



1. About Sumitomo Electric Industries

**2. Solution for Global Warming with CPV**

3. Activity of Sumitomo in Morocco

4. Application of Redox Flow (RF) Battery

# The Energy Sector's Impact on Climate Change

## Fossil Power Plants



- CO2 Emissions
- Serious impact on global warming

## PV Power Plants



- No CO2 emissions
- No affect on global warming  
(Amount of energy on the earth unchanged)

# Current Issues for Si based PV

## ① Low Efficiency

- Si based PV converts only about 10% to 15% of solar energy into electricity(Record lab efficiencies are around 25%).

## ② Degraded Power Generation at High Temperature

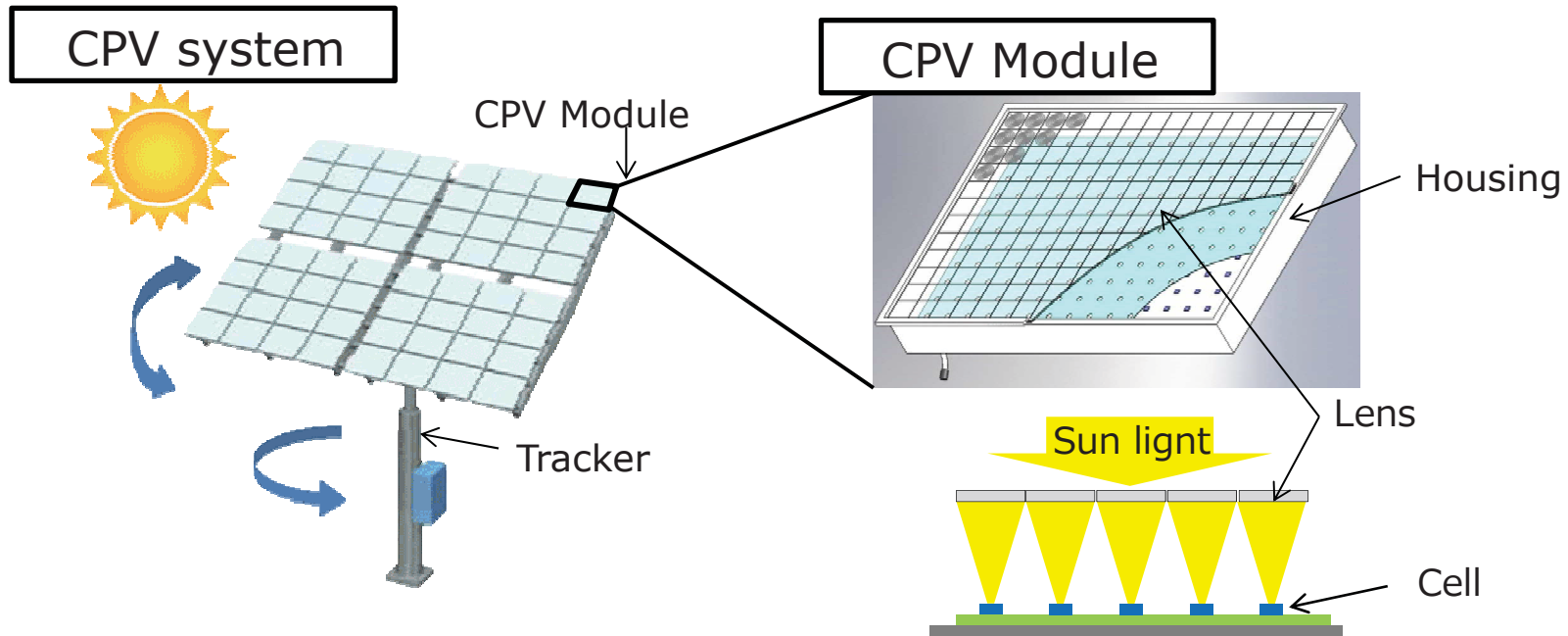
- Power generation drastically decreases at above 30°C

## ③ No power generation at night or on cloudy days

# CPV Dramatically Improves Power Generation Efficiency

- CPV technology generates approximately twice larger output per module area
- Power generation efficiencies with CPV technology are more than 30% (Record lab efficiency is 46%)
- Higher efficiency is expected with technological advances (Theoretical efficiency is more than 80%)
- Degradation at high temperature is negligible

# CPV Technology



CPV in Ouarzazate (2015-2016)

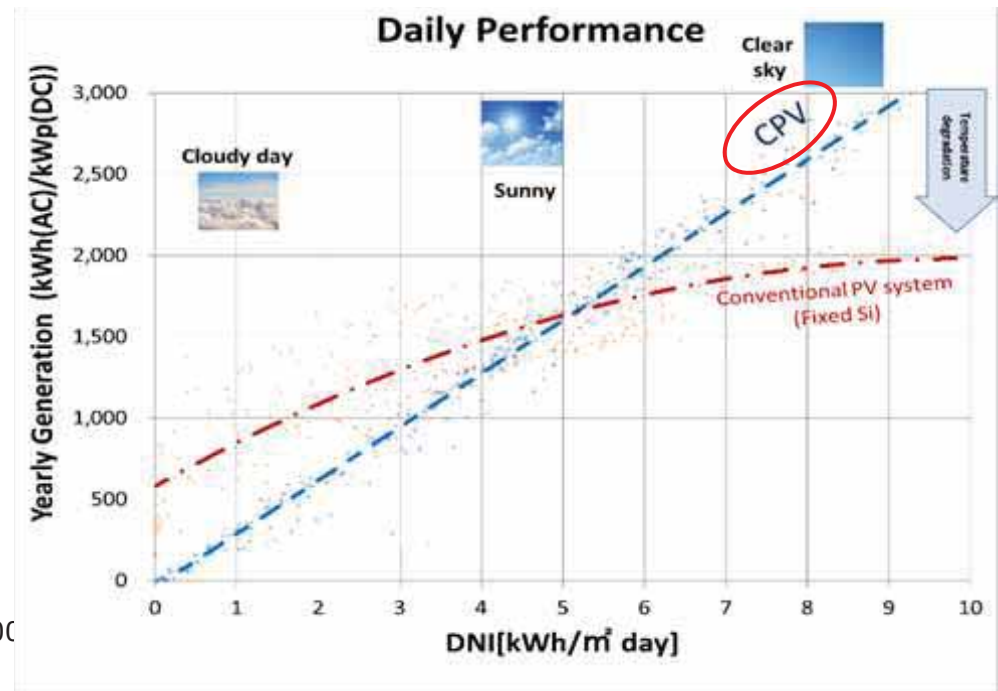
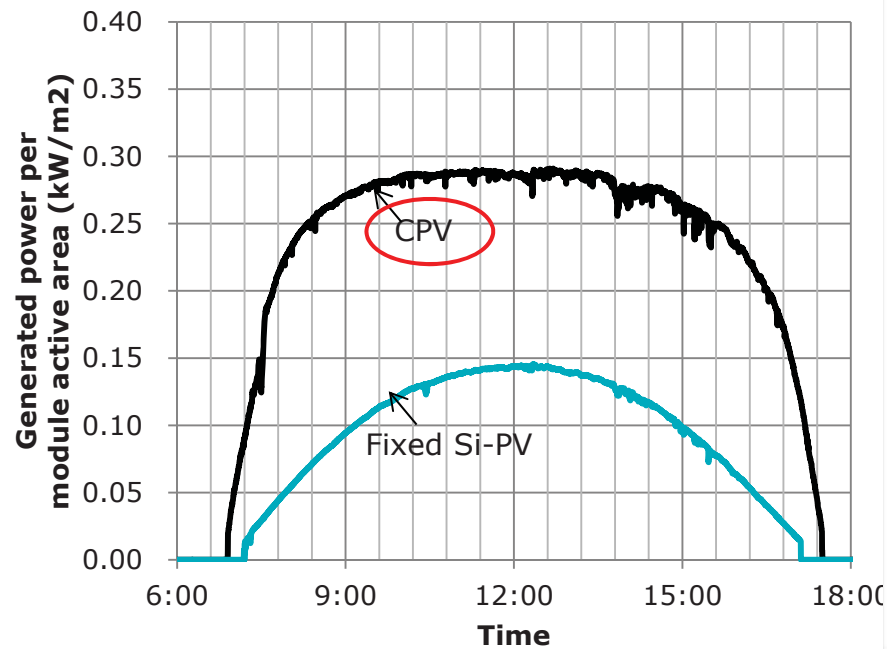
- High efficiency cell with compound semiconductor(GaAs based) applied - technology used in satellites
- Efficiency even improved by adopting 3 layers structure absorbing broad wave length
- Size of a cell is minimized by focusing sunlight by lenses and a tracker to reduce the cell cost

# CPV Doubles Electricity Generation

Double Electricity Generation than Conventional PV System

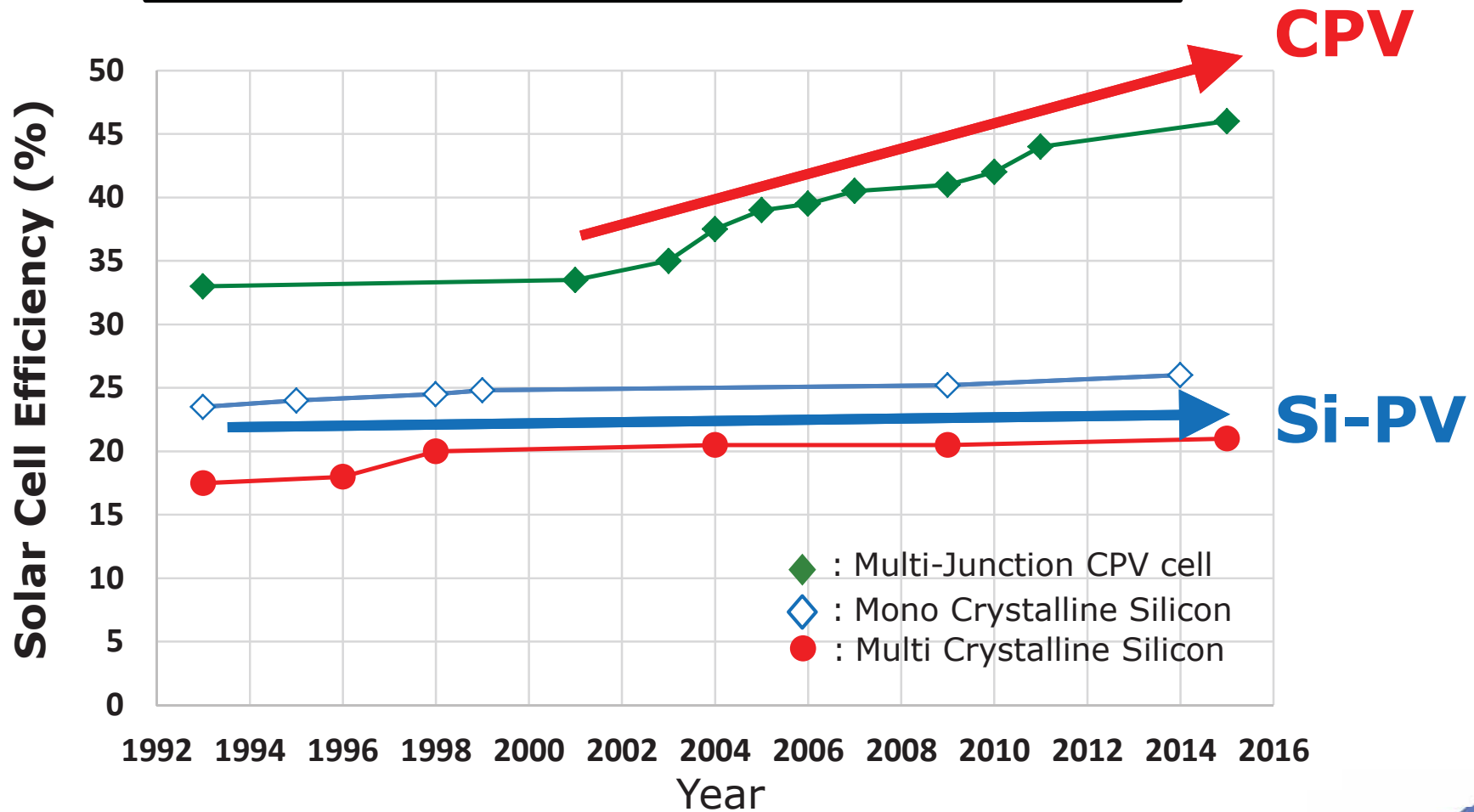
Higher Generation in High Irradiation Area

Collected in Ouarzazate, 2015

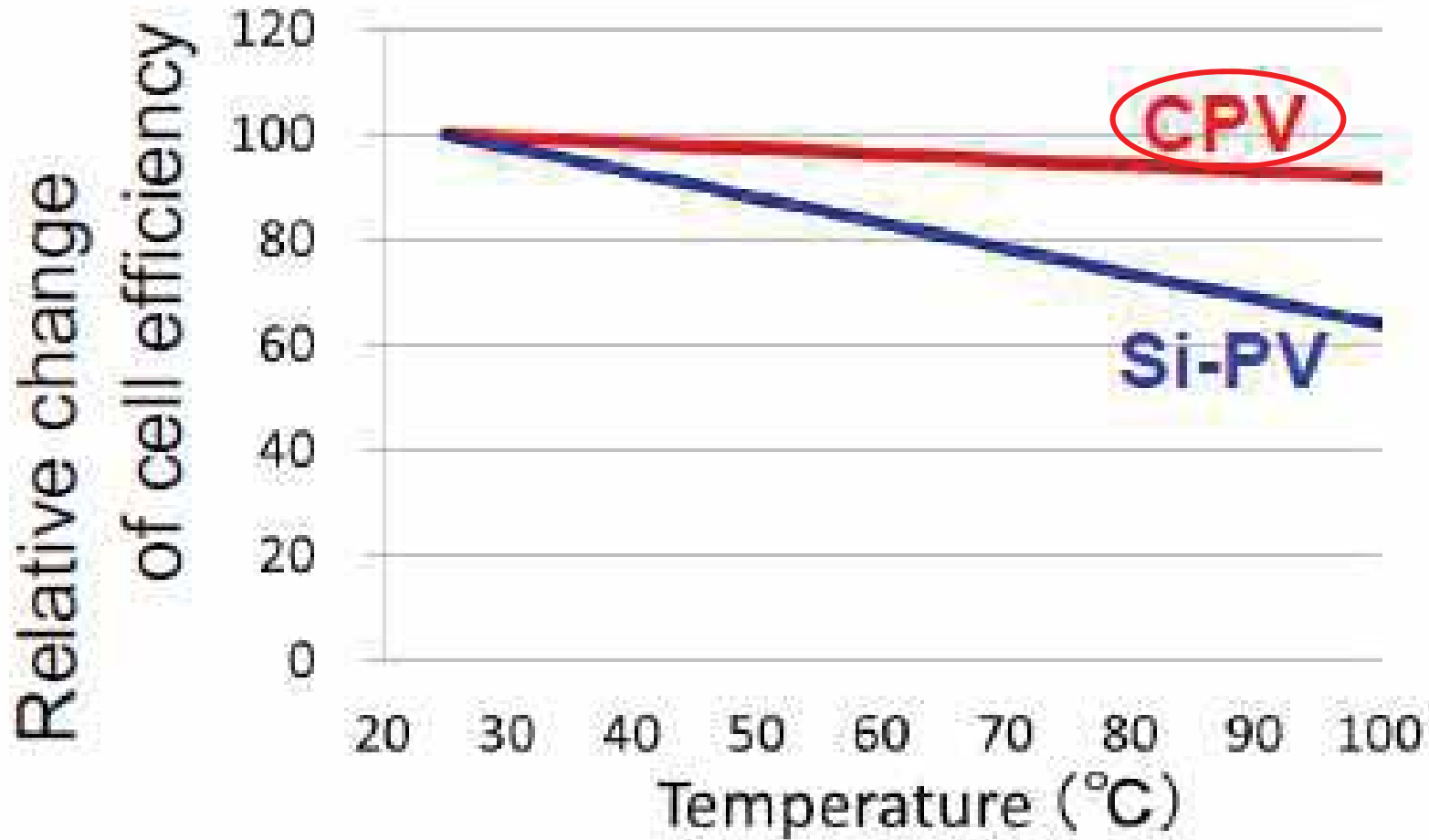


# Road Map for Efficiency

Top record for CPV is 46%  
More than 50% is expected in 2020



# Degradation at High Temperature







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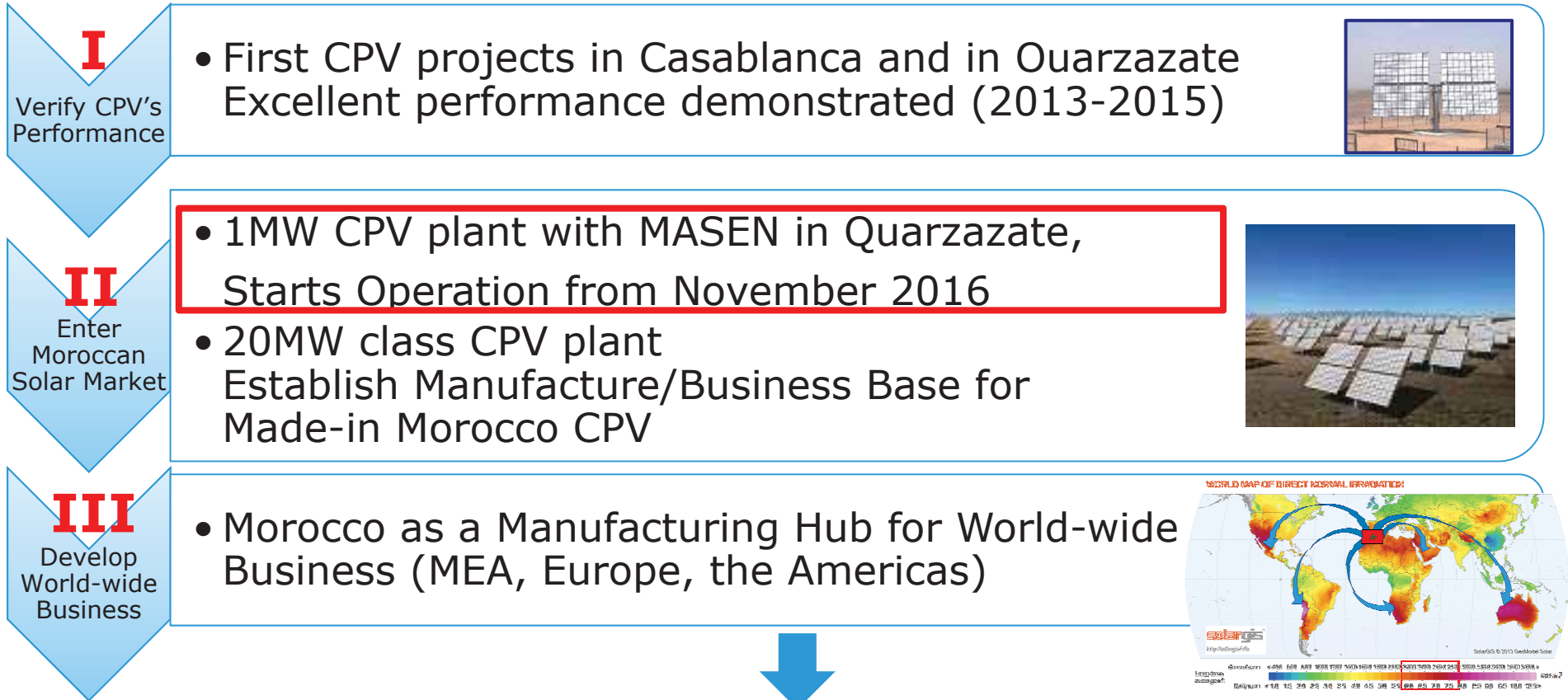
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# Sumitomo's CPV Project and Plan in Morocco

## For World-wide Business Development: Future Business Plan



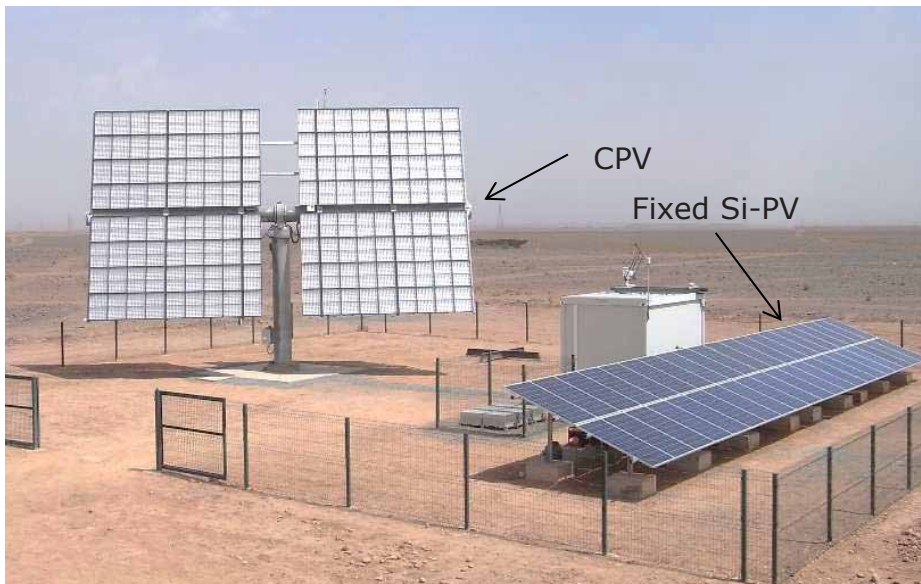
- Bring Investment and Employment Opportunities
- Strengthen Energy Security

I

# Sumitomo CPV in Morocco



CPV in Casablanca (2013)



CPV in Ouarzazate (2015-2016)

Collaborated with MASEN and JICA

## II 1 MW CPV Project in Ouarzazate

### Contract for the Project signed



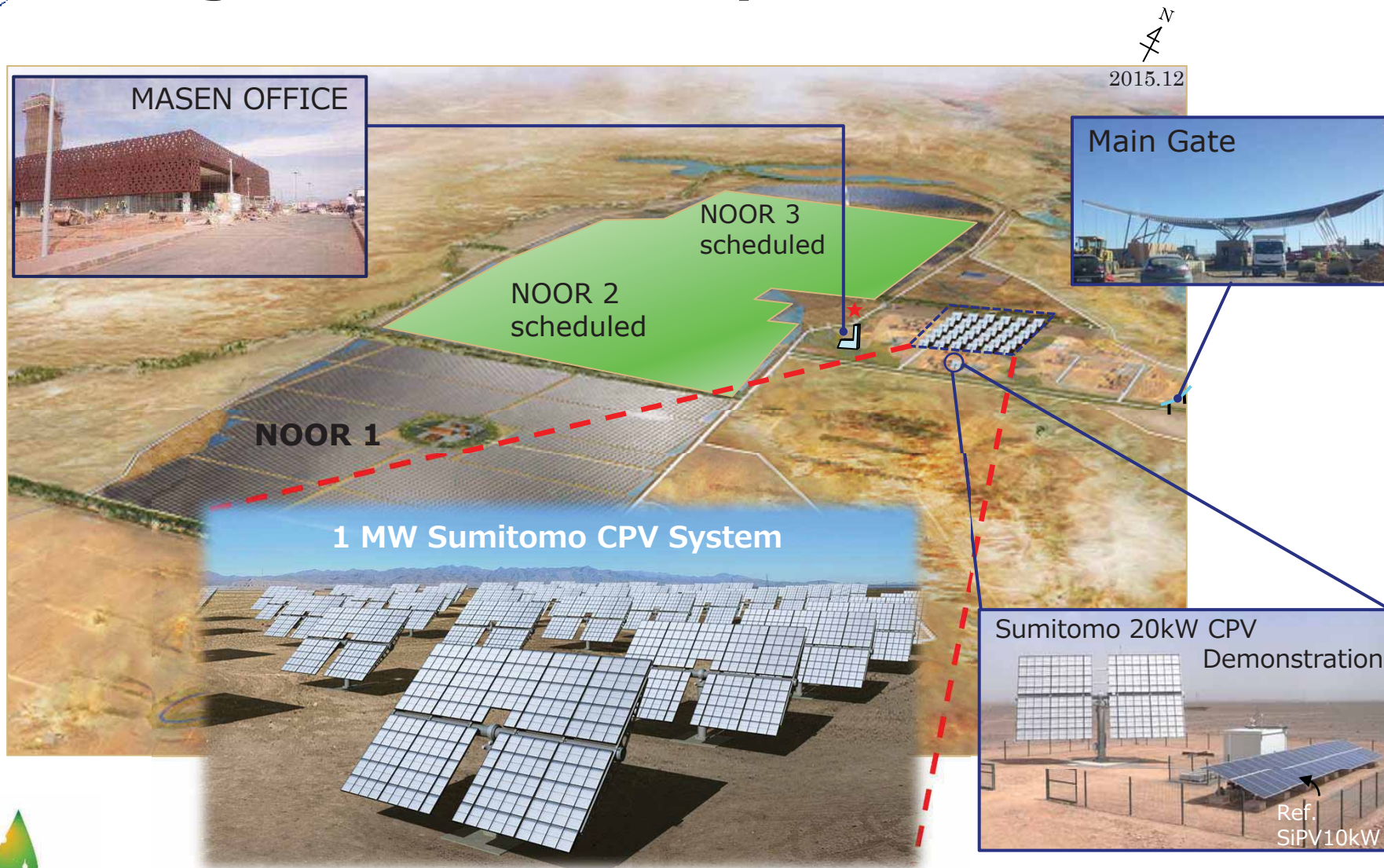
MASEN and Sumitomo agreed and signed on May 4, 2016, at the 4<sup>th</sup> Japan-Arab Economic Forum in Casablanca.

### Outline of the Project

- Install 1MW CPV in MASEN R&D site, collect the data on power generation, and evaluate the merits of CPV
- Collaborate local institute and local suppliers for future mass production in Morocco
  - MAScIR manufactured a part of cell packaging
  - Jet Energy manufactured trackers designed by Sumitomo, and achieved construction work
- Establish O&M method and procedure
- Look for larger scale CPV projects in Morocco



# Image of 1 MW CPV System in Ouarzazate



- Start operation just before COP 22 in Nov. 2016
- Application of RF battery is under discussion

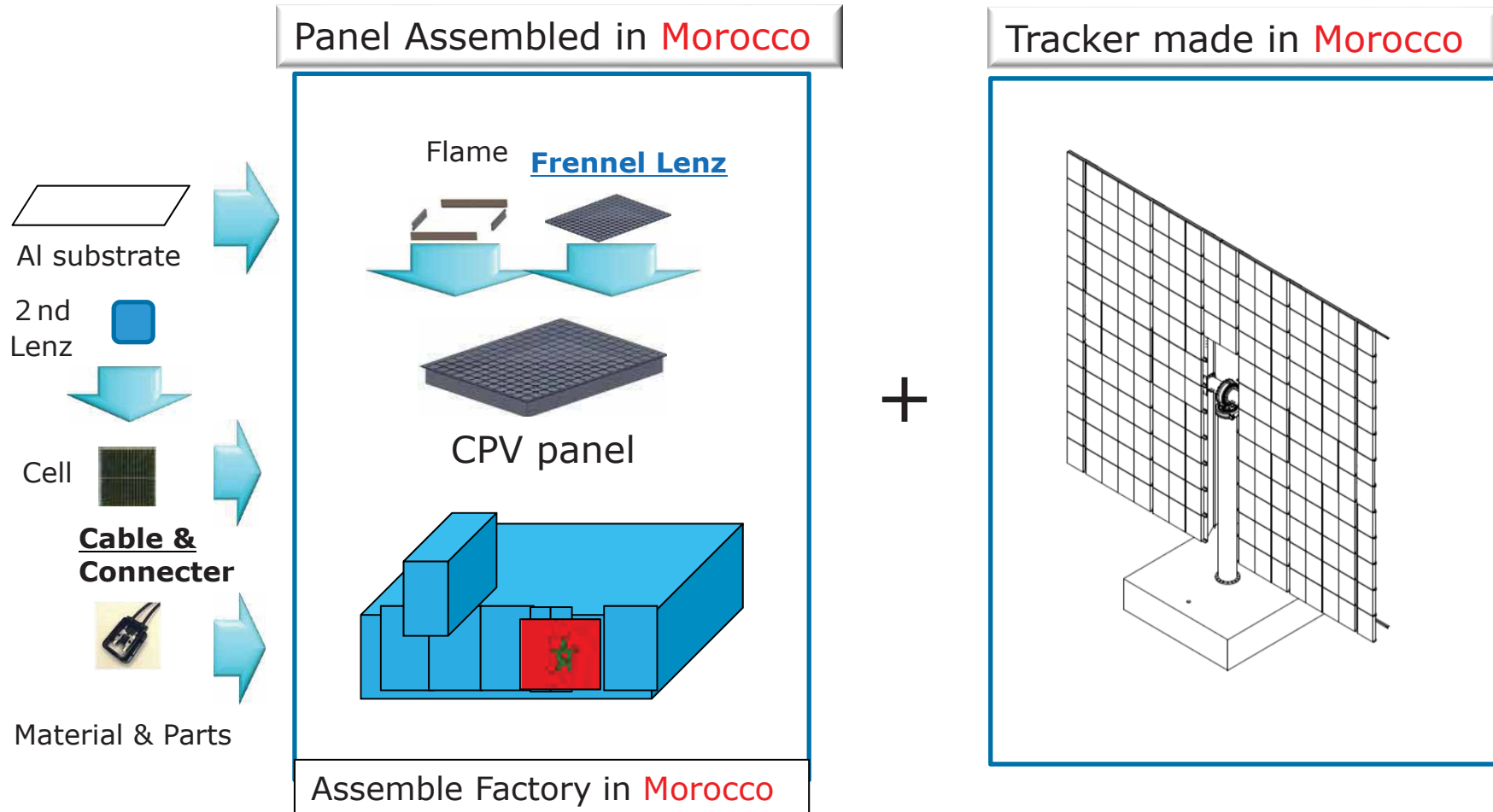
# 1 MW CPV System in Ouarzazate

“Panel surface upside down to reduce the dust and sand on the surface”



# III Sumitomo's CPV in Morocco: Near Future

## Morocco as a Manufacturing Hub for CPV Business



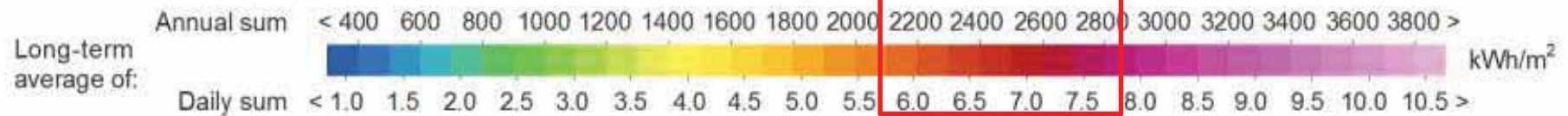
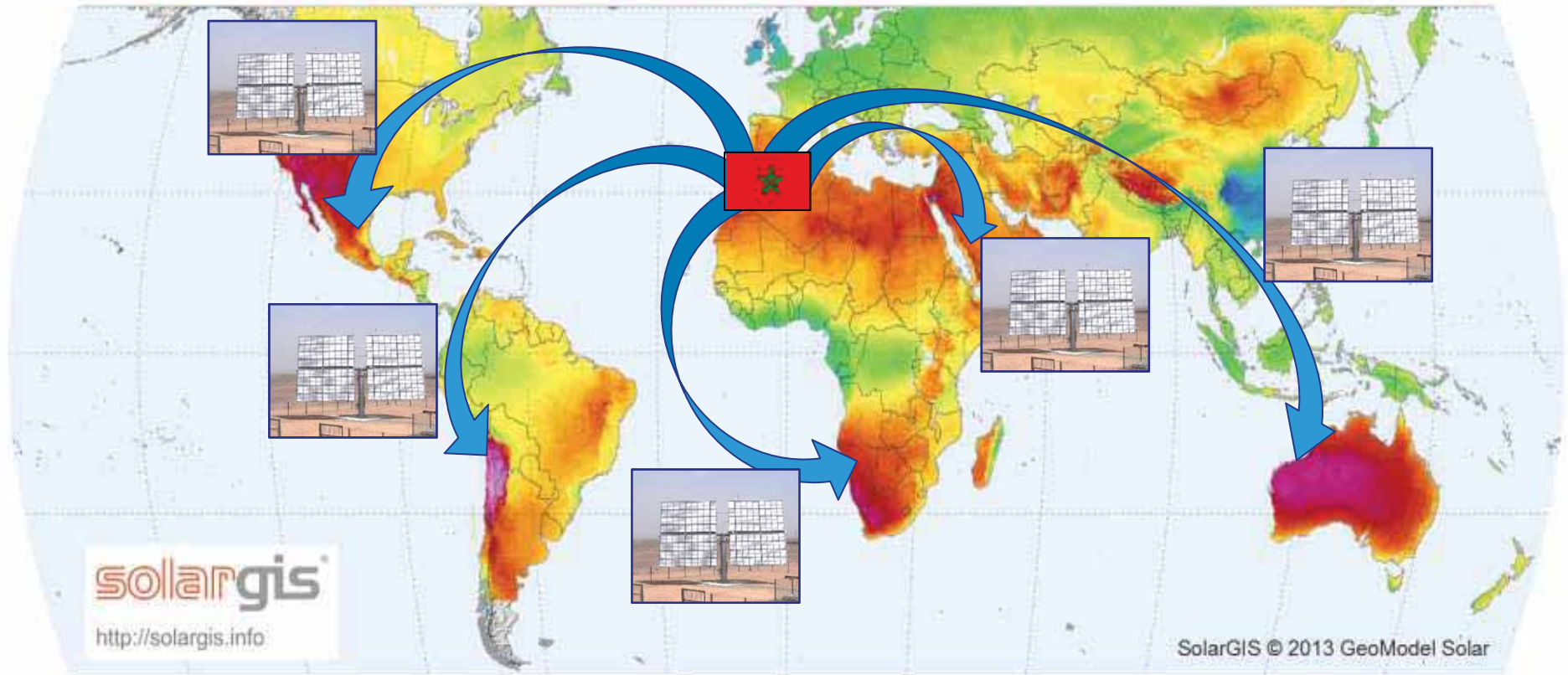


# Sumitomo's CPV in Morocco: Near Future

## Morocco as a Manufacturing Hub for CPV Business

WORLD MAP OF DIRECT NORMAL IRRADIATION

GeoModel  
SOLAR





# Sumitomo's Contribution

- Participate in Renewable Energy Generation
- Create CPV Industry in Morocco
- Create Investment and Employment Opportunities
- Educate for Human Resources

King Mohammed VI stated at COP21 in December 2015

"Objective of securing 42% of the country's energy mix from renewable sources by 2020 has recently been increased to 52% by 2030."



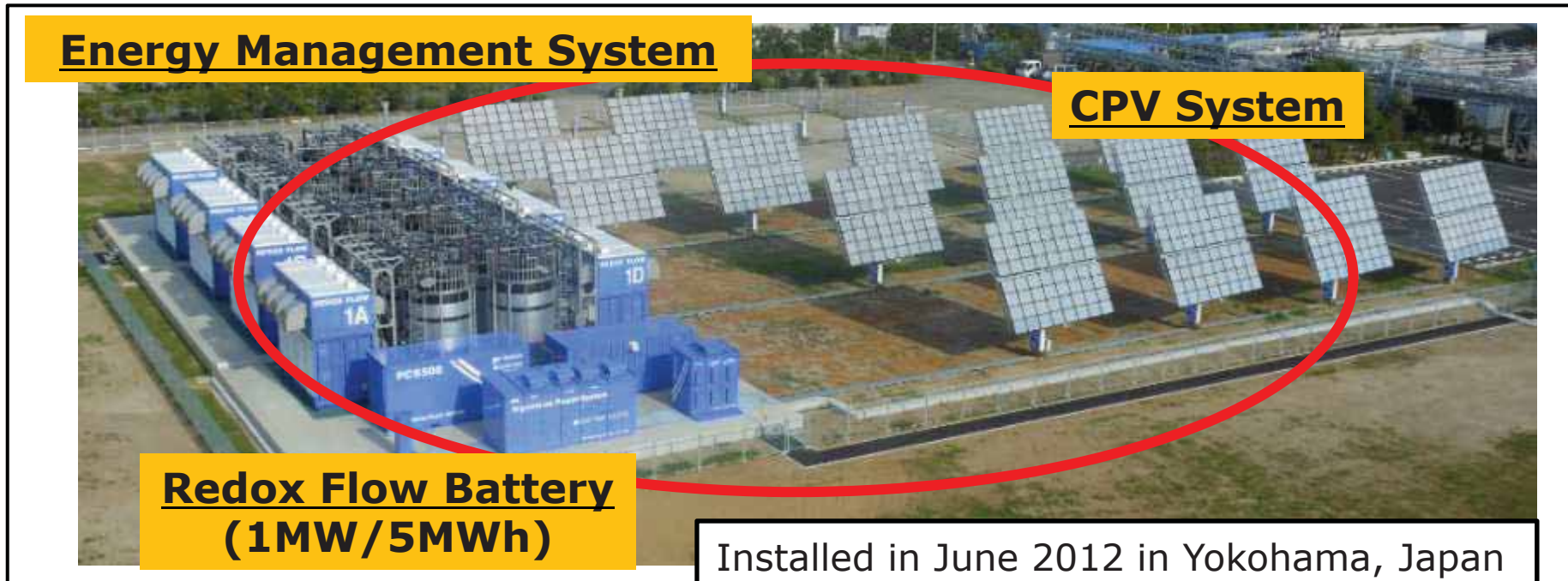
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# CPV and Battery



- Charging battery day time, discharging at night or on cloudy days
- Stabilize fluctuation of utility grid voltage and frequency by charging/discharging battery
- **RF Battery** (Redox Flow) is best suited for the purpose

# Features of RF Battery

## 1. Long Life

- **Unlimited Charge/Discharge cycle life**
- Electrolyte is reusable after decommissioning

## 2. Safety

- **Non-flammable Electrolyte**
- Flame Retardant Materials
- Accurate and Reliable SOC Management

## 3. Multi-Purpose

- **Fast Response & Long duration Applications**
- **Hybrid Uses for more Flexibility and Revenue**

## 4. Easy Operation

- **Accurate and Real-time SOC Acquisition**
- **No Operational Constraint on cycle life**
- Operational DOD : 0~100%

## 5. Design Flexibility

- Separation of Power (MW) and Energy (MWh)
- Easy to build long-duration and large-scale systems

# Large Scale RF Battery in Japan



- Funded by Japanese government
- **Size: 15 MW, 60 MWh**
- Location: Substation of Hokkaido Electric
- Application: Multi-purpose
  - Local & Central Control of BESS Dispatch
  - Frequency control
  - Renewable generation mitigation, etc
- On-line: Dec., 2015

