The Floating Solar Power Plant Based on Recycled Domestic Plastic Waste

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1. Introduction

The idea of this project consists of three steps:

1. Construction of the floating structures based on the recycled plastic,
2. Installation solar-panels on the floating structures;
3. Deploy this power plant in the sea.

The floating solar power plants in the close water - lakes, were already implemented in India, China, Japan, UK, but no one yet deployed the floating solar plant in the open sea, another important feature of this project is to use recycled plastic for the floating structures, for example high density polyethylene (HDPE), which can be produced from the domestic plastic waste.

It is **unique concept** and can be successfully implemented in the countries with:

- Big amount of mismanaged plastic wastes;
- High-density of population;
- Lack of renewable energies and supporting policies exist in the countries.

The whole process of making the electricity from the Floating Solar Power Plant (FSPP) showed in Appendix 1 and in this link - https://www.youtube.com/watch?v=ecnkj3sVBdk

The main applications are remote locations/islands; fish/algae farms; marine ports; hydrogen production.

The project will consist two parts:

- Small-scale power plant with nominal power 15 kW;
- Full-scale power plant with nominal power 3 MW.

2. The Main Purposes

- **Managing plastic waste through using recycled plastic for the floating structures;**
- **Saving land space by deploying the power plant on the sea;**
- **Producing "green" electricity from the mature technology – solar energy.**

The amount of mismanaged plastic waste in the World showed below (Figure 2-1).

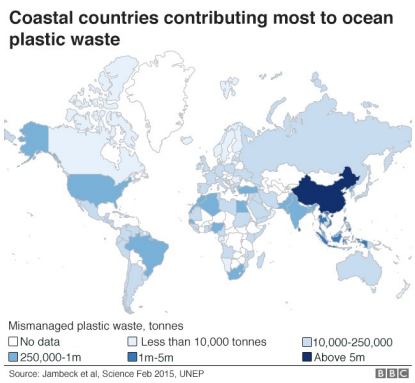


Figure 2-1: Plastic waste overview [1]

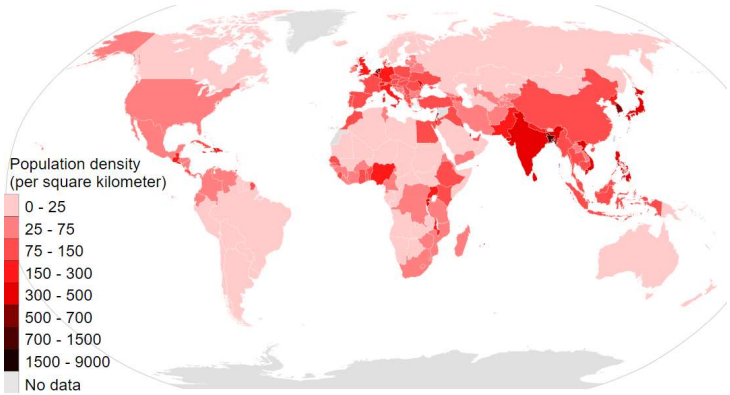


Figure 2-2: Map of density population [2]

This project can be successfully implemented, for example, in China, Indonesia, India, South Korea. In these countries a big amount of mismanaged plastic and high-density population.

In the patent "**Recycling of high-density polyethylene from domestic polymer waste**[1]" (PCT/EP2012/056279) [3] showed the process for recycling of the high density polyethylene (HDPE) waste and returned to the product cycle. This technology allows the factory to make a higher-grade product for onward sale to manufacturers. Several benefits to use HDPE showed below:

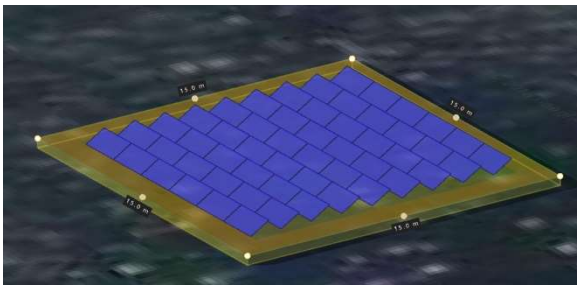
- HDPE is a light material. For example, density of steel: 7850 kg/m^3 and aluminum: 2700 kg/m^3 and HDPE: 960 kg/m^3.
- HDPE is indestructible material. It's product life cycle is much longer that other materials and it is completely recyclable after use.
- It can bring down carbon footprint[2], HDPE is **5 times lower carbon footprint than traditional building materials like aluminum, steel**.

The small-scale power plant, 15 kW, area of floating structure – 225 m^2 and it is 126 000 recycled plastic bottles. The full-scale power plant, 3 MW, area of floating structures – 28 350 m^2 and it is **15 876 000 recycled plastic bottles**.

[1] This patent will be used for the basis of the recycled process and improved by new researches.
[2] A carbon footprint is historically defined as the total set of greenhouse gas emissions caused by an individual, event, organization, or product, expressed as CO_2 equivalent.

Using recycled HDPE considerably cheaper (0.84-0.97 USD/kg) than buying virgin material (1.9-2.0 USD/kg), the price of HDPE is mainly driven by the price of oil plus other global factors.

HelioScope software [4] was used to assess the **annual energy production** of the FSPP for Yantai Port in China. Preliminary design[3] of small-scale power plant, with nominal power 15 kW is shown below:



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,457.6	
	POA Irradiance	1,675.3	14.9%
	Shaded Irradiance	1,521.7	-9.2%
	Irradiance after Reflection	1,478.0	-2.9%
	Irradiance after Soiling	1,448.4	-2.0%
	Total Collector Irradiance	**1,449.4**	**0.1%**
Energy (kWh)	Nameplate	25,062.1	
	Output at Irradiance Levels	24,866.2	-0.8%
	Output at Cell Temperature Derate	24,450.1	-1.7%
	Output After Mismatch	23,321.4	-4.6%
	Optimal DC Output	23,316.8	0.0%
	Constrained DC Output	23,316.7	0.0%
	Inverter Output	22,887.4	-1.8%
	Energy to Grid	**22,790.4**	**-0.4%**
Temperature Metrics			
	Avg. Operating Ambient Temp		15.2 °C
	Avg. Operating Cell Temp		22.7 °C
Simulation Metrics			
	Operating Hours		4579
	Solved Hours		4579

Figure 2-3: HelioScope preliminary results for small-scale prototype, 15 kW [4]

- Total energy to the grid (small scale -15 kW): 22.8 MWh/year;
- Total energy to the grid (full scale - 3 MW): 3.9 GWh/year (in Appendix 2).

3. Conclusion

1. This innovative technology can find **widely application** (marine ports, fish/algae farms, remote locations, hydrogen production) in different countries with high density population, for example, China, Indonesia, India, South Korea.
2. The floating platform based on the recycled HDPE **can reduce amount of domestic plastic waste**;
3. Floating solar power plant **does not occupy space on the land**;
4. Solar technology produces **"green" electricity** and this technology already proved its potential.

4. Bibliography

[1] BOMAC, "CHINA BANS PLASTIC WASTE," ed, 2017.

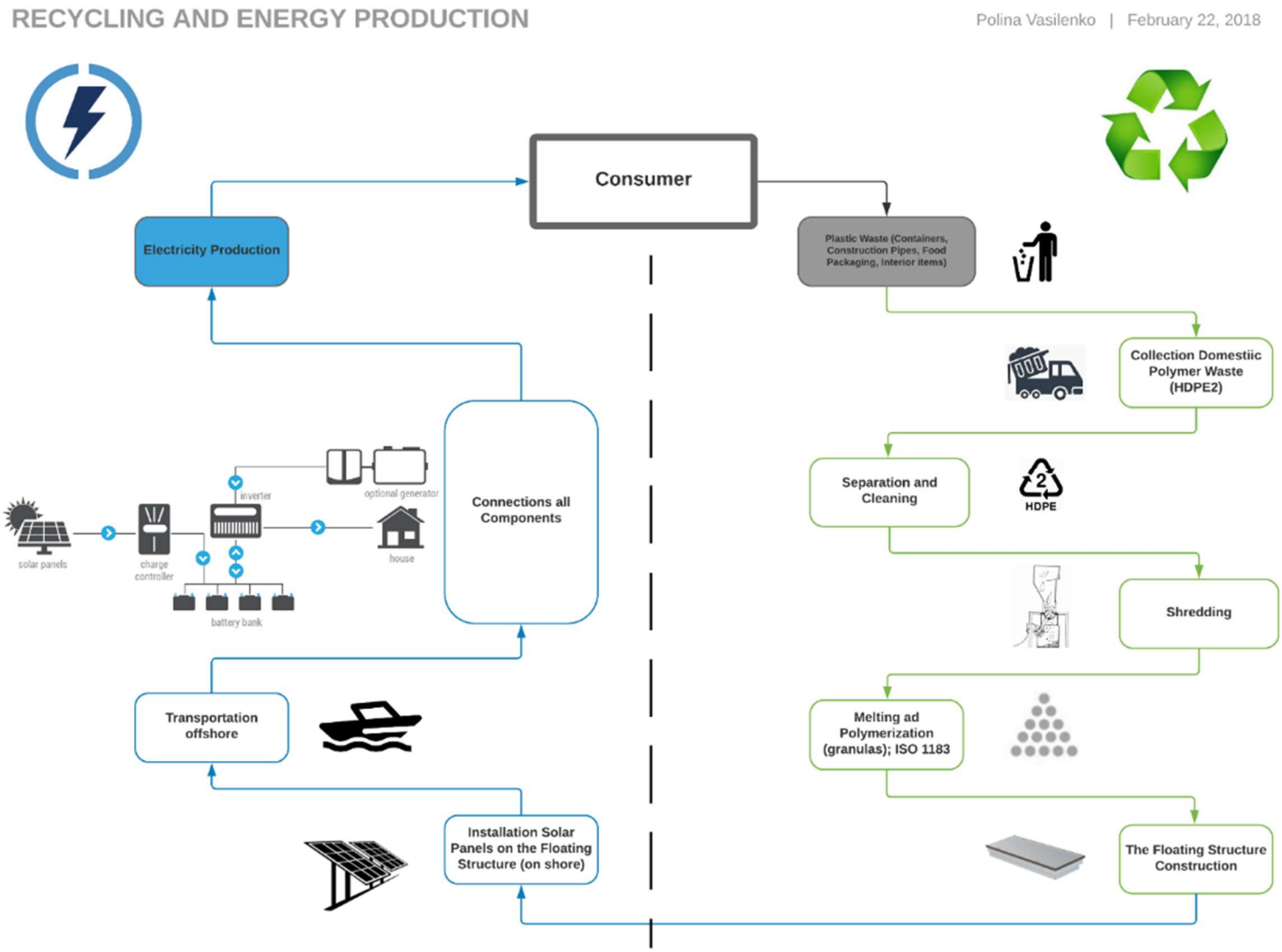
[2] Wikipedia. (2018). *List of countries and dependencies by population density*. Available: https://en.wikipedia.org/wiki/List_of_countries_and_dependencies_by_population_density

[3] L. Duranel and J.-M. Mlinaric, "Recycling of high-density polyethylene from domestic polymer waste," 2012. Available: https://patents.google.com/patent/WO2012139967A1/en.

[4] HelioScope. (2018). *Solar Assessment*. Available: https://www.helioscope.com

[3] Note: For better calculation, correct data for wires, inverter, distance to port should be defined. Depends on the port electricity consumption, the total area of the floating solar plant can be adjusted.

5. Appendix 1: The Schematic of whole process



See video here https://www.youtube.com/watch?v=ecnkj3sVBdk

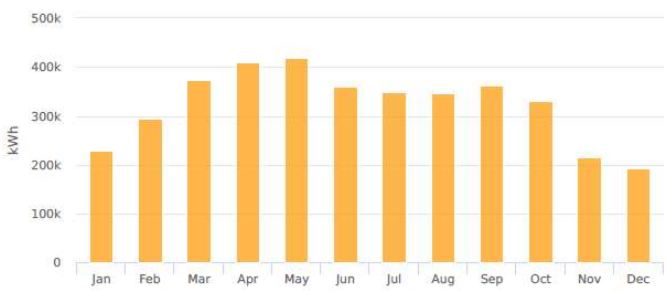
Appendix 2: Energy Production, 3 MW

Report	
Project Name	China
Project Description	The Floating Solar plant (pilot project)
Project Address	70 Zhifudao E Rd, Zhifu Qu, Yantai Shi, Shandong Sheng, China, 264000
Prepared By	Polina Vasilenko polina.vasilenko@uni-oldenburg.de

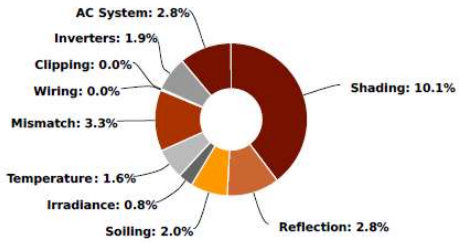
System Metrics	
Design	China:3MW
Module DC Nameplate	3.01 MW
Inverter AC Nameplate	2.43 MW Load Ratio: 1.24
Annual Production	3.884 GWh
Performance Ratio	77.0%
kWh/kWp	1,289.9
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Simulator Version	d0f27324e4-ea5288de2a-0f5a53c183-1b5b770b12

Project Location

Monthly Production



Sources of System Loss



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	Irradiance after Reflection	1,463.3	-2.8%
	Irradiance after Soiling	1,434.1	-2.0%
	Total Collector Irradiance	**1,434.1**	**0.0%**
Energy (kWh)	Nameplate	4,321,090.9	
	Output at Irradiance Levels	4,286,488.0	-0.8%
	Output at Cell Temperature Derate	4,215,872.5	-1.6%
	Output After Mismatch	4,076,518.8	-3.3%
	Optimal DC Output	4,074,976.8	0.0%
	Constrained DC Output	4,073,074.5	0.0%
	Inverter Output	3,997,370.0	-1.9%
	Energy to Grid	**3,884,410.0**	**-2.8%**
Temperature Metrics			
	Avg. Operating Ambient Temp	15.2 °C	
	Avg. Operating Cell Temp	22.6 °C	
Simulation Metrics			
	Operating Hours	4579	
	Solved Hours	4579	