

# Presentation of MASEN R&D

Hicham Bouzekri, Ph.D.

Director of R&D and Industrial Integration



**ESMAP Workshop**

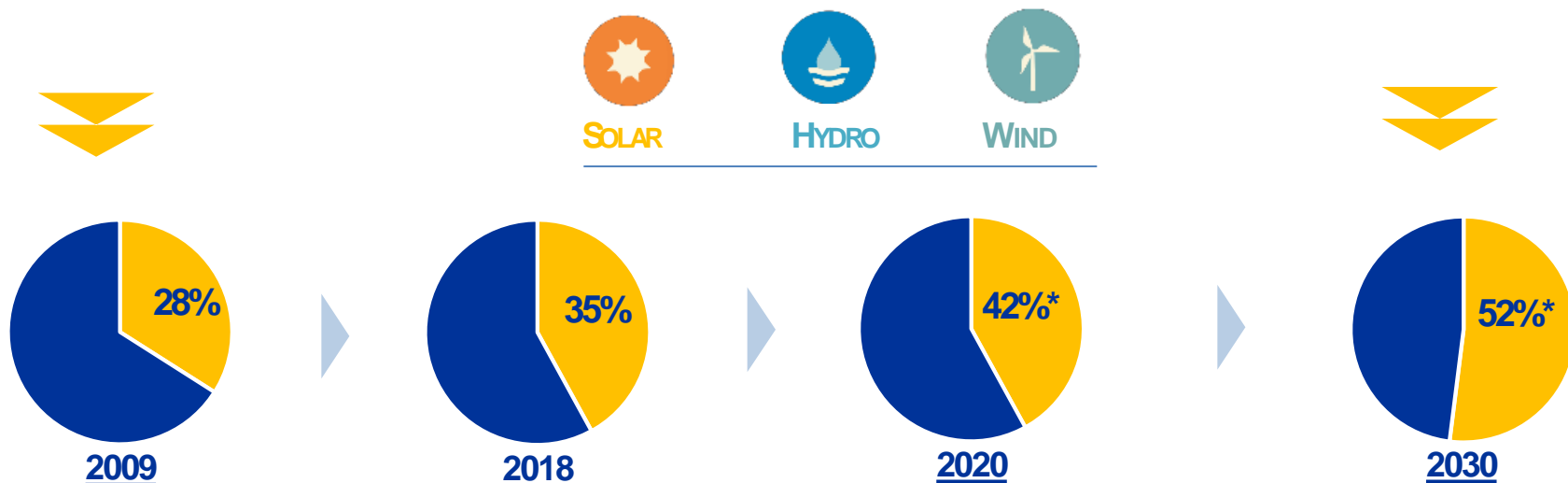
January 2020





# AN AMBITIOUS ENERGY STRATEGY WITH CLEAR OBJECTIVES

AMBITIOUS OBJECTIVES SET TO ENSURE THE ENERGY SECURITY OF THE COUNTRY, DIVERSIFY THE SOURCES OF ENERGY AND PRESERVE THE ENVIRONMENT



## ENGAGED ACTORS TO ACHIEVE NATIONAL ENERGY TARGETS

PRIVATE ACTORS

Law 13-09

Key partner to develop REN projects

المكتب الوطني للكهرباء و الماء الصالح للشرب  
Office National de l'Electricité et de l'Eau Potable



Law 57-09 / Law 37-16

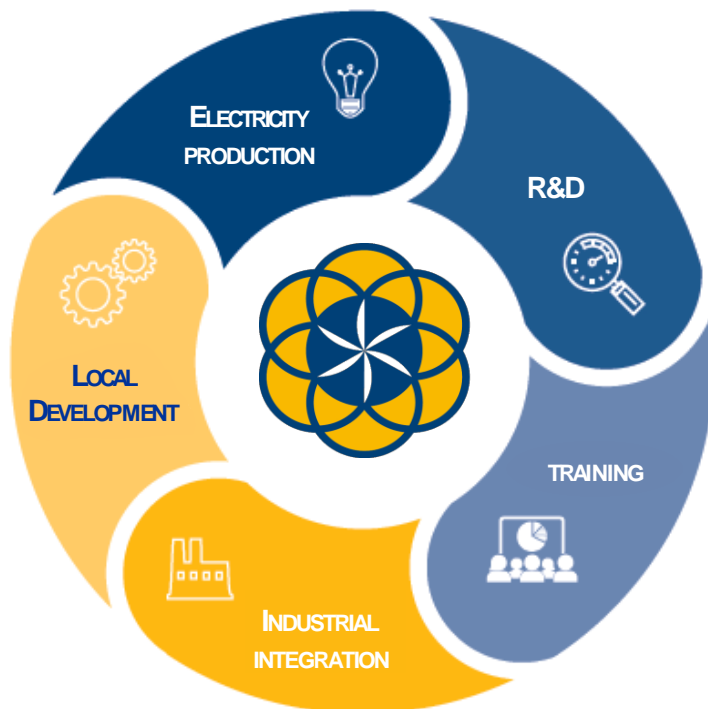




# MASEN: CONTRIBUTION TO THE DEVELOPMENT OF AN INTEGRATED REN ECOSYSTEM

5

A UNIQUE MODEL RELYING ON AN INTEGRATED VISION OF REN PROJECTS DEVELOPMENT



## SEVERAL ACTIONS FOR AN INTEGRATED DEVELOPMENT

### Solar Cluster

- 80 members and 300 companies connected
- Several projects incubated and financed

CLUSTER SOLAIRE



### R&D

- Several partnerships
- European projects of R&D collaboration
- 1 demonstrator in operation, 1 demonstrator in construction and many others under study



HORIZON 2020

Sumitomo



### Local development

- 5 sectors of intervention and 4 territories
- More than 150 actions led since 2010
- More than 77 000 beneficiaries



...for the development of an integrated RENecosystem



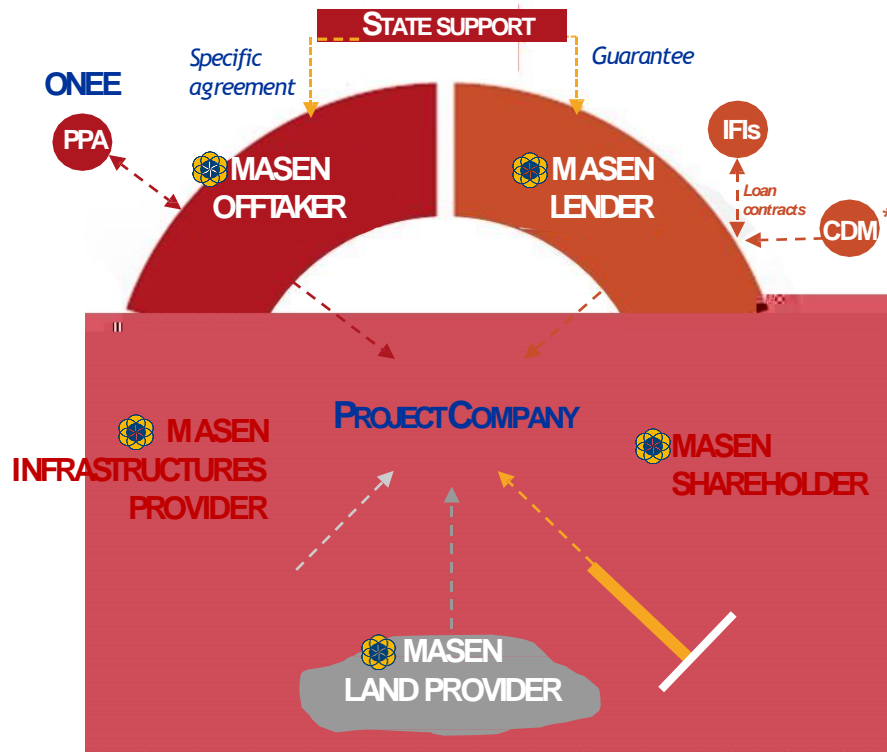


# MASEN: AN INNOVATIVE INSTITUTIONAL SCHEME

4

A UNIQUE MODEL RELYING ON AN INNOVATIVE INSTITUTIONAL SCHEME

## INNOVATIVE INSTITUTIONAL SCHEME



## MOBILIZATION OF CONCESSIONAL FINANCING



... designed to optimize the risk allocation

An outstanding mobilization of financing

\* CDM: Clean Development Mechanism



# NOOR OUARZAZATE COMPLEX, 580MW MULTITECHNO SOLAR PLANT

**NOOR<sub>0</sub> III**

**150 MW**

*CSP Tower*



**NOOR<sub>0</sub> II**

**200 MW**

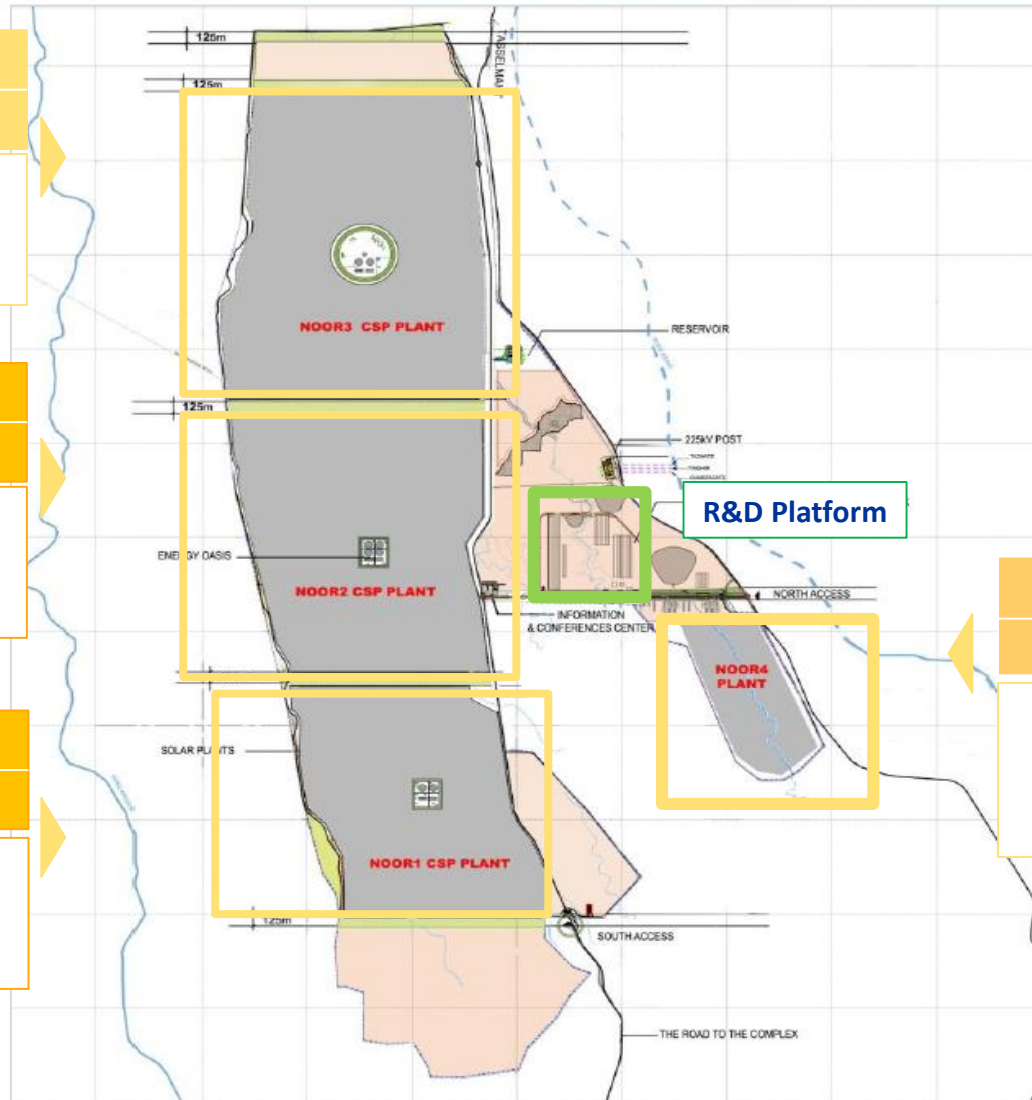
*CSP Parabolic trough*



**NOOR<sub>0</sub> I**

**160 MW**

*CSP Parabolic trough*



**NOOR<sub>0</sub> IV**

**~ 70 MW**

*PV*





# ALMOST 4 000 MW OF RENEWABLES IN OPERATION OVER A TOTAL INSTALLED CAPACITY OF 8 200 MW

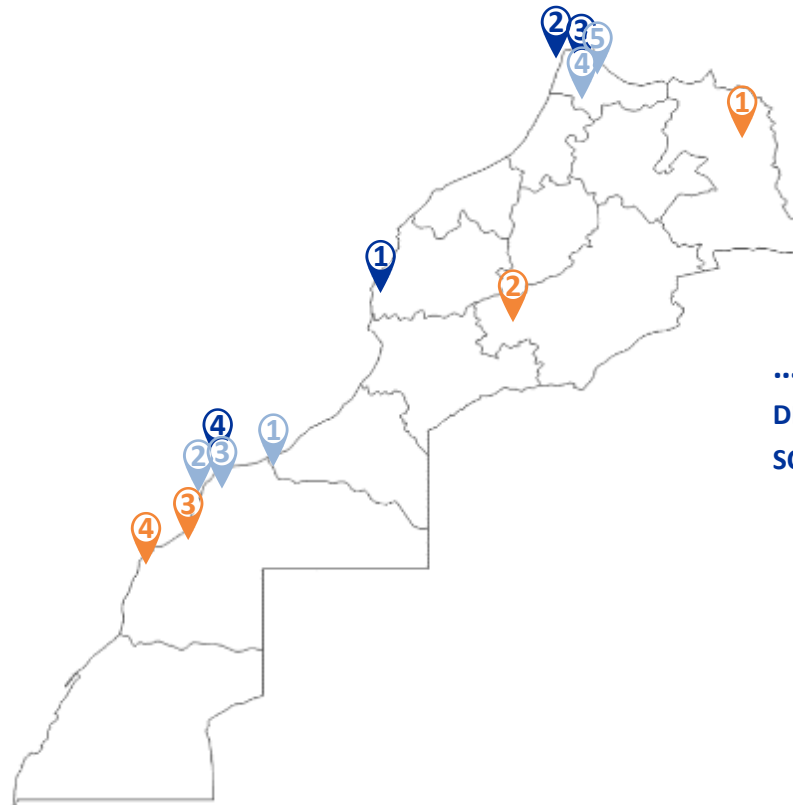
## SOLAR PROJECTS – 700 MW

AIN BENI MATHAR – 20 MW	①
NOOR OUARZAZATE I – 160 MW	②
NOOR OUARZAZATE II – 200 MW	②
NOOR OUARZAZATE III – 150 MW	②
NOOR OUARZAZATE IV – 70 MW	②
NOOR LAAYOUNE – 80 MW	③
NOOR BOUJDOUR – 20 MW	④



## HYDRO PROJECTS – 1 770 MW

MORE THAN 29 HYDRO-ELECTRIC DAMS  
ACROSS THE COUNTRY AND 1 STEP



## WIND PROJECTS – 1200 MW

①	AMOUGDOUL – 60 MW
②	TANGER I – 140 MW
③	TORRES / KOUDIA AL BAIDA – 50 MW
④	TARFAYA – 300 MW

...OF WHICH AROUND 620 MW  
DEVELOPPED UNDER THE LAW 13-09  
SCHEME

①	AKHFENIR 1 & 2 200 MW	④	HAOUMA 50 MW
②	FOUM AL OUED 50 MW	⑤	LAFARGE 32 MW
③	CIMAR 5 MW		





# FUTURE REN PROJECTS : OTHER PROJECTS PLANNED



## SOLAR PROJECTS



700 MW OF SOLAR PROJECTS IN OPERATION



## WIND PROJECTS



1 200 MW OF WIND PROJECTS IN OPERATION



## HYDRO PROJECTS



1 770 MW OF HYDRO PROJECTS IN OPERATION  
MORE THAN 29 DAMS IN OPERATION AND 1 STEP



**NOOR ARGANA**  
**200 MW**



**NOOR ATLAS**  
**200 MW**



**NOOR PV II**  
**800 TO 1 000 MW**



**NOOR MIDELT II**  
**800 MW**



**WIND PROJECT -**  
**INTEGRATED PROJECT**  
**OF 850 MW**



**WIND PROJECT – TAZA**  
**150 MW**



**KOUDIA AL BAIDA**  
**REPOWERING –**  
**120 MW**

**DETAILED PROGRAMING ONGOING TO**  
**TAKE INTO ACCOUNT THE POSSIBLE**  
**SYNERGIES BETWEEN REN**  
**TECHNOLOGIES**



**+ 3000 MW by 2020**  
**+ 6000 MW by 2030**

NB: private projects developed under the Law 13-09 included

2018

2030





**Focus on R&D**



**masec**

endless power for progress



# MASEN R&D ECOSYSTEM POSITIONNING

1

*MASEN has an end-to-end holistic value chain approach to developing renewable energies in Morocco*

2

*As part of this complete approach, MASEN R&D offers an accelerated path for industrialization of applied Renewable Energy R&D*

3

*MASEN R&D adopts a market pull approach where market opportunities are the driver for innovation effort in complement to a university-push approach where research teams proposals are the driver*

4

*MASEN R&D efforts help industrialize lab demonstrators (TR 4) by funding at scale demonstration systems in operational environments (TRL 7)*

5

*The overlap secures a continuum of support for market competitive renewable energy innovations*





## Technology Readiness Levels

- TRL 0: Idea.** Unproven concept, no testing has been performed.
- TRL 1: Basic research.** Principles postulated and observed but no experimental proof available.
- TRL 2: Technology formulation.** Concept and application have been formulated.
- TRL 3: Applied research.** First laboratory tests completed; proof of concept.
- TRL 4: Small scale prototype** built in a laboratory environment ("ugly" prototype).
- TRL 5: Large scale prototype** tested in intended environment.
- TRL 6: Prototype system** tested in intended environment close to expected performance.
- TRL 7: Demonstration system** operating in operational environment at pre-commercial scale.
- TRL 8: First of a kind commercial system.** Manufacturing issues solved.
- TRL 9: Full commercial application,** technology available for consumers.

Current CFP

MASEN R&D



## A DEDICATED R&D PLATFORM IN OUARZAZATE

As a part of MASEN's holistic approach to renewable energy development, MASEN R&D is a dedicated R&D platform for:

Qualification of innovative renewable energy technologies

Animation of a collaborative ecosystem of industrial and academic actors



**THIS R&D  
PLATFORM HOSTS**

**At-scale demonstration pilots that test component and system reliability in real operating conditions**

**Collaborative projects that enable research-industry tech transfer**

**Commercial services offers for national and international universities, research centers, multinational and start-ups developing innovative renewable energy solutions**

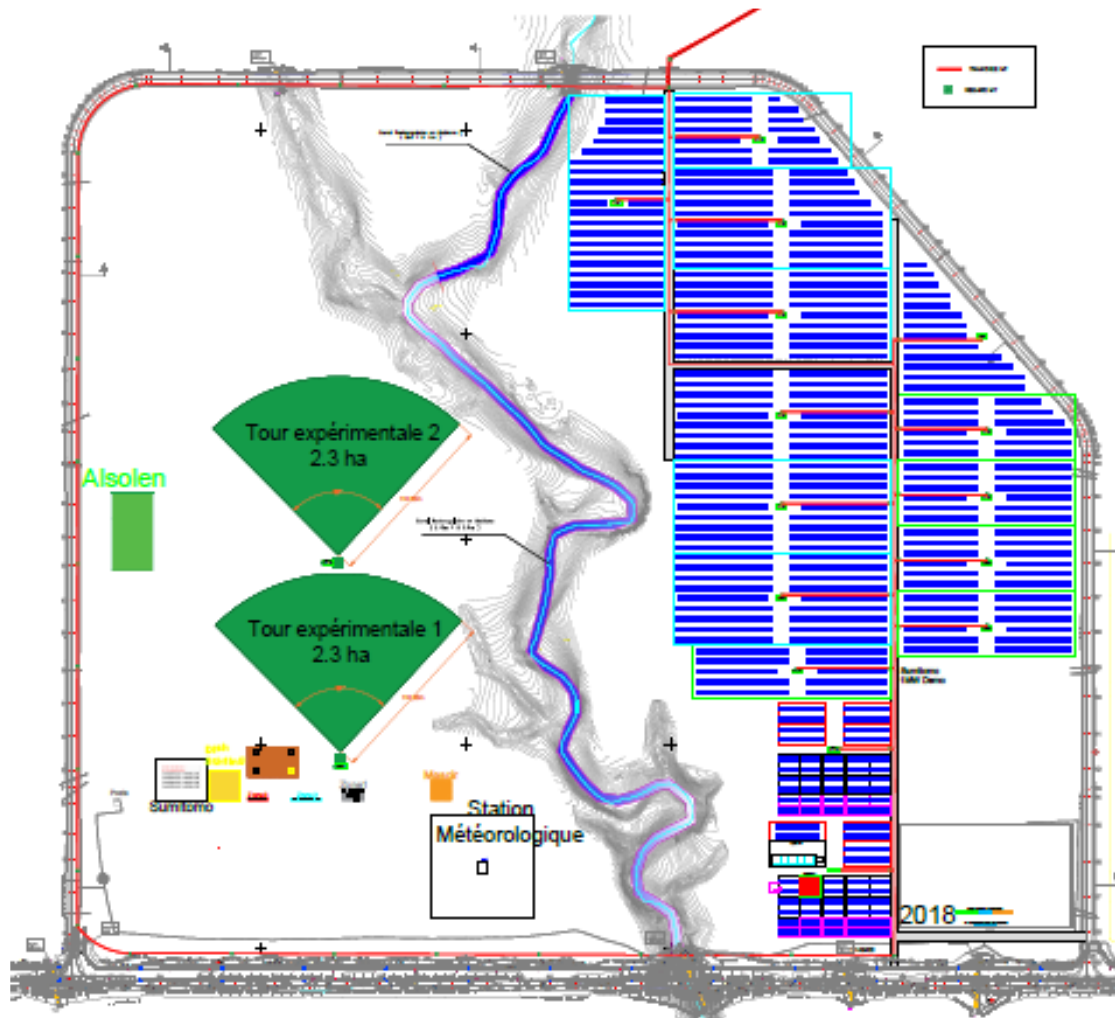


## DIFFERENTIATING ELEMENTS of MASEN R&D

- ✓ **MASEN R&D Outdoor exposition sites are located on the production sites giving an « operating conditions » demonstration environment**
- ✓ **MASEN R&D offers a network of exposition sites covering most African renewable energy sites production conditions: Desert, mountains and sea side, covering different dust, sun and rain profiles**
- ✓ **By prioritizing market opportunities as an R&D driver, MASEN R&D is maximizing the success rate of innovation & technology transfer to industrialization**
- ✓ **By linking R&D efforts to renewable energy project procurement, MASEN R&D is creating self-sustaining, job creating industrial opportunities pipe for innovative solutions**



## A 240 HECTARES R&D PLATFORM IN OUARZAZATE...



- Global surface area: 240 hectares
- Grid connection availability
- High Solar Irradiance → DNI > 2600 kwh/m<sup>2</sup>/yr
- Desert-like and real operational and meteorological conditions
- Available infrastructures (roads, utilities and telecoms.)
- Dedicated Masen's personnel
- Situated within a 580 MW Solar Complex





# R&D projects

MASEN R&D



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## Objectif



**Valoriser les déchets sidérurgiques dans des industries énergivores (céramique, verre ...) par:**

- La purification des déchets sidérurgiques et élimination des composants non ferreux pour une revalorisation minière,
- La fabrication de *pebbles*\* pour des applications de récupération de l'énergie dans des procédés industriels à usage intensif en énergie
- L'utilisation des *pebbles* dans le stockage thermique de l'énergie dans les centrales solaires CSP
- La production de composants céramiques réfractaires innovants

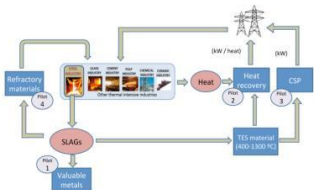
## Budget

**9 721 241 €** équivalent à **940 MH** dont 278 000 € (2,8%) alloués à Masen, équivalent à **48 MH**

**Durée**

**42 Mois** ( Sep. 2015 → Fév. 2019)

## Partenaires du consortium





## Objectif



### Water Saving for Solar Concentrated Power :

- Développer une solution intégrée et innovante destinée à optimiser la gestion de l'eau dans les centrales CSP
- Atteindre une réduction significative de la consommation d'eau (jusqu'à 70% à 90%) dans les systèmes de refroidissement du lot turbine et de nettoyage des surfaces optiques du champ solaire

## Durée

Janv. 2016 – Dec. 2019

## Budget

5 941 607 € équivalent à 645 MH dont 397 500 € alloués à Masen, équivalent à 50 MH

## Partenaires du consortium





## Objectif



## CoSt redUction and enhanced PERFORMANCE of PV systems

=> SUPER PV's goal is to reduce costs of the photovoltaics (PV) system by combining technological innovations and data management methods along the PV value chain:

1. Integration of innovations (nanocoating, enhanced encapsulation, bifacial, ...) into state of the art PV modules
2. Enhancing PV power electronics durability and efficiency
3. Innovative Digital platform for PV management and Building Info. Mangt insuring integrated flow

## Durée

01/05/2018 to 30/04/2022 (48 Months)

## Budget

9 907 793,00 € inc. 199 500,00 € allocated to Masen

## Partenaires du consortium



## DEMO-SITES

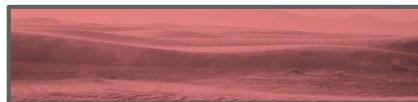
In harsh climate conditions to evaluate cost efficiency and demonstrate competitiveness of the solutions



Temperate (cold/wet) climate  
-Norway: Oslo & Trondheim  
-Lithuania: Vilnius



Tropical (hot/wet) climate  
-Spain: Sevilla



Desert (hot/dry) climate  
-Morocco: Ouarzazate & Rabat  
-Tunisia: Tozeur

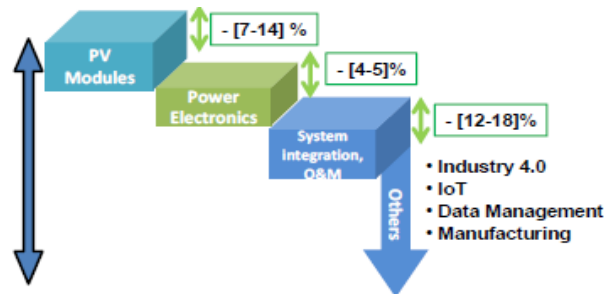
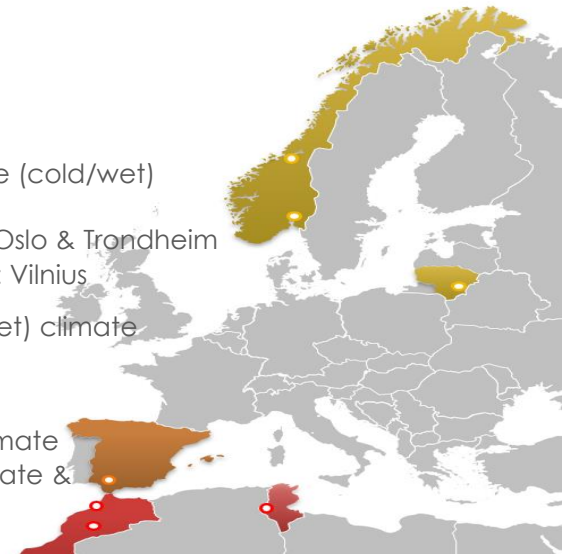


Figure 1 Project planned impact on LCOE



# DEMONSTRATION PROJECTS: CPV BY SUMITOMO (2/2)

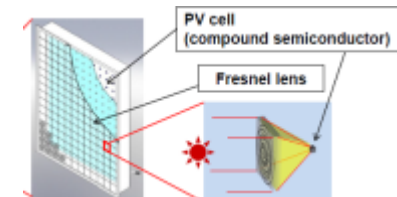
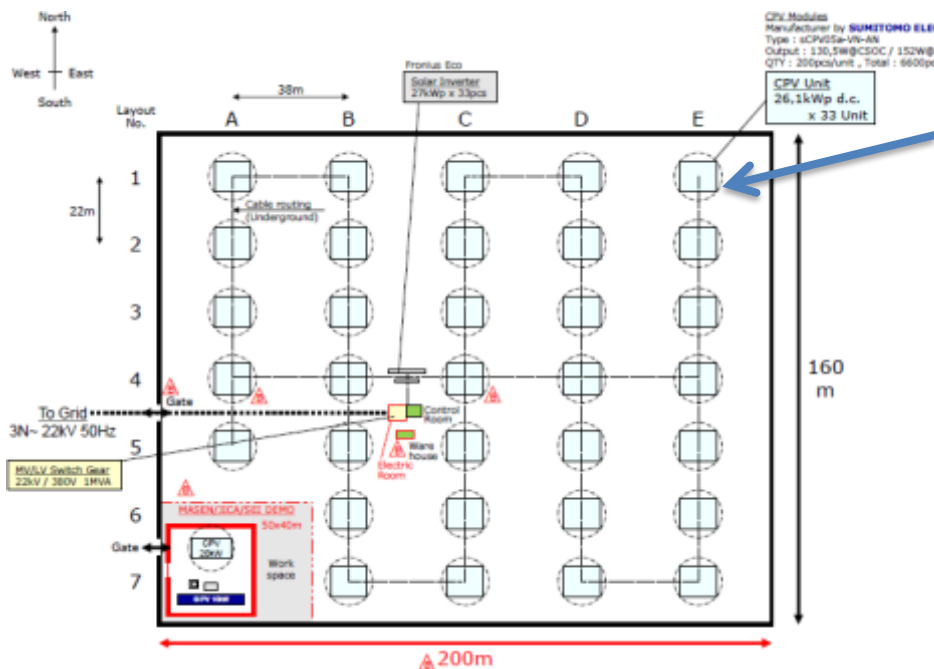
## Objectif

Extension du premier démonstrateur à 1MW en collaboration avec un industriel marocain

## Budget

5M\$ USD

## Parties prenantes





# Vanadium Flow Battery pilot

- UNIDO – LCET funded pilot deployment
- Vanadium Flow Battery from Sumitomo
- 125kw AC , 500kwh capacity
- Islanding & grid connected modes
- AC coupled to 3 CPV trackers for smoothing and peak shaving
- Commissioned Nov 2019





# Azelio: long term thermal storage pilot

## HOW AZELIO DIFFER FROM COMPETITORS

### AZELIO

- Stores heat thermally
- Effective storage up to 13 hours
- Technical service life 30 years
- 30% cycle efficiency
- Charges with electrical- or thermal energy

### COMPETITORS (BATTERY/BESS)

- Stores heat electrochemically
- Effective storage up to only 4 hours
- Technical service life about 7-8 years
- 85-90% cycle efficiency
- Only charged with electrical energy

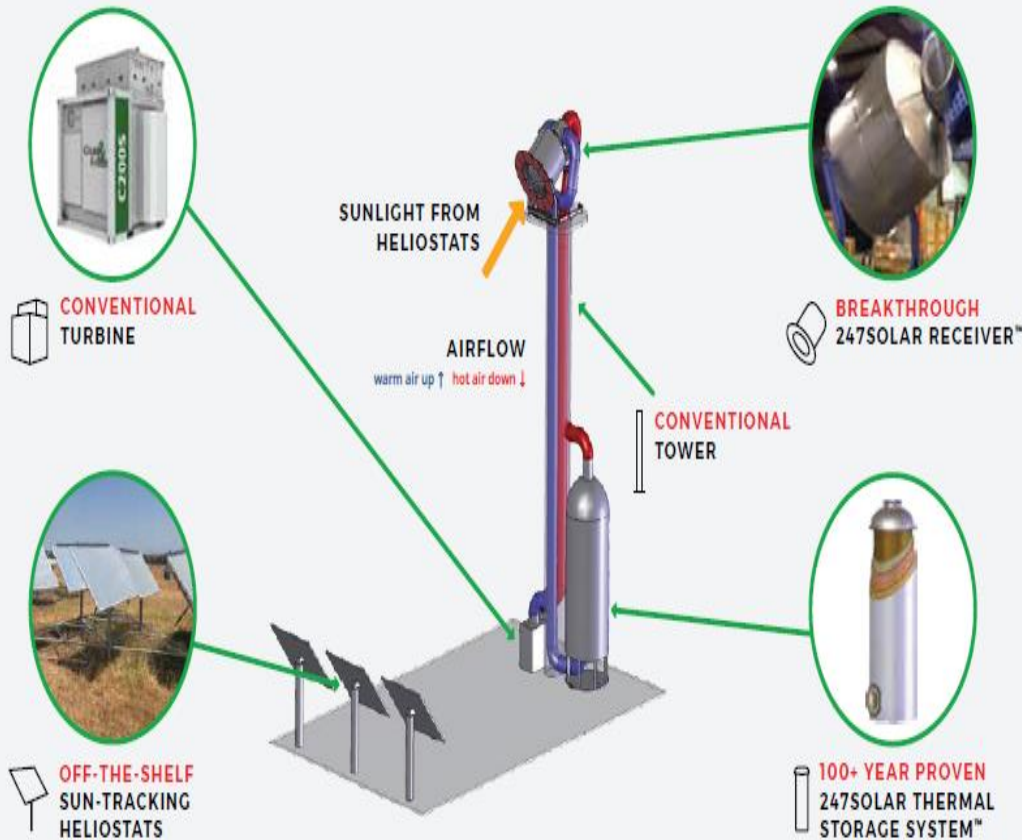


- AI PCM based heat storage
- PV powered (could be wind)
- Up to 13hours of storage
- 13kw Stirling engine per unit
- 30% round trip efficiency
- First electricity generated Dec'19



# 247Solar: Air based heat storage

Simple design, few moving parts



- High temp turbines 2x200kWe
- Air based heat capture and storage
- Widely available clay based heat storage medium
- Potentially full day operation in high DNI areas
- Reach DoE CSP price target of 6cts



# KOICA funded SMMART

## SMMART Demonstrator Architecture

### Smart Microgrid R&D Laboratory

- Real-time simulator with PHIL capabilities
- Main controller and data acquisition system for the Modular Microgrid (MMG) system
- Small generators
- Energy storage systems
- Controllable loads
- Cable simulators
- Power electronics converters

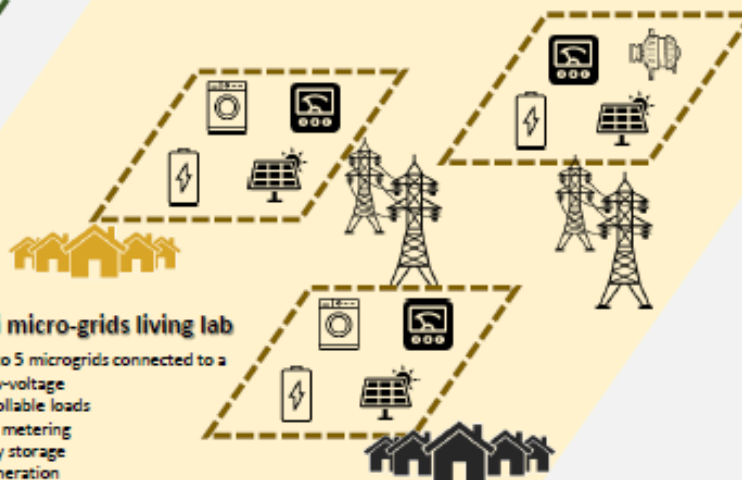
### R&D multi-micro grid systems (demonstration field)

- Various PV generator types
- MV network of 10 MWp
- Different types of generators (ranging from 20 kWp up to 1 MWp)
- Large scale Energy storage systems
- LV and MV radial networks
- Different types of consumers
- Connected to the national grid

### Large PV Plant



### R&D PV Plant



### Multi micro-grids living lab

- 3 up to 5 microgrids connected to a real low-voltage
- Controllable loads
- Smart metering
- Energy storage
- PV generation

- KOICA funded for 4M\$
- Microgrid modeling & simulation lab
- 3 interconnected Microgrids pilots
- Both NiMC & LiFePO4 batteries
- Deployment should start Q4'20





**Thank you!**

Questions?



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