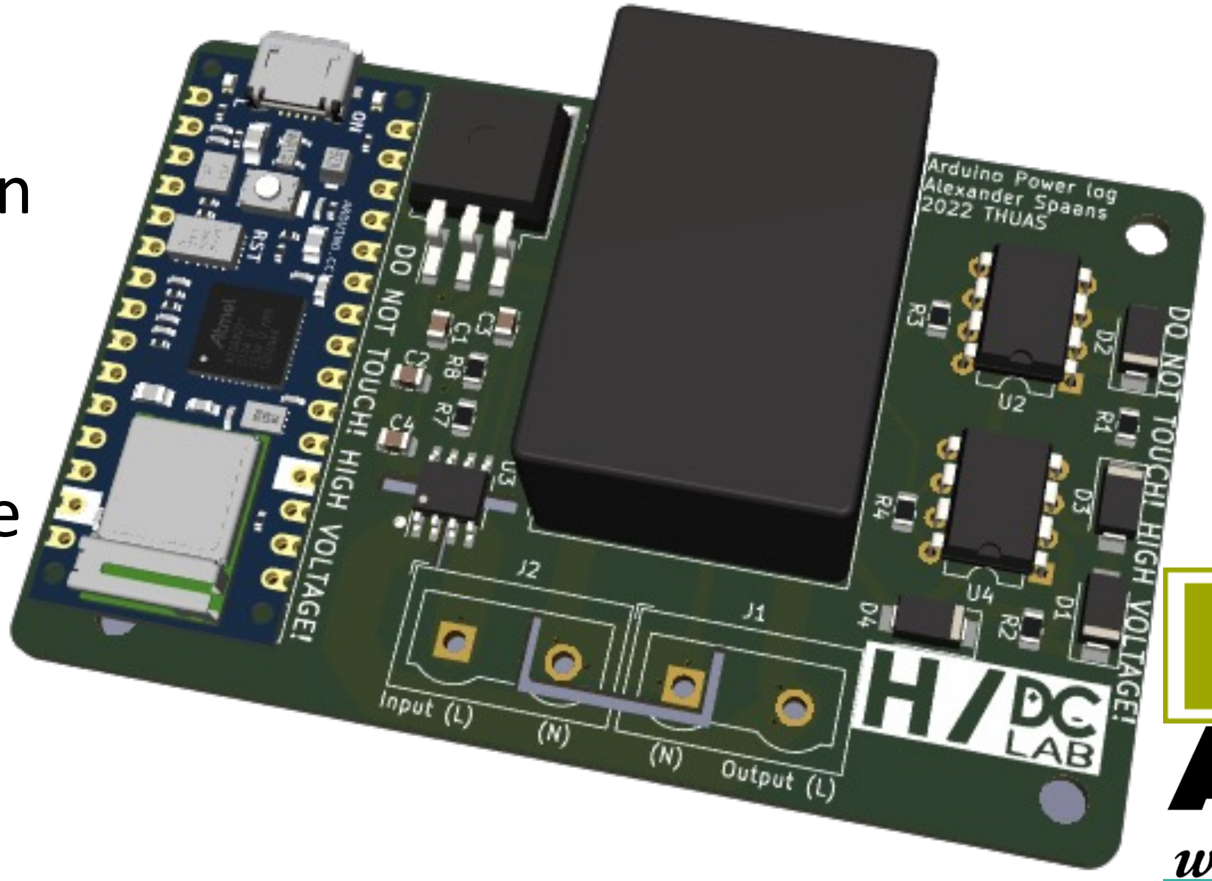
GEKOZEN AANPAK

- Congestie manager (droop control)
- Vermogensprofielen
- Powerlogger
- Stabiliteit van het net

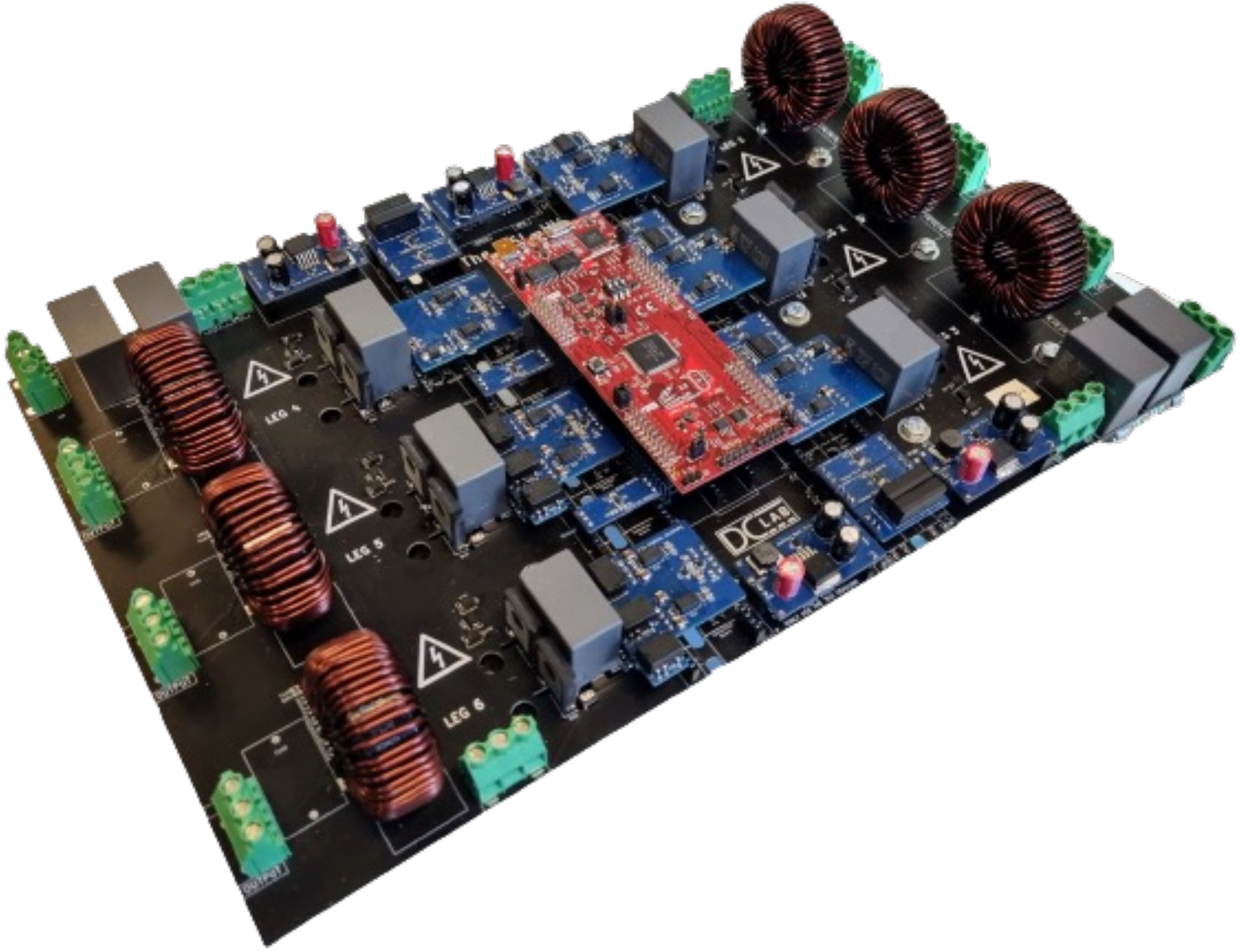


POWERLOGGER

- Arduino Nano 33 IOT
- AC én DC spanning meten
- Ook stroom te meten
- Volledig zelfstandig
- 100 Samples per seconde
- Websockets



UNIVERSAL GRID MANAGER

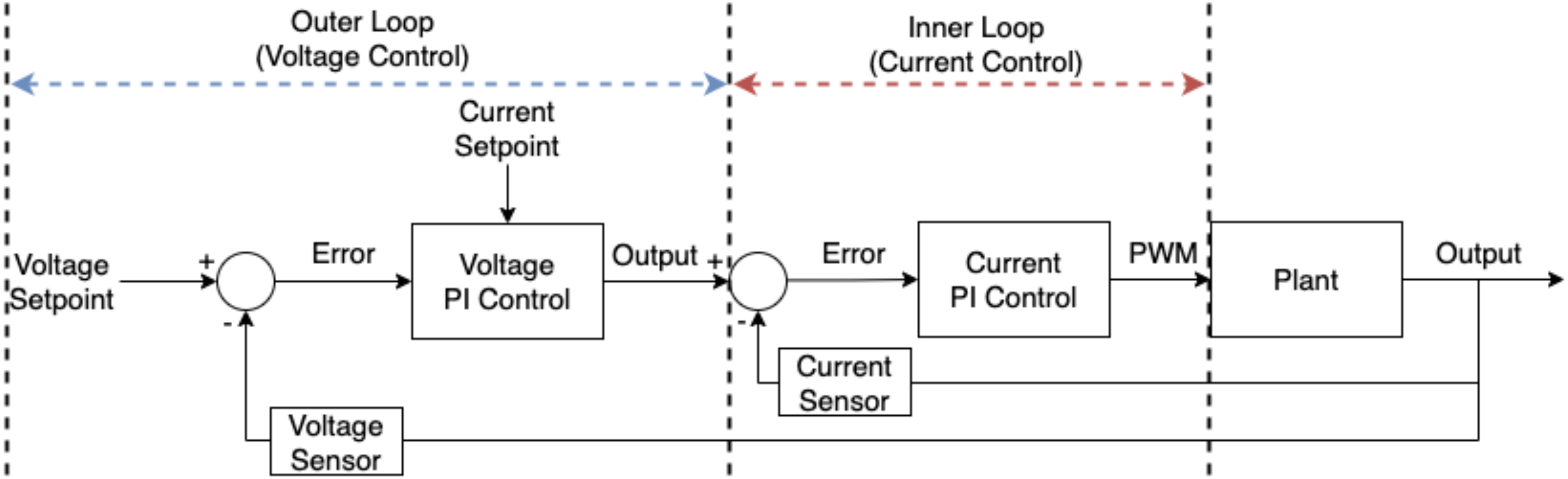


- Universal 6 Leg
- Opvolger van de U4L (educatief)
- Meerdere halve bruggen
- BI-directionele DC/DC converters
- DC-DC/DC-AC/DC-3Phase AC inversie
- 1500V-10A per output

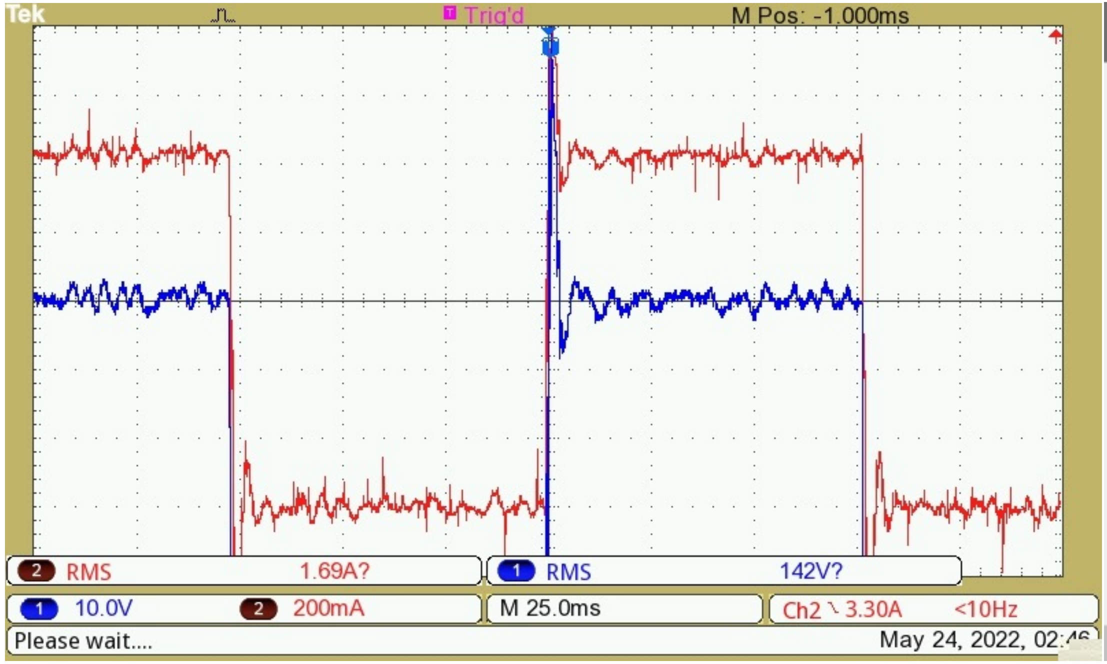
CONGESTIE MANAGER

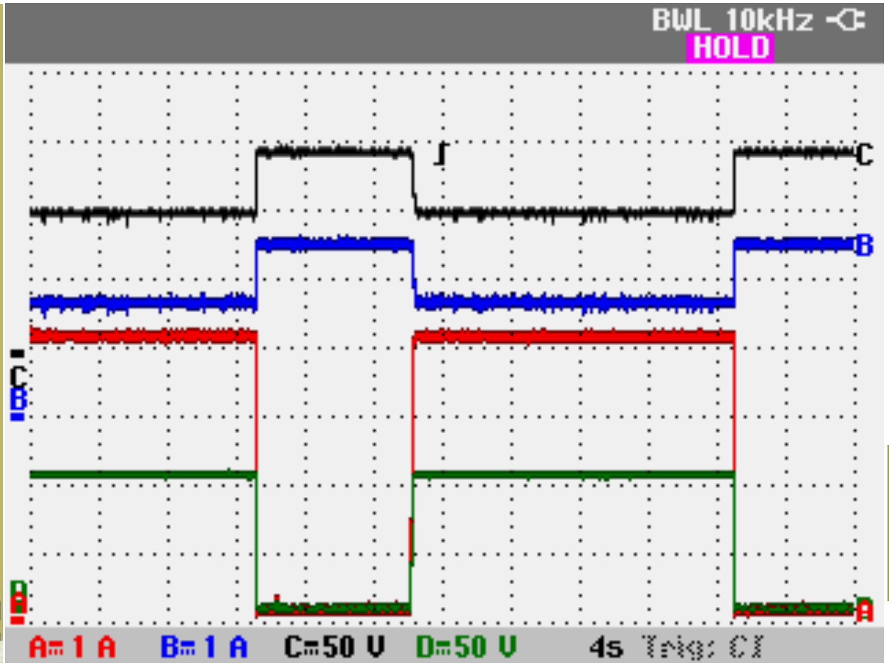
- Uitgang wordt gelinkt aan parameters
- Is het net stabiel?
- Constant meten van I/O
- Maximaal vermogen gebruikt?
- Aanpassingen aan de hand van vermogensprofiel
- Uitgangen worden aangepast!

VOLTAGE AND CURRENT PI CONTROL



CONGESTIE MANAGER





PAPER (DROOPCONTROL)

- CODIT 2022 –IEEE
- 8th International Conference on Contrl, Decision and Information Technologies

Droop Control in DC Grids for Kitchen Appliances to avoid Power Congestion

Alexander Spaans[1], Diëgo Zuidervliet[2], Peter van Duijsen[3].

Abstract— **To avoid power congestion in a DC grid, droop control based on voltage signaling is applied for a kitchen application. Using static droop characteristics, the maximum amount of power that is allowed or available can be regulated. A typical design process is to first define the droop characteristics in a design tool, simulate the characteristics for varying load, and/or verify the droop characteristics in a setup. A laboratory setup is presented along with a design tool and simulation tool to define the droop characteristics for a kitchen appliance.**

I. INTRODUCTION

In renewable energy systems, DC grids are the natural choice for power distribution because renewable energy sources like solar power are easily integrated. DC grids allow power management to be implemented using power electronics, enabling the direct control of various loads such as LED lighting, consumer electronics, and motion-controlled appliances.

To avoid power congestion, power management is facilitated by droop control, where the DC grid voltage is the controlling signal for power management. The main advantage is that droop control is functioning independently of any communication, only the voltage level of the DC grid determines the amount of energy available in the DC grid.

The droop control based on voltage level signaling is very similar to the way AC generators are controlled by frequency and power load droop control [1]. The voltage level is a simple signaling method not requiring any secondary control method [2]. The voltage droop on the DC bus signals the amount of power available and in that way gives a simple power flow control method. The DC converters applied in the DC grid are used to interface the loads and sources in the DC grid [3]. A virtual impedance method is the backbone of droop control. Seeing he connected load or source in series with a virtual impedance lowers the voltage level when more power is consumed and increases the voltage level when more power is produced. This can be illustrated with the basic example of a resistor circuit with voltage sources, see figure 1.

If source V_1 is higher than the voltage on the DC bus V_{dc}, that source will deliver power into the DC grid. But as soon as the source V_1 is lower than the V_{dc}, power will flow from the DC grid V_{dc} into the V_1.

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[3]**Corresponding Author** Email:p.j.vanduijsen@hhs.nl

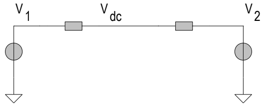

Fig. 1. Voltage V_{dc} depends on the current through the virtual impedance, here represented by resistors.

Since most appliances in a DC grid are connected via power electronics converters, these converters can directly be used to control the power flow in a DC grid [4]. The droop control can be used to improve energy availability, power density, and overall energy and power efficiency in various applications or power grids. For example in ships with electric propulsion, data-centers offices, and commercial buildings. The resistors in Fig. 1 are in that case replaced by a virtual impedance, being the power electronics converters.

One problem with droop control using a virtual impedance is that any voltage drop due to losses in the lines in the DC grid influence the voltage level signaling method. Therefore various voltage drop adjustment methods were proposed, such as hierarchical control in DC grids as introduced in [5]. Three control levels, including the internal current control loop, were defined to overcome the voltage deviation in droop control for DC grids. At level 3 the power flow is controlled, level 2 control ensures that the electrical levels are inside the required values and level 1 control is the voltage-based droop control. Also, a level 0 is proposed which is the inner voltage and current control of the converter itself.

The principle of various static V-I characteristics to control the power flow proved to be simple to implement and stable method. In [6] various static V-I characteristics are discussed to connect different appliances by utilizing power electronic converters with a virtual impedance. The slope of the static V-I characteristic and its maximum and the minimum value are defined per appliance and in such a way, the various appliances connected to a DC grid can operate and exchange power with any external control method.

One drawback of the simple voltage level signal method is the voltage drop over the line impedance. In the first place, the voltage at the appliance terminals is always lower than the DC grid voltage because of the natural voltage drop over the line impedance. Secondly, the voltage drop deviation due

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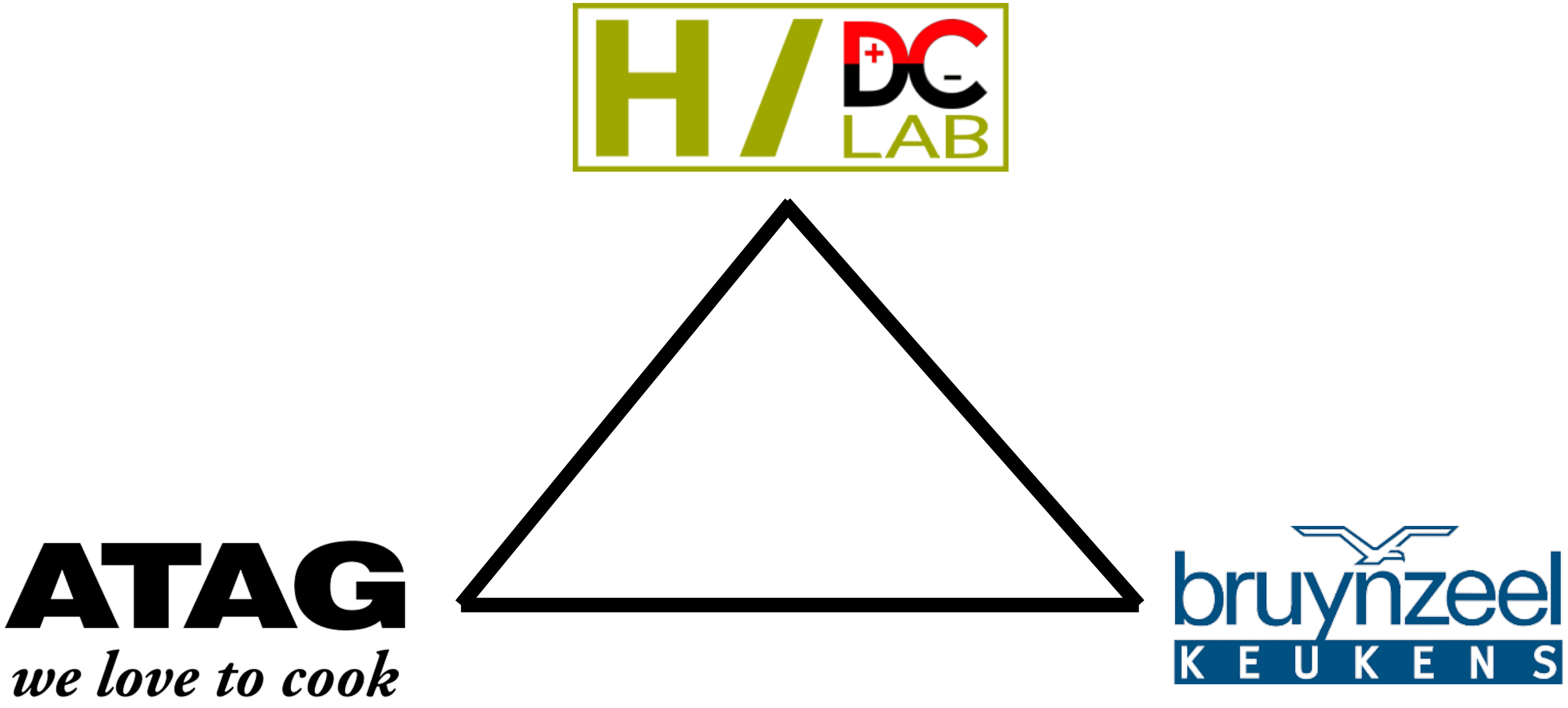

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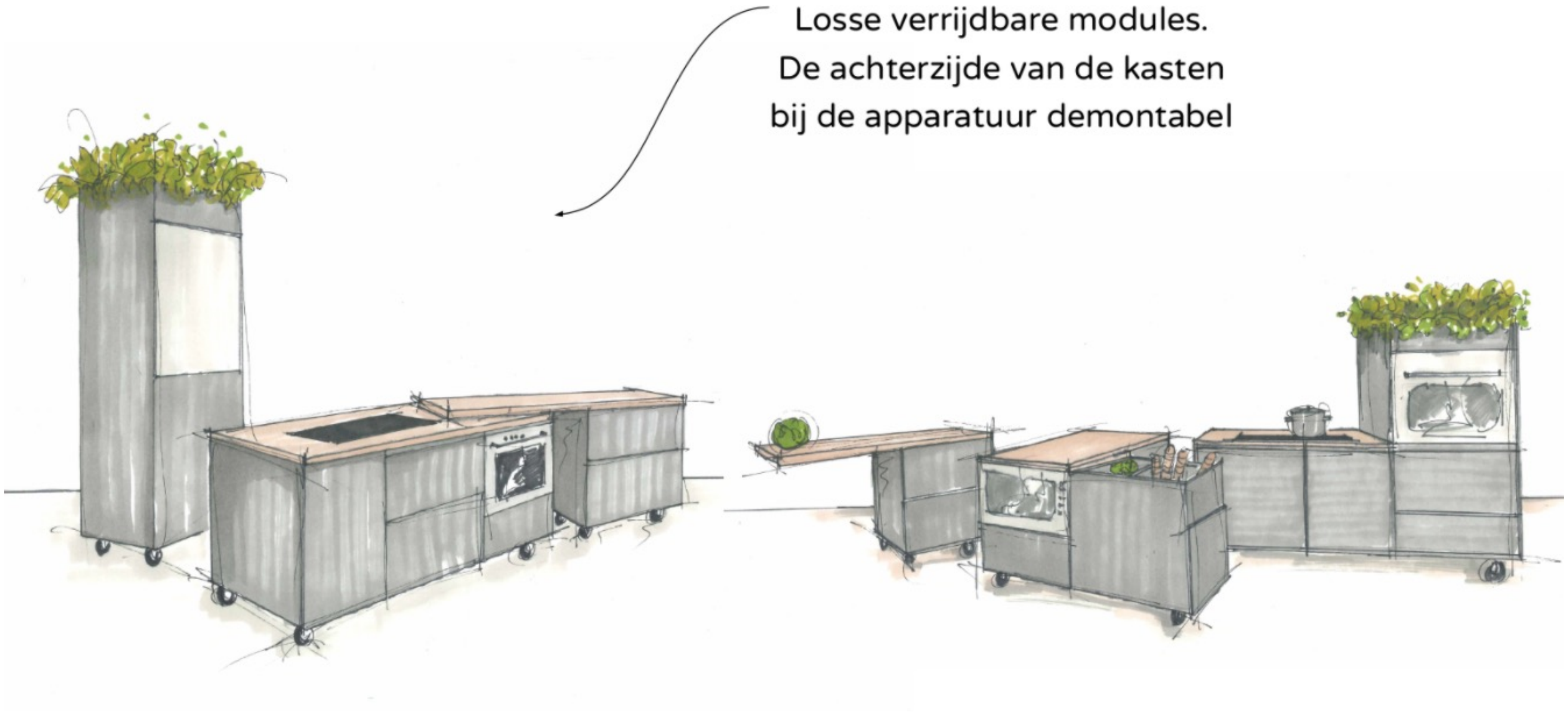
Losse verrijdbare modules.
De achterzijde van de kasten
bij de apparatuur demontabel

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ZAL DIT HET PROBLEEM OPLOSSEN?

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