FLOATING PHOTOVOLTAIC SYSTEMS

FSEC ADVISORY BOARD MEETING

10.19.18

D3ENERGY
COMPANY OVERVIEW

D3ENERGY is a floating photovoltaic developer with expertise in:

- Design
- Sales
- Installation
- Maintenance

We have experience in all aspects of **engineering, design and permitting** of floating photovoltaic systems.

CIEL & TERRE
COMPANY OVERVIEW

- **CIEL & TERRE** has been developing large-scale solar power plants since 2006.
- Since 2011, CTI has been providing innovative floating solar solutions.
- Considered the **FLOATING SOLAR PIONEER** – have 90%+ market share in world.
- 7 patents registered
- Their industry-leading floating technology is called Hydrelio®.

D3ENERGY and CIEL & TERRE have entered into a partnership to market and develop floating photovoltaic systems in the United States.

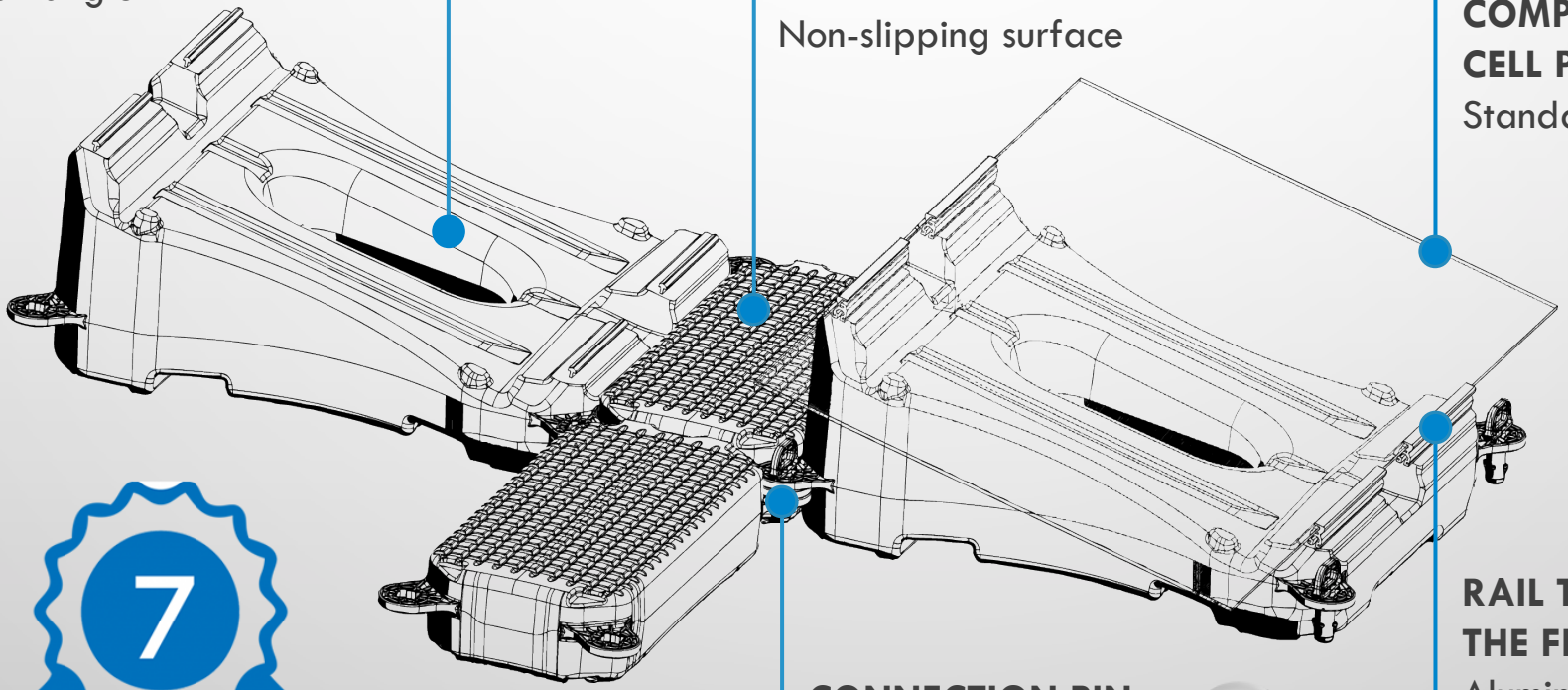
HYDRELIO® – FLOATING PV SYSTEM

- Allows most standard PV panels to be installed on large bodies of water such as reservoirs & cooling ponds.
- A simple and affordable alternative to ground-mount systems.
- The Hydrelio® technology has a lifetime of over **20 years**
- Has a portfolio of **over 85 floating PV** plants in more than 20 countries.

HYDRELIO® – FLOATING PV SYSTEM

MAIN FLOAT SUPPORTING THE PV MODULE
HDPE material
Inclination angle: 12°

SECONDARY FLOAT FOR MAINTENANCE/BUOYANCY
HDPE material
Non-slipping surface



COMPATIBLE WITH 60- & 72-CELL PV MODULES
Standard framed or frameless

RAIL TO FIX THE PV MODULE ON THE FLOATS
Aluminium or fiberglass-reinforced PP
Certified ISO 3302-1/1996

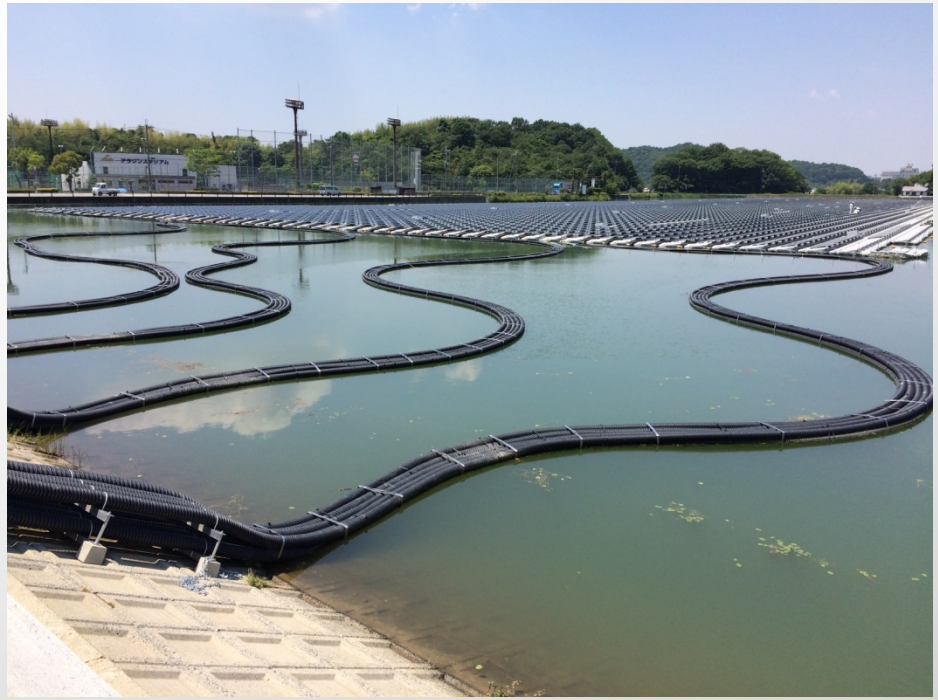
CONNECTION PIN
Fiberglass-reinforced PP
NFT 58 000 standard

inter solar award 2017 WINNER

7 PATENTS REGISTERED

ELECTRICAL

- All electrical wires are encased in reinforced conduits & above the surface of the water
- All PV panels are wired in series and terminate at the combiner boxes
- A floating conduit is used to connect the array to the inverters on shore
- In the event of a short, circuits on that row would be tripped and the current eliminated before a system wide short or shock could occur.



No hazard exists where the pond water may be electrified

INSTALLATION

- U.S. made – Manufactured in Atlanta, GA.
- Arrays are fully assembled on shore.
- Once the array is configured, it is either fed or towed into the water.
- Segments are positioned and are then attached to anchors which fix its location in-place.

ANCHORING SYSTEM

There are **2 methods of anchoring** – Shore-mount & Bottom-mount.

The anchoring system design is usually composed of:

- Aluminum spreader bars
- Cables to link spreader bars to anchors & chains to adjust length
- Main and secondary float rows (without PV panels) to secure buoyancy
- Anchors to moor the island to withstand wind loads and to reduce movement of the island

FLOATING PV IN COLD CONDITIONS

- Arrays in Sweden & Korea that spend every winter frozen in ice
- Ice will build either around or under the floats
- Feasibility studies need to be done if there is a large amount of moving ice
- HDPE is a strong material that will contract in the ice & dilate when it melts

ENVIRONMENTAL

Ecological report by **WRA Environmental Consultants** for California concluded:

- Potential adverse effects to wildlife species are minimal
- Minimal ground & vegetation disturbance during installation
- The array, made from HDPE does not leech chemicals into the environment
- Maintenance requires no detergents or chemicals
- Gaps in the floats were intentionally created to allow diving birds to come up within the Array
- Drinking water compliance tested by the English Water Quality Center

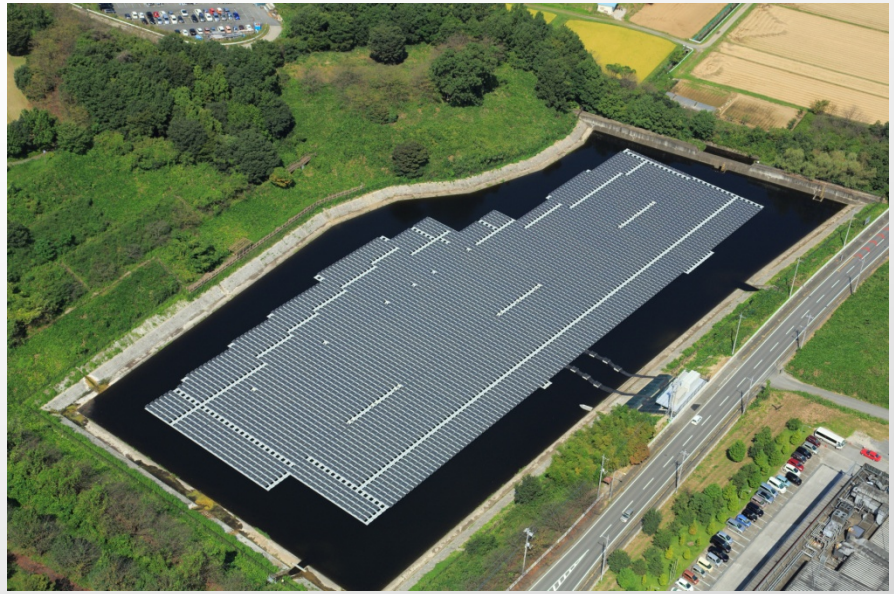
OPERATIONS & MAINTENANCE

- Cleaning of the panels occurs on an “as needed” basis
- The standard cleaning interval is 1-2 times per year.
- Cleaning is done manually by a technician using a broom or large brush.
- No detergents, chemicals or cleaners are recommended for cleaning panels.
- Ongoing or preventative maintenance is recommended on a regular basis
- Estimated O&M Costs $8,000 / MW annually

ADDITIONAL ADVANTAGES OF FLOATING PV

- Reduces evaporation

- Reduces sunlight penetration, precluding growth of algae
- Eliminate / Reduce costs associated with algae treatments



PERFORMANCE

- Research paper conducted by Korea Water Resources Corp. examining the cooling effect of water on a floating solar farm.
- They concluded floating PV has an 11% higher generation efficiency than overland PV systems.

- Hydrelio® floats are made of HDPE through a blow molding process which gives the system a 20+ year lifetime.
- Hydrelio ® comes with a 5-year standard warranty & an extended 20-year warranty is available.
- Tested by ONERA (the French aerospace lab), Hydrelio® can withstand up to 130 mph winds.
- Projects can be specifically studied and adapted to deliver higher system wind-resistance.

COST ANALYSIS – BENEFITS

- No cost of land

- Greater efficiency output due to cooling effect of the water

- Lower annual O&M

- Ancillary cost savings – (evaporation costs, algae treatments, etc.)

92 MWp

TOTAL INSTALLED CAPACITY

195+ MWp

TOTAL ON-GOING PROJECTS

JAPAN

Okegawa	1,180 kWp	July 2013
Kawagoe	696 kWp	June 2014
Maeno-ike	848 kWp	September 2014
Yasugi	1,098 kWp	November 2014
Kato-shi	2,870 kWp	March 2015
Sawa-ike	1,008 kWp	May 2015
Sakasama-ike	2,313 kWp	May 2015
Fuku-ike	1,076 kWp	June 2015
Hirai-ike	1,125 kWp	July 2015
Hanamidai	1,153 kWp	August 2015
Funatsu Osawa	1,485 kWp	September 2015
Umenoki	7,550 kWp	October 2015
Kawarayama-ike	1,428 kWp	December 2015
Toriga-ike	630 kWp	February 2016
Sakurashita-ike	809 kWp	February 2016
Juman-ike	490 kWp	March 2016
Sohara-ike	2,398 kWp	March 2016
Naga-ike Nishi	1,078 kWp	March 2016
Kichioka	59 kWp	April 2016
Kasaoka	973 kWp	May 2016
Kobe Oike	1,212 kWp	May 2016
Gono-ike	1,203 kWp	May 2016
Takada	59 kWp	June 2016
Yakino-ike	1,714 kWp	July 2016
Rengeji-ike	300 kWp	July 2016
Hira-ike	1,260 kWp	July 2016
Tsuga-ike	2,400 kWp	August 2016
Kurobe	195 kWp	August 2016
Hirono Shin-ike	1,751 kWp	September 2016
Isawa-ike	632 kWp	October 2016
Sayama Ootori-ike	2,502 kWp	November 2016
Sayama Nigori-ike	280 kWp	November 2016
Naga-ike Higashi	2,156 kWp	November 2016
Sakurakami-ike	1,992 kWp	December 2016
Hikona	660 kWp	January 2017
Kyuhin	1,188 kWp	January 2017
Kire-ike	691 kWp	January 2017
Gojiga-ike	572 kWp	January 2017
Noma-ike	2,435 kWp	March 2017
Tachiai Oku-ike	835 kWp	March 2017
Besso-ike	1,426 kWp	June 2017
Yukimine Kami-ike	1,568 kWp	July 2017
Ootsuda-ike	973 kWp	August 2017
Shimoyama-ike	1,966 kWp	August 2017
Daikai-ike	300 kWp	August 2017
Hirono Nigo-ike	1,261 kWp	September 2017
Hachigo-ike	2,402 kWp	October 2017
Sara-ike	1,176 kWp	October 2017
Komaga	2,297 kWp	November 2017
Watashi-ike	2,170 kWp	December 2017
Tano-ike	2,552 kWp	December 2017
Ichinomiya-ike	2,242 kWp	December 2017
Besho Sara-ike	540 kWp	December 2017
Onuma	318 kWp	December 2017
Osawa	2,449 kWp	January 2018
Yamakura dam	13,744 kWp	March 2018
Togawa-ike	2,362 kWp	March 2018
Ota-ike Naka	2,435 kWp	March 2018
Ota-ike Higashi	2,435 kWp	March 2018
Iwano-ike	2,596 kWp	Winter 2018
Otori Babe-ike	2,495 kWp	June 2018
Uwa-ike	637 kWp	June 2018
Urayasu-ike	9,087 kWp	February 2019

NORTH AMERICA

UCF Orlando (FL)	5 kWp	March 2016
Kunde Winery (CA)	10 kWp	May 2016
Orlando Utilities (FL)	32 kWp	February 2017
R5 pond (CA)	2,560 kWp	Winter 2017
Sayreville WTP (NJ)	4,403 kWp	Early 2018
Windsor WTP (CA)	1,715 kWp	Early 2018

LATIN AMERICA

Miraflores (PA)	24 kWp	February 2017
Goiás Farm - GO (BR)	305 kWp	July 2017
Sobradinho - BA (BR)	1,248 kWp	December 2017
Sobradinho extension	3,744 kWp	April 2018
Balbina - AM (BR)	4,992 kWp	December 2018

EUROPE

Piolenc (FR)	15 kWp	February 2011
Sheeplands (EN)	200 kWp	September 2014
Nofar (IL)	22 kWp	November 2015
Bör (SE)	13 kWp	December 2015
Ben Acre (EN)	3 x 100 kWp	December 2015
Polybell (EN)	471 kWp	December 2015
Reeders (EN)	50 kWp	December 2015
Godley (EN)	2,991 kWp	January 2016
Queen Elizabeth II (EN)	6,338 kWp	March 2016
Wattco pilot (NL)	4 kWp	May 2016
Alto Rabagao (PT)	218 kWp	November 2016
Maxima Bridge (NL)	57 kWp	December 2016
Pontecorvo (IT)	343 kWp	February 2017
Cegonha (PT)	11 kWp	February 2017
Engie pilot (NL)	26 kWp	October 2017
Slufter (NL)	51 kWp	November 2017
Hesbaye Frost (BE)	998 kWp	November 2017

ASIA & OCEANIA

Yothathikan pilot (TH)	5 kWp	October 2014
O-Chang (KR)	495 kWp	February 2015
Sungai Labu (MY)	108 kWp	November 2015
Kas Green Energy pilot (ID)	5 kWp	June 2016
Tengeh (SG)	3 x 100 kWp	October 2016
Ulu Sepri (MY)	270 kWp	November 2016
Pirongji (KR)	706 kWp	December 2016
Shek Pik (HK)	99 kWp	March 2017
Taoyuan (TW)	481 kWp	March 2017
Agongdian (TW)	2,320 kWp	June 2017
Heze City (CN)	600 kWp	June 2017
Pei County (CN)	9,982 kWp	July 2017
Plover Cove (HK)	111 kWp	November 2017
Lismore (AU)	100 kWp	November 2017
Tian Chang (CN)	1,000 kWp	November 2017
Anhui CECEP (CN)	70,000 kWp	Winter 2018
Anhui GCL (CN)	32,686 kWp	Winter 2018
Sugu #1 (TW)	1,100 kWp	February 2018
Taoyuan extension (TW)	1,444 kWp	March 2018
Agongdian extension (TW)	7,680 kWp	June 2018
Sugu #2 (TW)	4,100 kWp	Summer 2018
Taoyuan Bitan (TW)	10,620 kWp	Summer 2018

AFRICA

Kairouan pilot (TN)	5 kWp	May 2017

RE-CAPPING BENEFITS OF FLOATING SOLAR

- Opens up possibilities of on-site solar in locations where ground & roof-top will be too expensive / not applicable.
- Reliable technology lab-tested and field proven with up to 20 year extended warranty.
- Electrical generation of the plant is improved due to the cooling effect of the water.
- Hydrelio® system is made of UV-Stabilized HDPE material & is resistant to extreme wind conditions.
- Reduces water evaporation & minimizes algae growth.
- Has little to no effect on environment or wildlife.

THANK YOU FOR YOUR ATTENTION !