

**WHY FLOATING  
SOLAR WITH  
CIEL & TERRE<sup>®</sup>?**



[www.ciel-et-terre.net](http://www.ciel-et-terre.net)



## I. WHY FLOATING SOLAR

Solar Landscape

Remaining Challenges for Solar  
Response from floating

## II. WHY CIEL & TERRE<sup>®</sup>

Experience

Expertise

R&D

## III. WHY HYDRELIO<sup>®</sup>

Quality

Reliability

Proximity

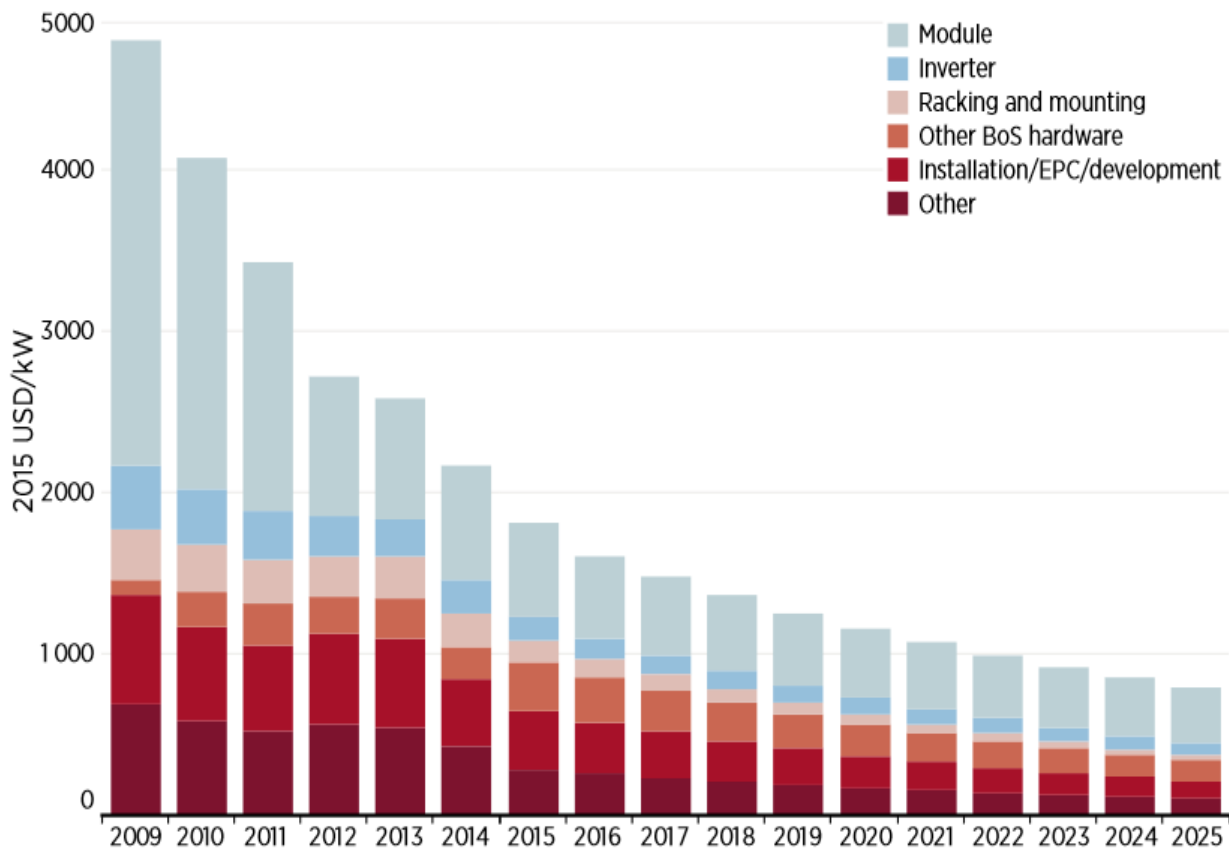
Innovation

# WHY FLOATING SOLAR?



- From 2009 to 2016, average cost of Utility Scale PV farm **was divided by 2.7**
- Cost reduction should continue and decrease up to **57%** in 2025

FIGURE ES 1: GLOBAL WEIGHTED AVERAGE UTILITY-SCALE SOLAR PV TOTAL INSTALLED COSTS, 2009-2025



## Main Economic Drivers



Rising of PV modules production capacity



Inverters & PV modules efficiency



Cost of financing



Accumulated know how



Economy of scale



Ground mounted system development face some challenges :

- Remote spaces requiring high infrastructure costs (Substation,..)
- Difficult areas (hilly, unstable,..) rising the costs of CAPEX
- Cost of lands can be expensive
- Difficulties to identify land owner
- Environmental Impact Assessment



Roofs are not always suitable for PV installation :

- Limited size MWp capacity
- Require higher cost of maintenance
- Difficulties to dismantle
- Lower efficiency of PV Modules due to low ventilation



**Solution: Floating Fotovoltaic**

# FLAOTING PV BENEFITS

## ENVIRONMENTAL



- Minimizes water evaporation (water & ecosystems conservation)
- Improves water quality and reduces algal bloom
- Limits erosion of reservoir thanks to wave action
- Neutral/Positive impact
- Make PV possible when there is a lack of space



Iran  
Chile

## ECONOMIC



- Converts unused spaces into profitable areas
- Smoothest & fastest development processes
- Enhances electricity generation thanks to the cooling effect
- Reduces grid-connection costs and major infrastructures investments

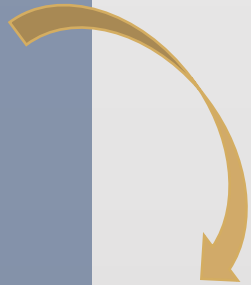


Brazil

## SOCIAL



- Preserves valuable lands for other uses
- Rehabilitates contaminated areas with clean energy
- Compatible with recreational activities
- Environmental amenity, positive aesthetics



India  
Malaysia  
Thailand  
USA

Japan  
Taiwan  
Singapore

# FLOATING PV COMPETITIVITY

## Traditional Solar

Low ventilation due to surrounding obstacles

Soils & roofs emit more heat

Low humidity : greater isolation

Dusty environments : reduction of efficiency



Ventilation



External temperature



Humidity concentration



Environmental conditions

## Floating Solar

Fresh water area bodies are subject to refreshing winds

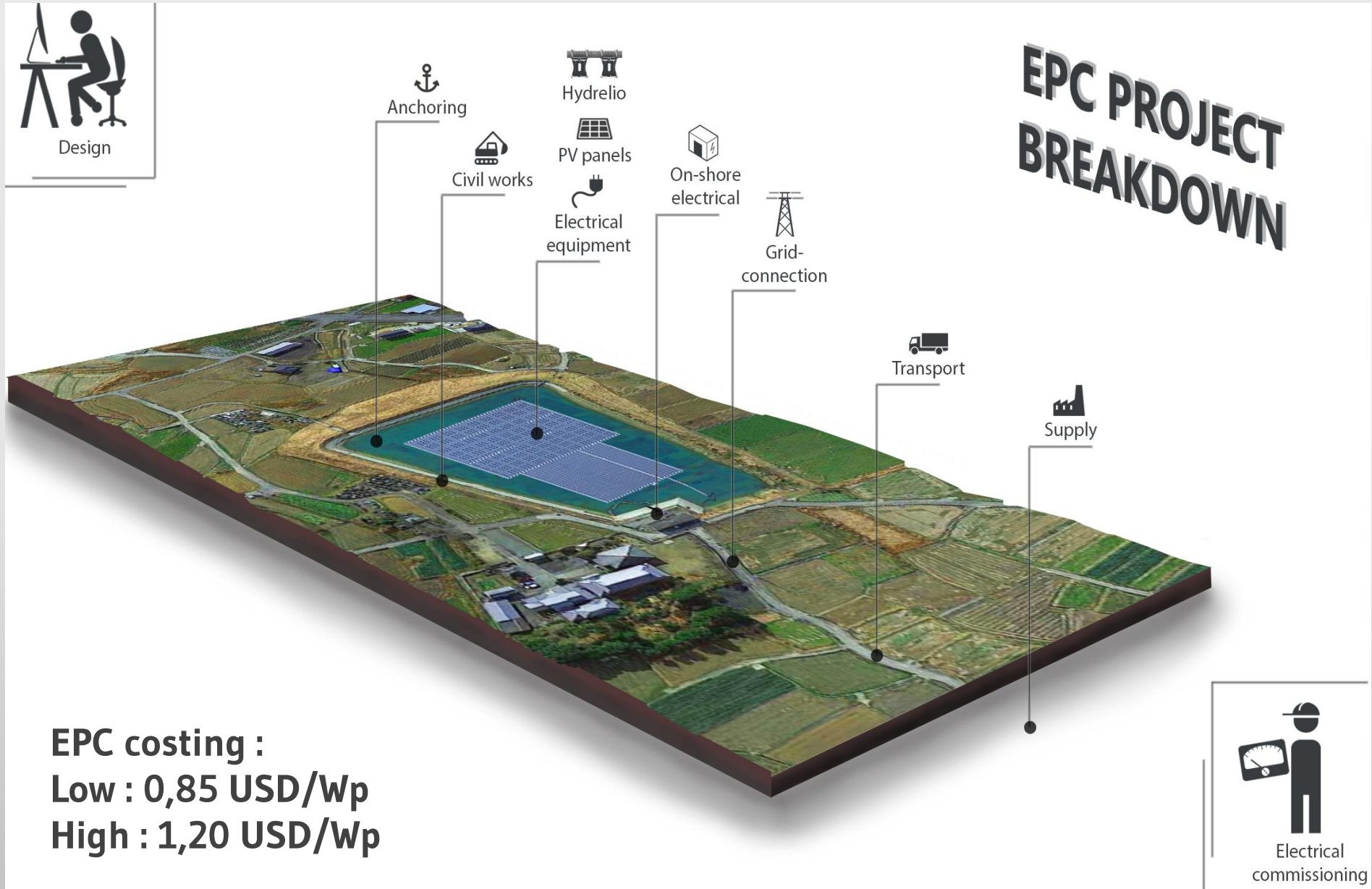
Water bodies require more energy to warm

High Humidity: better convection of temperature

Less dust and powder

**Up to 10% of  
YIELD  
ENHANCEMENT**

# FLOATING PV COMPETITIVITY







**WHY CIEL & TERRE<sup>®</sup> ?**



**EXPERIENCE**



**EXPERTISE**



**INNOVATION**



[www.ciel-et-terre.net](http://www.ciel-et-terre.net)

# LARGEST EXPERIENCE IN THE WORLD



**>200 MWp**

Total floating solar capacity installed  
[May 2018]



**25 Countries**

In total with floating PV plants installed with Hydrelío®



**>200 MWp**

Total on-going projects to be  
connected



**5 Continents**

In total with floating PV plants installed  
with Hydrelío®



**>100 Projects**



**120 Experts**

dedicated to Floating Solar



**70 MWp**

Largest floating PV project



**in 9 Local offices**



**5 years**

Oldest floating PV project



**30 Manufacturing lines**



# OUR EXPERTISE

Ciel & Terre® has developed a recognized expertise and acquired the largest experience to install large scale floating solar systems, on artificial reservoirs. Our expertise encompasses:

**Feasibility Study**  
**Engineering**  
**Turnkey**  
**Hydrelio® supply**  
**Development**  
**Financing**

Floating Solar presents quite lot of challenges that Ciel & Terre® has evaluated and overcome thanks through its past experiences.



Training & Supervision on site to ensure a smooth and long lasting installation



Design Review by 3<sup>rd</sup> Party based on local standards  
Local endorsement



**BUREAU  
VERITAS**



R&D innovation primed by Intersolar Award 2017



# ASSISTANCE ON THE VALUE CHAIN

	Feasibility	Development	Construction	O&M	Financing
Technical	<ul style="list-style-type: none"> <li>• Site visits</li> <li>• Preliminary engineering</li> </ul>	<ul style="list-style-type: none"> <li>• Bathymetry</li> <li>• Soil study</li> <li>• Detailed engineering</li> </ul>	<ul style="list-style-type: none"> <li>• EPC training</li> <li>• Anchoring installation</li> </ul>	<ul style="list-style-type: none"> <li>• Commissioning visit</li> <li>• Performance troubleshooting</li> </ul>	<ul style="list-style-type: none"> <li>• Technical due diligence</li> </ul>
Financial	<ul style="list-style-type: none"> <li>• EPC budgeting</li> <li>• Hydrelío® pricing</li> </ul>	<ul style="list-style-type: none"> <li>• Business plan Modeling</li> <li>• LCOE calculation</li> </ul>	<ul style="list-style-type: none"> <li>• Cash flow modeling</li> <li>• Working capital optimization</li> </ul>	<ul style="list-style-type: none"> <li>• O&amp;M budgeting</li> <li>• Billing management</li> </ul>	<ul style="list-style-type: none"> <li>• Equity financing</li> <li>• Recapitalizing</li> <li>• Financing consulting</li> </ul>
Commercial	<ul style="list-style-type: none"> <li>• Site identification</li> <li>• Preliminary assessment</li> </ul>	<ul style="list-style-type: none"> <li>• Permitting</li> <li>• PPA review</li> <li>• Lease agreement</li> </ul>	<ul style="list-style-type: none"> <li>• EPC selections</li> <li>• Contract review</li> </ul>	<ul style="list-style-type: none"> <li>• O&amp;M selections</li> <li>• Contract review</li> </ul>	<ul style="list-style-type: none"> <li>• Third-party introduction</li> <li>• Debt provider introduction</li> </ul>

# ANCHORING SYSTEM



## ANCHORAGE ON BANKS

When the bottom needs to be protected (liner...)



## ANCHORAGE ON BOTTOM

With plate anchor or with dead weight



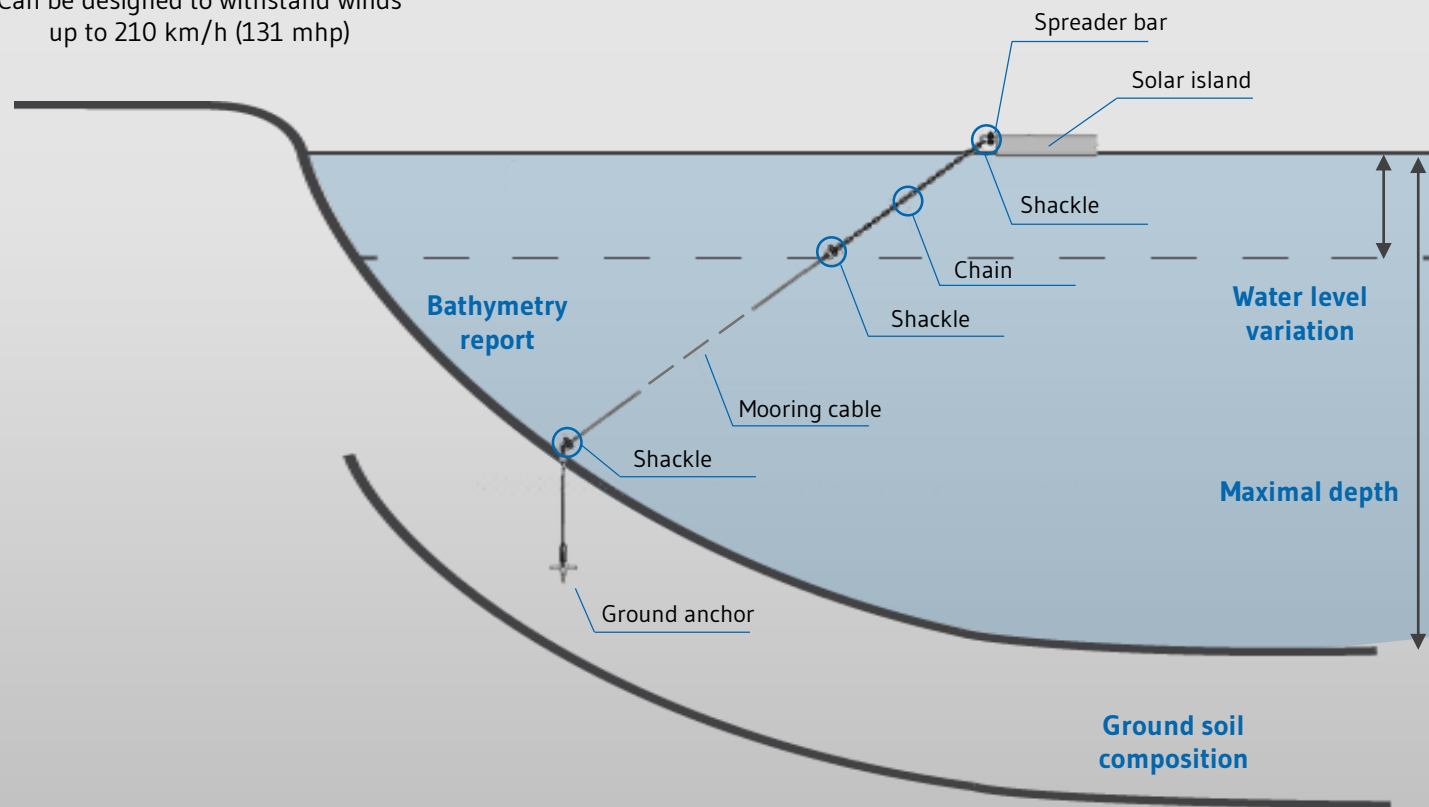
## SPREADER BAR

To connect the floating island with the anchoring system  
**Up to 4,000 daN**  
**1.6 tons per spreader bar**



### WIND SPEED

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



# WHY CIEL & TERRE® ?



## C&T

Depth



CTI developed its own **anchoring installation technology** for high depth even on hard soils

Level



Variation

**CTI engineering** has the capability and knowledge to design and select the mooring system capable of absorbing the highest water level targeting

Waves

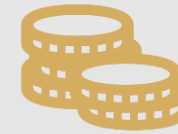


CTI **Hydrelio® products** have been all designed to **withstand stress fatigue equivalent to high waves constraints** backed up by neutral high reputed 3<sup>rd</sup> party testing labs.

Dam Integrity



CTI Engineering know how encompass Feasibility study to collect **all relevant data** and **adapted design** to protect **Dam integrity** (Spilling gateways, Current analysis,..)



All the solutions developed by CTI are targeting **cost competitiveness** to ensure to the stake holder

- . **Attractive IRR**
- . **Secure Investment**
- . **Easy & low maintenance**

## HIGH DEPTH

Extreme Conditions to send divers

+ Difficulty in dropping deadweight with accuracy.

+ Requires use of expert technology

= Development of Ciel & Terre® owned anchoring technology called Ancrelio.

Ancrelio is :

- Compatible with hard soil
- Capable of installing anchors very deep
- Fast track installation per day = cost competitiveness



## ANCHORING

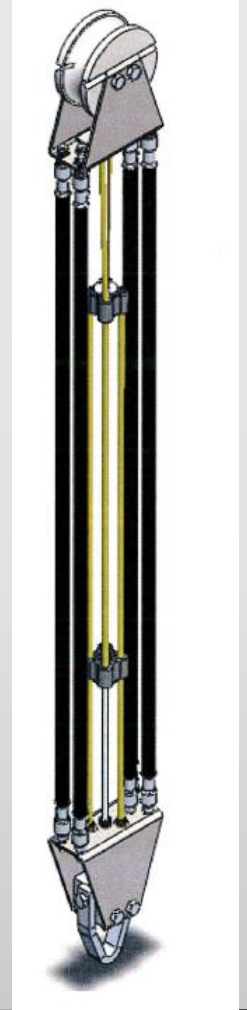
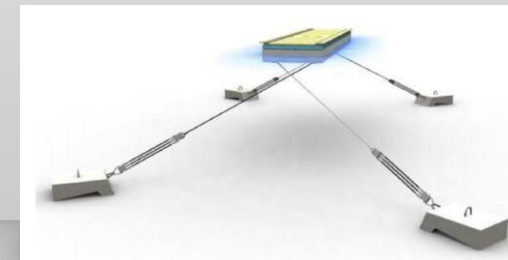
# WATER LEVEL VARIATIONS

High water level variation lead to :

- 1) Lot of tensions concentrated on a few points that can damage floats
- 2) Wide movement area that require extra sizing of cables (DC)
- 3) Potential changes in azimuth affecting the electricity generation

Ciel & Terre® have collaborated with technology supplier to develop solutions to address the highest water level variations at :

- 1) Design Phase
- 2) Construction Stage
- 3) R&D



## ANCHORING





- In addition to the detailed engineering, Ciel & Terre® invest in R&D to find solutions to any challenge face by our customers and partners :



Research for installation of FPV on fish farming and oxigenation



Development of **Ancrelio** an anchoring installation device for High Depth



Development of **HandrHelio** system for an Australian project



OUR INNOVATION

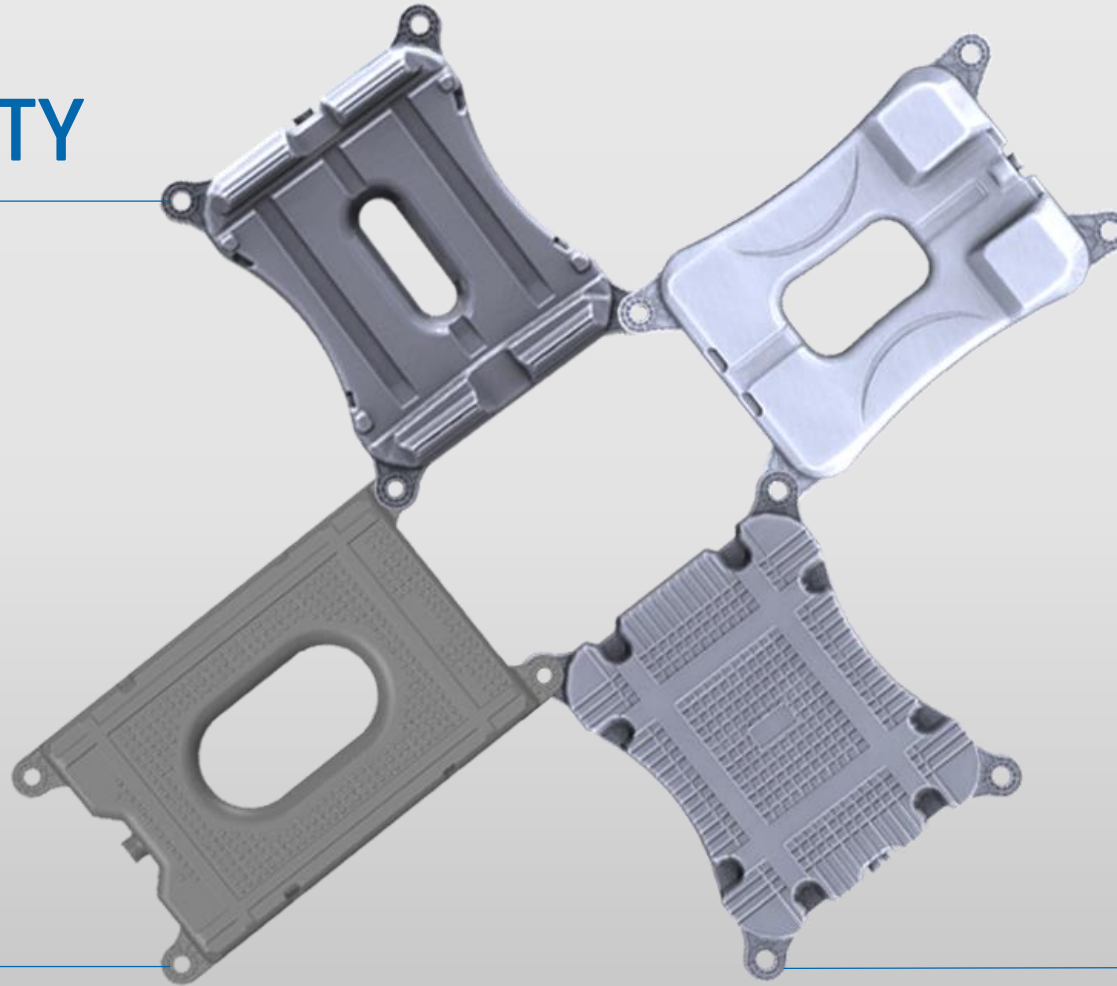
# WHY HYDRELIO<sup>®</sup> ?

**BANKABILITY**

---

**RELIABILITY**

---



**PROXIMITY**

---

**FLEXIBILITY**

---

WHY HYDRELIO® ?

# MULTI TESTED TECHNOLOGY

## TESTED TO EXTREME WIND

Wind Tunnel Testing and Computational Fluid Dynamics

60m/s



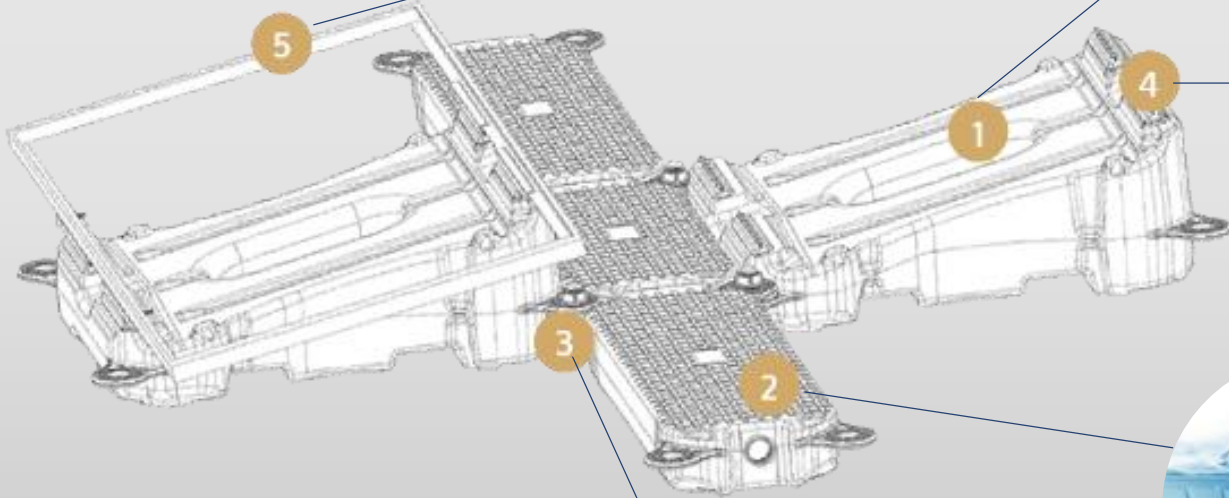
## TESTED TO UV CORROSION

HDPE Blow-molding

+20 YEARS Lifetime

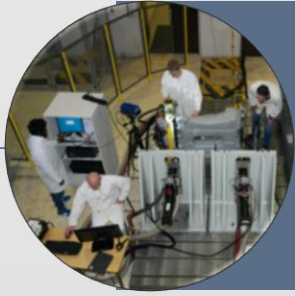
5-20 YEARS Warranty

Xeno Test: 30 000h



## TESTED TO TENSILE STRENGTH

Hydrelio System designed to resist 20kN



## DRINKING WATER COMPLIANCE

BS 6920:2000 water drinking

- 1. Odour & Flavour
- 2. Appearance of Water
- 3. Cytotoxicity
- 4. Growth of Aquatic Microorganisms
- 5. Leaching of Metals



## BENDING FATIGUE TESTED

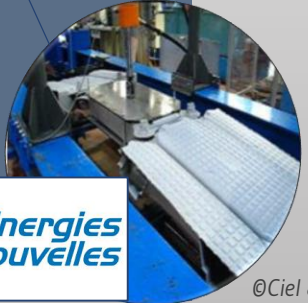
360 000 cycles

1 meter Waves

1M cycles

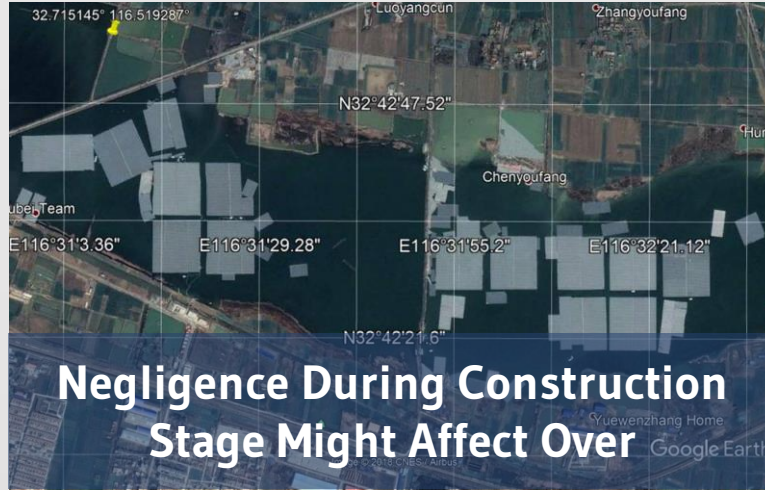
Fixation System

TESTED BY



**WHY HYDRELIO® ?**

Floating Solar is still new on the market therefore, it is crucial choose the technology based on its performance. Here are a few example of what to prevent (all pictures are not related to Ciel & Terre® projects)



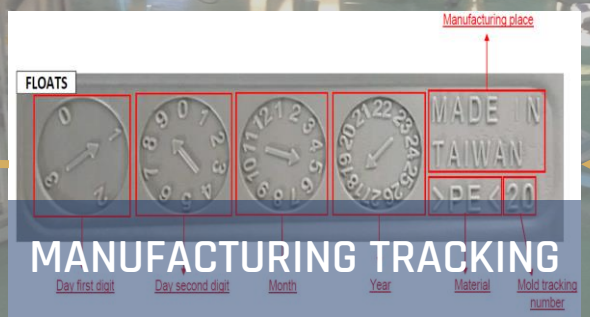
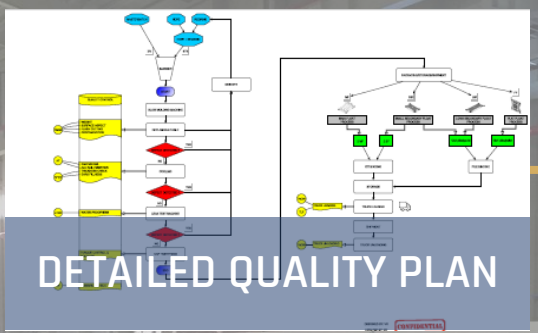
**Risk for Multi Million Asset Integrity**



**BANKABILITY**

# HIGH QUALITY MANUFACTURING - ISO 9001 & ISO 14001

WHY HYDRELIO® ?



RELIABILITY

\* Certifications owned by our manufacturing partners, depending on every country

# PROXIMITY



Ciel & Terre Members are spread in **10 countries** in the heart of our activities (Americas, Asia and Europe).



All our collaborators are **100 % dedicated to Floating Solar** making them absolute experts in their respective fields: **Development, Construction, Engineering** or **Financing**.



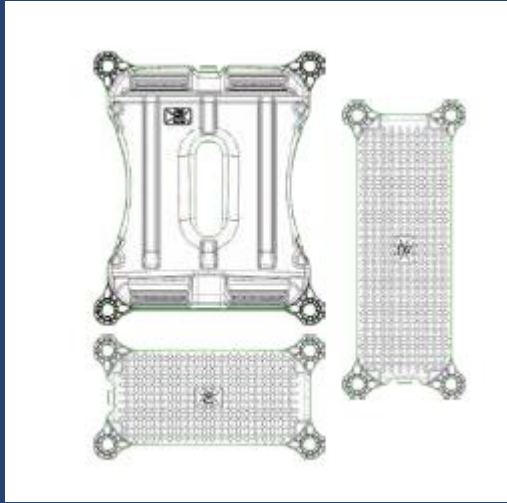
We combine **local knowledge and deep expertise** to address any challenges and **find tailor made solution**.



We have set up a wide local **manufacturing network** to reduce **logistic impacts** & ensure swift **after sales services**.

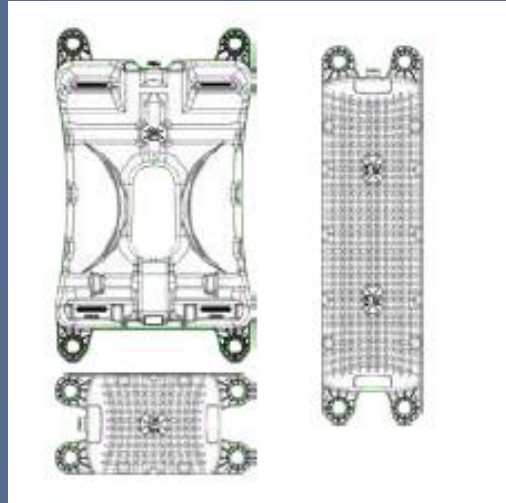
# FLEXIBILITY: HYDRELIO®

- Ciel & Terre has developed a portofolio of solutions design to market specificities



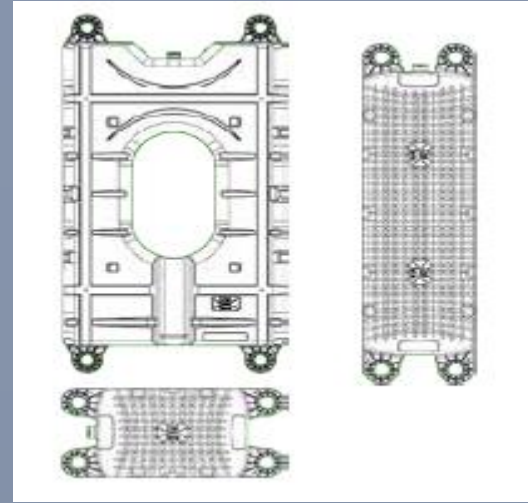
## Classic

- **Standard tilt of 12°**, with 15° and 22° tilt options.
- Easy **operation and maintenance**.
- Compatible with comfort, eco and dual-orientation configurations\*.



## Equatorial

- **Fixed tilt of 5°**,
- Designed for equatorial countries
- Lighter anchoring.
- Cost effective transport solution.
- Optimized for the 4-in-a-row configuration\*.



## aiR

- Flat float with a racking system.
- Extraventilation
- Multiple tilts available.
- Cost-effective transport solution.
- Optimized for the 4-in-a-row configuration\*.

# FLEXIBILITY: LAYOUT

To reach cost competitiveness and maximize the available spaces

### CLASSIC DUAL ORIENTATION



Modules tilt: 12°  
Most suitable for East/West orientation

**Features**

Maintenance Ease	<input type="checkbox"/>	Buoyancy	<input type="checkbox"/>
Anchoring Affordability	<input type="checkbox"/>	Water Coverage	<input type="checkbox"/>
Transport Efficiency	<input type="checkbox"/>	Capacity / m <sup>2</sup>	<input type="checkbox"/>

60 or 72 cells  
Comfort maintenance rows  
2-in-a-row  
Dual orientation

### EQUATO 4-IN-A-ROW



Modules tilt: 5°

**Features**

Maintenance Ease	<input type="checkbox"/>	Buoyancy	<input type="checkbox"/>
Anchoring Affordability	<input type="checkbox"/>	Water Coverage	<input type="checkbox"/>
Transport Efficiency	<input type="checkbox"/>	Capacity / m <sup>2</sup>	<input type="checkbox"/>

60 or 72 cells  
Comfort maintenance rows  
4-in-a-row  
Single orientation

### CLASSIC ECO



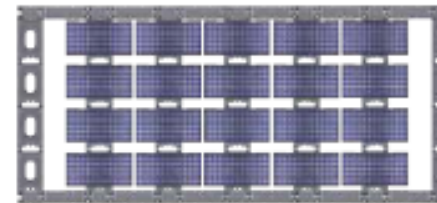
Modules tilt: 12°

**Features**

Maintenance Ease	<input type="checkbox"/>	Buoyancy	<input type="checkbox"/>
Anchoring Affordability	<input type="checkbox"/>	Water Coverage	<input type="checkbox"/>
Transport Efficiency	<input type="checkbox"/>	Capacity / m <sup>2</sup>	<input type="checkbox"/>

60 or 72 cells  
Eco maintenance rows  
Single row  
Single orientation

### AIR 4-IN-A-ROW



Modules tilt: 11°

**Features**

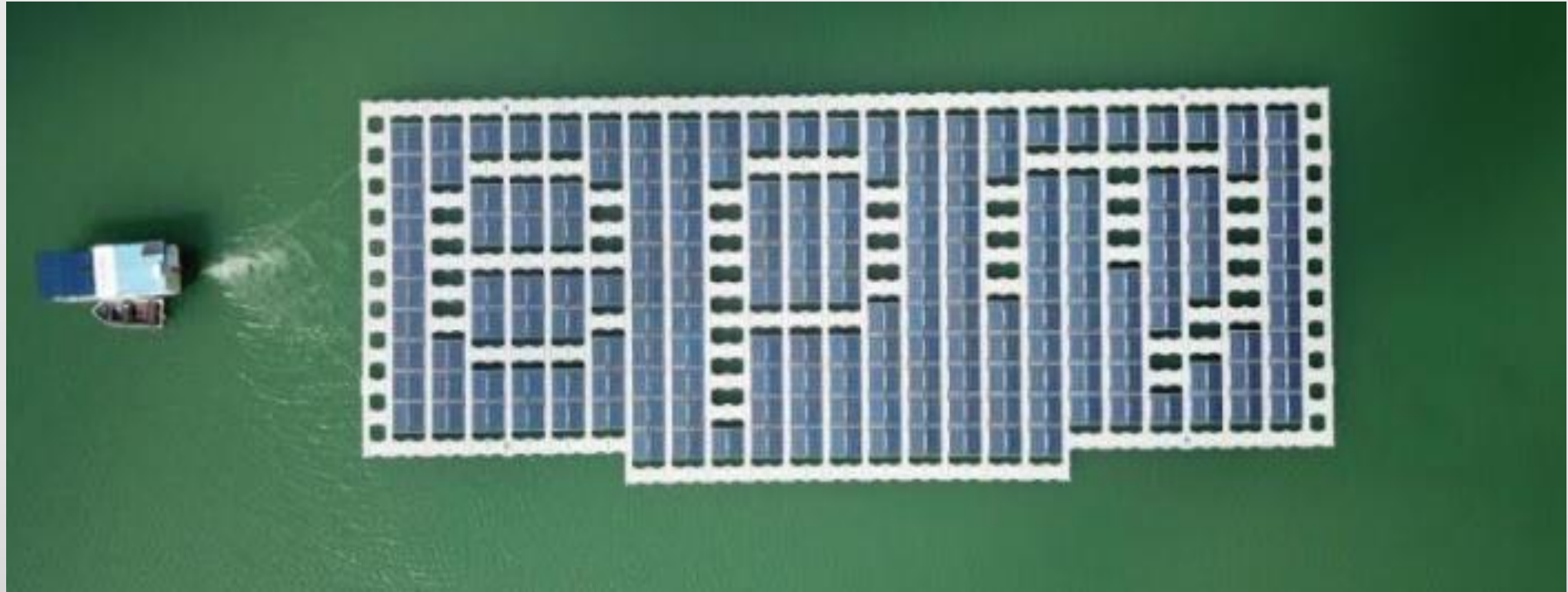
Maintenance Ease	<input type="checkbox"/>	Buoyancy	<input type="checkbox"/>
Anchoring Affordability	<input type="checkbox"/>	Water Coverage	<input type="checkbox"/>
Transport Efficiency	<input type="checkbox"/>	Capacity / m <sup>2</sup>	<input type="checkbox"/>

60 or 72 cells  
Comfort maintenance rows  
4-in-a-row  
Single orientation



# FLEXIBILITY: CREATIVITY

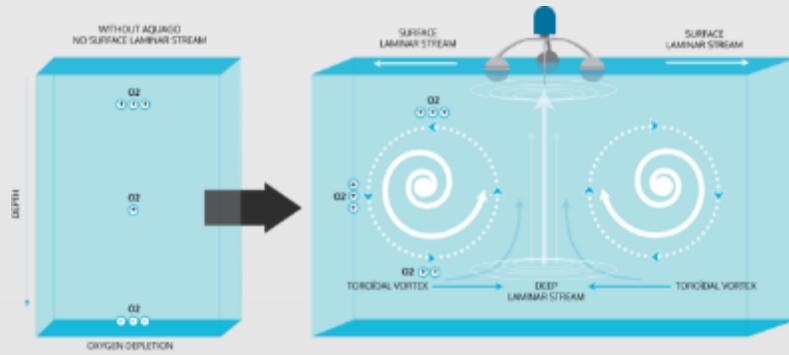
WHY HYDRELIO® ?



SHOWCASE YOUR LOGO  
WITH CLEAN ENERGY!

# WHY HYDRELIO® ?

## FLEXIBILITY ADDITIONAL FEATURES



In partnership with  
Aquago®  
(Techsub® company)

Antibird System, to protect your PV system  
From birds soiling



System for completely covering water surface  
to reduce evaporation and minimize algal  
growth



Battery system to provide continuous power,  
peak shaving





**FRANCE**  
**Ciel & Terre International**  
**Head Office**  
100 avenue Harrison  
59262 Lille



**JAPAN**  
**Ciel Terre Japan CO, Ltd.**  
Kyobashi Yamamoto bldg. 3F, 3-12-7  
Kyobashi, Chuo-ku, Tokyo, 104-0031



**UNITED KINGDOM**  
**Floating Solar UK, Ltd.**  
Sheeplands Farm, Twyford Road Wargrave,  
Berkshire, RG10 8DL



**USA**  
**Ciel & Terre USA**  
755 Baywood Drive, 2<sup>nd</sup> floor,  
Petaluma, CA 94 954, USA



**BRAZIL**  
**Ciel & Terre Brasil, Ltda**  
Rua Rocío, 423, Floor 12  
CEP 04552-000 – Vila Olimpia, São Paulo



**CHINA**  
**Ciel & Terre China**  
381 Panyu Road, Building E-403,  
Changning District, Shanghai



**TAIWAN**  
**Ciel & Terre Taiwan**  
3F-6, No. 99, Yongke 3rd Rd.,  
Yongkang district, Tainan 710



**MALAYSIA**  
**Ciel & Terre ASEAN and Oceania**  
Kuala Lumpur – KLCC – Etiqa Twins Level 25 Tower 2,  
11 Jalan Pinang 50450 Kuala Lumpur, Malaysia



[information@cielletterre.net](mailto:information@cielletterre.net)



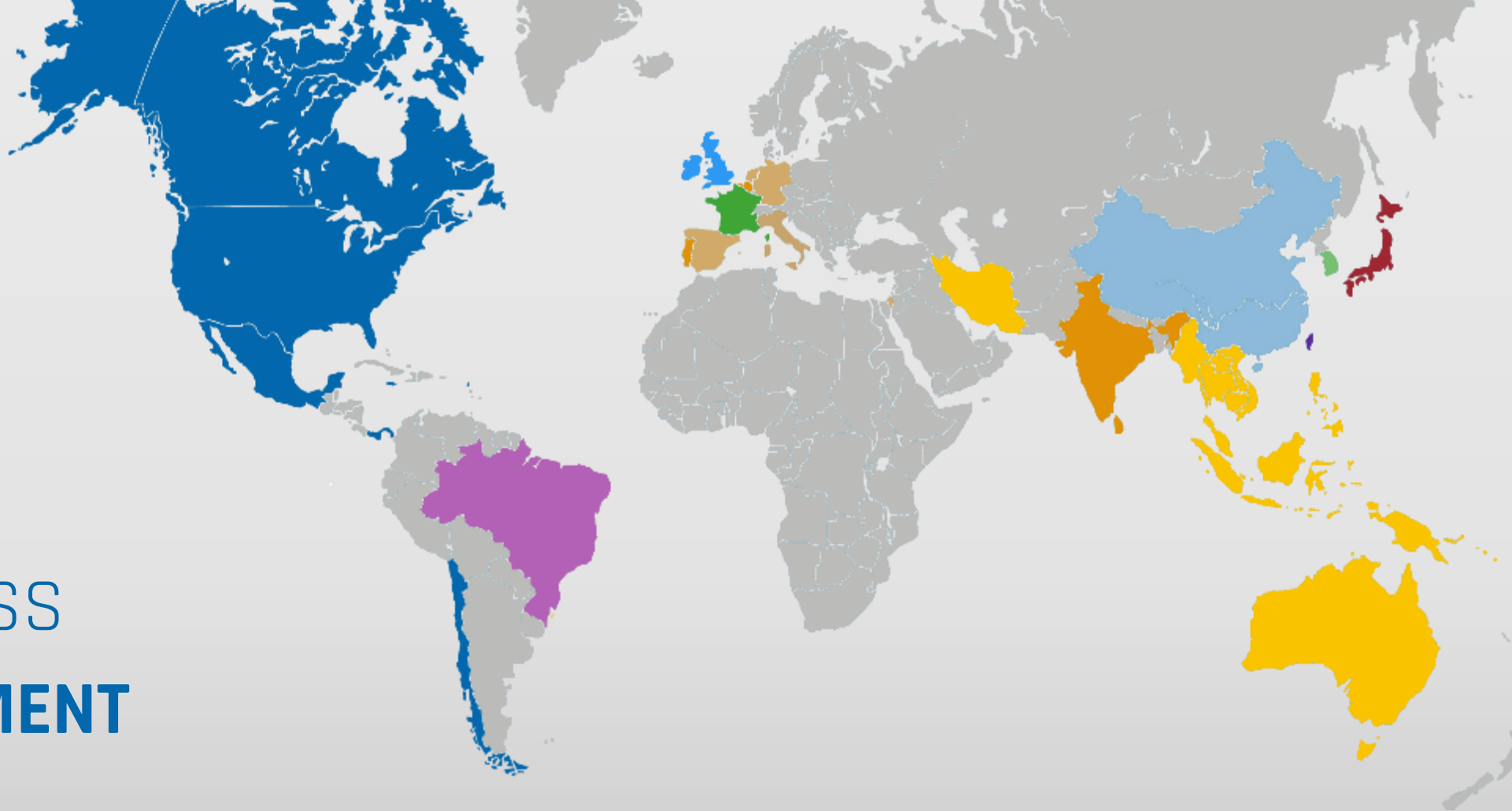
[www.ciel-et-terre.net](http://www.ciel-et-terre.net)



CONTACT



# 10+ AGENTS & DISTRIBUTORS



### EUROPE

Netherlands  
Portugal

### ASIA

Indonesia  
Philippines  
Vietnam  
Myanmar  
Iran

### OTHERS

Australia  
Chile  
Israel  
Nigeria  
Angola

# BUSINESS DEVELOPMENT



**Eva PAULY**  
North America



**Orestes GONÇALVES**  
Brazil



**Marc BENNETT**  
UK



**AKU ENERGY**  
France



**Neige BREANT**  
Europe



**Stéphane PROUVOST**  
India



**Harold MEURISSE**  
ASEAN + Oceania



**Philippe DESCHAMPS**  
China



**Cédric JAEG**  
Taiwan



**Thomas KIM**  
South Korea



**Hajime MORI**  
Japan



**Jack SETTON**  
Rest of world





**THANK YOU FOR YOUR  
ATTENTION !**



[www.ciel-et-terre.net](http://www.ciel-et-terre.net)