



# Floating PV – The 3<sup>rd</sup> Market Segment – Asia takes the lead



## Asia Clean Energy Forum 2018

Deep-Dive Workshop:  
Gigatech Solutions for Gigaton Problems  
Floating Solar Practice and Potential

ADB | Manila

June 8, 2018

Frank Haugwitz | Director | [Frank.Haugwitz@aecea.com.de](mailto:Frank.Haugwitz@aecea.com.de)  
Asia Europe Clean Energy (Solar) Advisory Co. Ltd. (AECEA)

# Asia Europe Clean Energy (Solar) Advisory Co. Ltd.



Founder & Director -  
Hong Kong since 2012



Global Head of Conference  
Development – since 2010 in  
Europe / US / Brazil / India / UAE



Co-Founder - Singapore 2011  
Director Market & Policy



Senior Advisor -  
since 2010

The PV Market Alliance



Founding Member -  
since 2015

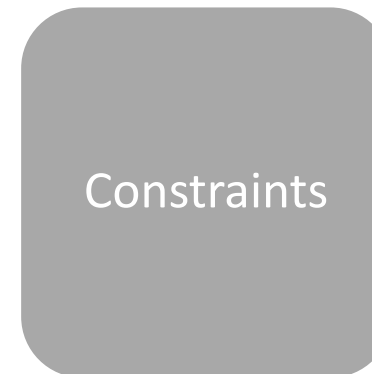
# Drivers for Deploying Floating PV Plants

Numerous constraints are off-set by limitless potential & opportunities

- ❖ Covering precious arable land with solar PV (?)
- ❖ Regulations, land costs, technical issues, distance to grid
- ❖ Opportunities in highly densely populated areas and/or regions with significant water bodies
- ❖ Literally unlimited potential, if we imagine « off-shore PV »

## Favorable Trends

- ❖ Availability of land is limited
- ❖ Increasingly lower costs for floating PV systems
- ❖ Dams offer very large potential
- ❖ Industrial self-consumption

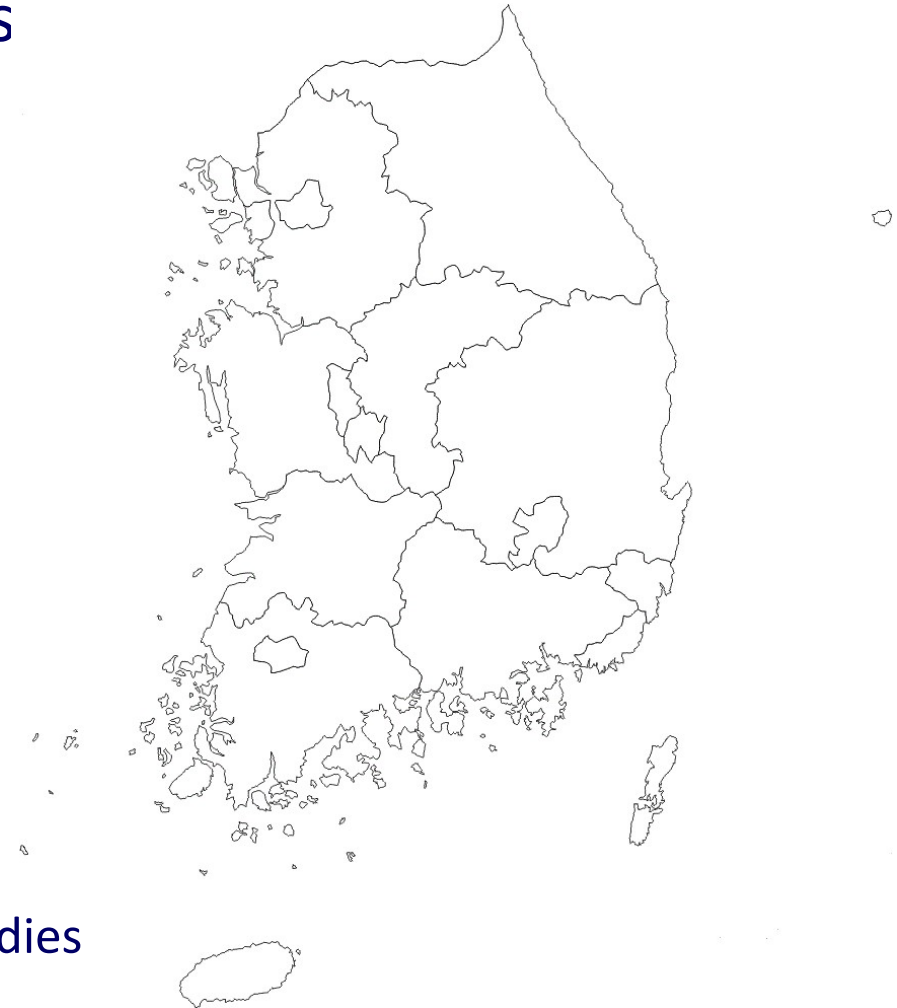


# Early Beginnings – Japan & South-Korea

## Motivation for Deploying Floating PV Power Plants



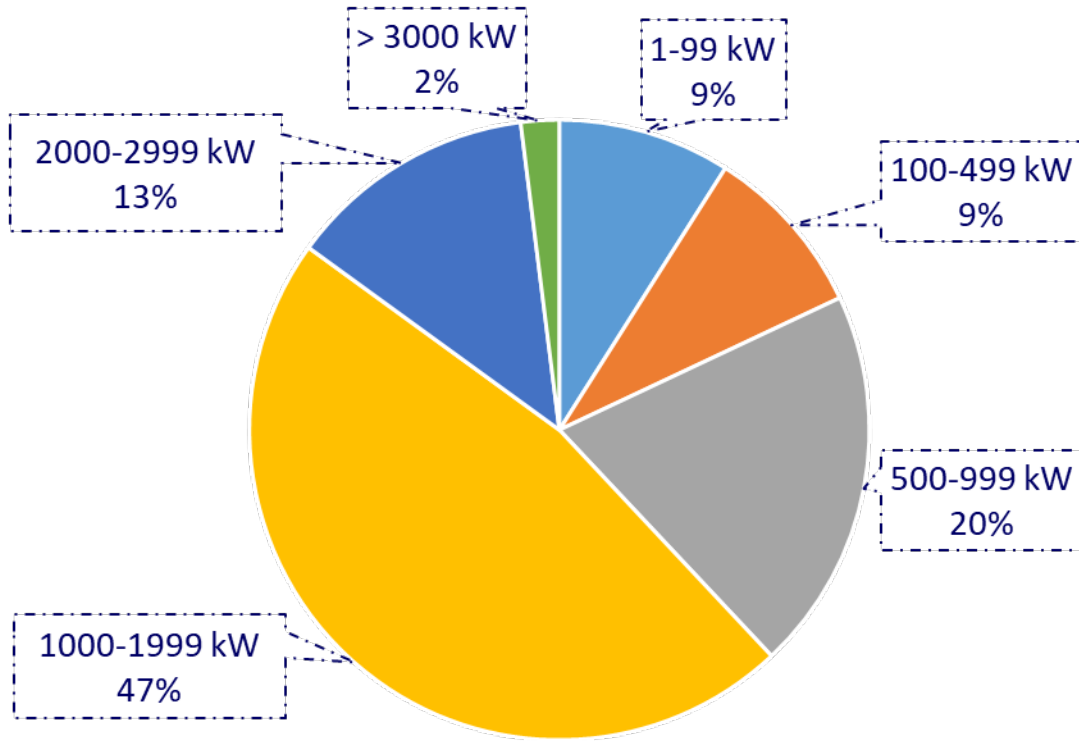
- ❖ High Population Density
- ❖ Prohibitively High Land Costs
- ❖ Significant Number of Water Bodies



# Japan

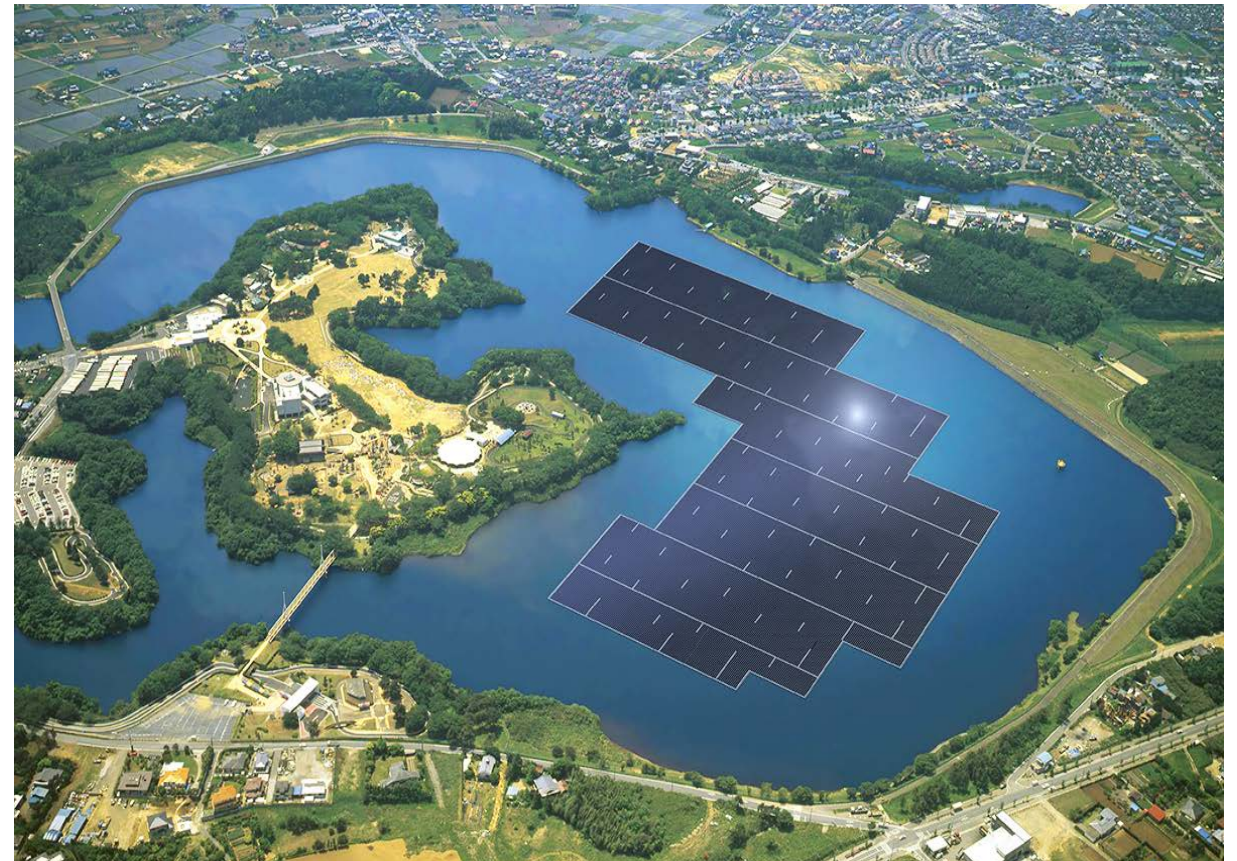
First Mover – National Potential est. 39 GW

### Size of Floating PV Plants



**approx. 150-200 MW deployed to date**

### Yamakura Dam | 13.7 MWp | March 2018



# South-Korea

Potential: 90% of all mines (limestone, coal, etc.) are closed / abandoned

- ❖ Case Study: 1 MW at Open-Pit Limestone Mine
- ❖ Initial investment: USD 2,7 mio (est. in 2014)
- ❖ **Paypack period: approx. 12.3 years**
- ❖ **IRR: 9.37%**

## Deployment Prospects

- ❖ Hanwha develops 100 MW plant 2018/2019
- ❖ Korea Rural Community Corp. plans to have installed 280 MW by 2019
- ❖ K-Water sees potential to install more than 1 GW by 2022

## Otae / Jipyong Reservoir | 6 MW | Oct 2015



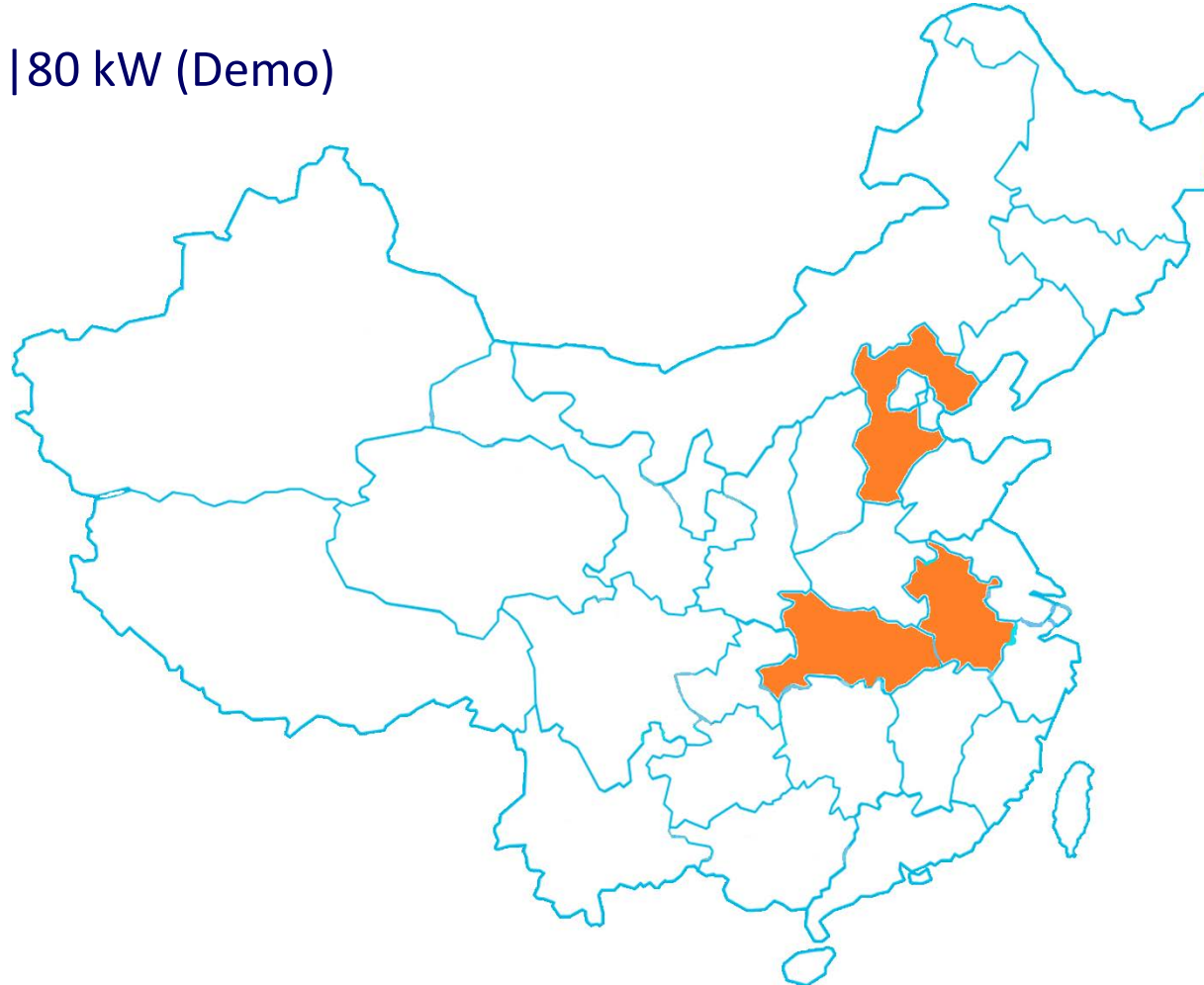
# China

## Multiple Demo and Small-Scale Project Developments till 2015 early 2016

❖ Anhui | Bailing | 2015 | 80 kW (Demo)



❖ Hubei | Zaoyang |  
Oct 2015 – Feb 2016 |  
200 kW (Demo)



❖ Hebei | Linxi County |  
July-Sept 2015 | 8 MW

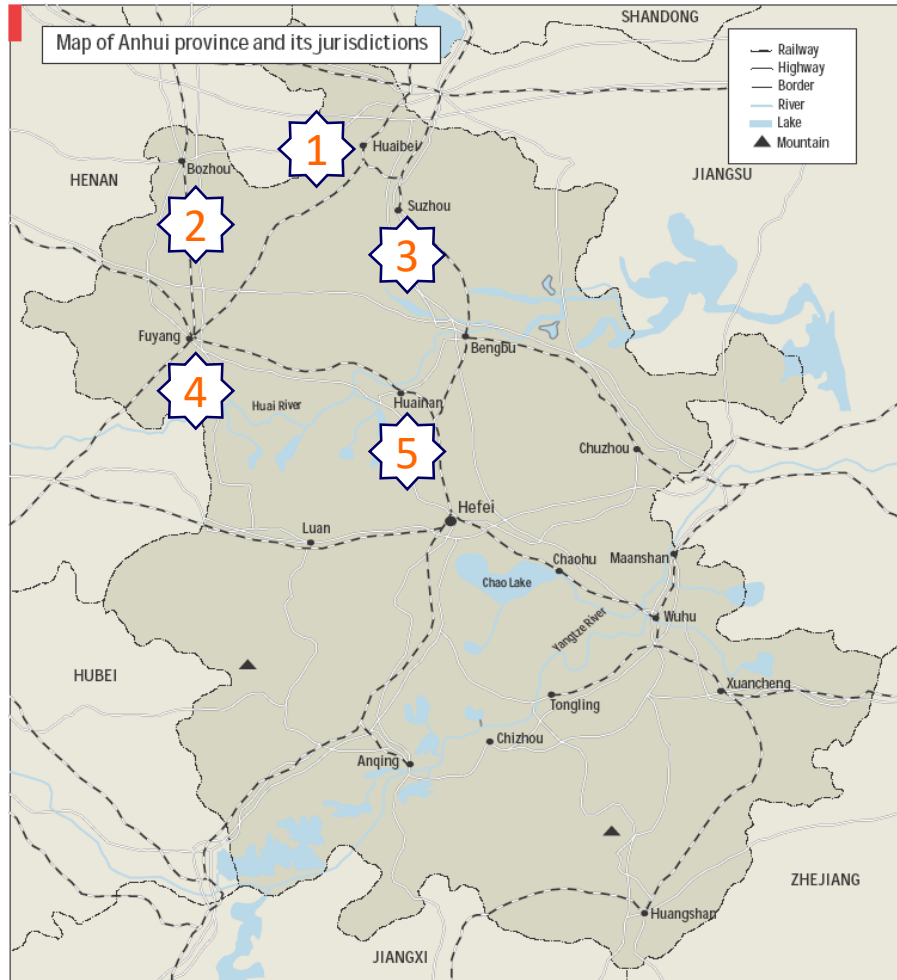


❖ Anhui | Sanshan |  
July 2015 | 8.5 MW



# China: Anhui Province – GW Ambitions

Five Locations shall be home to 3.2 GW btw. 2016 through 2018



- ❖ July 2016 – Anhui Govt. released a three year plan aiming at the deployment of 3.2 GW across five locations throughout Anhui Province
- ❖ **Caution:** Definition of projects may not strictly limited to „floating“

1	Huaibei: 850 MW btw. 2016-2018
2	Bozhou: 220 MW till 2016
3	Suzhou: 450 MW btw. 2016-2018
4	Fuyang: 300 MW btw. 2016-2017
5	Huaihan: 1380 MW btw. 2016-2018



# China: 2017 – Large-Scale Arrived

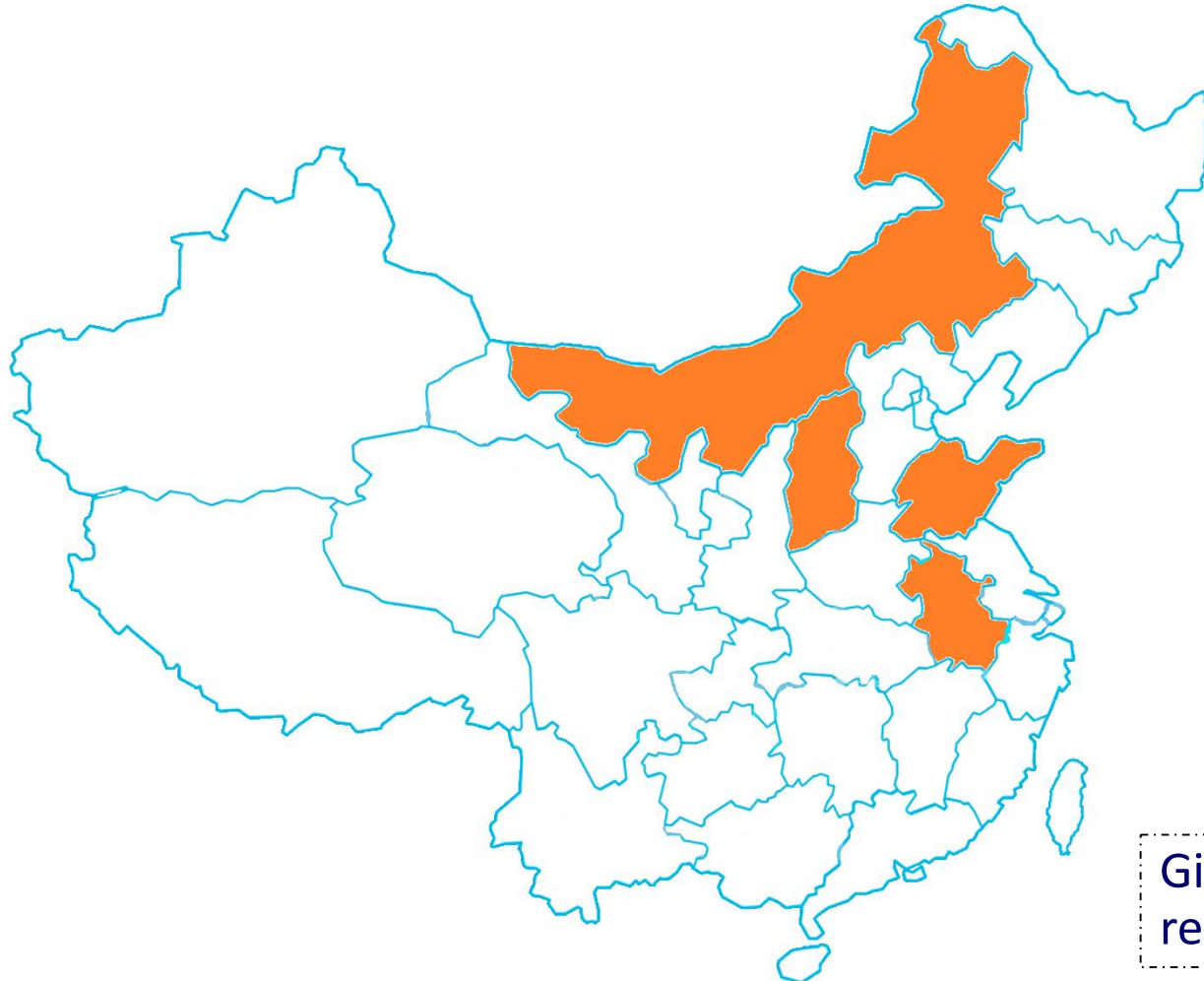
Floating PV Projects just gets more and bigger



- ❖ Jiangsu Runhai Huanbao Co. Ltd.  
Feb 2017 | 20 MW | Jiangsu | Sheyang
- ❖ Sungrow Co. Ltd  
June 2017 | 40 MW | Anhui | Huaian City
- ❖ Trina Solar Co. Ltd.  
Sept 2017 | 40 MWp | Anhui | Lianghuai
- ❖ CECEP Co. Ltd. (plus Ciel & Terre Intl. Co. Ltd.)  
Dec 2017 | 70 MWp | Anhui |
- ❖ Sungrow Co. Ltd.  
Dec 2017 | 150 MWp | Anhui | Huaian City
- ❖ Three Gorges Co. Ltd.  
2017/2018 | 150 MWp |

# China: 2017 – Floating Top-Runner

A pipeline of 4.5 GW?



## Aug 2017 – Top-Runner Ambitions

- ❖ Anhui | 1 GW
- ❖ Shanxi | Yangquan | 1 GW
- ❖ Inner Mongolia | Baotou | 1 GW
- ❖ Inner Mongolia | Wuhai | 500 MW
- ❖ Shandong | Jining | 500 MW
- ❖ Shandong | Xintai | 500 MW

It remains to be seen whether all or just some of these projects will indeed be „floating PV“

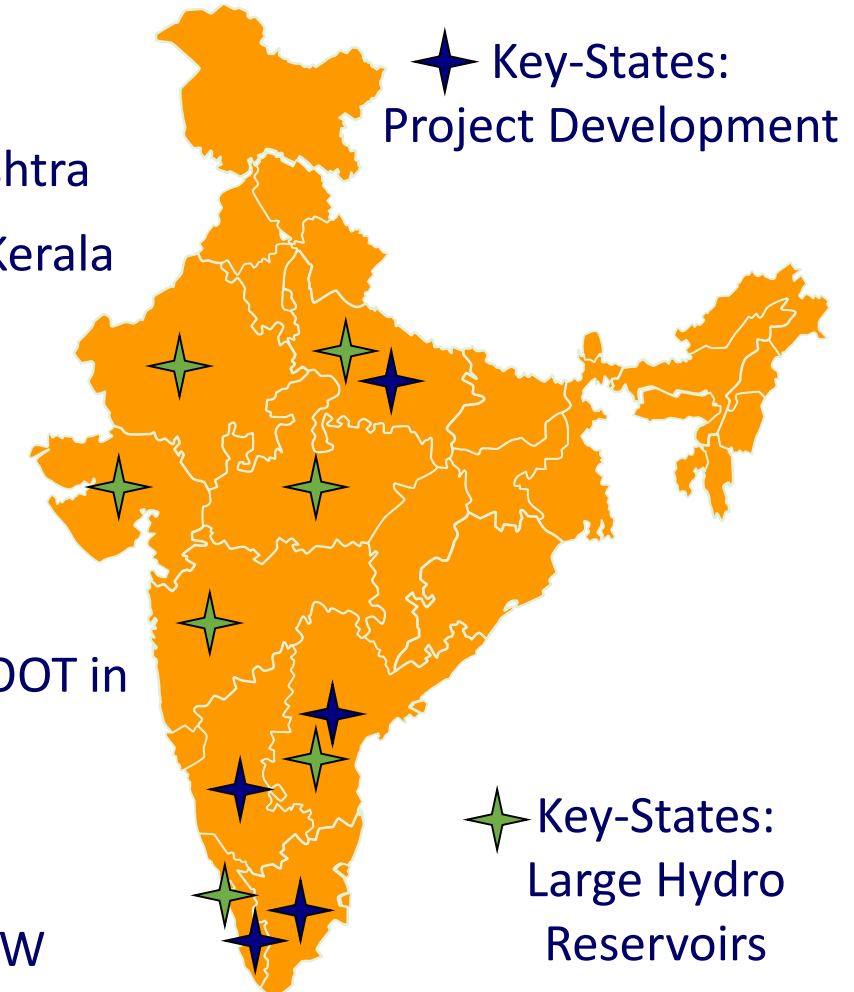
Given the June 1<sup>st</sup>, 2018 policy announcement it now remains to be seen how much will be indeed realized?

# India

## Massive Potential Yet to be Tapped – National Potential est. 310 GW

- ❖ First floating solar PV plant became operational in 2015
- ❖ 06/2016: Natl. Hydroelectric Power Corp. aims at 600 MW in Maharashtra
- ❖ 06/2017: MNRE / kfw to support financing 40 MW in Maharashtra & Kerala
- ❖ 09/2017: Andhra Pradesh (Greater Visakhapatnam Municipal Corp.) invited bids for 2 MWp
- ❖ **12/2017: SECI via a tender seeks EOI for in total 10 GW (2018-2020) based on a PPA model**
- ❖ 04/2018: SECI released a Request for Selection (RfS) for 3x50 MW / BOOT in Uttar Pradesh (UP) on a 25 year PPA basis
- ❖ **04/2018: Maharashtra requested EOI for 1 GW floating PV**

★ Conservative estimate of large hydro reservoir potential approx. 40 GW



# Indonesia

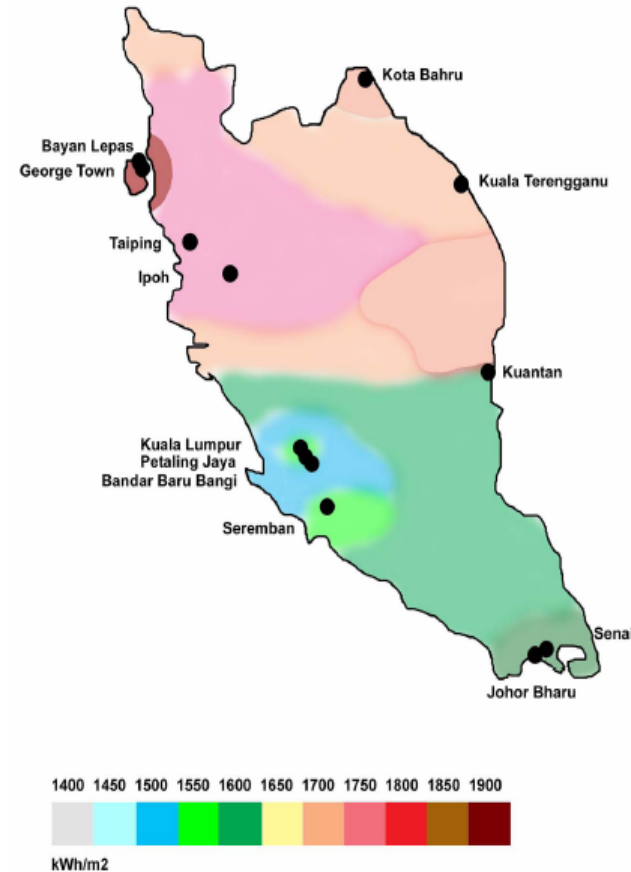
## 200 MW planned in West-Java by PLN and Masdar



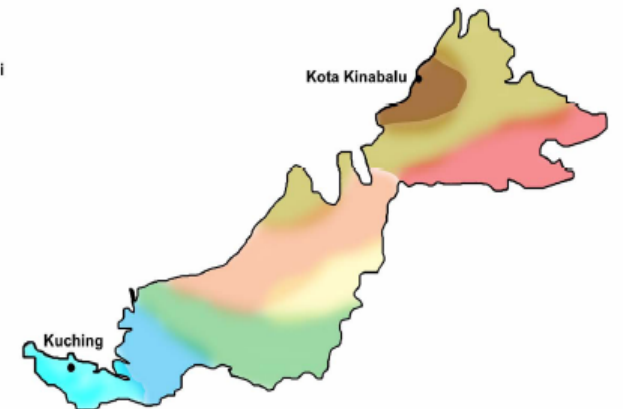
# Malaysia

Peninsular Malaysia could generate 8.4 TWh using 10% of water surface

- ❖ 2015 the “Ministry of Energy, Green Technology and Water, supported the first 100 kWp system which became operational later 2016
- ❖ 2016: SEDA set a mandatory installation target of 0,27 MW
- ❖ 2017: several small-scale projects executed
- ❖ 2017: Tender released for 49 MW
- ❖ 04/2018: Sarawak Chief Minister proposed to CN company Longi to develop floating projects across the state

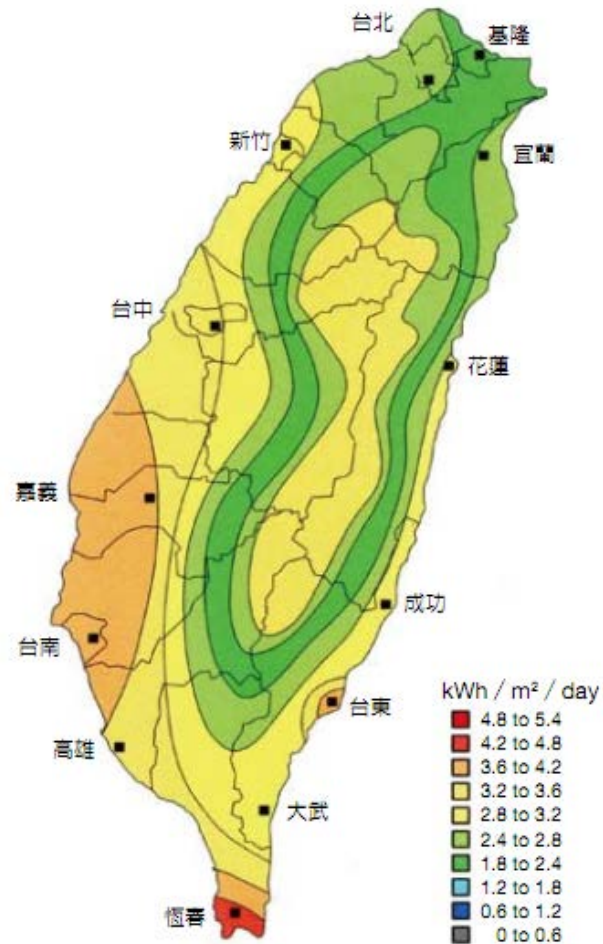


A total of 78 lakes suitable for floating PV have been identified in Peninsular Malaysia



# ROC – Legislative Framework

## Special FIT for Floating PV



Period	System Type	Capacity (kW)	2018 FIT (TWD/kWh)	2017 FIT (TWD/kWh)	Difference (%)
1H/2018	Rooftop	$\geq 1 \sim < 20$	5.3848	6.1033	-11.77
		$\geq 20 \sim < 100$	4.7906	4.9772	-3.75
		$\geq 100 \sim < 500$	4.4564	4.5388	-1.82
		$\geq 500$	4.3264	4.4098	-1.89
	Ground-mounted	$\geq 1$	4.3785	4.5467	-3.70
	<b>Floating</b>	<b><math>\geq 1</math></b>	<b>4.7723</b>	<b>4.9403</b>	<b>-3.40</b>
2H/2018	Rooftop	$\geq 1 \sim < 20$	5.2827	6.1033	-13.45
		$\geq 20 \sim < 100$	4.6885	4.9772	-5.80
		$\geq 100 \sim < 500$	4.3636	4.5388	-3.86
		$\geq 500$	4.2429	4.4098	-3.79
	Ground-mounted	$\geq 1$	4.2943	4.5467	-5.55
		<b>Floating</b>	<b><math>\geq 1</math></b>	<b>4.6901</b>	<b>4.9403</b>

❖ Nov 2017 New Green Power announced to build a 14 MW in Taoyuan

# Viet Nam

A late comer with big ambitions

**Yen Bai Province**  
500 MW (03/2017)  
Korea / Solkiss

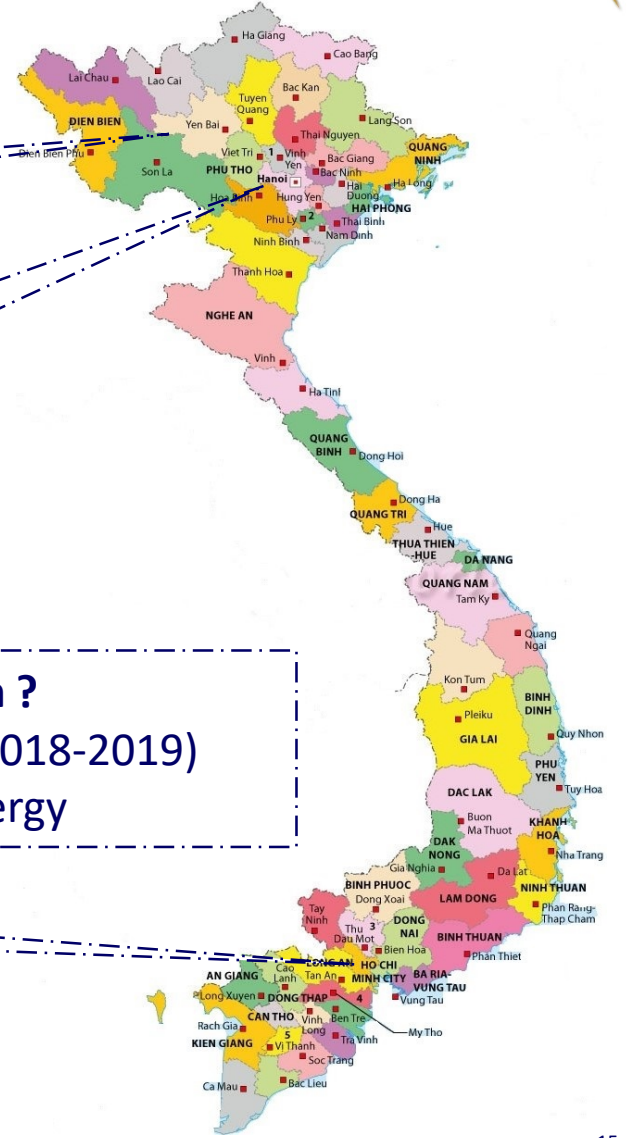
**Hanoi**  
126 MW (03/2017) Floating

**Status as of 06/2018**

- ❖ 3.5 GW planned
- ❖ 350 MW approved

**Ho Chi Minh City**  
1 GW (timeline ?)

**Location ?**  
2 x 40-50 MW (2018-2019)  
Vasari Energy



# Global Floating Industry Prospects



A thriving industry ... anticipated to generate USD 1 bln by 2022/2023





# Floating PV Technologies

Fixed, Single, Double-Axis Tracker, CPV, Off-Shore Technologies being depolyed

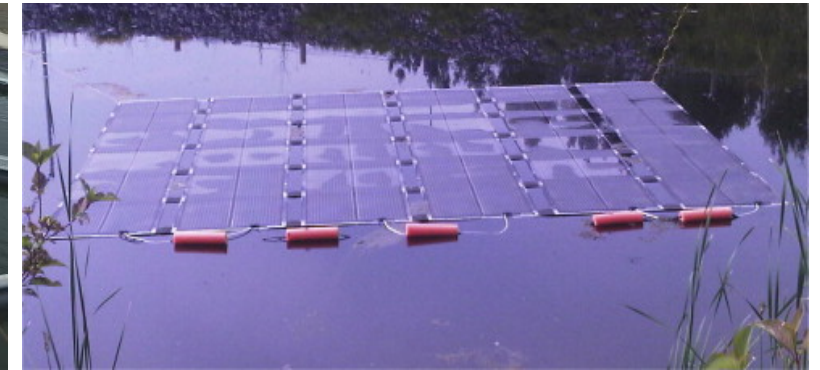
Pyron (US): Floating CPV



Infratech (AU)



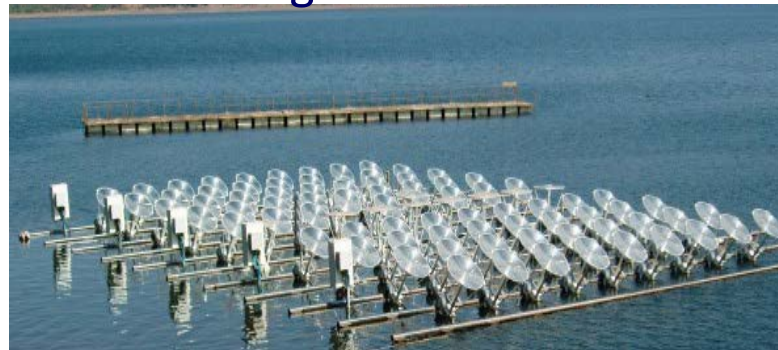
(US): Floating



Pisa (IT): Floating Tracking Cooling Concentrator



Sunengy (India): Floating Solar Collectors



Swimsol (A): Off-shore



# Local Deployment Creates New Jobs

Local Installation creates the bulk of new jobs



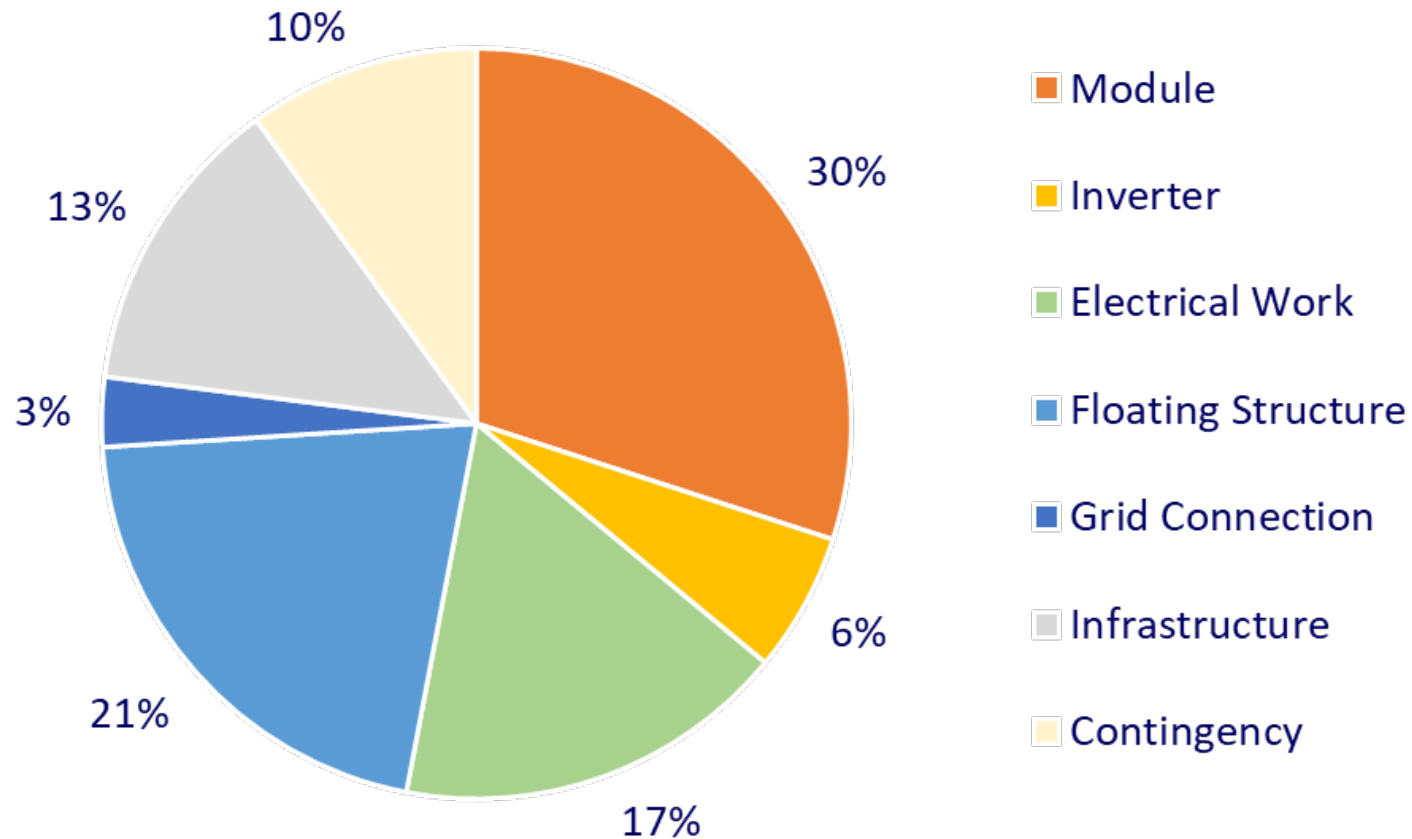
# Local Production Creates New Jobs

Intl. IP Providers favour a high degree of localized production



# Global Floating PV Market Forecast

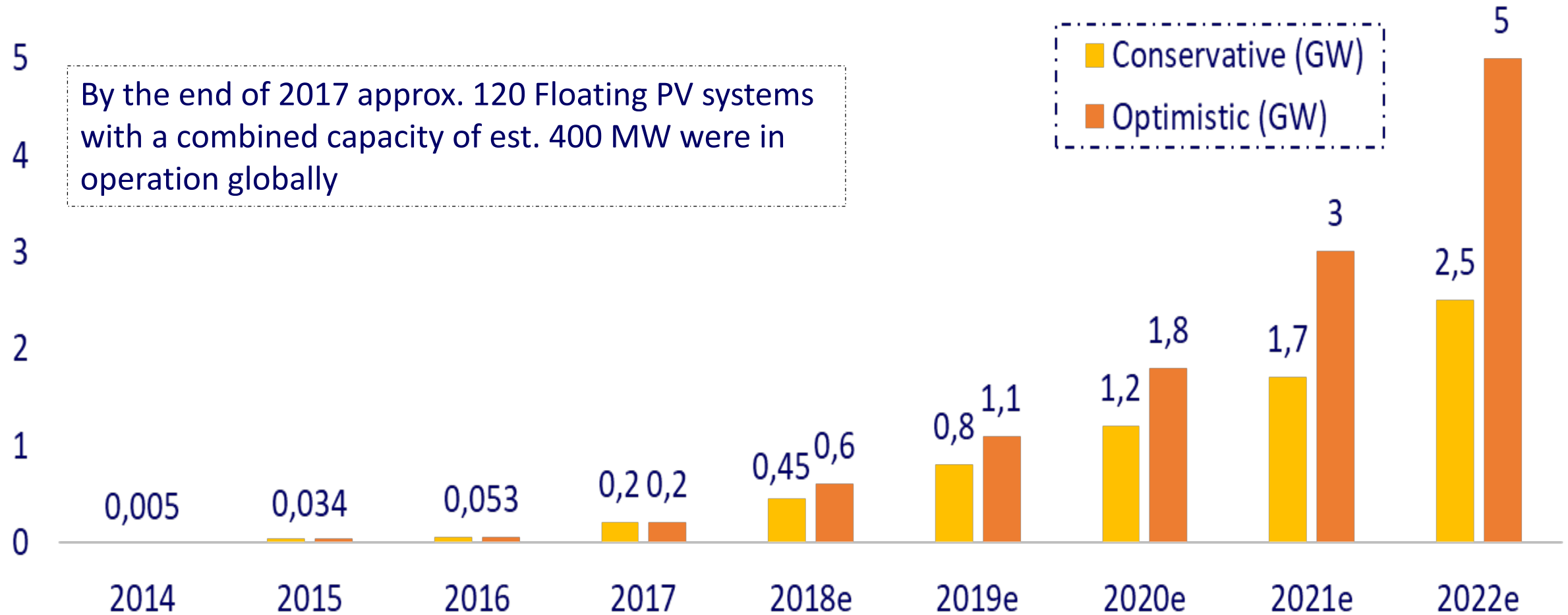
## System Cost Break-Down – Base Case – “A Reference”



- ❖ Price development: on average approx. 15-25% higher compared to ground-mounted systems
- ❖ Grid connection cost is highly project dependent
- ❖ Land use fees not applicable
- ❖ Cost for civil works/ground preparation are lower
- ❖ est. price reductions on average in the range from 5-8% / a

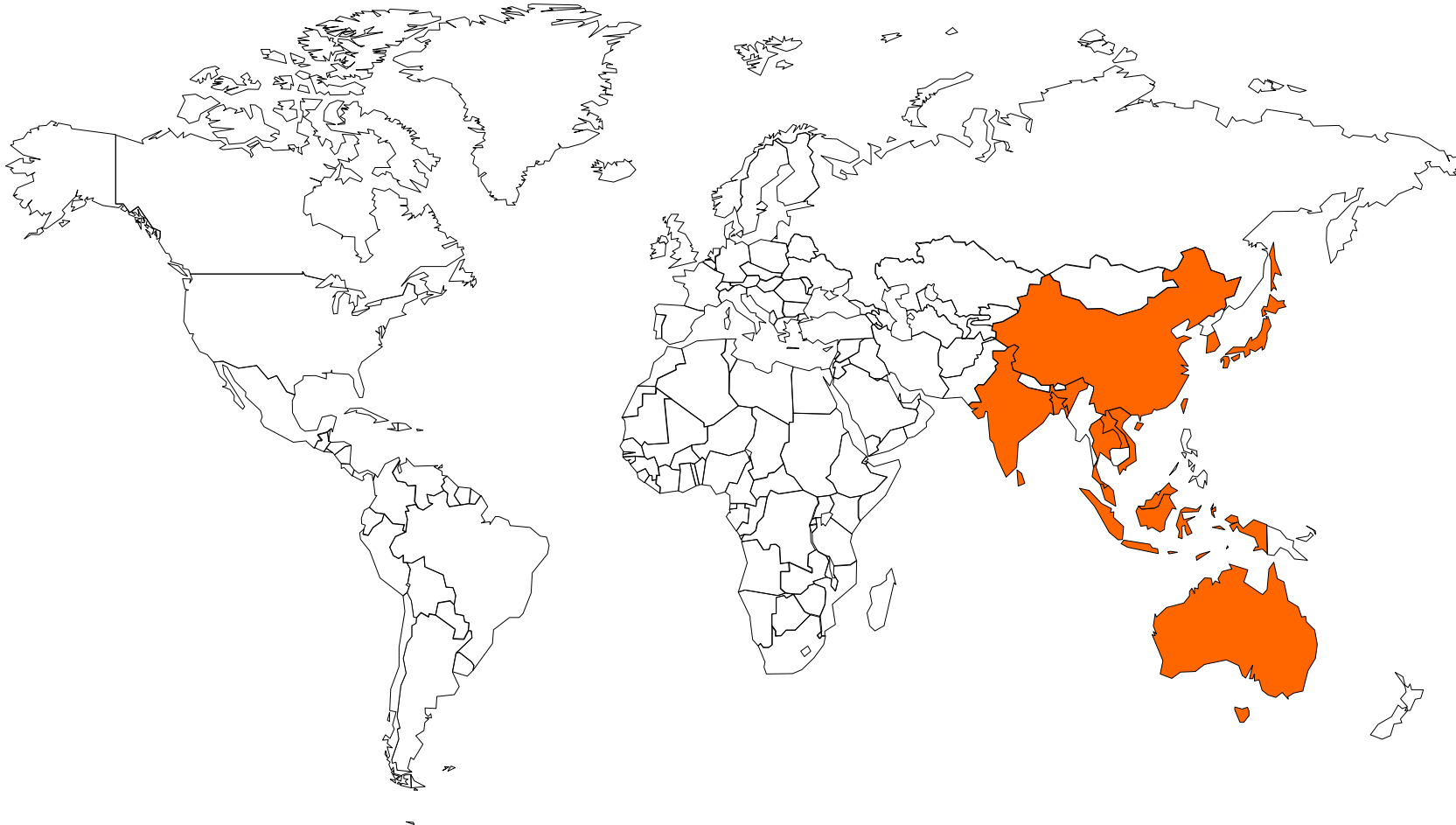
# Global Floating PV Market Forecast

Promising for both “On-Shore and Off-Shore” Floating PV



# Asia takes the lead

## Multiple countries actively pursuing the deployment of Floating PV



Bangladesh: 50 MW  
China: 2-3 GW  
India: 10 GW  
Indonesia: 200 MW  
Japan: XX MW  
Laos: 300 MW  
Malaysia: 49 MW  
Singapore: 2.5 MW  
South-Korea: 1 GW  
Sri Lanka: 100 MW  
Thailand: 65 MW  
Taiwan: 14 MW  
Viet Nam: 350 MW

# Floating PV + Hydropower

The best of two worlds ...

## Hydropower (Benefits)

- ❖ Flexible, quick-start, adjustable, etc.
- ❖ Predictable and reliable electrical output
- ❖ Clean and renewable

## Hydropower (Disadvantages)

- ❖ Heavy environmental impact
- ❖ High upfront cost
- ❖ Affected by droughts

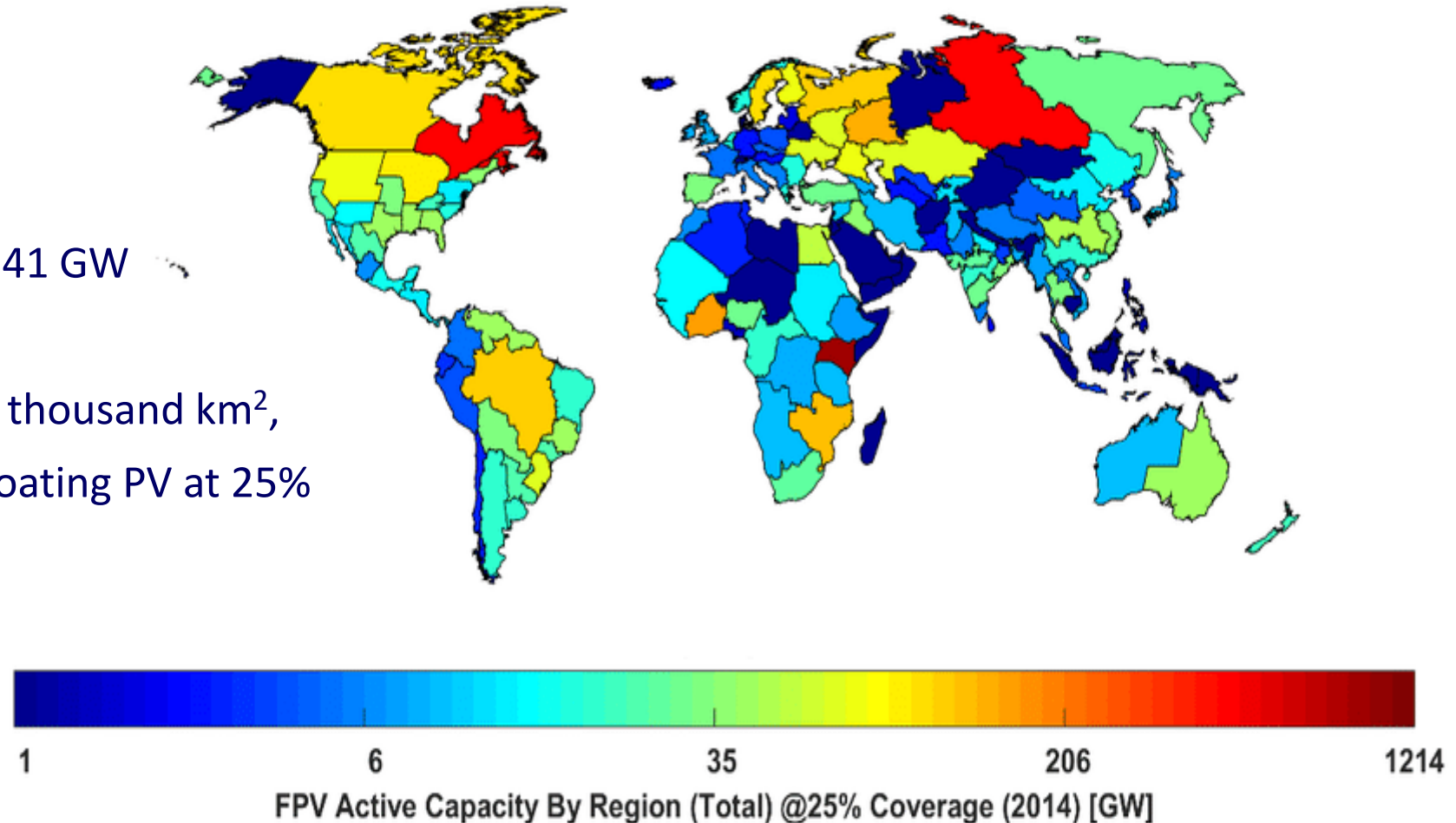
## The Best of two Worlds – Complementary Aspects

- ❖ Deployment of PV on existing reservoirs
- ❖ Existing electrical infrastructure and grid connection leading to overall **lower capex**
- ❖ Floating PV can compensate for the hydro energy deficiency in dry season
- ❖ Floating PV can support day-time peak load and more hydropower is reserved for evening peak
- ❖ **Dispatching of hydropower is more flexible** and the system peak-load regulation capacity increases

# Floating PV + Hydropower

## Massive Global Potential

- ❖ Globally, approx. 1170 GW of hydropower capacity installed
- ❖ 328 GW (hydro run-of-river); 842 GW (hydro reservoir) incl. 141 GW (hydro pumped storage)
- ❖ Reservoir surface approx. 265.7 thousand km<sup>2</sup>, **potential to host 4400 GW** of floating PV at 25% reservoir surface coverage
- ❖ PV power plants also could prevent approx. 74 billion m<sup>3</sup> of water evaporation annually





# Off-Shore Floating PV

The ultimate frontier ...

New consortium builds first offshore floating solar energy farm in the world Project 'Solar-at-Sea' starts

Feb 2018: 15 km off the coast of The Hague / The Netherlands



# Summary & Prospects

## Floating PV – the 3<sup>rd</sup> major market segment with GW potential annually

- ❖ To date, ground-mounted utility-scale projects across the world dominates the domestic markets
- ❖ **Global man-made reservoirs** with a 500,000 km<sup>2</sup> alone has the potential for TW of Floating PV installations
- ❖ Due to specific country characteristics, Japan and South-Korea were the early movers
- ❖ Today, **China is taking the lead** in deploying floating PV with potentially multiple GWs in the pipeline
- ❖ **India**, home to large water reservoirs, has equally bullish ambitions like China
- ❖ To date, a host of technologies and applications being developed and deployed
- ❖ Recently attraction shifted towards a **combination of floating PV with traditional hydropower**
- ❖ **Increasing number of legislative frameworks and project tenders are featuring floating PV**
- ❖ Until recently the focus was on lakes, man-made freshwater reservoirs ...
- ❖ ... **but the ultimate frontier is “ off-shore “ across the globe**

# Thank You!



[Frank.Haugwitz@aecea.com.de](mailto:Frank.Haugwitz@aecea.com.de)