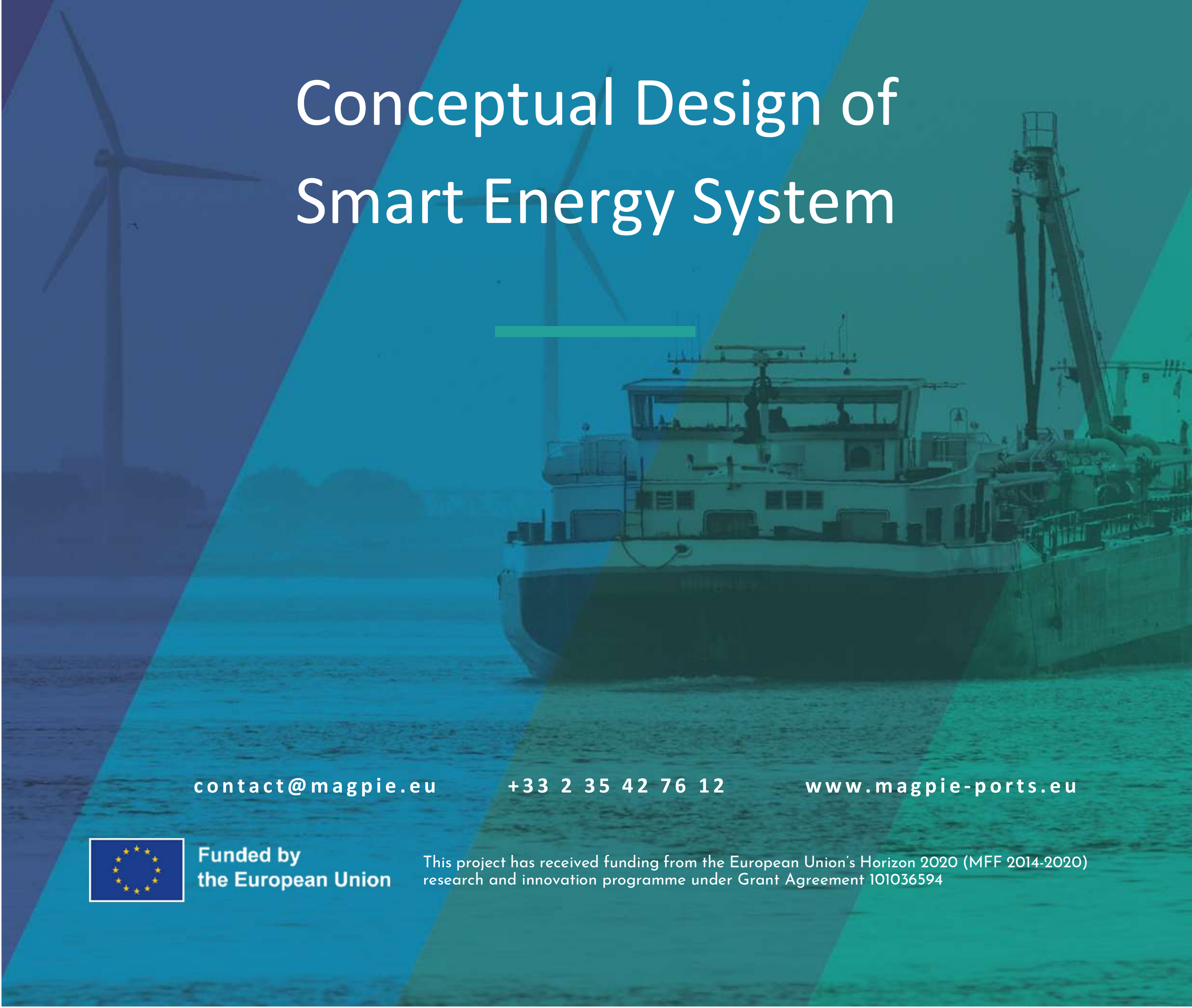
MAGPIE

SMART GREEN PORTS

Conceptual Design of Smart Energy System



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Conceptual Design of Smart Energy System
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All	Clarified RSP demo and mock-up developments with smart energy system	20-07-2022
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Table contents

Executive Summary

Context

Providing (green) electricity to a ship moored in port for instantaneous on-board use of electricity (shore power) is an effective way to reduce the in-port emissions of ships. Shore power has some key challenges of which one is the relatively high investment (CAPEX costs) in shore side infrastructure when the installation is designed for the maximum expected load which will only occur occasionally. When these demand peaks occur, high OPEX costs are also associated with the transport of the required energy volume.

This work package

Local storage of energy could relieve the grid loading in these moments thus lowering the OPEX costs that, ultimately, are imputed to the end user (in this case, the ship owner). To schedule and control the charging and discharging of the battery energy storage unit in a cost-effective way a Smart Energy System is needed.

This Work Package aims to produce both a physical demo of an integrated storage and shore power system at; and to assess and validate smarter ways of market integration and, power trading, interacting with the battery and the shore power installation.

This deliverable

This report provides the principal set-up of the (physical) shore power installation as well as the assessments on storage that are being made. It also describes the (digital) smart energy system that is being assessed, as well as the fieldlab validations that will bridge the digital and physical angles of this work package.

Conclusions and recommendations

So far no real conclusions have been made, but the consortium was able to scope (as in chapters above) the work package, and is aligned on further steps to take. The work package is now set up to work in two parallel tracks: the hardware side (ENECO, ZES driving) and the software and modelling side (TNO, Blocklab driving). For speed of execution this is the best way forward.

1. Introduction

MAGPIE project is an international collaboration working on demonstrating technical, operational, and procedural energy supply and digital solutions in a living lab environment to stimulate green, smart, and integrated multimodal transport and ensure roll-out through the European Green Port of the Future Master Plan and dissemination and exploitation activities. The consortium, coordinated by the Port of Rotterdam, consists of 3 other ports (DeltaPort, Sines and HAROPA), 9 research institutes and universities, 32 private companies, and 4 other organisations.

The project is divided in 10 main work packages which include energy supply chains, digital tools, 10 demonstrators for maritime, inland water, road, and rail transport, non-technological innovations, and the development of a Masterplan for European Green ports. In WP 3 of MAGPIE, present and future demand patterns associated with the several transport modalities that co-exist in the port ecosystem are studied. In addition, different supply streams capable to accommodate such demand are designed "from source to plug". In this context, the Shore power peak shaving demonstrator is responsible to investigate one specific use case of this "source to plug" link.

Providing (green) electricity to a ship moored in port for instantaneous on-board use of electricity (shore power) is an effective way to reduce the in-port emissions of ships. Shore power has some key challenges of which one is the relatively high investment (CAPEX costs) in shore side infrastructure when the installation is designed for the maximum expected load which will only occur occasionally. When these demand peaks occur, high OPEX costs are also associated with the transport of the required energy volume. Local storage of energy could relieve the grid loading in these moments thus lowering the OPEX costs that, ultimately, are imputed to the end user (in this case, the ship owner).

To schedule and control the charging and discharging of the battery energy storage unit in a cost-effective way a Smart Energy System is needed. This system will ensure that excess of RES power production is stored and intelligently used (i.e., to power the ship when it is moored, to provide ancillary services to the grid when there is no demand from ships). The objective of this deliverable is to describe the conceptual design of this Smart Energy System. This will include a description of the components and the use of the Smart Energy System.

Chapter 2 gives a description of the MAGPIE shore power demonstration (demo 3) to set the scene for the Smart Energy System which is described in Chapter 3. Chapter 4 describes how the Smart Energy System will be developed and integrated in the shore power system, focusing on experimental development and verification in a down-scaled mock-up. Finally, in Chapter 5 conclusions are drawn and recommendations for the further developments are given.

2. Shore power demo

Shore power is the supply of electrical power to a ship moored in port to replace the onboard generation of electricity, which in most cases uses diesel generators. The objectives are to: 1) reduce emission of GHG gasses, and 2) improve air quality in port and surrounding areas. To support this, ports need to provide shore side connections which are compatible with the vessel connectors, and which can provide the required electrical energy for in-port operations.

Apart from standardisation of vessel connectors, other key challenges for shore power are the large variations in load and the high peak load required by some ship types such as crane vessels and passenger vessels. When designing the power supply infrastructure to the maximum power requirement, the infrastructure will be under-utilised most of the time. In addition, when these demand peaks occur, the infrastructure will be loaded near its maximum transport capacity, which entails high OPEX costs. Therefore, other solutions such as local storage of energy at the shore side can provide peak shaving of the energy supply and lead to cheaper and better utilised power infrastructure. In this chapter the concept of the MAGPIE Shore Power Peak Shaving demonstration (demo 3) is described to position the conceptual design of the Smart Energy System in the context of the project.

2.1 Overall objectives

Considering the two key challenges mentioned above, the MAGPIE Shore Power Peak Shaving demonstrator (demo 3) sets out to "Increase utilisation of a shore power hub facility to reduce costs by shaving the peaks using stored energy"[1]. This high-level ambition is achieved by pursuing the following objectives:

- To demonstrate the effect of locally stored energy on relieving the electricity grid and infrastructure loading caused by large, low frequent power demand variations.
- To demonstrate the contribution of locally stored energy on the grid stability considering both large load demands for shore power and temporal overproduction of green electricity.
- To simulate the grid dynamics in a controlled environment including the smart energy system controlling the charging and discharging of locally stored energy.

These objectives are achieved by demonstrating the shore power connection at a selected site as described in the next section. MAGPIE project partners TNO, BlockLab, Port of Rotterdam (PoR), INESCTEC, EDP, Heerema, APS, Haropa, DTP and Eneco work together in this demonstrator.

2.2 Plan for demonstration

The Municipality of Rotterdam and the PoR Authority are conducting a joint strategy and development programme to accelerate and scale up shore power for sea-going vessels. The aim is that by 2030 a large proportion of seagoing vessels will be 'plugged in' when at the quay.

Since mid-March 2022 RSP has put its first installation into operation at the Heerema Rozenburg site. The shore-based power installation is located at Landtong Rozenburg (Figure 2) near Heerema's home port at Calandkanaal in the Port of Rotterdam. The berthing location of Heerema at the Calandkanaal is serving three large Heerema-owned

[1] MAGPIE Proposal

ships, namely Thialf (Figure 1), Aegir and Sleipnir. The Calandkanaal is regularly visited by other vessels as well.

Figure 1. Heerema's Thialf crane vessel

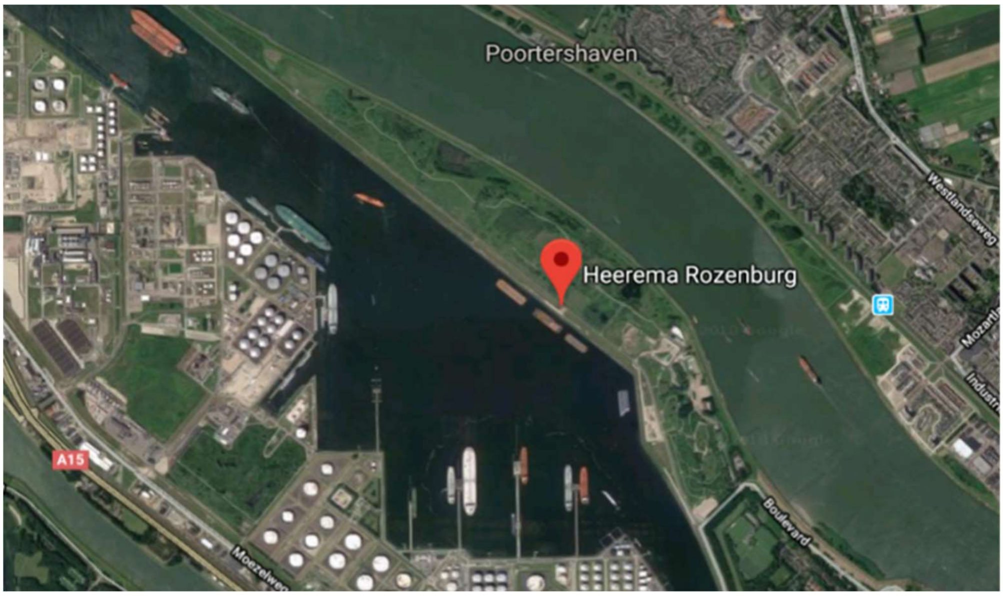


Figure 2. Location of Heerema Rozenburg site

As shown in Figure 3 the shore power installation transforms the voltage and frequency of the grid (or wind park) to the required voltage and frequency on board the ships. A cable management system makes the connection between shore and ship.

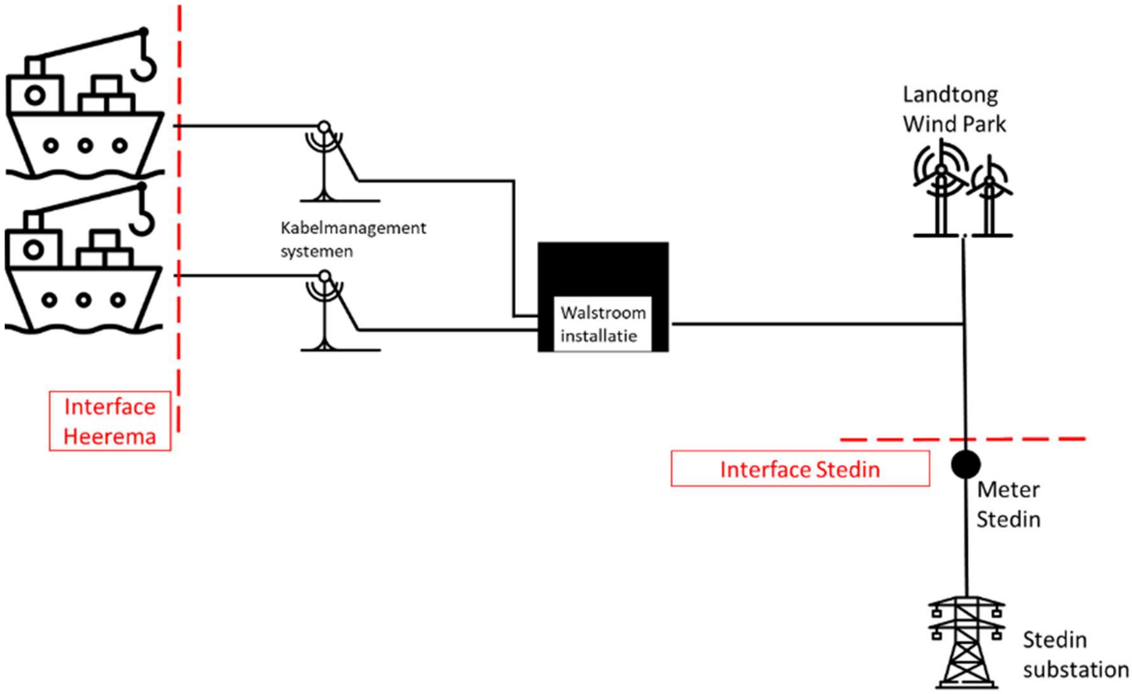


Figure 3. Concept of Heerema shore power installation

When the design of the shore power installation was made, a conscious decision was taken to leave local storage of energy out of scope as this did not provide a better business case. The design however can still be updated to include locally stored energy if this is proven beneficial. Local energy storage could have been used to optimize transport costs and generate income from, for example, the Power capacity markets, e.g. FCR market[2] when there are no ships at the quay.

Heerema's shore power system connects Eneco's wind farm at Rozenburg (Figure 4) with the shore power installation through a 25kV Stedin grid connection. In the simplified Single Line Diagram the interconnections are shown, as the shore power installation is connected to the wind farm.

[2] https://www.tennet.eu/electricity-market/dutch-ancillary-services/

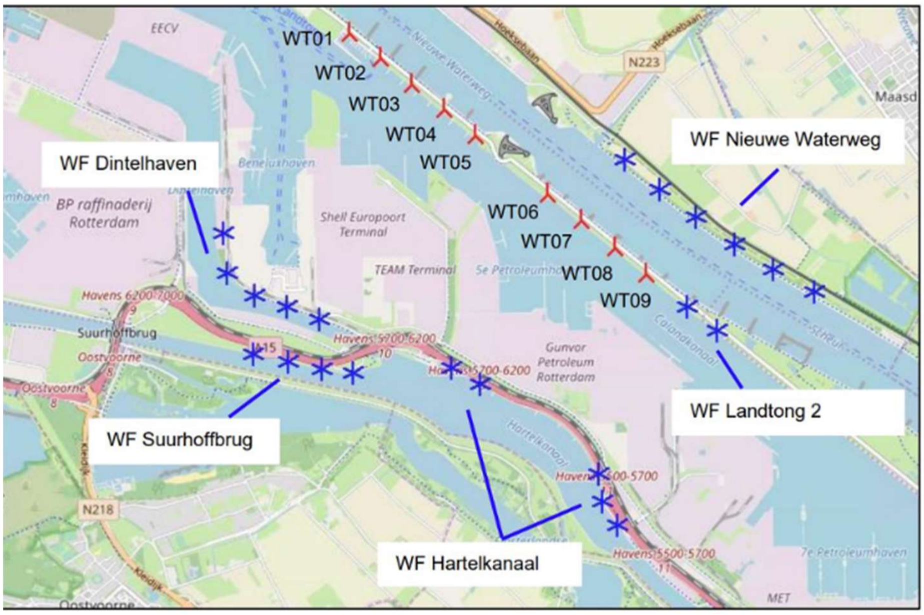


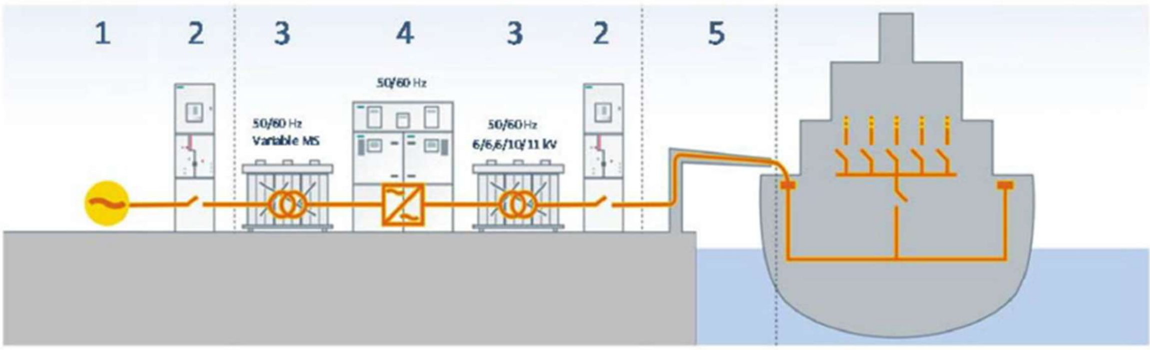
Figure 4. Eneco's wind farm Rozenburg

The wind farm consists of nine wind turbines (9x4,5MW) situated on a small land strip between the waterways 'Nieuwe Waterweg' and 'Callandkanaal' in the Rotterdam port area. The surrounding area is characterized by a variation of water ways and industrial harbour complexes. The location of the wind turbines (red icons with ID) is visible in Figure 4 together with other existing wind turbines (blue icons).

The shore power installation is a 20MW (2x10) connection designed to accommodate a maximum of 2 vessels and 2 cranes at the same time. Demand profiles of the ships have a relatively high base load and high peak load. Typically, 1 ship uses 5MW (baseload) and when they crane on another 5 MW. However, since the installation is only operational since mid-March 2022, RSP still needs to gain experience with Heerema's electricity demand. On average, is expected for Heerema to demand 20GWh per year.

As can be seen in Figure 5 the main components of the electrical (static) shore power infrastructure are:

- E-house (including switch gear, converter units, cooling, auxiliary, control systems);
- Transformers (2 input, 2 output, 1 auxiliary);
- Cable Management System (CMS).



1. Local grid connection
2. Substation 50/60 Hz
3. Transformers
4. SIPLINK converter system
5. Cable management system

Figure 5. Schematics of Heerema shore power installation

In this work package we are assessing to ways further sophisticate the smart energy system as shown in figure 5: by adding storage and battery management to the installation (2.3) and/or by connecting the installation to a A.I. driven marketplace for its power procurement (Ch. 3).

2.3 Shore power and battery system implementation scenarios

MAGPIE demo 3 aims to increase the system utilisation of a shore power hub facility and to reduce its operational cost base, enabling for a more cost-effective multi-user shore power service. The first step in this is integrating electricity storage thus making the shore power facility more flexible. A final decision on the implementation of the storage system has not been made yet and is part of a thorough assessment:

1. Preliminary specifications, originating from the current Heerema deployment set-up for battery system including inverters, should meet the specs.
2. Three options for battery system were identified (see Table 1) and are currently being assessed to understand which one fits better with the preliminary specifications. Three dimensions are currently being analysed on:
    a. Technical feasibility;
    b. Lead time;
    c. Financial feasibility.
3. The work package partners will make a shared decision on execution and share outcomes with the MAGPIE organization directly after.

The three implementation scenarios are briefly summarized in the matrix on the next page – the assessments may lead to changes.

Table 1. Shore power and battery scenarios

	Option 1	Option 2	Option 3
Description	The integration system will be a docking station (charging station) for ZES. Containerized integration system and batteries (ZESPack[3], the containerized battery system as designed and exploited by ZES)	The integration system will be rented to a third party. The Battery will be the ZESPack	Wärtsilä integration system[4] + their batteries Batteries = ZESPack not required
Cost	TBC	TBC	TBC
Lead time	+	++	TBC
Medium Voltage System	TBC	TBC	TBC
Footprint	2 times standard ISO 20ft container	1 standard ISO 20ft container + integration system size	(w, d, h) 2076mm x 3169 mm x 2462 mm
Tech specs of the components of the system	Attached	TBC	Attached

2.4 Positioning of Smart Energy System

The Smart Energy System is an integral part of the shore power installation as this will optimize the charging and discharging of the local energy storage aiming to: 1) reduce the peak load and load variations required from the energy grid, while contributing to the grid stability; 2) increase the cost-effectiveness of the shore power service by bidding in power and capacity markets. To achieve this, the smart energy system will require several different inputs such as the energy demand of vessels, information on possible grid congestions, the state of charge of the local energy storage. In the next chapter the concept design of the Smart Energy System is detailed.

[3] ZESpack - Zero Emission Services
[4] Wärtsilä Energy Storage - GridSolv Quantum - Next generation storage (wartsila.com)

3. Smart Energy System

The Smart Energy System is an integral part of shore power controlling the energy supply to and from the local storage unit. Controlling will be done based on grid capacity, availability of green energy and the requirement concerning when the local storage should be full and ready for a vessel alongside. This requires links to other digital systems such as the port digital twin (MAGPIE WP 4) to receive information on vessel ETA and charging requirements. In this chapter the concept design of this system is described.

3.1 Objectives

The objectives of the Smart Energy System are:

- To support the shore power provided to vessels moored in ports.
- To predict shore power demand on the short to medium term.
- To provide grid stability by regulating charging and discharging of the local energy storage.
- Demonstrate energy trading possibilities when using locally stored energy to balance the grid.

MAGPIE partner BlockLab is tasked with developing the Smart Energy System in WP 3 task 3.9.

3.2 Conceptual design: scenarios for energy trading using the shore power battery

The market design research focuses on embedding the shore power demo assets in a local power market, seeking for optimal balance between supply and demand and for price efficiencies. For this, Blocklab will leverage the Distro Marketplace that it co-developed and that was recently incorporated into Distro Energy BV (backed by Port of Rotterdam and S&P Global).

Distro is a peer-to-peer power trade marketplace that has been designed to unlock proven market and exchange mechanisms on a localized level. It facilitates algorithmic trading in a 48 hour forward market, in 15-minute time intervals. This allows its participants to use forecasts to place forward bids and asks, to set local prices, and to use storage and flexible loads to balance local supply and demand. Moreover, Distro facilitates the trade of the aggregated position from all peers against (a reflection of) wholesale market prices, thereby also allowing extra revenue models for storage and flexible demand.

Towards the port power market ecosystem, and towards a nodal network of shore power stations, we will simulate and test several scenarios in which the shore power supply chain shifts from linear to a decentralized configuration.

The benchmark deployment model illustrates a scenario where the Distro platform is out of scope, cf. Figure 6. We assume the windfarm to also sell into other markets or via other PPAs, and battery owner to be interest in tapping into capacity markets.

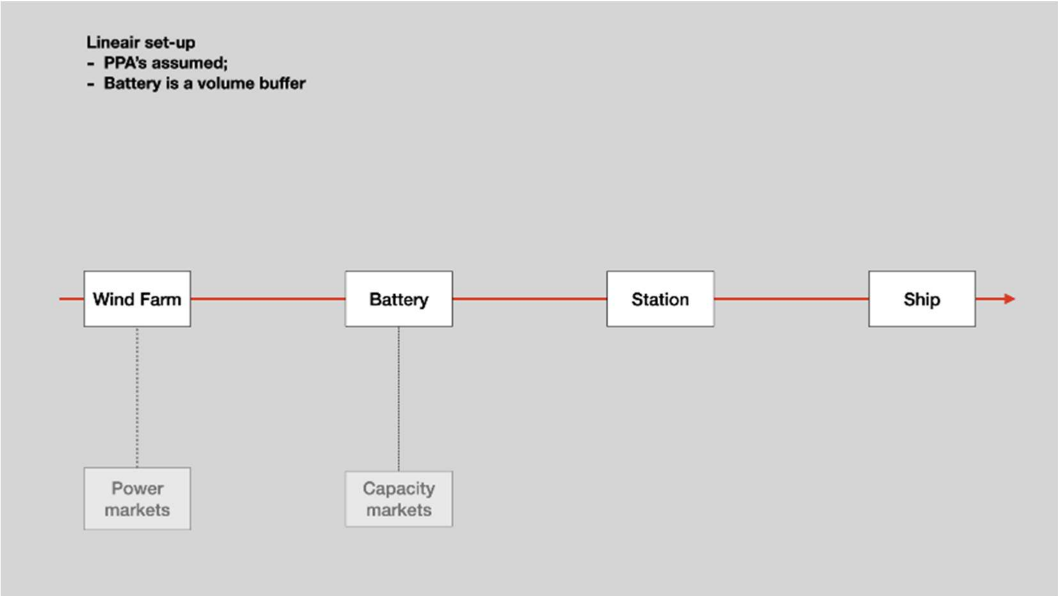


Figure 6. Linear shore power deployment including battery as a buffer

MAGPIE will simulate and optimize a competing scenario, as schematized in Figure 7, in which the demo assets will act as trading actors rather than being centrally controlled. Some aspects included in the optimization are the battery specifications, the wholesale (spot) market price reflections and the possibility to access to capacity markets. All assets are treated as independent economic entities in these.

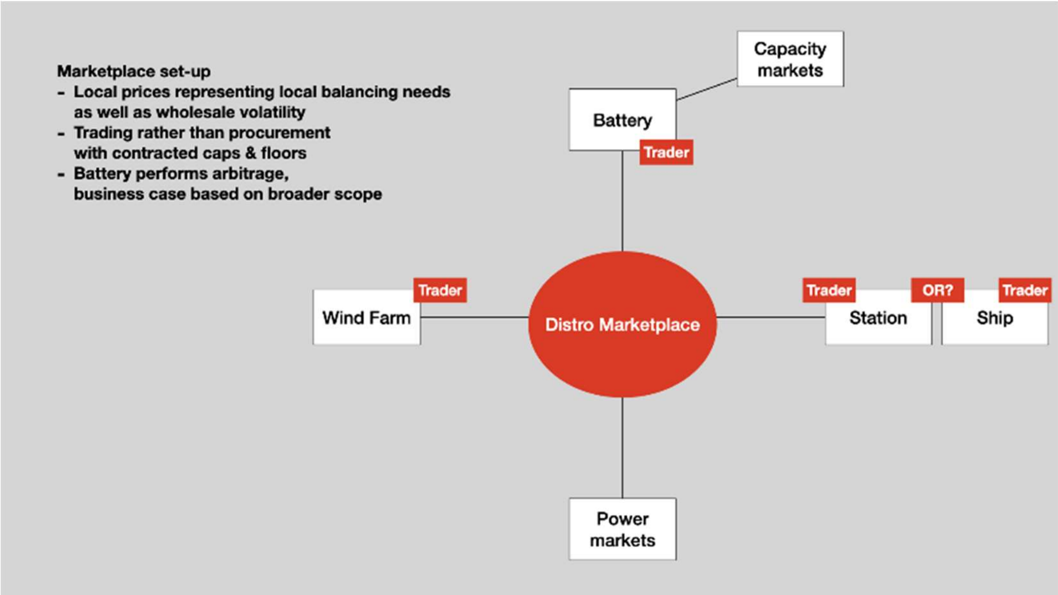


Figure 7. Shore power deployment and battery over a local decentralised marketplace

Furthermore, a high-over analysis will be performed for a shore power growth model over the local Marketplace (fig 8).

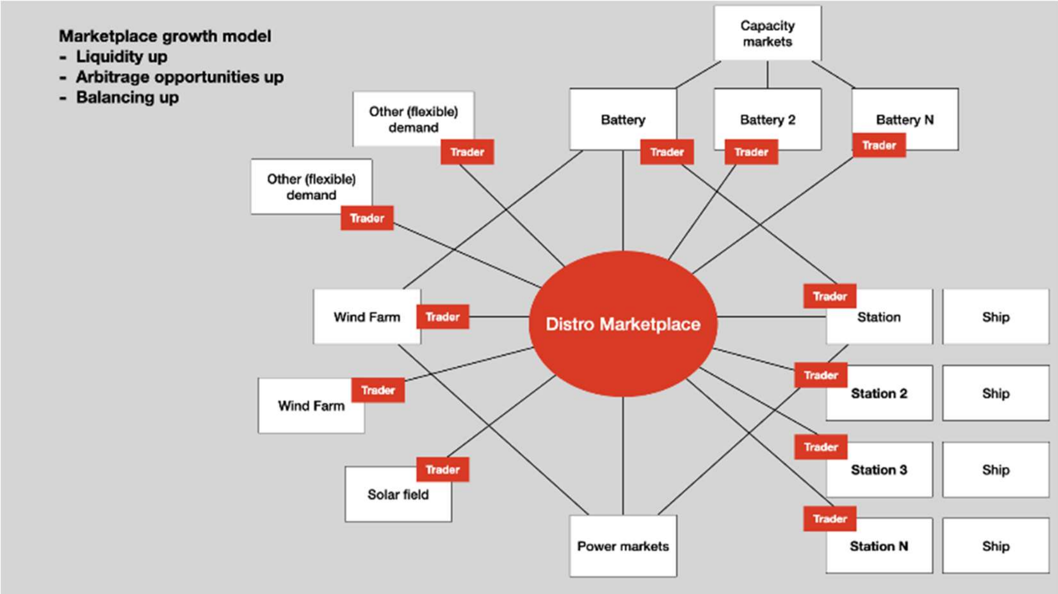


Figure 8. Growing shore power portfolio embedded in a local decentralised market

For all the demonstration tests, demo-partners' data and energy profiles will be used, complemented with Dutch power market data and Port power grid data. To simulate different operational scenarios and specially to include growth models, Blocklab will work closely together with TNO and its SWITCH lab (section 4). Real data will be used whenever possible; generated data and modelling will be used when needed. Analyses will include:

- Full year economic analysis of local market trade.
- Variations of battery (following insights from battery assessment (Ch 2) and SWITCH simulations (Ch 4.) and benchmark price parameters.
- Outcomes on price levels; utilization of local generated power; battery arbitrage results. i.e.: what is best business case in terms of price and energy efficiency?

3.3 Components around the Distro marketplace

Figure 9 shows all components and the system logic of a full Shorepower-Distro deployment. The challenge for modelling will be optimization of the trading models and price curves, providing the best shore power business case possible., The challenge for deployments will be in accessing ship demand profiles and integrating the shipping information, the marketplace, and the battery management system.

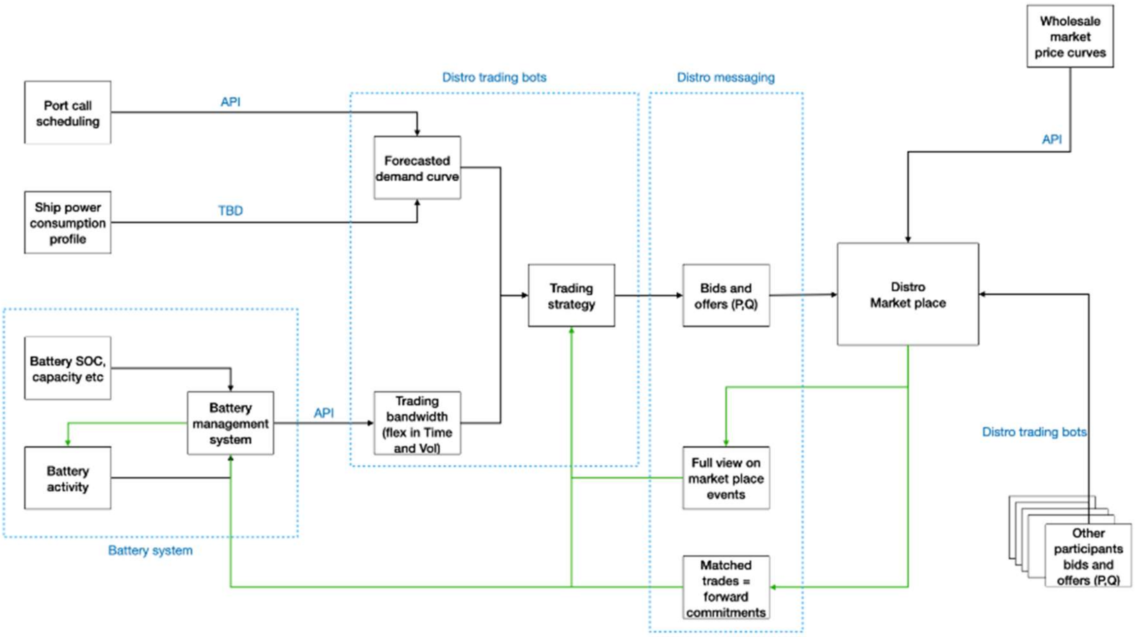


Figure 9. Overview of smart energy system components and logic

The flow of logic across the components is as follows:

- To be able to forecast volume demand of a ship, two inputs are needed:
  - **Port call scheduling** (Port operator system: time scheduling for ship to run stationary at the shore power connection point);
  - The **ship's power consumption profile**: ideally historic data sets from earlier calls, and at minimum the average and maximum load needed.
- With a battery installed at the shore power station, the second input for power trade are **the state and the parameters** as well as **the activity of the battery,** all managed and communicated via the **Battery management system;**
- Via API's, these inputs go into the **Distro trading bots**, which produce **forecasted demand curves** (volumes needed for specific timeframes) and determine their **trading bandwidth,** i.e. the optionality to flex up or down power demand (ship demand plus/minus battery activity).
- Based on the demand forecast and the trading bandwidth, Distro trading bots design a **trading strategy** to optimize the power purchase on behalf of ship + battery.
- Via the **Distro messaging** system the bots send **bids and offers (P,Q combinations)** to effectuate the trading strategy into the **Distro marketplace.**
- The Distro Marketplace brings together **price curves that represent wholesale markets** (EPEX related buying and selling prices) and the **bids and offers from all participants** (shore power installation, windfarm, etc). When supply and demand meet on price, trades get matched and settled automatically.
- The Distro Marketplace feeds back all **matched trades** as well as **all market events** (price changes, new bids or offers coming in, etc) via the Distro messaging system to both the trading bots (to iterate their trading strategies and start the same loop) and to the battery management system (to charge/discharge according to traded schedule).

3.4 User/Use profiles

Power supply, energy management and grid management are of course an ecosystem play. For the trading solution we focus on the users who are directly involved in trade, summarized in the following user stories:

- As a shipper I want reliable and affordable access to onshore power supply;
    - Preferably including origin and CO2 accounting
- As a shore power station operator I want the best ROI/IRR on my deployment
    - Which means I want to lower my total cost of energy;
    - Which means I want to use my flex (battery) capacity for price elasticity, arbitrage opportunities and ancillary services.
    - Preferably including origin and CO2 accounting
- As an renewable power supplier (e.g. offshore wind) I want to tap into flex capacity to sell my peak load against optimal prices;

3.5 Next steps

Within the scope of Magpie next steps are:

- Distro simulation runs on scenarios above, using actual market and user data (kicked off already);
- SWITCH field lab tests coupled with Distro simulations runs, as described in section 4 (scoping sessions being scheduled)
- Assessment of system integration with port and battery systems (pends progress in section 2 actions).

Beyond Magpie, towards impact:

- Assessment and roadmap for further roll-out through port.

4. Shore power mock-up

4.1 Mock-up system at SWITCH field lab

As part of the MAGPIE demo 3, a scaled mock-up of the shore power installation will be tested and validated at the SWITCH field lab. SWITCH[5] is a new field lab for the energy transition, located in Lelystad in the Netherlands, cf. Figure 10. It is a collaboration between TNO and Wageningen Research, with ample opportunities for third parties to engage in collaborative research and testing. The lab consists of wind turbines, a solar-PV arrays, a battery and an electrolyser and can be configured by selecting the appropriate interconnections to represent various types of hybrid energy systems. It can either be operated in grid-connected mode or in off-grid mode, with the battery system providing the local voltage and preserving power balance. In grid-connected mode the option to weaken the grid is built in, so to enable voltage control and to study dynamic and harmonic interactions between clustered power-electronic converters. During operation, meteorological data, power distribution data, and status monitoring data of the assets is continuously collected and analysed.

Figure 10. Overview of the SWITCH field lab

Key assets of the SWITCH field lab that will be available for the MAGPIE mock-up are:

- 4 wind turbines, stall-regulated, 10kW each (operational)
- 2 wind turbines, pitch-regulated, variable speed, 10kW each (operational)
- 6 solar PV systems, 7.5kWp/6kVA each (Q2 2023)
- Battery system (Lithium Iron Phosphate: LFP) 58kWh/60kW (Q2 2023)
- Electrolyzer (Proton Exchange Membrane: PEM) 25kW (Q4 2023)
- Meteorological mast: wind, temperature, air pressure and irradiance (Q2 2023)

[5] TNO Wind Energy - roadmap System integration

4.2 Approach for supporting RSP

The overall approach in supporting the shore power demonstration and its operation is the following:

- A physical scaled mock-up of the shore power demo system is realized at SWITCH.
- Algorithms to optimize and control the system are developed (e.g., decide on when to charge/discharge the battery to the vessel or grid, based on WF generation and RSP load profiles and scenarios provided by RSP). These will serve as baseline for benchmarking with the Distro local marketplace.
- A computer simulation model scaled for the mock-up system configuration at SWITCH is made, wherein the above algorithms will be tuned.
- A scaled experiment is performed with the mock-up system at the SWITCH field lab to validate the developed algorithms. These are implemented in a local industrial computing platform, e.g. a PLC, operating as an Energy Management System (EMS).

Note: Although the scale difference is considerable, the SWITCH assets technology is comparable to the full-scale demo system. For instance, two wind turbines are pitch-controlled, which is the current standard for large wind turbines. The battery chemistry (Lithium Iron Phosphate) at SWITCH is a commonly used technology for large electricity storage systems and probably also preferred at the RSP demo. Any differences in battery system characteristics will be included in the relevant model parameters and thus the behaviour of the lab configuration can be translated with some fidelity to the real-life case.

Different assumptions and scenarios (e.g., on battery performance) are considered in these experiments with the mock-up system in the SWITCH field lab in order to de-risk and optimise the full-scale demo and further upscaling / roll-out plans. In Table 2 an overview of the conceptual experiment design is given.

Table 2. Overview of conceptual experiment design

Experiment use-cases	Full-scale demo configuration	Mock-up SWITCH configuration: assets in use*	Objective/Innovation/Development
Peak-shaving and increased WF utilization	20MW wind, 2MWh battery, 4-7MW load	20-60kW wind, 58kWh/60kVA battery	• Evaluate baseline algorithms and potential benefits of alternative configurations, e.g., doubling battery capacity; • Distro First Deployment scenario and Energy Management System, optimizing (mainly) battery system operation: energy import or export bids on day-ahead and intraday market, based on predicted and actual WF production, load levels and prices. System and controller characterisation. Training and validation of EMS and monitoring & control system for abovementioned cases;
Peak-shaving an d	20MW wind, 2MWh battery,	20-60kW wind, 58kWh/60kVA	• Evaluate potential benefits of adding

increased WF and PV utilization – optional	4-7MW load	battery, 4-7kW load*, 15-45 kWp solar energy	solar energy to the input mix – a more robust supply of renewable energy (using baseline algorithms) • Demonstrate decentralised system capacity with Distro Future Vision
Grid support while ships are out at sea	20MW wind, 2MWh battery with AC converter if available, 4-7MW load	20-60kW wind, 58kWh/60kVA battery	• Evaluate potential of grid support functionality (using baseline algorithms); • Distro Future Vision, EMS and monitoring & control system offering grid support services, e.g.: 1) fast dynamic active/reactive power provision to mitigate inrush (peak-shaving) currents and dynamic loads (grid voltage stabilisation, flicker reduction); 2) Active compensation of harmonics; 3) Grid voltage support during voltage dips and short outages. Training and validation of EMS and monitoring & control system for abovementioned cases;

* Note: In addition, a controllable load is to be deployed when needed, i.e. when grid congestion and local grid voltage impact need to be considered.

4.3 Data requirements

Data required for these experiments are:

- Forecasts: wind farm (WF) power production (or wind speed and wind **farm** validated power curve), market data, ship logistics i.e., base-load level, and crane operation, incl. uncertainties: levels/timing.
- Historic datasets: WF production and load profiles + inrush and harmonics current.
- Battery system: rated and available capacity and power, round-trip efficiency and
- Grid: model and operational data (generation and storage capacity may not be fully available in some cases)

4.4 Existing modelling tools

To support the baseline algorithm development and prepare experiments in the mock-up system a quasi-static simulation modelling an optimization tool is available, EMERGE (Energy Management systEm for combined Renewable Generation and storagE). It will be deployed to provide optimum power dispatching considering predicted and actual power generation, local consumption and storage. These assets are considered as a centrally controlled single integrated hybrid power plant, whereas the approach of the DISTRO platform is decentralized.

TNO's market simulation model EYE (ElectricitY market price Evolution simulator) will be applied to assess the market value of different approaches for several *future* market scenarios, which is relevant considering the increasing need for flexibility and its effect on market prices, due to the rapid expansion of intermittent renewable generation.

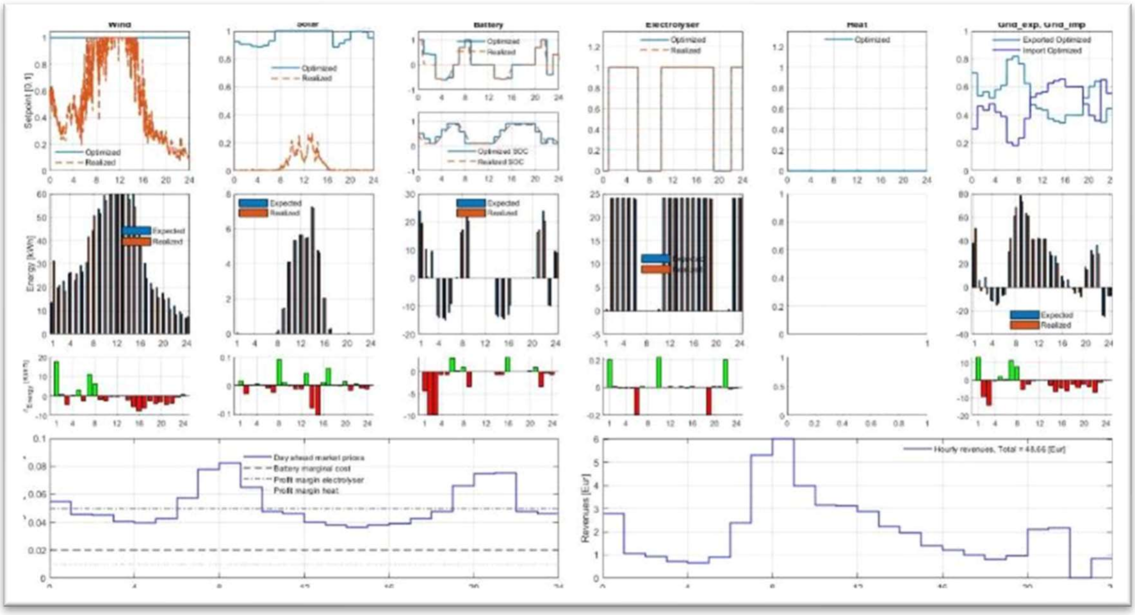


Figure 11. EMERGE software dashboard

To support the development of operational strategies for the MAGPIE shore power demonstration, the various assets of this demo are simulated in the EMERGE tool. If needed for developing ancillary services such as voltage or frequency control, in-house MATLAB code, dedicated for modelling system dynamics and control development, is available to use.

5. Conclusions and Recommendations

In this chapter the conclusions of the work describe in this deliverable are drawn and recommendations for the next steps are given.

5.1 Conclusions

So far no real conclusions have been made, but the consortium was able to scope (as in chapters above) the work package, and is aligned on further steps to take.

5.2 Recommendations

The work package is now set up to work in two parallel tracks: the hardware side (ENECO, ZES driving) and the software and modelling side (TNO, Blocklab driving). For speed of execution this is the best way forward. Knowledge sharing and expert discussions between both tracks should be regularly scheduled.

Annex 1: Contribution to the Knowledge Portfolio

Background - Blocklab	
Owner(s)	Blocklab & Distro energy BV
Nature	Design and (Distro) patented software
Registration/Protection	
Description	Distro product logic, data structures and software are all proprietary IP, owned by Distro Energy BV. One patent has been granted, a second one is pending approval.
Access conditions for research in the project / Limitations	Blocklab will be licensed by Distro Energy BV to run simulations with its software and data models, and to share results after Distro valuation. Under NDA consortium partners can be included in test runs, especially TNO with who Blocklab and Distro intent to do mock-up runs together.
Access conditions for Use / Limitations	Distro's products and data will be commercially available against reasonable terms.
Licensees in the project	Names of the licensees - 1st set To follow
	Date of allocation
	Type of licence/specific access rights granted
	Signature of parties (optional)
	Names of the licensees - 2nd
	Date of allocation
	Type of licence/access rights granted
	Signature of parties (optional)
Licensees for use	Names of the licensees - 1st set To follow
	Date of allocation
	Type of licence
	Signature of parties (optional)
	Names of the licensees - 2nd set
	Date of allocation
	Type of licence
	Signature of parties (optional)

Exploitable Foreground Blocklab	
Type of exploitable foreground	• General advancement of knowledge • Commercial exploitation of R&D results • Exploitation of results through (social) innovation
Exploitable Foreground (description)	Exploitable foreground foreseen: • Data models on shore power consumption profiles and shore power-battery interaction; • Economic analysis, market designs and trading strategies to optimize shore power power purchase and Capex/Opex business cases
Confidential	Yes /
Foreseen embargo date	01-01-2028
Exploitable product(s) or measure(s)	Trading bots, trading strategies
Sector(s) of application	Power markets
Timetable for commercial use or any other use	Organically 2022-2028
Patents or other IPR exploitation (licenses)	No new ones
Owner & Other Beneficiary(s) involved	Blocklab and Distro Energy BV (to be arranged bilaterally properly)

Patents, Trademarks, Registered designs, etc.	
Type of IP rights*	Please select: Patents / Trademarks / Registered Designs / Utility Models / Others
Application reference(s) (e.g. EP123456)*	
Subject or title of application*	
Confidential*	Yes / No
Foreseen embargo date	DD-MM-YYYY
Applicant(s) as on the application*	
URL of application	(Mandatory for Patents)