THE RISING TIDE OF FLOATING SOLAR
## TABLE OF CONTENTS

I. Let’s discover ‘Floating PV’ in pictures  

II. Market conditions  

III. Floating PV potential & application  

IV. Ciel & Terre technology & activities
LET’S DISCOVER ‘FLOATING PV’ IN PICTURES...

CIEL & TERRE
CORPORATE MOVIE
2006-2016
FLOATING SOLAR: AN ALTERNATIVE WITH A HUGE POTENTIAL
The main challenge of utility scale SOLAR is **SPACE**.

Without using farm land or valuable natural land

3 MW = 1/10 ha for wind power
  = 6 ha for solar power

→ 60 times more
FLOATING PV, AN ALTERNATIVE?

- Regulations
- Land costs
- Technical issues
- Grid connection distances

Make it more and more difficult to find appropriate spaces in many countries
Floating solar is most appropriated to **HIGHLY DENSIFIED COUNTRIES OR REGIONS** with many water bodies.
A 3 GW market in year 2020

We expect the floating solar market to reach 3% of the global solar market in 2020 with more than 1.5 GW in China.

Favorable trends:
- Limitation of land availability
- Lower cost of floating solar system
- Very large projects on dams
- Industrial self-consumption
APPROPRIATE WATER BODIES?

**KATO-SHI**
- 2.9 MWp
- Installed on 2 irrigation reservoirs
- Grid-connected in March 2015

**QUEEN ELIZABETH II**
- 6.3 MWp
- Installed on a drinking water reservoir
- Grid-connected in March 2016

**BALBINA DAM**
- 4.9 MWp
- Installed on a hydroelectric dam
- The ‘hybridization’ solution
**TAIWAN**

- **Total area**: 35,980 km²
- **Mountainous area**: 21,588 km² (60%)
- **Water area**: 3,921 km² (10.9%)
- **Irrigated area**: 3,820 km² (10.6%)
- **Agricultural lands**: 8,617 km² (22.7%)
- **Density**: 639,55 inh/km² (14th of the world)

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**Why Floating Solar in Taiwan?**

- Cost of land is *higher* due to land scarcity
- A FiT dedicated to Floating Solar up to 0.19 USD/kWh

Applications & potential:

1,033 ha. of Semi artificial ponds + 8,964 ha of artificial reservoirs + 40,000 ha of Fish Farms =

49,997 hectares of available spaces = 49 GWp of FPV

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**LANDS SCARCITY**
### Focus on... one country

**JAPAN**

**Total area** 377,915 km²

**Mountainous area** 268,319,65 km² (71%)

**Water area** 13,430 km² (3.5%)

**Irrigated area** 24,690 km² (6.5%)

**Agricultural lands** 47,239 km² (12.5%)

**Density** 349 inh/km² (20th of the world)

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### Why Floating Solar in JAPAN?

- **Cost of land is higher due to land scarcity**
- **A FiT still high 0,19 USD/kWh**
- **Potential using 50 % of existing irrigation reservoirs:**
  - 51,500 ha. = 51.5 GWp
- **Interest rates for loans very low**

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**50,904 KYOCERA PV MODULES x 270 W = 13.7 MWp**

- Covered surface (%)
- Water regulation pond (depth m)

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**4,970 households**

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**LANDS SCARCITY**
Focus on... one country

SINGAPORE

Total area 697 km²

Water area 10 km² (%)

Irrigated area 0 km² (%)

Density 7,829 inh/km² (2nd of the world)

Agricultural lands 6 km² (%)

400 PV MODULES x 250 W = 250 kWp
- Covered surface (%)
- Water regulation pond (depth 8 m)

Cost of land is one of the most expensive of the world

Potential on water reservoirs = 1 GWp equivalent to 7 % of existing capacity

Why Floating Solar in SINGAPORE?

LANDS SCARCITY
Focus on... one country

INDIA

Total area
3,287,263 km²

Irrigated area
667,000 km² (20.2%)

Agricultural lands
1,988,794 km² (60.5%)

Water area
km² (%)

Density
380.7 inh/km² (329th of the world)

1,2 billions of population

Food security priority

Growing demand in consumption

Preserve agricultural land to secure food

Provide clean power

Preserve water evaporation

54% of India faces high water stress

Current issues

INDIA

Floating Solar

LANDS USE CONFLICT

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FLOATING PV, A MAJOR SOLUTION

Focus on... one country

CHILE

Irradiation
2700 kWh/kWp/year in Atacama...

Grid Saturation
Energy saturation because of uninterconnected grids

Lowest kWh
Leads to a spot price at 0 kWh

Current issues CHILE

Strong Agricultural industry

Desert areas not connected to consumers

Severe droughts for Irrigation & Hydroelectric dams

Preserve agricultural land

Avoid transmission investment

Contain water evaporation

Floating Solar

WATER PRESERVATION
FLOATING PV, A MAJOR SOLUTION

WATER PRESERVATION

Evaporation rate
3 950 mm/m³/year

Irradiation
2 000 kWh/kWp/year

Wide space available
Desert areas with a lot of available space

Cost of m³
Cost of cubic meter of water is high (1 €)

Focus on... one country

IRAN

Drying Zayandeh rud river

Chah Nimeh Business Case

- Total Area: 16.3 km²
- Usable area: 10.2 km²
- Capacity of FPV: 1 GWp
- Surface covered for evaporation: 7.14 km²
- Cubic meter preserved: 28 203 000 m³/year
APPROPRIATE WATER BODIES?

- Irrigation reservoirs
- Industrial reservoirs
- Fishery ponds
- Hydroelectric dams
- Water utilities reservoirs and treatment plants
- Quarry lakes

ALWAYS ARTIFICIAL SITES ONLY FRESH WATER
POTENTIAL SIZE OF FLOATING PV PLANTS

From **200 kWp**
Sheeplands Farm, UK

And much more...
A **70 MW** project in China (2017)

To **13.7 MWp**
Yamakura dam, Japan
ELECTRICAL ARCHITECTURE

• Similar to ground-mounted PV plants

• Two choices for inverters location:
  • On shore
  • On water

• PV panels specifications?
LIMITS OF FLOATING SOLAR

- Lakes size and wind issues
- Anchorage costs
- Snow and frost
- What about the sea?
- Artificial water bodies only, to limit environmental issues
OTHER BENEFITS OF FLOATING SOLAR

- Natural refreshing PV cells
- Limitation of evaporation
- Water quality improvement (algae, ...)
- Proximity to grid connection or self-consumption possibilities
- Easier, quicker, less expensive development time
<table>
<thead>
<tr>
<th>Category</th>
<th>Environmental Impact Assessment</th>
<th>Grid Connection Study</th>
<th>Planning Permission</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JAPAN</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground Mounted</td>
<td>6 months</td>
<td>3 to 6 months</td>
<td>&lt;2MWp 1 to 6 months &gt;2MWp 2 to 5 years</td>
</tr>
<tr>
<td>Floating Solar</td>
<td>4 months</td>
<td>3 to 6 months</td>
<td>&lt;2MWp 0 to 6 months &gt;2MWp Up to 2 years</td>
</tr>
<tr>
<td><strong>BRAZIL</strong></td>
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</tr>
<tr>
<td>Ground Mounted</td>
<td>3 years</td>
<td>6 months</td>
<td>1 year</td>
</tr>
<tr>
<td>Floating Solar</td>
<td>1 year</td>
<td>6 months</td>
<td>1 year</td>
</tr>
<tr>
<td><strong>USA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground Mounted</td>
<td>12 months</td>
<td>&lt; 2 MW - 6 months &lt; 20 MW – 1 year &gt; 20 MW – 2 years</td>
<td>8 to 12 Months</td>
</tr>
<tr>
<td>Floating Solar</td>
<td>Exempted</td>
<td>Self consumption Fast track : 4 Months</td>
<td>Permitted developed zone : 12 Weeks No visual impact = no</td>
</tr>
</tbody>
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**DEVELOPMENT PROCESS**
FLOATING PV, A MAJOR SOLUTION

LOW EFFICIENCY OF PV

<table>
<thead>
<tr>
<th>Traditional Solar</th>
<th>Floating Solar</th>
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</thead>
<tbody>
<tr>
<td>Low ventilation due to surrounding obstacles</td>
<td>Ventilation</td>
</tr>
<tr>
<td>Soils &amp; roofs emit more heat</td>
<td>External temperature</td>
</tr>
<tr>
<td>Low humidity: greater isolation</td>
<td>Humidity concentration</td>
</tr>
<tr>
<td>Dusty environments: reduction of efficiency</td>
<td>Environmental conditions</td>
</tr>
<tr>
<td></td>
<td>Fresh water area bodies are subject to refreshing winds</td>
</tr>
<tr>
<td></td>
<td>Water bodies require more energy to warm</td>
</tr>
<tr>
<td></td>
<td>High Humidity: better convection of temperature</td>
</tr>
<tr>
<td></td>
<td>No dust and powder</td>
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</tbody>
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Up to +15%
HYDRELIO® SOLUTION

CIEL & TERRE
TECHNOLOGY & ACTIVITIES
HYDRELIO® BENEFITS

1. Resistance to UV Corrosion
2. Drinking Water Compliance
3. Extreme Wind Resistance
4. Safe Mounting & Maintenance

Indicative ratio*: 1 kWp / hour / worker
ANCHORING SYSTEM

COOLING EFFECT

Optimize the electricity generation

• Active cooling
• Passive cooling

SPREADER BAR
To connect the floating island with the anchoring system
Up to 4,000 daN
1.6 ton / spreader bar

WIND SPEED
Can be designed to withstand winds up to 210 km/h (131 mph)

Maximal wind speed

ISAWA-IKE
• 632 kWp
• Grid-connected in October 2016
• Equipped with an active-cooling system
WORLDWIDE PRESENCE

85+ Total portfolio in MWp

75+ Collaborators

8 Local offices: France, Japan, UK, China, USA, Brazil, Taiwan, Malaysia

8 Manufacturing lines: France, Japan, UK, South Korea, China, USA, Brazil, Taiwan

15 Commercial & Technical partners
THANK YOU FOR YOUR ATTENTION!

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