Floating solar power plant

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About DUAL Ports

DUAL Ports is an Interreg North Sea Region project started in December 2015, with a duration of 3 years. In December 2018, DUAL Ports was extended until 2021 with an increase in partners, pilots and budget. DUAL Ports is based on the operational pilots in Regional Entrepreneurial Ports REP's). DUAL Ports will be measured in the concrete success of the pilots and the pilots' renderability to other REP's.

DUAL Ports addresses the Interreg Programme's objective of promoting resource efficiency and stimulate the adoption of new products, services and processes to reduce the environmental footprint of regions around the North Sea.

A series of pilot reports

DUAL Ports consists of 16 pilot projects and 16 partners from the port industry, knowledge institutions and tech business within sustainable energy. In a series of publications, we are introducing each of the pilot projects highlighting the experiences, results and learnings from their work. Knowledge sharing is vital for the continuous development of sustainable energy and the publications of DUAL Ports pilot projects will be a source for further work.

For more information about the Pilot Project: **Floating Solar Power Plant**, please contact the DUAL Ports partner:

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Summary of pilot

The 14th of January 2022 a new floating solar power plant (FSPP) was installed in the Oostende port, Belgium, under DualPorts European program. 10 different companies from 7 different countries were involved in the project (link).

The main goal of the project is to reduce CO_2 emissions during operations in a warehouse by producing a clean energy, the second goal is to save land space, typically solar panels occupy a lot of land space and this space is not available in the port.

During 2 months the system produces 363kWh of clean energy (Figure 1).

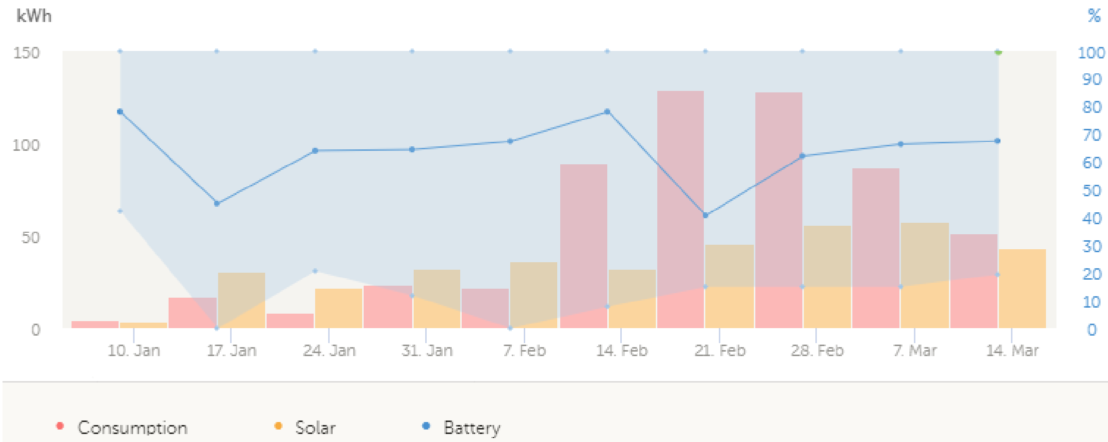

Figure 1: Energy production from FSPP

FSPP already survived 2 storms Corrie and Eunice.

Similar FSPP can be installed in other EU ports.

Project Description

10kWp floating solar power plant installation in Port Oostende in cooperation between HelioRec and Greenpipe (Figure 2).

The main motivation is to carry out the FSPP and to analyze the impacts of the natural environment (wind, waves, salt water) and efficiency of clean electricity production.

Main aspects to consider are clean power generation, installation time, cost effectiveness, circular economy and sustainability.

Figure 2: Floating solar power plant in Oostende port

At the first stage (6 months, January – July 2022), the power plant will provide electricity to a warehouse in Port Oostende, where an old boat is being restored.

The main parameters of the system will be assessed by HelioRec's experts:

- Survivability in sea-conditions;
- System movement;
- Energy production evaluation;
- Hydrophobic additives assessment.

Within the project the high-class cable protection system Snap Panzar™ made from 100% recycled plastic will be incorporated to protect the export cables.

The Project's Objective

- Save the land space in the port area – 130 m^2.
- Produce clean energy for port's needs.

Problem Definition

- Land scarcity (not enough space to place solar panels on the ground)
- High cost of electricity from the grid.

The Process – From Concept to Completion

Phase 1: Signing contract between Greenpipe Group AB and HelioRec SASU | 01.06.2021.

Phase 2: Engineering and design of FSPP | 01.08.2021 (Appendix 1)

Phase 3: Molds (rotational and injection) production and QA/QC | 01.09.2021 (Appendix 2)

Phase 4: Floating system production, QA/QC and testing | 01.10.2021 (Appendix 3)

Phase 5: Purchasing and delivery all components to Oostende | 01.11.2021

Phase 6: Installation at Oostende port | 14.01.2022

Phase 7: System monitoring for 6 months |14.01.2022 – 14.07.2022 (planned)

10kWp of floating solar power plant was designed specifically for Oostende port. Wind speed of 44m/s and ship route were taken into consideration.

HelioRec has patented "hydro-lock" feature. The idea of “hydro-lock” is to keep the water inside the floater and it gives additional mass and consequently stability without extra costs for the ballast-materials such as metal, concrete. HelioRec’s floaters are 3.5 times more stable than floater without “hydro-lock”, conventional blow-moulded floater (link).

HelioRec’s floating system possesses a stackability functionality through which it is able to efficiently pack up the floaters while shipping them between our target location and the manufacturing firm. This allows to use up to 50% less space in containers, thus, reducing logistics costs and environmental impact.

HelioRec’s system connected by robust and flexible connectors between modules and it helps to reduce mechanical stress from the waves and wind. Special lifting test was conducted during installation and all parts remained unbroken (Figure 3).

Figure 3: Lifting test in Oostende Port

DC cables from floating solar power plant to PV equipment was protected with Greenpipe's cable protectors made from recycled plastic:

- Snap Hardlock™ 60/50 mm (link);
- Snap Panzar™ 110/90 mm (link);
- Snap Multibox™ (link);

Figure 4: DC cable protected with Greenpipe's divisible cable protection pipes.

PV Equipment Design

24 solar panels Jinko Cheetah HC72M, 400W, Mono Perc Half Cell Module (link) were placed in 4 rows (string). Each string (row) is controlled by 4 maximum power point tracking (mppt) devices with MultiPlus-II Inverter/Charger. Solar panels were covered with hydrophobic additive D-Solar Defender (link). Energy is stored in 7.2kWh battery (MGLFP24x280) with MG Master LV – Battery Management Controller. System can be monitored remotely with Cerbo GX with a touch screen (Figure 5).

High quality of DC cables with UV Resistant based on EN 50618 and TÜV 2Pfg 1169-08 and water presence: AD8 submerged were used.

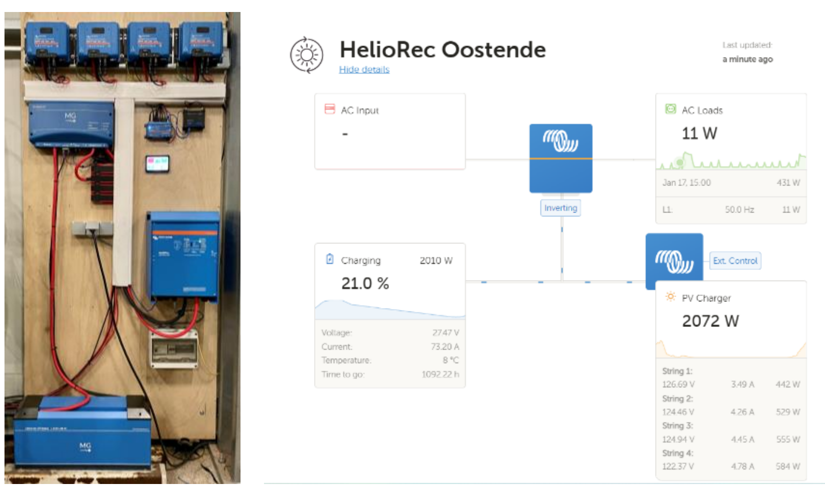

Figure 5: Left -PV equipment set-up; Right – monitoring system (link)

This set-up allows to control energy from each string and corelate it with system movement with waves, wind and ship nearby.

Mooring Lines Design

Mooring lines were designed for water depth 8 m with water level changing on 0.3 m. 4 anchor-blocks (2 tons/each) were placed on the bottom (Figure 6) and combination of:

- 10 mm high strength polypropylene rope (breaking strength up to 1350 kg);
- 15 mm high strength polypropylene rope (breaking strength up to 3400 kg);
- 10 mm DIN 766 stainless steel chain (breaking load: 5,000 kg).

Figure 6: Anchor block positioning

System Movement Assessment and Energy prediction

Every row (string) of power plant was equipped with a digital accelerometer ZET 7152-N (Figure 8) and

- Offline recorder ZET 7173;
- Interface recorder ZET 7176;
- Interface converter ZET 7177.

All equipment was places in IP 67 box and placed on power plant (Figure 7).

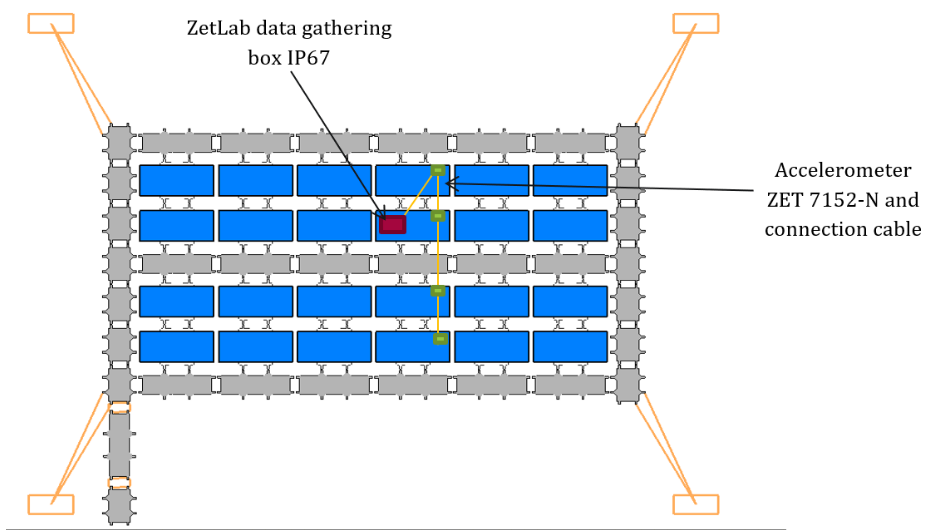

Figure 7: Monitoring system set-up

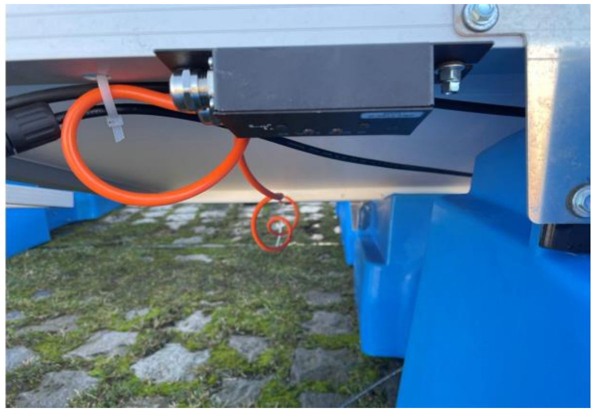

Figure 8: Accelerometer connected to solar panel

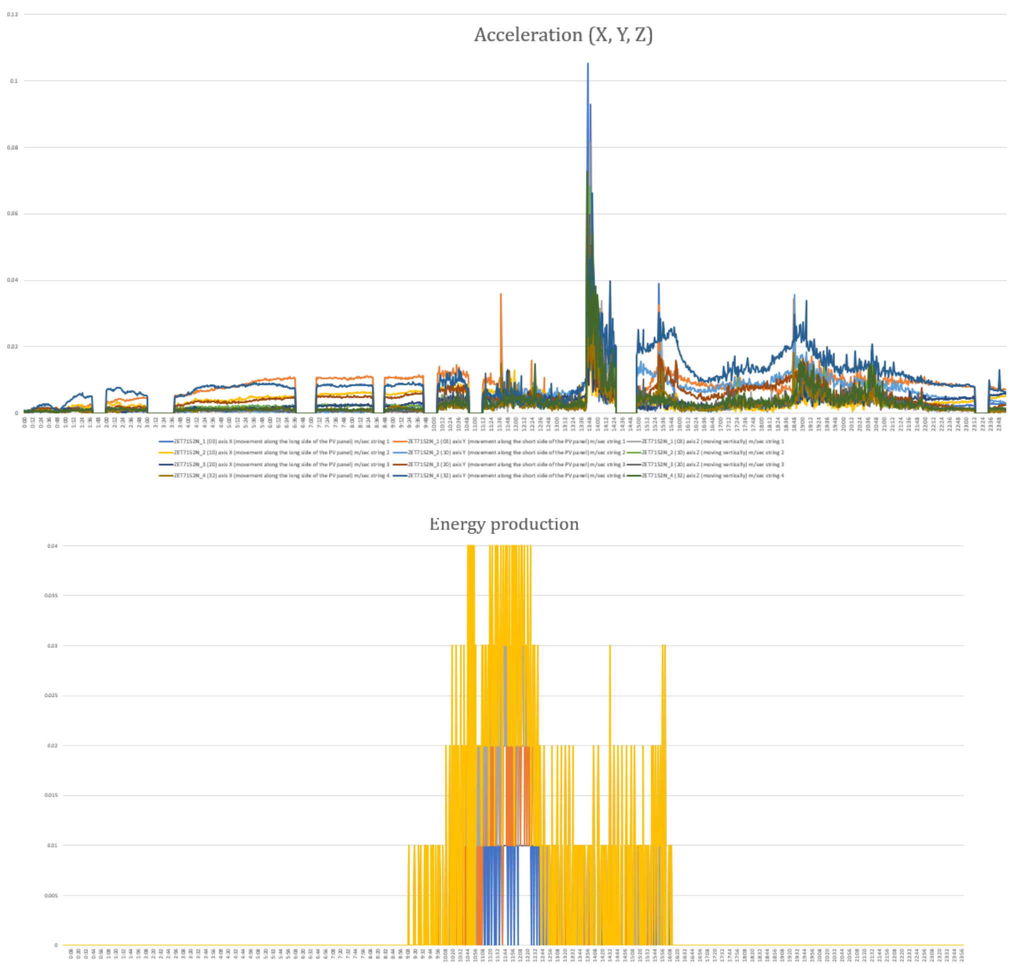

Figure 9: Preliminary results of data from accelerometers (top) and energy production from each string (bottom)

The main idea of the monitoring system is to analyze the system movement and understand losses due to this movement with waves, wind and ship route and corelate these data with energy production from each string (Figure 9). Innovative AI/ML algorithms will help to predict energy generation in 1-5-10 years and optimize O&M (link).

Results

- The pilot was successfully installed in the Oostende port and already survived 2 storms.
- The system is generating clean energy for warehouse needs (363 kWh during 2 months).
- Added value – no need to occupy land space for the solar panels. Unused water space can be used for clean energy generation.
- Data is gathered by different sensors and will be analyzed (planned)
- We did not observe any difference with and without hydrophobic additive.
- Opening ceremony with invited companies within the line of business such as Van Oord, Jan De Nul, TNO, North Sea Port, PortXL etc (link).
- This project will be presented at OPIN webinar (link).
- Discussed with different companies at Belgian Offshore day (link).
- FSPP inspection was performed by HelioRec team (link) – some minor improvements will be implemented in the future.

Deliverables and milestones

The project can easily be implemented in other ports and generate a clean energy and save CO_2. Valuable land space will be saved for other needs.

The most suitable areas for the installation is in "shallow waters" where ship cannot path.

What makes this project sustainable?

The FSPP already survived 2 storms and constantly generate clean energy.

The project can be easily implemented in similar locations and combined with land-based solar power plant. For example, in Ringkøbing Fjord, Denmark (Figure 10). 30kW floating solar power plant can produce 27.7MWh/year.

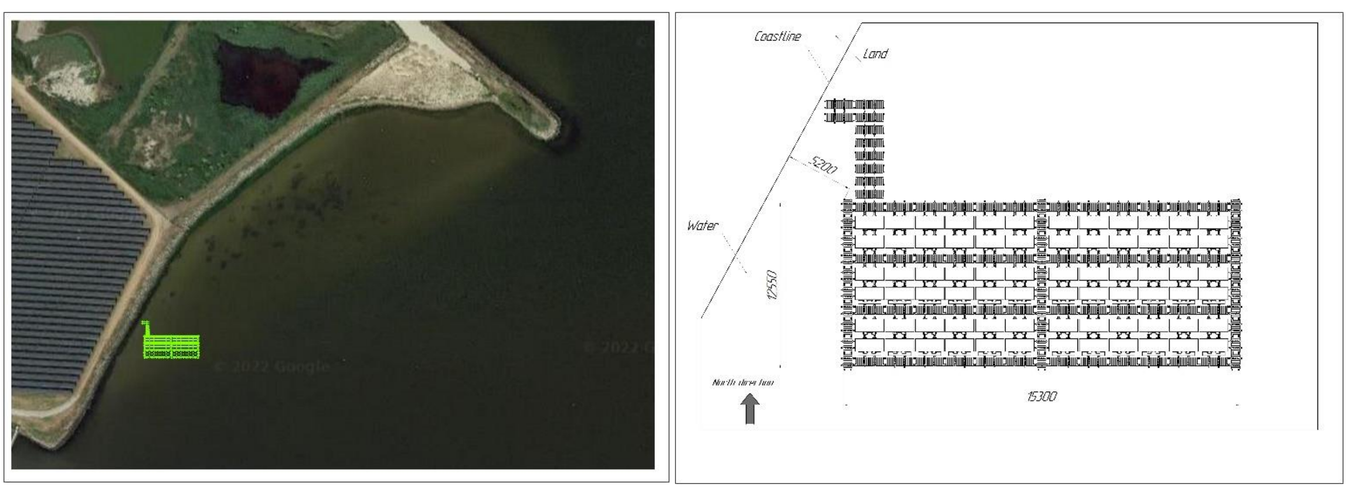

Figure 10: Example of installation in Ringkøbing Fjord

The system can perfectly withstand the high wind speed in Denmark.

Conclusions & lessons learned

The FSPP was installed to close to the pier resulting in shadow after 14:00, reducing the production of energy.

Construction of FSPP took longer time than we expected since installing bouncy plate in the floaters was more time consuming than we expected. The design will need to be upgraded.

DC cabling can be improved.

Partners

- GreenPipe (https://greenpipegroup.com/) – cable protector providers and Dual Ports partner.
- HelioRec (https://heliorec.com/) – engineering of floating solar power plant, including manufacturing of floating modules and design of mooring lines;
- Port Oostende (https://www.portofoostende.be/en) – facilitator
- ZetLab (https://zetlab.com/en/) – sensors providers
- EcoEnergy (http://ecoenergy.group/) – monitoring system providers
- Sol Navitas (http://www.solnavitas.eu/) – Solar panels providers.
- ChemiTek (https://chemitek.pt/index.html) – hydrophobic additive supplier
- Ecole Central de Nantes (https://www.ec-nantes.fr/english-version) – wave tank testing
- Watson Reddingboot3 – user of clean energy (warehouse where the old boat is being restored)
- Top.Systems (https://www.top.systems/) – Photovoltaic equipment providers, including inverter, mppts, battery.

Contact information

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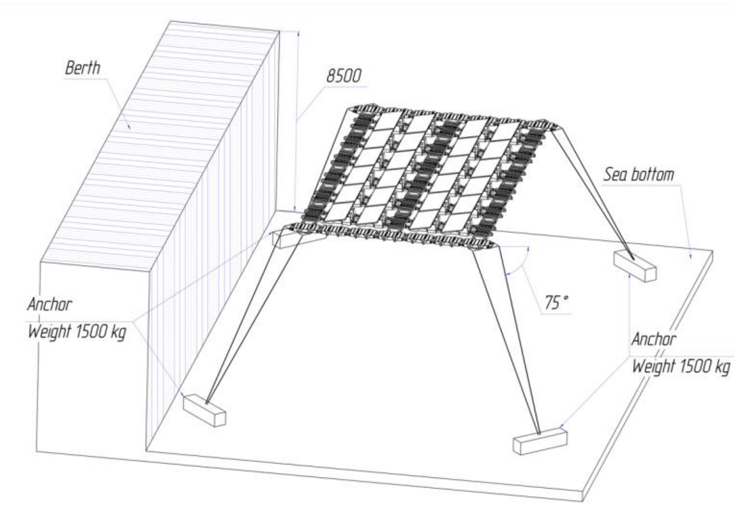
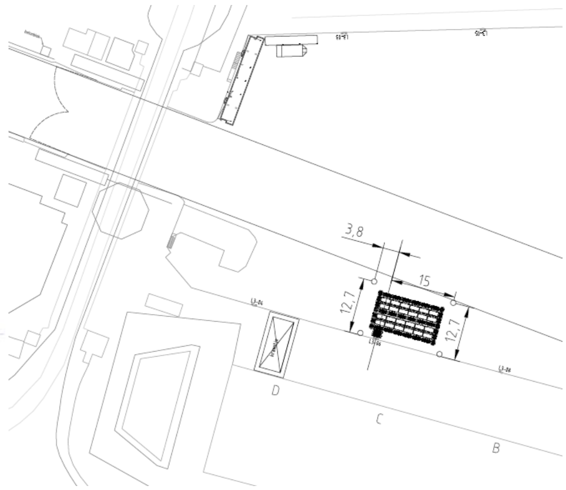
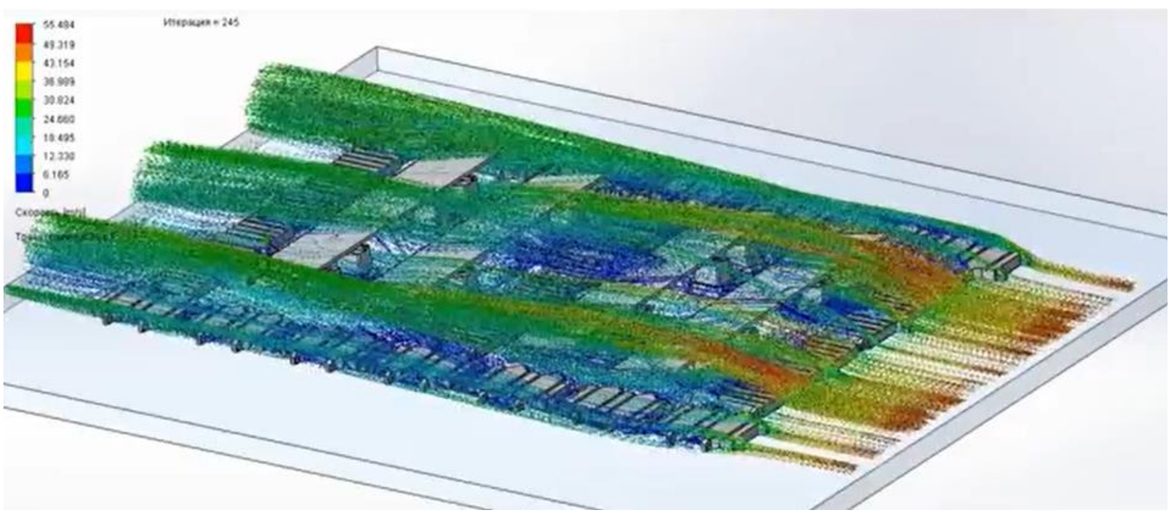
Appendix 1 – Engineering FSPP

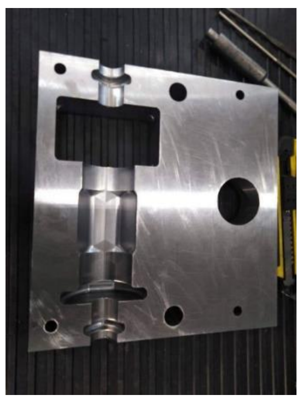
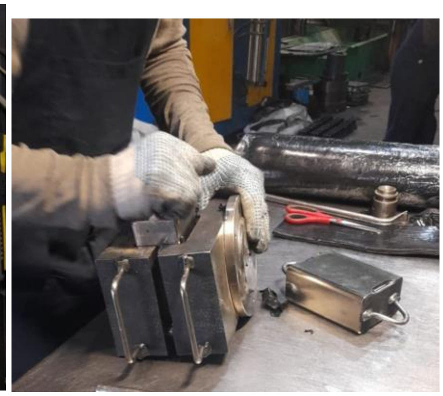






Appendix 2 – Molds



Appendix 3 – Samples of floating solar system

Appendix 4 – Cable protectors