Classified

The project has been accepted for funding within the Key Digital Technologies Joint Undertaking (KDT JU), a public-private partnership in collaboration with the Horizon Europe (HORIZONI Framework Programme and National Authorities under grant agreement number 101096387.

PowerizeD

Digitalization of Power Electronic Applications within Key Technology Value Chains

Deliverable	**D3.2.4 Summary Report on demonstrators along the value chains of the Renewable, Grids and Lighting Use Cases**		
Involved WPs	WP3	**Deliverable type**	Public
Project	PowerizeD	**Grant Agreement Number**	101096387
Deliverable File	D3.2.4	**Last Modified**	28.11.2025
Due Date	M35	**Actual Submission Date**	M35
Status	Released	**Version**	1.0
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Document history			
V	**Date**	**Author**	**Description**
0.1	05.09.2025	Eugen de Mol	Initial Version
0.2	17.09.2025	Eugen de Mol	UC2.3 updated
0.3	31.10.2025	Jochem Jonkman	UC2.1 updated
0.4	28.11.2025	Eugen de Mol	Video links added
1.0	28.11.2025		Final Version after check by PMO

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1 Publishable summary

Project acronym	***PowerizeD***
Project Logo	PowerizeD Digitalization of Power Electronic Applications within Key Technology Value Chains
Project full title	Digitalisation of Power Electronic Applications within Key Technology Value Chains
Project Coordinator	Mr. Jochen Koszescha, Jochen.koszescha@infineon.com Infineon Technologies AG
Coordinating Entity	Infineon Technologies AG

The objective of this deliverable is to list the main aspects of the Renewables, Grids & Lighting use cases that define the corresponding value chain and to link them to the high-level objectives as applied to WP3. The domain Renewables, Grids & Lighting contains four use cases:

- UC2.1 Flow battery power electronics (AQUA)
- UC2.2 Power Electronics for Green Hydrogen (PRO)
- UC2.3 LED Driver and LV DC Distribution Grid (SIGN)
- UC2.4 Personal Mini PV with Storage (FPG)

2 Introduction & Scope

2.1 Purpose and target group

The objective of this deliverable is to list the main aspects of the use cases in the Renewables, Grids & Lighting domain that define the corresponding value chain and link them to the high-level objectives for PowerizeD as applied to WP3. For this domain this includes the first four objectives:

- O1: Intelligence for More Efficiency and Greener Operation
- O2: Intelligence for Novel Materials and Reliability
- O3: Intelligence for Robust und Safe Operation
- O4: Intelligence for Functional Integration

The scope consists of:

- Description of each demonstrator
- List of the relevant aspects they contribute to the product value chain
- The corresponding link to the high-level objectives.

2.2 Contributions of partners

The following table explains which partner were involved and their activities in their various sections.

Chapter	Partner	Contribution
3.1	AQUA	Input UC2.1
3.2	PRO	Input UC2.2
3.3	SIGN	Input UC2.3
3.4	FPG	Input UC2.4

TABLE 2-1 CONTRIBUTIONS

2.3 Relation to other activities in the project

The relation to the Cross Domain Topics of WP2 for each use case can be seen in the table below:

UC vs CDT Matrix

					Reliability, Modelling & Digital Twins				Substrates, Materials & Integration			Intelligent Sensing		Tools & Standards				Sustainability
Domain	Leader	UC	UC Title	Leader	CDT1.1	CDT1.2	CDT1.3	CDT1.4	CDT2.1	CDT2.2	CDT2.3	CDT3.1	CDT3.2	CDT4.1	CDT4.2	CDT4.3	CDT4.4	CDT5.1
					Reliability	Modelling	Digital Twins	Federated Learning	Substrates	Interconnection Materials	Packaging and Cooling	SW-related Control Approaches	HW-related Sensing & Control Approaches	HW-Tools	SW-Tools	Measurement Equipment & Standards	EMC prediction & design optimization	Comparison of environmental impacts of SiC MOSFET vs Si IGBT modules
Renewables, Grids & Lighting	SIGN	UC2.1	Flow battery power electronics	AQUA	x		x											
		UC2.2	Power Electronics for Green Hydrogen	PRO	x	x	x									x		
		UC2.3	LED-Driver and LV DC Distribution Grid	SIGN		x	x							x	x	x	x	
		UC2.4	Personal Mini PV with Storage	FPG							x	x	x					

TABLE 2-2 USE CASE RELATIONSHIPS WITH CROSS DOMAIN TOPICS

- Inputs: This deliverable derives its inputs from the preceding project deliverables D1.1 Requirements along the value chain (1) and relevant content from the three Reports on common definitions on Cross Application & Domain Topics D2.1.1, 2.2.1, 2.3.1, and 2.4.1.
- Outputs: The output documented in this deliverable will guide the further work for the use cases in the Mobility domain towards the realization of demonstrators that show the potential to reach the targets for each given use case.

3 Summary report on demonstrators along the value chains in the Mobility Use Cases

For each use case the demonstrator(s) and the results are shown in a short video. Chapter 3 provides a short description of the video belonging to each use case and a link to the video itself.

Domain	Leader	UC	UC Title	Leader
Renewables, Grids & Lighting	SIGN	UC2.1	Flow battery power electronics	AQUA
		UC2.2	Power Electronics for Green Hydrogen	PRO
		UC2.3	LED Driver and LV DC Distribution Grid	SIGN
		UC2.4	Personal Mini PV with Storage	FPG

Table 3-1 shows the list of use cases belonging to the Renewables, Grids & Lighting domain.

Domain	Leader	UC	UC Title	Leader
Renewables, Grids & Lighting	SIGN	UC2.1	Flow battery power electronics	AQUA
		UC2.2	Power Electronics for Green Hydrogen	PRO
		UC2.3	LED Driver and LV DC Distribution Grid	SIGN
		UC2.4	Personal Mini PV with Storage	FPG

TABLE 3-1: LIST OF USE CASES IN THE RENEWABLE GRIDS AND LIGHTING DOMAIN

3.1 UC2.1 Flow battery power electronics

The video shows the 4 demonstrator scopes, described below, developed within UC2.1. The realization is a combined effort and cooperation by Aquabattery and the TUDelft and the results are compliant to the use cases' KPI objectives. Further details can be found in project deliverables 3.2.3 and 3.2.5.

Demonstrators

- Operational Aquabattery demonstrator Pilot plant & Data acquisition dashboard
- R&D mid-sized stack test setups
- Real time flow battery Digital twin setup
- 10 kW testing of the Bi-directional DAB DC-DC converter

3.1.1 Aquabattery demonstrator pilot plant: multi-stack operation & D.A.Q.

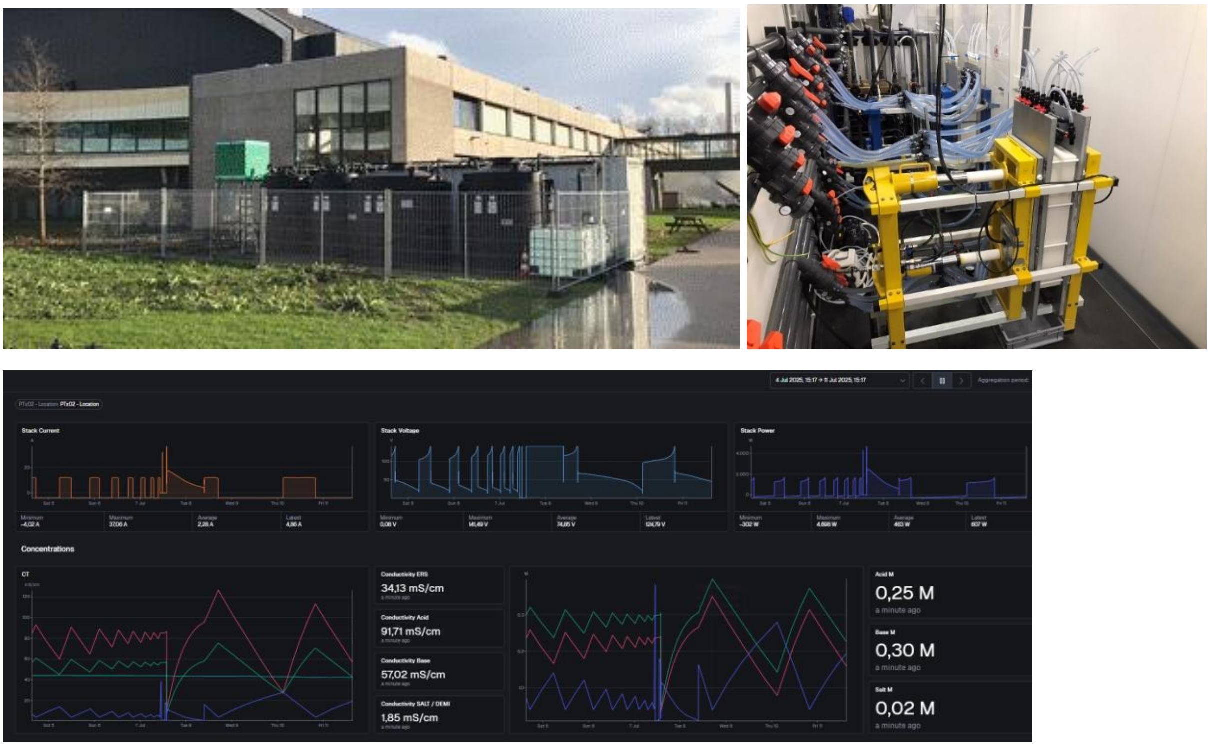
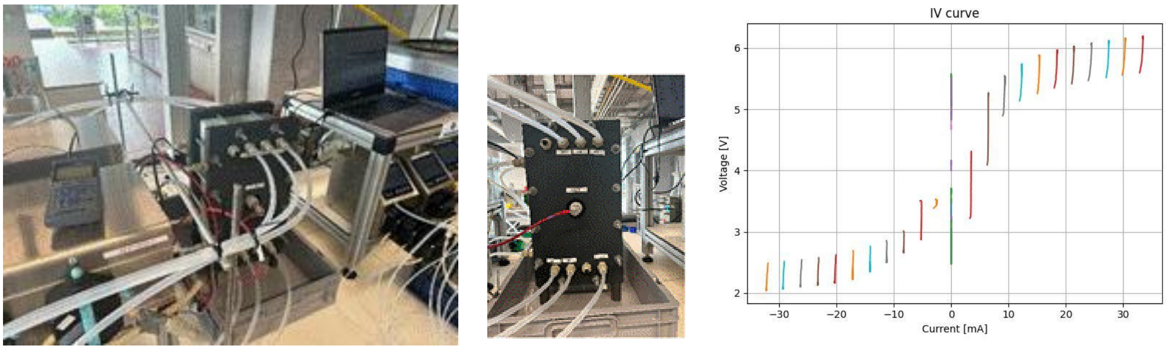


FIGURE 3-1: AQUABATTERY DEMONSTRATOR PLANT & DATA ACQUISITION DASHBOARD

3.1.2 R&D mid-sized stack setups for optimized operation



Conductivity Base channel at SoC 0%	0	mS/cm
Conductivity Base channel at SoC 100%	178	mS/cm
Conductivity change for a 1% SoC step	1.78	mS/cm

	Cycle 4	Cycle 5	Unit
File	Cycle4_C60_D60_WS3-D-WV1-10	Cycle5_C200_D30_WS5-D-WV1-10	
Current Charge	60	200	A/m^2
Current Discharge	-60	-30	A/m^2
Conductivity Base channel Start	11.38	11.64	mS/cm
Conductivity Base channel before Discharge	144.4	175.6	mS/cm
Conductivity Base channel End	135	98.1	mS/cm
Temperature Start	24.8	20.4	degree C
Temperature before Discharge	26.5	25.7	degree C
Temperature End	26.1	24	degree C
SoC Start	0.063932584	0.065393258	%
SoC before Discharge	0.811235955	0.986516854	%
SoC End	0.758426966	0.551123596	%
Volume Acid	1.50	1.24	L
Volume Salt	1.50	1.24	L
Volume Base	1.50	1.24	L
Volume ERS	1.50	1.24	L

FIGURE 3-2: R&D LAB TEST SETUP OF IMPROVED INTERNAL DEVELOPED STACK & RESISTANCE IV CURVE AND CURRENT DENSITY RESULTS AN INPUT FOR DIGITAL TWIN

3.1.3 Real time flow battery digital twin

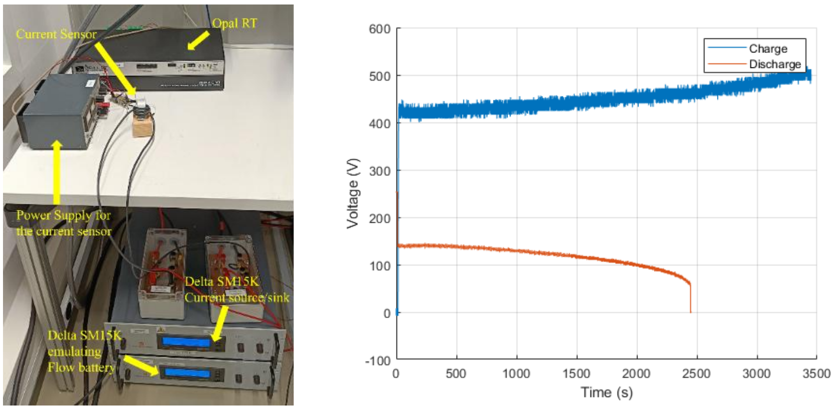


Figure 3-3: *Real time Flow battery Digital twin experimental setup* & Experimental result of 3.3A charge and discharge of flow battery digital twin.

3.1.4 10 kW testing of Dual Active Bridge DC-DC converter

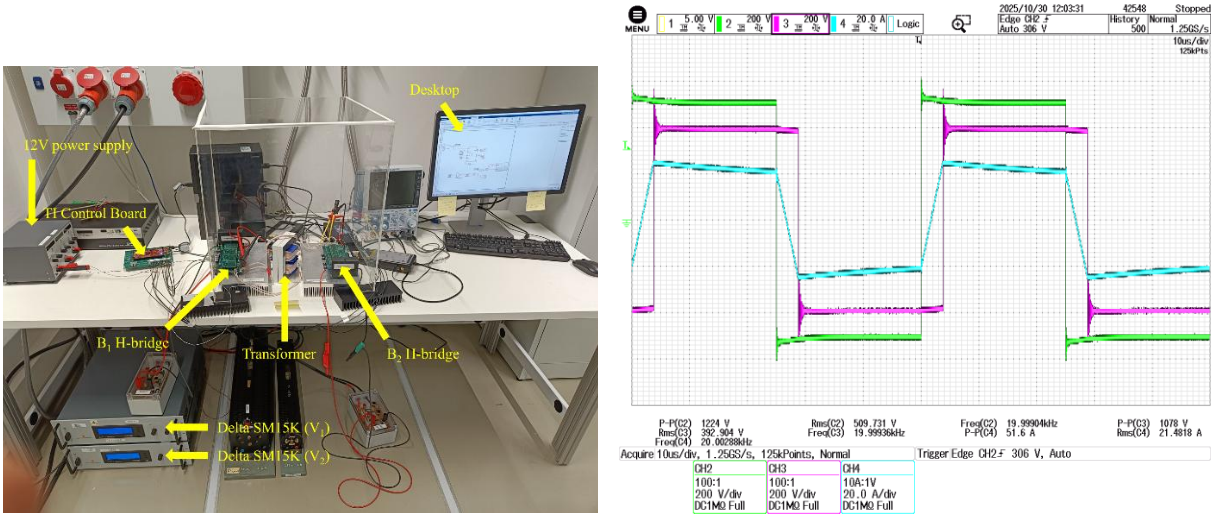


Figure 3-4: Experimental setup of 10kW Dual Active Bridge converter & Result 🕓 Operation of the DAB at 10kW.

The video is available at:

[https:\\demonstrators.powerized.eu](https:\\demonstrators.powerized.eu)

3.2 UC2.2 Power Electronics for Green Hydrogen

The demonstrators in this use case include a high reliability SiC MOSFET power module and a 200kW SiC-based rectifier module based on the chosen IMS power module. The rectifier is a crucial part in the process and equipment for production of green hydrogen. Without suitable electronics, bulk hydrogen production will not be possible due to lacking efficiency, large, single-use and monolithic systems and grid distortion. The SiC-based rectifier electronics concept developed in the PowerizeD project will allow significant reductions in size, losses and downtime. The latter is realized through integrated sensing in the module along with remaining lifetime modelling.

The final result will be a scalable rectifier system, comprised of one- or multiple racks filled with rectifier modules. The video clearly depicts the modular approach including the switch gear and additional hardware in a shipping container, as it would arrive at the hydrogen production plant:

FIGURE 3-5 EXAMPLE OF A SCALABLE RECTIFIER SYSTEM.

The demonstrator relates to the PowerizeD project objectives as follows:

- O1: Intelligence for More Efficiency and Greener Operation
    - The power module features integrated sensing for accurate and real-time remaining lifetime modelling and prediction. This allows for trustworthy predictive maintenance and replacement, reducing downtime of the hydrogen production plant.
- O2: Intelligence for Novel Materials and Reliability
    - Extensive lifetime testing and power cycling testing have created accurate remaining lifetime prediction models for the rectifier electronics.
- O4: Intelligence for Functional Integration
    - Advanced control methods allow for distributed control of the switches so that the system can be infinitely scalable, independent of the rack and container configuration.

The demonstrators in this use case will pave the way for further development of the rectifier system, comprised of modules, racks and eventually containers, and will facilitate future bulk (GW-scale) hydrogen production from green energy.

The video is available at:

[https:\\demonstrators.powerized.eu](https:\\demonstrators.powerized.eu)

3.3 UC2.3 LED Driver and LV DC Distribution Grid

The video shows the demonstrator and the results of the ‘Fast track market introduction 1800W LED driver’. Target applications are indoor and outdoor sport fields, but also large areas like airports and cargo points, see Figure 3-6 for pictures of the LED driver and its applications. In deliverable D3.2.3 the demonstrator is described in more detail.

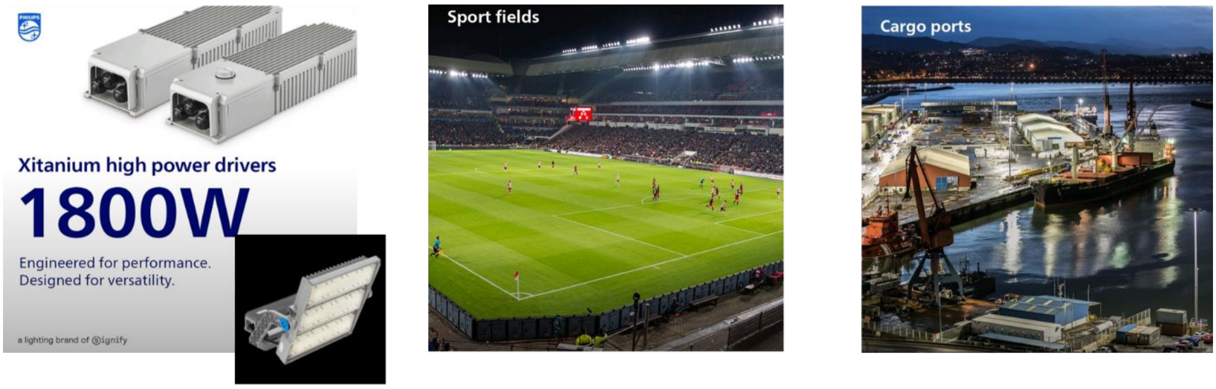


FIGURE 3-6 PROTOTYPE 1800W LED DRIVER AND ITS APPLICATIONS.

The video is available at:

https:\\demonstrators.powerized.eu

3.4 UC2.4 Personal Mini PV with Energy Storage

The demonstrator shows an improved battery storage system for private households, including power electronics and a low-voltage battery. The project-related innovations are an efficiency increase, extended functionality and increased power density. The efficiency is increased by an additional hardware auxiliary circuit and corresponding software-created control method, the functionality should be extended in terms of grid and load analysis as well as state of health analysis of the battery, improving by special control algorithms in terms of healthy charging and discharging current waveforms. Besides that, the power density of the whole power electronics unit is increased by designing a compact heatsink structure applicable to 3D metal printing technology.

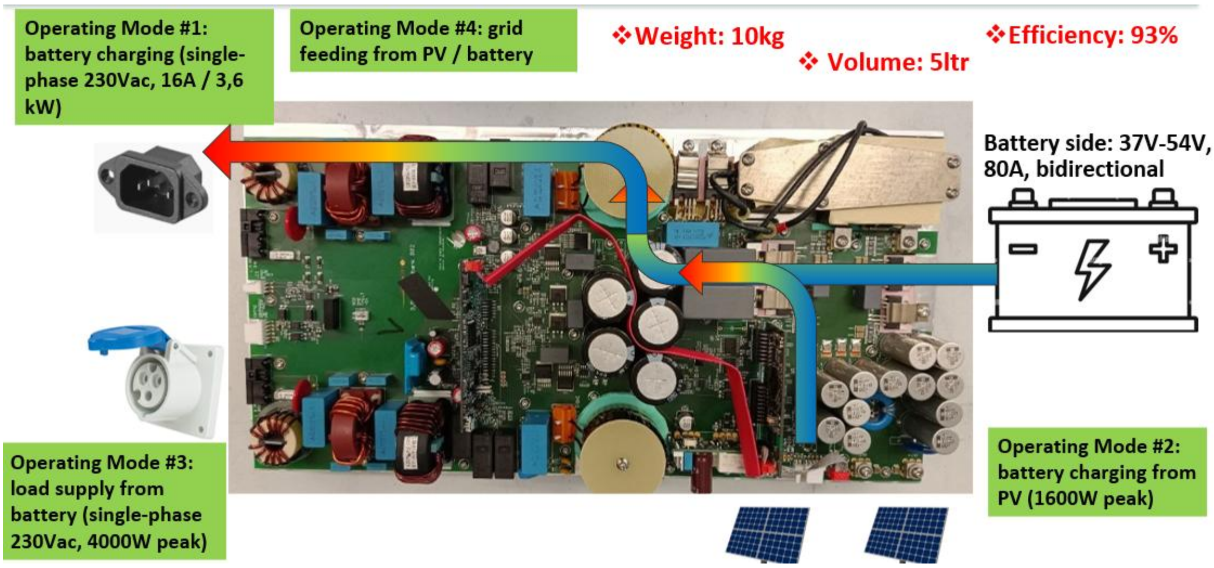


FIGURE 3-7 IMPROVED BATTERY STORAGE SYSTEM.

The video is available at:

https:\\demonstrators.powerized.eu

4 References

PowerizeD. *Report D3.2.3:* Report on the demonstration and validation in the value chains of the Renewable, Grids and Lighting Use Cases

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