IMPLEMENTATION OF A PHOTOVOLTAIC FLOATING COVER FOR IRRIGATION RESERVOIRS

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Abstract

The article presents the main features of a floating photovoltaic cover system (FPCS) for water irrigation reservoirs whose purpose is to reduce the evaporation of water while generating electrical power. The system consists of polyethylene floating modules which are able to adapt to varying reservoir water levels by means of tension bars and elastic fasteners.

Keywords: renewable energy, water reservoirs, floating covers.

1. Introduction

Electricity consumption of many irrigation systems has increased considerably due to irrigation modernization plans. Therefore, nowadays, power costs form a high proportion of the running costs of many farmers' irrigation associations.

On the other hand, the new irrigation plans involve the transformation of traditional systems into pressurized systems. In most cases, this modernization has demanded the construction of water reservoirs. Among the different storage systems available, earth reservoirs waterproofed with geomembranes are the most widely used solution.

In arid and semi-arid climates, water stored in reservoirs would be better managed if evaporation losses from the water surface were reduced but the practice of covering irrigation reservoirs is still relatively little used, although as water is becoming an ever scarcer resource, interest in these systems is expected to grow in the future. Techno-economic analyses conducted for several mitigation evaporation technologies confirm the exposed trend [1, 2]. Also, economics of deploying floating photovoltaic (PV) array concept for commercial electricity generation has been successfully developed by Trapani et al. [3, 4].

Additionally, since water reservoirs are fully integrated in the irrigation and water supply network of geographical areas with profitable agricultural activity, land is deemed to be used for food production.

With these premises, a floating photovoltaic cover system (FPCS) has been developed seeking both to reduce evaporation of water and also generate renewable electricity [5]. In such way, the irrigation system will move towards a more sustainable activity and thus, the whole agricultural sector.

2. Description of the system

The system consists of the following key elements [5] (Figure 1):

- Floating platform (pontoons) which guarantee the buoyancy and stability of the electricity-generating system. They are made from MDPE by rotational moulding and each supports two PV panels.
- Supporting structure (UF and CF cold-formed metal frames) which must be able to withstand the weight of the PV modules and transmit wind forces across the pontoons to the anchoring system located above the crest of the embankment.
- Articulated metal couplings between pontoons (metal chains or cables linking the pontoons together, allowing vertical and horizontal displacements as well as rotations) so that the deck is able to adapt to the concave profile of the reservoir.
- Flexible couplings (rubber or MDPE straps allowing to stretch up to a fixed length imposed by the action of a rigid polyester or nylon rope that works when the maximum displacement has been reached). So, the pontoons are able to move in relation to one another so that the system can adapt to different water levels.
- Ropes (polyester and nylon nautical ropes) used to tie the outside modules of the floating cover to the sides of the reservoir.
- Rigid anchoring system (reinforced concrete piles that resist lateral forces through the passive pressure of the surrounding ground) that anchors the floating cover and transmits horizontal forces to the sides of the reservoir.

Figure 1: Components of a FPCS

3. System implementation

In 2009, a full-scale prototype (1:1) of the FPCS was built in a test installation over an irrigation water reservoir in Agost (Alicante, Spain). The area covered was 350 m^2 (around 7% of the water surface of the reservoir) corresponding to a maximum installed power of 20 kWn (Figure 2).

a) **b)**

Figure 2: FPCS prototype: a) Aerial view; b) Side view

The favourable results obtained from the pilot plant along two years, prompted covering the whole of the reservoir with 1,458 PV panels supported on 750 pontoons in 2012, over a water surface of 4,490 m^2 (Figure 3).

Figure 3: The reservoir completely covered by PV panels

The electricity-generating plant has a nominal capacity of 300 kWn, which gives an annual production of 425,000 kWh $year^{-1}$ of renewable energy, which is fed directly into the supply network. The water saved thanks to covering the reservoir reaches 5,000 m^3 $year^1$, which means 25% of the reservoir's storage capacity.

Available data show how the successive cycles of filling and emptying the reservoir, with the consequent inclination of the panels, do not adversely affect the performance of the plant.

4. Conclusions

The system is technically feasible and economically viable as developed by the author [6]. Due to the continuous increase of electricity prices and declining prices of PV modules, the self-consumption is presented as an option increasingly promising the system exposed**.**

There is a great potential for the installation of floating solar panel electricity generating plants in order to improve the water and energy balances in arid and semi-arid zones with scarce water resources, as in areas near to the Spanish eastern Mediterranean coastline.

5. References

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Figure 1
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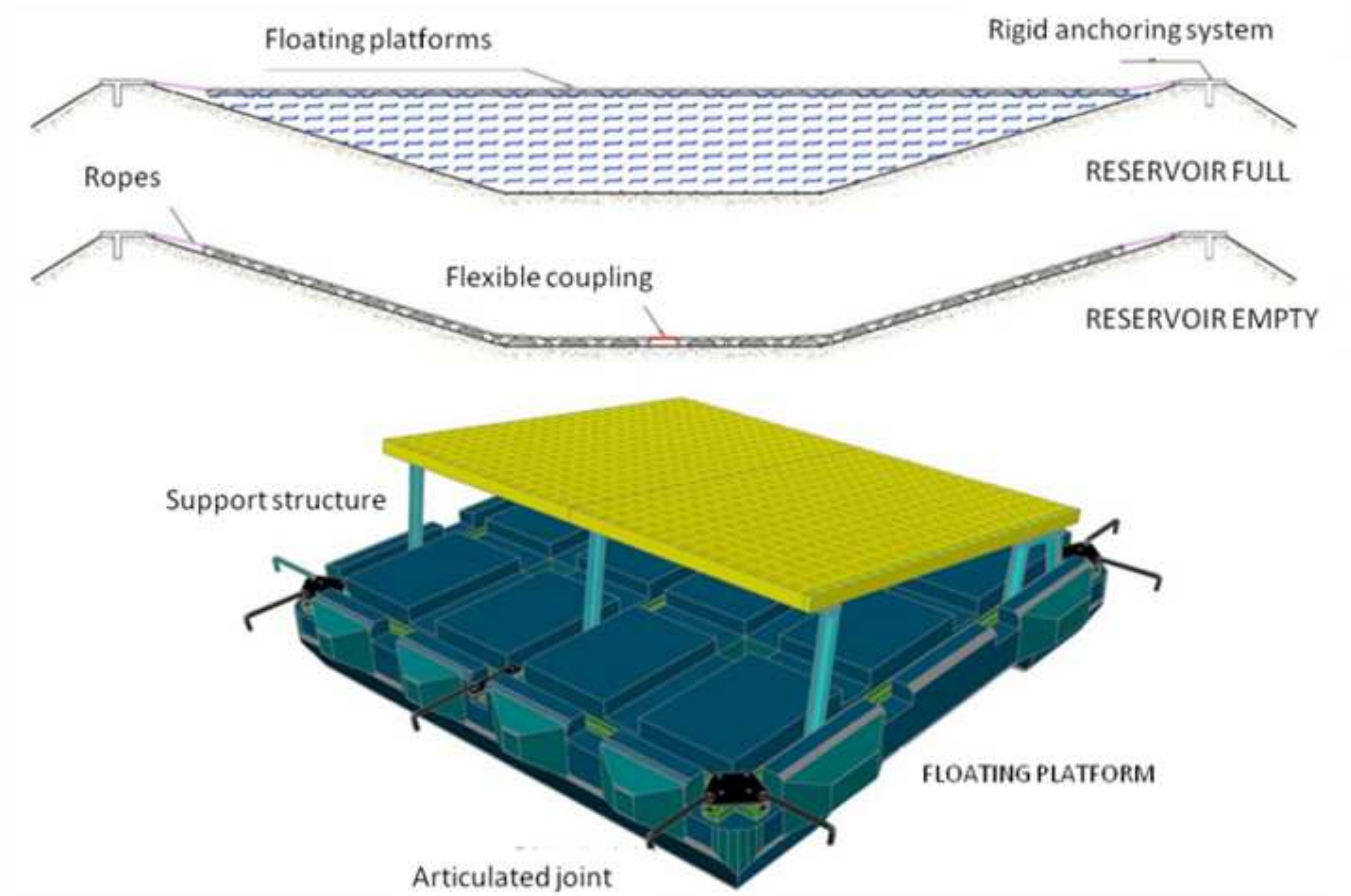

Figure 2

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