

MOROCCO TOWARDS A DECARBONIZATION OF ITS ENERGY MIX

HYDROGEN SUMMER SCHOOL



masen
endless power for progress

August 19th, 2021

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



SOLAR

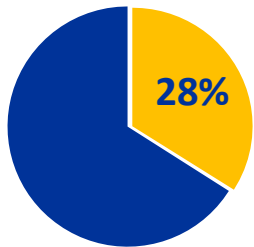


HYDRO

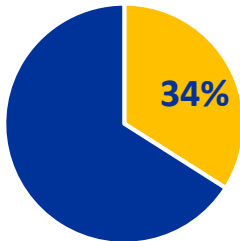


WIND

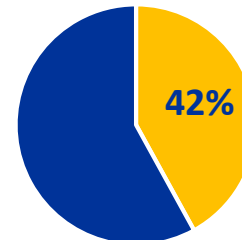
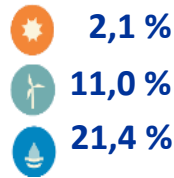
+ other RENs



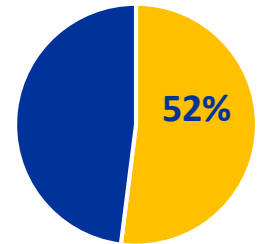
2009



2016



2020



2030

DEDICATED 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's founded as a limited company



A MODEL FOR THE SUCCESS OF DEPLOYED REN PROJECTS

1

CLEAR LEGAL FRAMEWORK TO SUPPORT MASEN'S ACTIONS

- **Law 57-09** establishing Masen completed by Law **37-16** following the new prerogatives
- **State – Masen agreement:** Conditions, technical requirements and guaranty of financial balance for the achievement of the solar plan
- **State – ONEE – Masen agreement:** Rules, conditions and guarantees for the purchase and supply, transportation and commercialization of electricity produced

STRONG SUPPORT FROM THE STATE

2

DEDICATED ACTORS FOR COMPLEMENTARY ACTIONS



Development of REN integrated projects

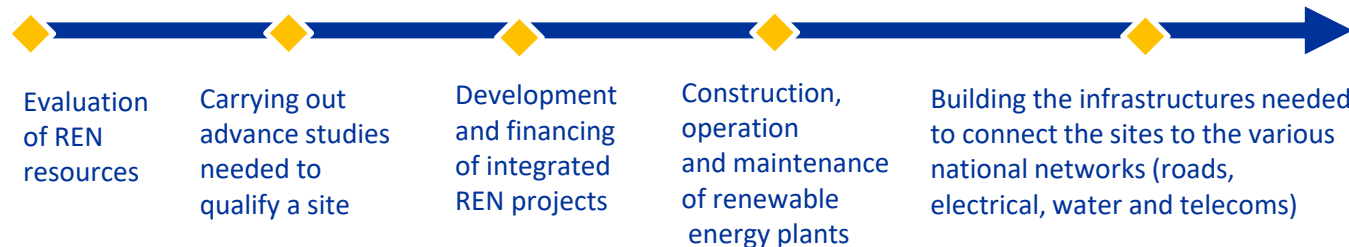


المكتب الوطني للكهرباء و الماء الصالح للشرب
Office National de l'Electricité et de l'Eau Potable

Key partner for the development of REN projects

3

MULTIDISCIPLINARY SKILLS AND EXPERTISE



RENEWABLE POTENTIAL IN MOROCCO

Morocco is among the most competitive countries for Renewable Energy (Solar and Wind)



Hydro : limited remaining potential



PV : High GHI is between 1500 and 2300 kWh/m²



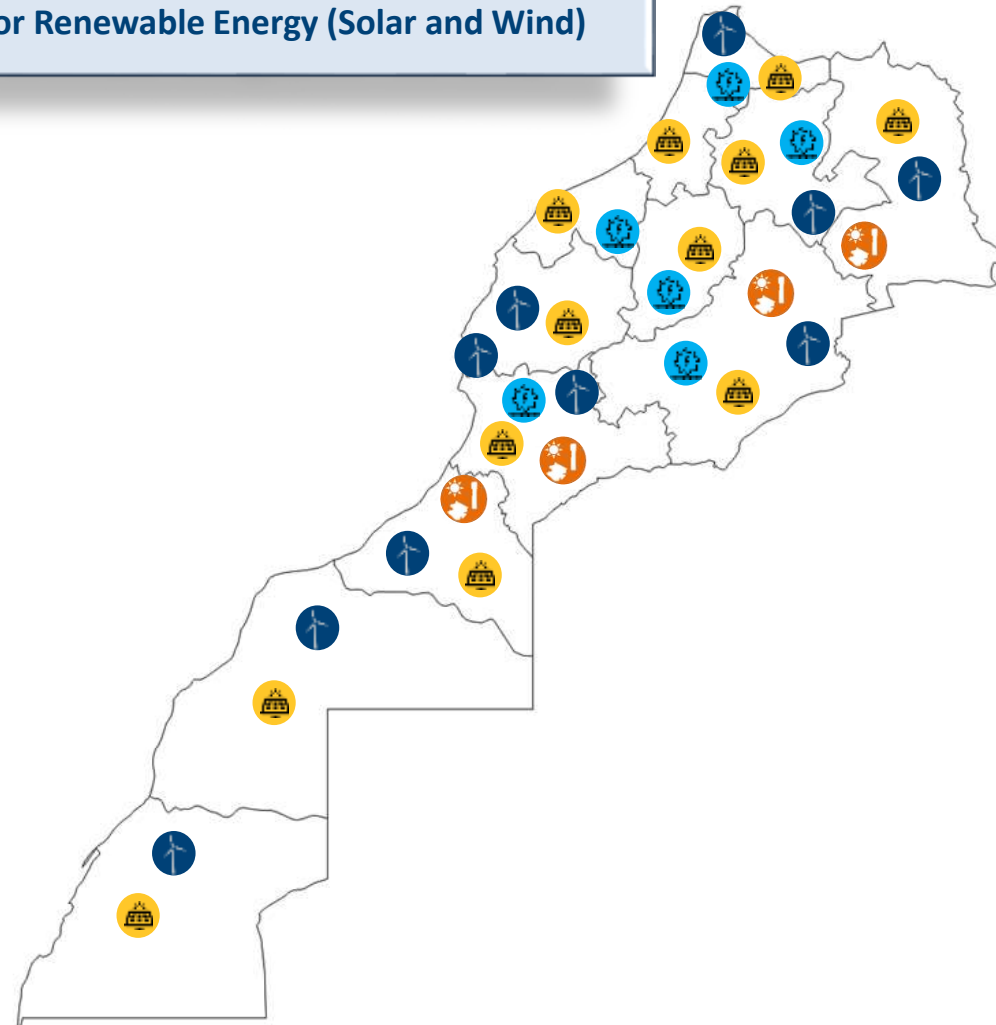
Wind : several sites with a capacity factor of around 50%.



CSP : High DNI is between 2300 and 2600 kWh/m²
Over different sites

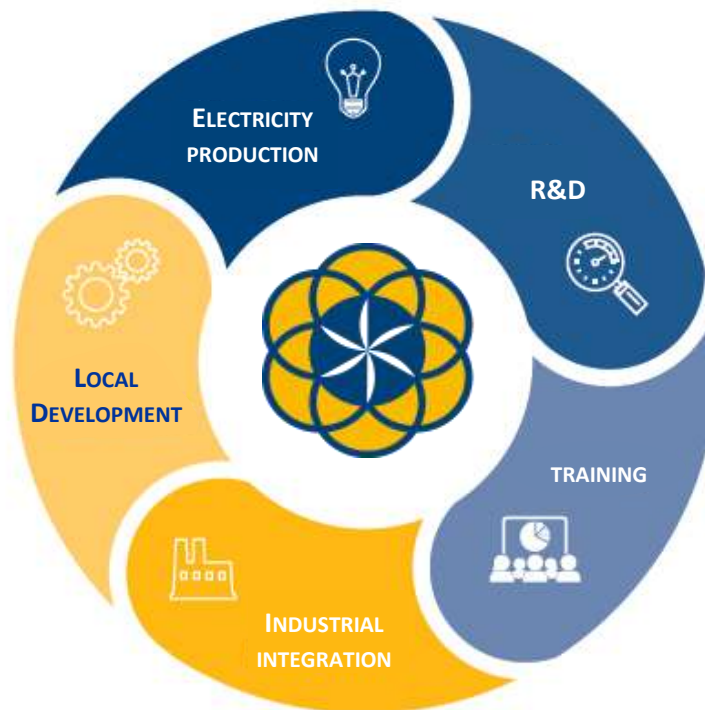


Offshore Wind : Exceptional potential in the Atlantic coast between Essaouira and Agadir



MASEN: CONTRIBUTION TO THE DEVELOPMENT OF AN INTEGRATED REN ECOSYSTEM

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



... for the development of an integrated REN ecosystem



More than 4000 MW of projects in operation to date

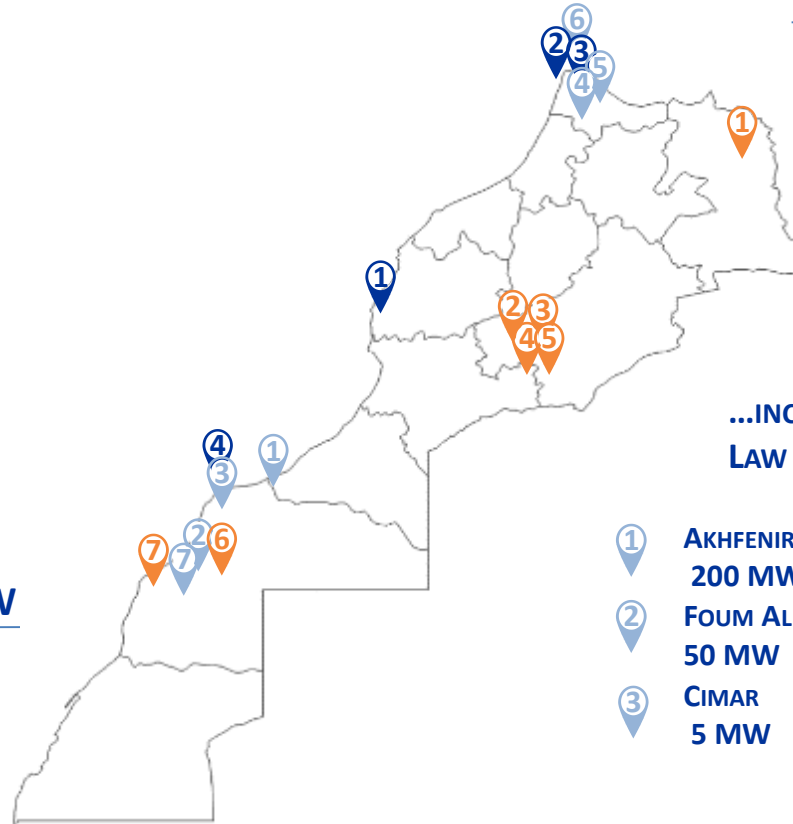
SOLAR PROJECTS – 700 MW

- ① AIN BENI MATHAR – 20 MW
- ② NOOR OUARZAZATE I – 160 MW
- ③ NOOR OUARZAZATE II – 200 MW
- ④ NOOR OUARZAZATE III – 150 MW
- ⑤ NOOR OUARZAZATE IV – 72 MW
- ⑥ NOOR LAAYOUNE I – 85 MW
- ⑦ NOOR BOUJDOUR I – 20 MW



HYDRAULIC PROJECTS– 1 760 MW

MORE THAN 20 DAMS SPREAD OVER MOROCCAN TERRITORY



WIND PROJECTS – 1 400 MW

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

...INCLUDING 657 MW DEVELOPED UNDER LAW 13-09

- ① AKHFENIR 1 & 2 200 MW
- ② FOUM AL OUED 50 MW
- ③ CIMAR 5 MW
- ④ HAUMA 50 MW
- ⑤ LAFARGE 32 MW
- ⑥ JBAL KHALLADI 120 MW
- ⑦



NOOR OUARZAZATE: MULTI-TECHNOLOGY SOLAR COMPLEXES



NOOR OUARZAZATE : 580 MW OPERATING COMPLEX COMBINING 3 DIFFERENT SOLAR TECHNOLOGIES

Noor Ouarzazate I



- **Technology : CSP trough**
- **Capacity : 160 MW**
- **Storage: 3 hours**
- **Avoided CO2 emissions : ~ 280 000 tCO2 / year**
- **Industrial integration: 30%***

Noor Ouarzazate II



- **Technology: CSP trough**
- **Capacity : 200 MW**
- **Storage : > 7 hours**
- **Avoided CO2 emissions: ~ 380 000 tCO2 / year**
- **Industrial Integration: 35%**

Noor Ouarzazate III



- **Technology: CSP Tower**
- **Capacity : 150 MW**
- **Storage : > 7 hours**
- **Avoided CO2 emissions: ~ 250 000 tCO2 / year**
- **Industrial Integration: 35%**

Noor Ouarzazate IV



- **Technology : PV with solar tracking**
- **Capacity : 72 MW**
- **Avoided CO2 emissions: ~ 87 000 tCO2 / year**



* actual industrial integration rate achieved: 34%

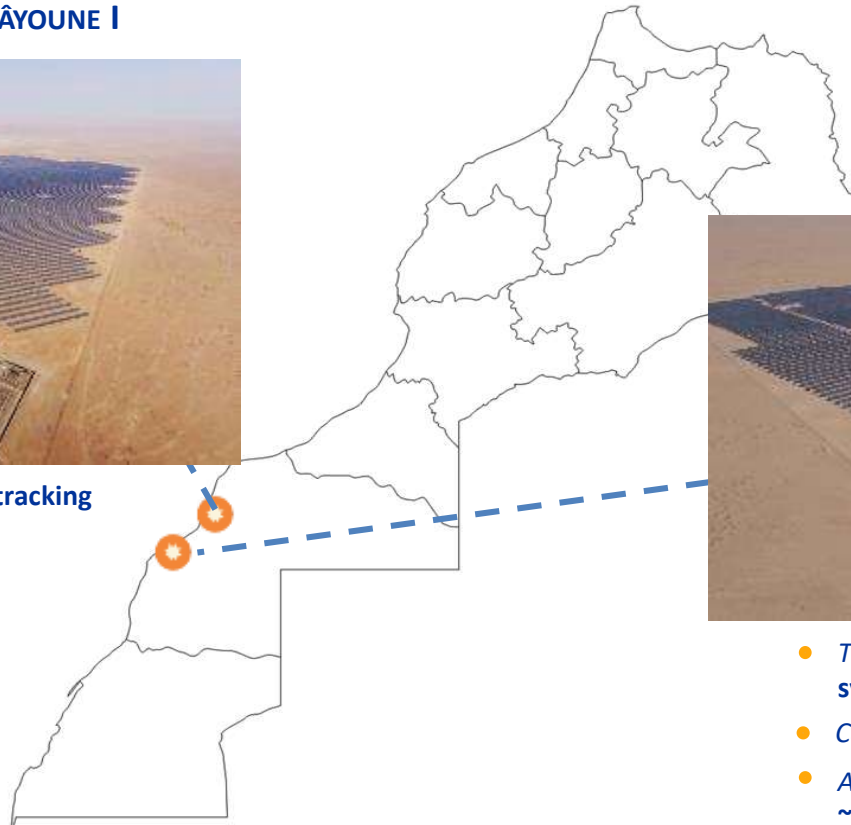


completion of two PV plants with a combined capacity of 100 MW

NOOR LAÂYOUNE I



- **Technology:** PV with solar tracking system
- **Capacity:** 85 MW
- **Avoided CO2 emissions:** ~ 104 000 tCO2/year



NOOR BOUJDOUR I



- **Technology:** PV with solar tracking system
- **Capacity:** 20 MW
- **Avoided CO2 emissions:** ~ 24 000 tCO2/year

Projects financed by green bonds for a total amount of MAD 1,200 million

FOCUS ON GREEN BONDS ISSUANCE: INNOVATIVE FINANCING INSTRUMENT BENEFITING FROM TWO LABELS

Institutional Investors

البريد بنك
AL BARID BANK



التجاري وفا بنك
Attijariwafa bank



البنك المركزي المغربي
Banque Centrale de Maroc
Groupe CDB

1150 Million Dirhams

Periodic reporting on Environmental and Social aspects

Funds Release

Green Bonds Issuance



Funds on-lent to the SPCs

Accredited by



Certifying the environmental and social benefits of the financed projects, Masen performance in the responsible management of its projects, along with the its RSE policy

Capital

SPC NOORO IV

SPC NOOR Laayoune

SPC NOOR Boujdour

Debt

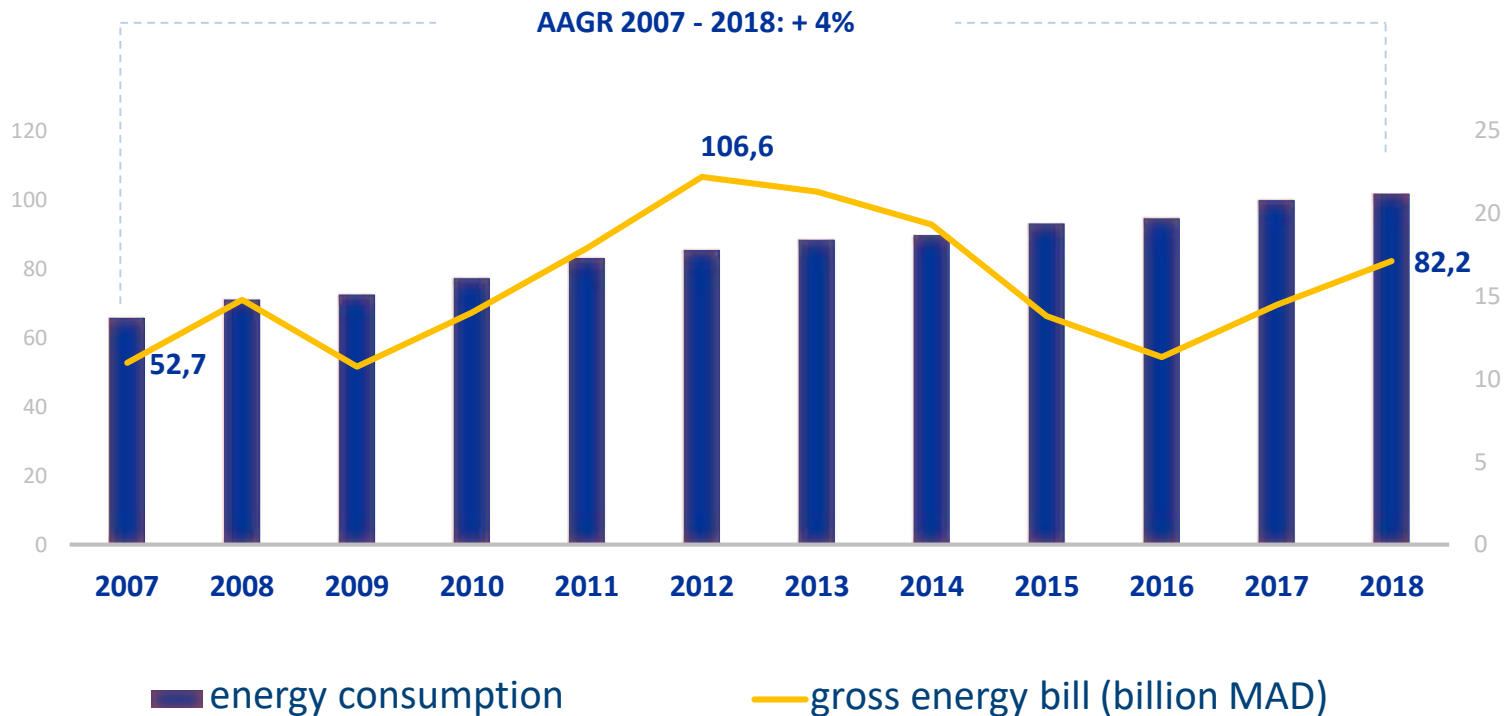


A PORTFOLIO OF COMPETITIVE PROJECTS



ENERGY CONTEXT OF 2009: AN ECONOMY DEPENDENT ON FOSSIL IMPORTS AND INCREASING ENERGY CONSUMPTION

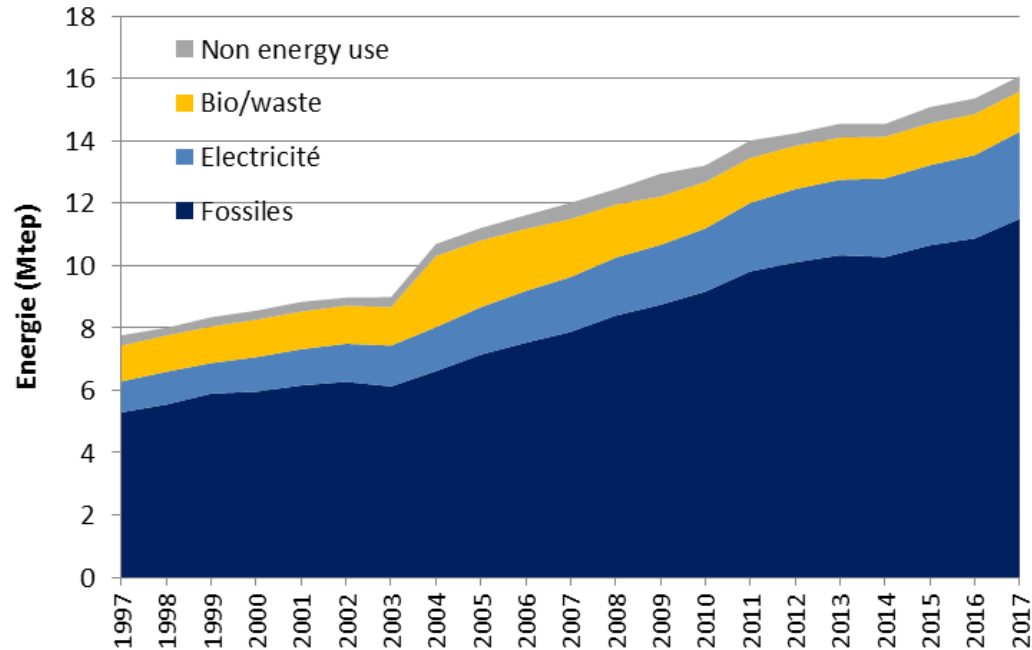
ENERGY CONSUMPTION RISING ON AVERAGE BY 4% PER YEAR, LINKED TO THE INCREASE IN THE RATE OF RURAL ELECTRIFICATION, THE MAJOR STRUCTURING PROJECTS IMPLEMENTED, THE INDUSTRIALIZATION OF THE COUNTRY, ITS URBANIZATION AND ITS DEMOGRAPHIC GROWTH ...



... WITH AN ENERGY DEPENDENCY RATE OF + 98% IN 2009 * IMPACTING THE KINGDOM'S ENERGY BILL.

BREAKDOWN OF THE KINGDOM'S ENERGY CONSUMPTION

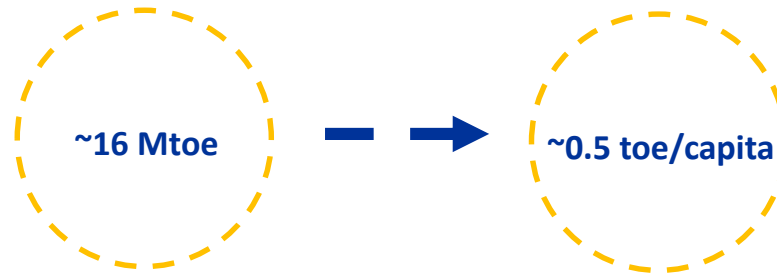
Evolution of final energy consumption by source in Morocco between 1997 and 2017 *



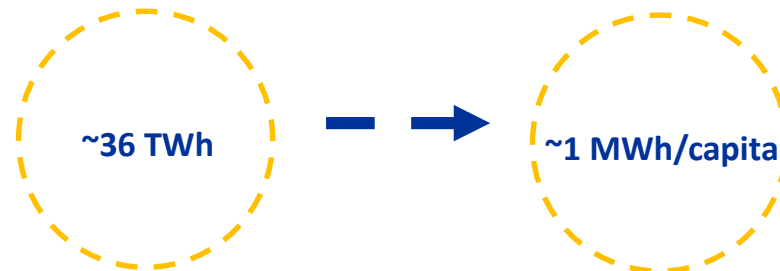
- Fossil energy directly represents more than 70% of final energy consumption
- Electricity does not exceed 17% of final energy consumption

ENERGY IN MOROCCO: VERY LOW CONSUMPTION PER CAPITA

Per capita energy consumption in Morocco remains well below the world average ~ 2 toe / capita

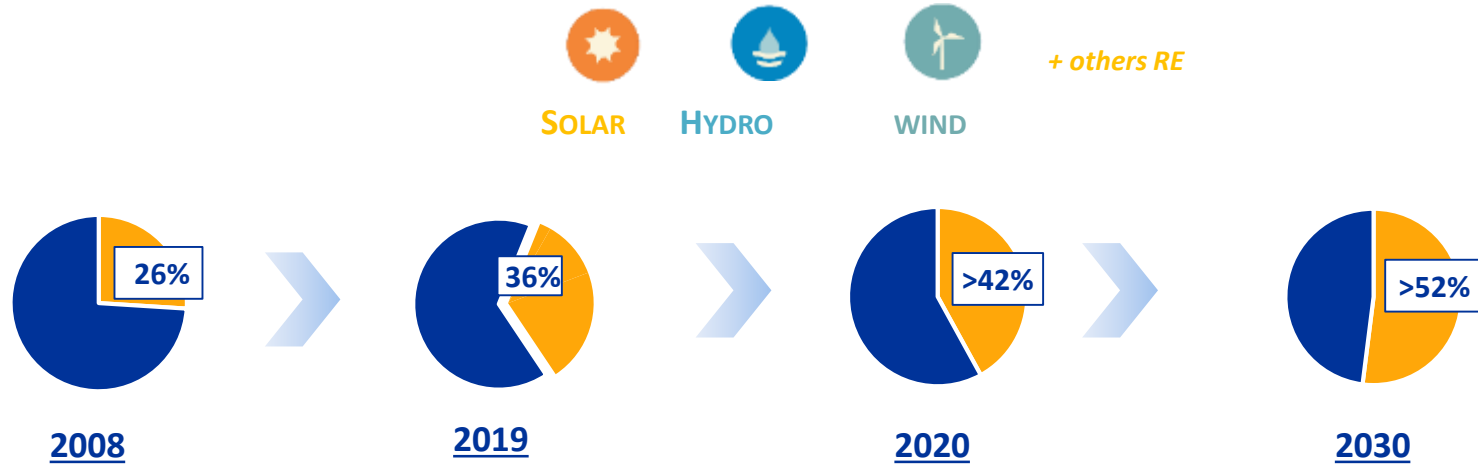


Ditto for electricity consumption, well below the world average $\sim 3,2$ MWh/capita



SUPPORT THE KINGDOM'S TRANSITION TO SUSTAINABLE AND INCLUSIVE GROWTH

AMBITIOUS RE TARGETS HAVE BEEN SET TO GUARANTEE THE COUNTRY'S ENERGY SECURITY, DIVERSIFY NATIONAL ENERGY SOURCES AND PRESERVE THE ENVIRONMENT



ACTORS COMMITTED TO ACHIEVING THE OBJECTIVES

SECTEUR PRIVÉ

*RE project leaders
RE electricity production and marketing*



*Central and integrated actor for
the development of renewable
energies*

Laws 57-09 & 37-16

IN TANDEM WITH ONEE

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

Law 13-09



RENEWABLE ENERGIES: A GROWING SHARE IN THE NATIONAL ELECTRICITY MIX, IN LINE WITH THE OBJECTIVES SET (1/2)

8 000 MW COMMITTED, FOR A TOTAL INVESTMENT (AS OF 2009) OF APPROX. 90 BILLION MAD

1

3 700 MW OPERATIONAL
 TOTAL CO2 AVOIDED: **5,4 M TCO2/YEAR**
 OR THE EQUIVALENT OF **216 MILLION TREES**

4 300 MW UNDER DEVELOPMENT / CONSTRUCTION
 TOTAL CO2 AVOIDED: **6,1 M TCO2/YEAR**
 OR THE EQUIVALENT OF **244 MILLION TREES**



NOOR SOLAR PLAN	WIND PLAN	HYDRO PLAN
<p>700 MW 7 PROJECTS</p> <p><u>CSP</u> <u>PV</u></p> <p>Noor Ouarzazate I Noor Ouarzazate IV Noor Ouarzazate II Noor Laayoune I Noor Ouarzazate III Noor Boujdour I Ain Bani Mathar</p>	<p>1 200 MW 12 PROJECTS</p> <p>Amougdoul, Tanger I, Koudia El Baida, Tarfaya, Akhfenir I & II, Foug Al Oued, Haouma, Aftissat, Jbal Khalladi, Cimar Lafarge</p>	<p>1 770 MW + 24 HYDRO-ELECTRIC POWER PLANTS</p>

RENEWABLE ENERGIES: A GROWING SHARE IN THE NATIONAL ELECTRICITY MIX, IN LINE WITH THE OBJECTIVES SET (2/2)

8 000 MW COMMITTED, FOR A TOTAL INVESTMENT (AS OF 2009) OF APPROX. 90 BILLION MAD

3 700 MW OPERATIONAL
TOTAL CO2 AVOIDED: 5,4 M TCO2/YEAR
OR THE EQUIVALENT OF 216 MILLION TREES

2

4 300 MW UNDER DEVELOPMENT / CONSTRUCTION
TOTAL CO2 AVOIDED: **6,1 M TCO2/YEAR**
OR THE EQUIVALENT OF 244 MILLION TREES

NOOR SOLAR PLAN

+ 2 700 MW
20 PROJECTS

Noor Tafilalet (120 MW, 3 sites)
Noor Midelt I (800 MW)
Noor Midelt II (800 MW)
Noor Atlas (200 MW, 7 sites)
Noor PV II (800 à 1000 MW)



WIND PLAN

1 250MW
9 PROJECTS

PEI 850 – Midelt (180 MW)
PEI 850 – Boujdour (300 MW)
PEI 850 – Jbel Lahdid (200 MW)
PEI 850 – Tiskrad (100 MW)
PEI 850 – Tanger II (70 MW)
Repowering Koudia Al Baida (120 MW)
PEI Taza I et II (150 MW)
Akhfenir II (200 MW)



HYDRO PLAN

350 MW
1 PROJECT

ETPS Abdelmouman (350 MW)
ETPS : Energy Transfer Pumping Station



53% 2022

PROJECTS UNDER CONSTRUCTION / DEVELOPMENT



SOLAR PROJECTS



700 MW OF SOLAR PROJECTS IN OPERATION



WIND PROJECTS



1 400 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

2018

2023



**NOOR ATLAS
200 MW**



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



**NOOR MIDELT I & 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**



52% by 2030

SOLAR CLUSTER : AN INITIATIVE LAUNCHED TO SUPPORT THE DEVELOPMENT OF A COMPETITIVE REN ECOSYSTEM

CLUSTER SOLAIRE



➤ IMPLEMENTED IN 2014



➤ FIRST CLEANTECH HUB IN THE REGION AIMING TO SUPPORT GREEN AND CLEAN TECHNOLOGY ENTREPRENEURS FROM MOROCCO AND MENA REGION

C
L
U
S
T
E
R



80 members, 300 companies

14 industrial projects developed and more than 30 startups incubated

More than 20 training and coaching sessions delivered to 500 beneficiaries

More than 15 events organized to support the development of a competitive solar ecosystem

3 millions of dirhams raised to finance the Cluster's activities

SEVERAL AREAS OF EXPERTISE

Projects
development

Green entrepreneurship

Skills development

Market intelligence

Networking



NOOR OUARZAZATE R&D PLATFORM

AN R&D PLATFORM DEVELOPED IN NOOR OUARZAZATE COMPLEX TO MEET SEVERAL OBJECTIVES:

1 Qualify new solar technologies

2 Create a network gathering industrial actors and research institutions

THIS PLATFORM HOSTS :



Demonstration projects in order to test, qualify and improve the different components of solar power plants



Research projects to encourage technology transfer and know-how on CSP and PV technologies



Commercial services provided to industrials and universities with high added value allowing a better global equalisation



R&D ACTIONS JOINTLY IMPLEMENTED WITH NATIONAL AND INTERNATIONAL INSTITUTIONS INCLUDING:



SET ROADMAP: A PROJECT JOINTLY CONDUCTED BY MASEN, WORLD BANK AND KEY OTHER PARTNERS



MARRAKECH
COP22|2016|CMP12
UN-CLIMATE CHANGE CONFERENCE

Signature during the COP 22 of the *joint declaration* for the development of a *roadmap* for the *exchange of green electricity between Morocco and Europe*



A PROJECT FOR WHICH THE SECRETARIAT OF THE STEERING COMMITTEE IS ENSURED BY MASEN



... WITH THE IMPLICATION OF KEY PARTNERS ...

Union for the
mediterranean



Union for the Mediterranean
Union pour la Méditerranée
الاتحاد من أجل المتوسط

European Commission



World Bank



Transmission system
operators « TSO »

... AROUND THREE KEY PHASES:

Sept. 2017

Oct. 2017

Nov. 2018

End of 2018/ beginning of 2019

Kick-off

Synthesis of previous
studies conducted and
gap analysis

Carrying out studies* and identifying
target markets for the electricity
exchanges between 5 countries

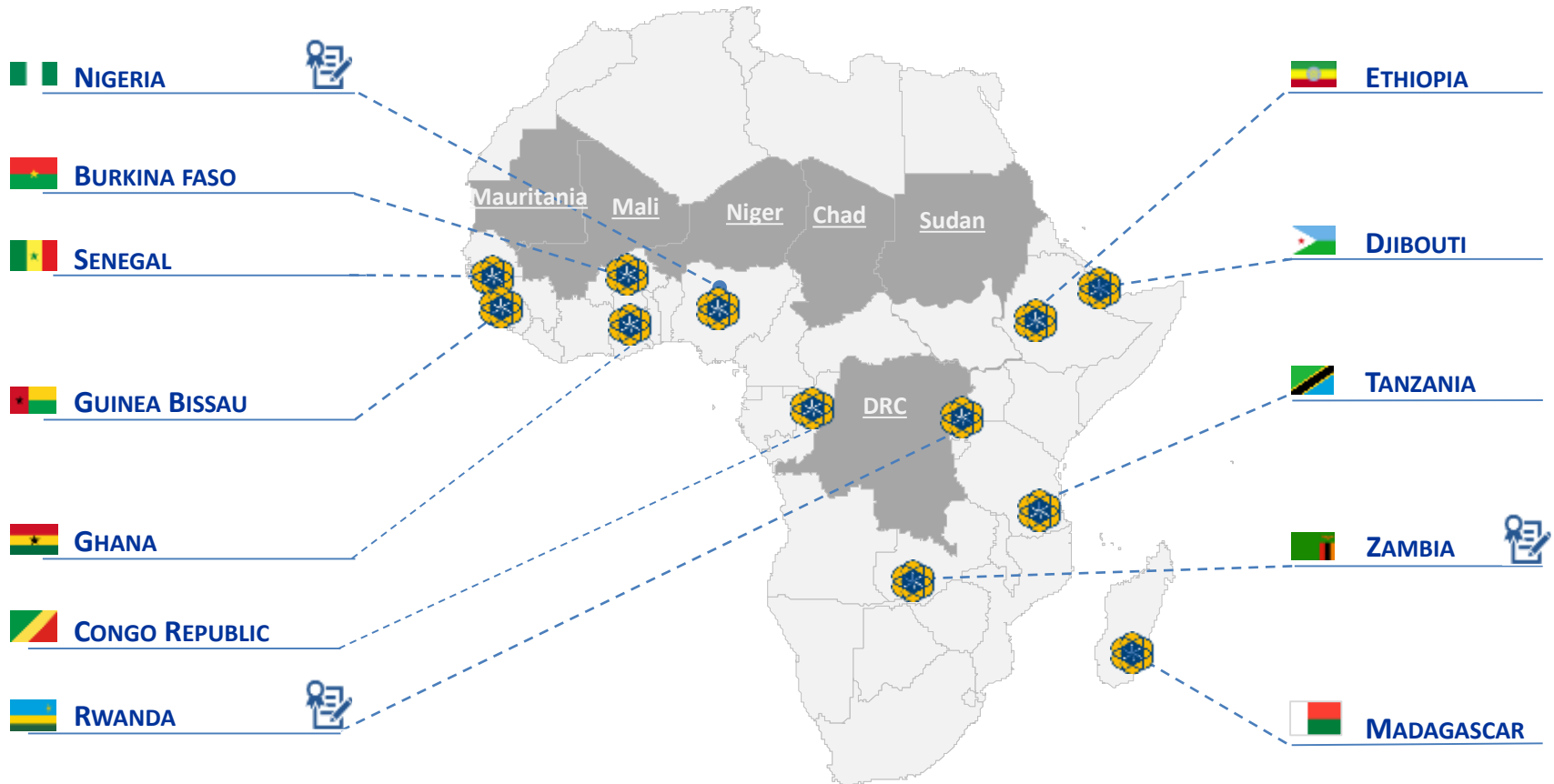
Definition of the
roadmap and preparation
for implementation

Roadmap
signature

* Studies on economic, financial, legal/regulatory, safety, technical, environmental, social and commercial aspects

MASEN INTERNATIONAL DEPLOYMENT: PARTNERSHIP OPPORTUNITIES AT THE INTERNATIONAL LEVEL AND IN AFRICA PARTICULARLY

SEVERAL MOU SIGNED IN AFRICA



OTHER POTENTIAL PARTNERSHIPS TO BE DEVELOPPED AT THE INTERNATIONAL LEVEL



MoU signed with Masen



Other potential countries

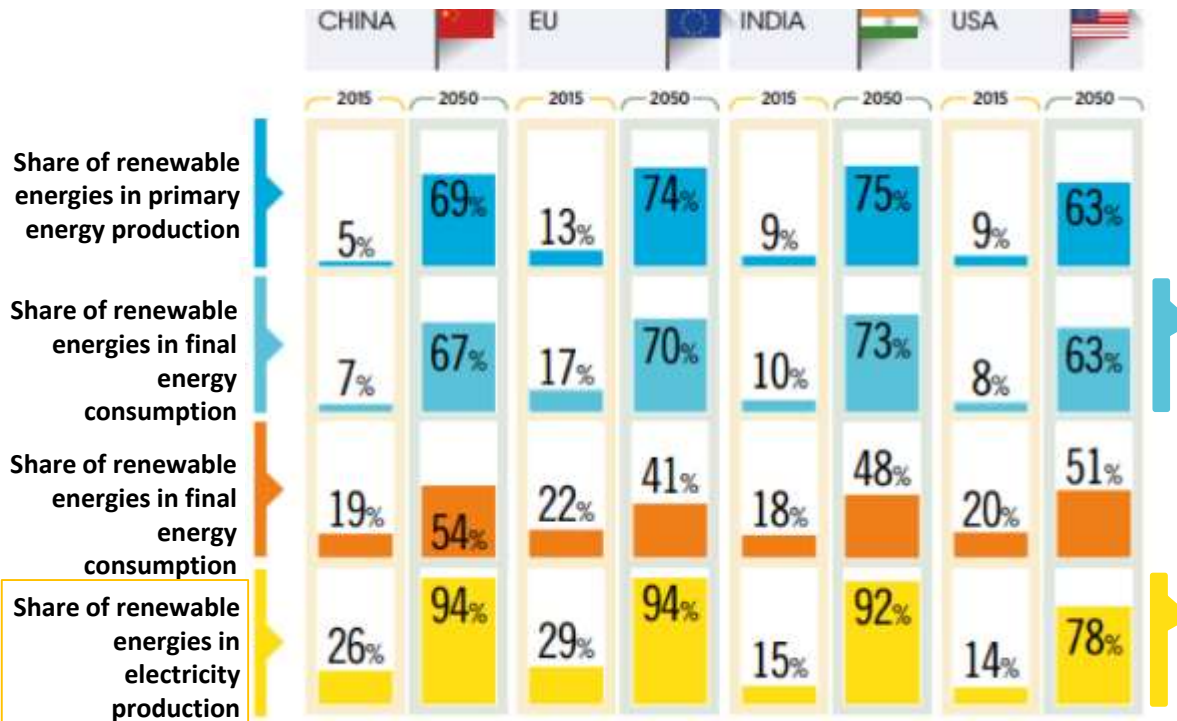


Framework agreement signed or being signed

FOR ENERGY SYSTEMS DOMINATED BY RENEWABLE ENERGIES BY 2050 - **WORLD** -

**DUE TO TECHNOLOGICAL AND MARKET DEVELOPMENTS, RENEWABLES ARE NOW A COMPETITIVE SOURCE OF ENERGY, REACHING A SIGNIFICANT SHARE IN MANY COUNTRIES
(IN GERMANY, RENEWABLE ENERGIES REPRESENTED 40% OF ELECTRICITY PRODUCTION IN 2019).**

KEY ENERGY OBJECTIVES FOR 2050 COMPARED TO 2015 FOR A SELECTION OF COUNTRIES:



Worldwide, the share of renewable energies in final energy consumption will only be 25% * in 2050, far from the 66% needed to reach the Paris Agreement

Source: IRENA

*and 17% by 2030, given current policies (compared to 10.5% in 2018).

THE ESSENTIAL ROLE OF RENEWABLE ENERGIES AS PART OF THE ECONOMIC RECOVERY (1/2)

THE ENERGY SECTOR, AND IN PARTICULAR ELECTRICITY, HAS PLAYED A CRITICAL ROLE IN THE OVERALL RESPONSE TO THE HEALTH CRISIS, WITHOUT WHICH THE ECONOMIC DAMAGE WOULD HAVE BEEN GREATER

By ensuring continuity in the supply of energy, from reliable and affordable electricity.

IMPACTS OF THE HEALTH CRISIS IN THE GLOBAL ENERGY SECTOR

3.6% drop in overall energy demand in T1 2020

6% decrease in energy demand forecast for 2020 compared to 2019
Equivalent to the increase of the last 5 years

ER provided a larger share in energy production (+ 1.5%)

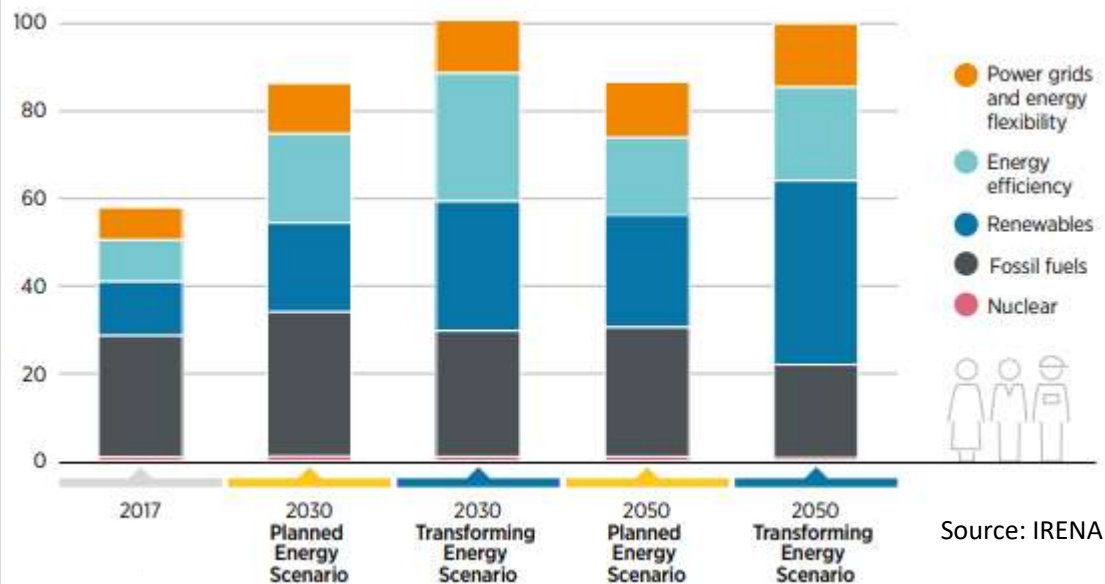
8% of the 40 million jobs in the energy sector are at risk

The experience during COVID-19 revealed new patterns of energy consumption and supply (acceleration of digitization, integration of renewable energies in front of a declining demand)

THE ESSENTIAL ROLE OF RENEWABLE ENERGIES AS PART OF THE ECONOMIC RECOVERY (2/2)

THE HEALTH CRISIS OFFERS THE OPPORTUNITY TO REBUILD A CLEANER AND MORE SUSTAINABLE WORLD THROUGH STIMULUS PACKAGES THAT HELP THE ECONOMY RETURN TO GREENER AND MORE RESILIENT GROWTH.

100 MILLION JOBS CREATED WORLDWIDE IN THE ENERGY SECTOR BY 2050



THE CUMULATIVE GAIN FROM TRANSFORMING THE ENERGY SYSTEM WOULD BE \$ 98,000 BILLION BETWEEN 2020 AND 2050 *

Investing in the de-carbonization process allows to reconcile both short and long term benefits
Job creation, GDP growth, reduction of inequalities, improvement of air quality, etc.

Several international initiatives. Ex:

EU GREEN DEAL:

- Carbon neutrality by 2050
- Creation of a € 750 billion Fund

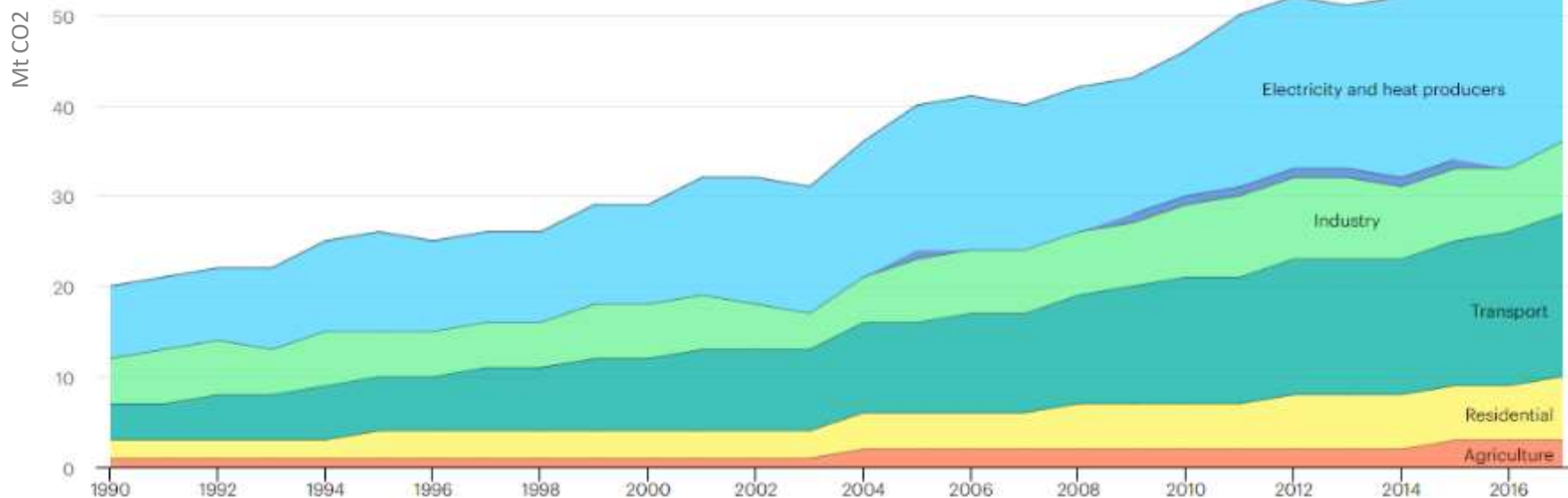
HELP TO PUT THE WORLD ON THE LOW CARBON TRAJECTORY ALIGNED WITH INTERNATIONAL CLIMATE OBJECTIVES

IN THE WORLD, CURRENT POLICIES WILL NOT BE ENOUGH TO ACHIEVE THE DECARBONIZATION TRAJECTORIES REQUIRED BY THE PARIS AGREEMENT, WHILE THE INCREASE IN CARBON EMISSIONS CONTINUES.

Global CO2 emissions increased from 32 to 34 billion tonnes between 2015 and 2019 * (IRENA).

THE IMPLEMENTATION OF SUSTAINABLE STIMULUS PLANS SHOULD MAKE IT POSSIBLE TO REVERSE THE UPWARD TREND IN CARBON EMISSIONS FROM 2020 AND PUT STATES ON A PATH CONSISTENT WITH INTERNATIONAL COMMITMENTS.

CHANGE IN CO2 EMISSIONS IN MOROCCO (Mt CO2)



Source: IEA

In Morocco, the 1st CO2 emitting sector is electricity (39%), followed by transport (30%).

* Emissions virtually stagnated in 2019 (+ 0.9% YoY). Source IEA

FOR ENERGY SYSTEMS DOMINATED BY RENEWABLE ENERGIES BY 2050 - MOROCCO -

GIVEN ITS EXCEPTIONAL POTENTIAL, THE COMPETITIVENESS OF ITS RENEWABLE ENERGY PROJECTS, MOROCCO CAN CLAIM TO A SHARE OF AT LEAST 80% OF RENEWABLE ENERGIES IN ELECTRICITY PRODUCTION BY 2050

A diversified renewable energy potential available throughout the Kingdom

Morocco, among the most competitive countries in the world for clean energy at low cost.

An RE and storage mix that takes advantage of synergies between technologies and sites, and that maximizes the integration of RE while providing useful energy.

An energy demand set to develop with regard to current and future uses *.

*Industriels, domestiques, mobilité électrique, technologies de traitement de l'eau, valorisation énergétique des déchets, etc.

DECARBONIZE ENERGY SYSTEMS IN DEPTH

SEVERAL SOLUTIONS ARE EXPERIENCING AN EVOLUTION AND INCREASING TECHNOLOGICAL MATURITY, WHICH WILL RADICALLY CHANGE THE FUNCTIONING OF ENERGY SYSTEMS

KEY SECTORS OF THE ECONOMY AT THE HEART OF THE ENERGY TRANSITION AS PART OF THE POST-COVID RECOVERY

Electricity

Transport

Industry

Building

Fuels

Emerging low-carbon technologies

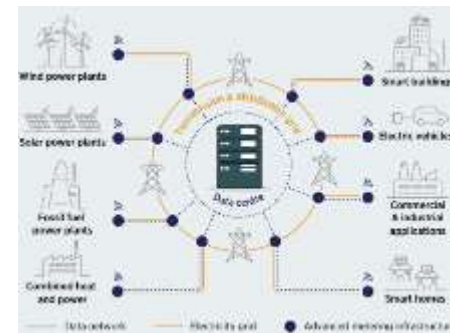
Examples:



Integration of renewable energies and network flexibility means



Electric mobility



Networks digitalization

Les territoires ont un rôle essentiel à jouer dans le développement, l'optimisation et l'intégration des différents réseaux d'utilités neutres en carbone : énergie, eau, déchets, mobilité, bâtiments

EXAMPLE OF ANTICIPATION OF NEW UPCOMING REQUESTS

Desalination: RE to meet water needs



Current estimate of water needs in Morocco:

~600 m³/capita/year



Globally recommended threshold
≈ 1000 m³/capita
Below which a country is considered to have a water shortage



To maintain the current ratio of 600 m³/capita/year :

- In 2030: need for desalination of ~ 1.6 billion m³ / year (taking into account only demographic change). It should be noted that the Government is planning 500 million m³ / year (i.e. for 572 m³ / capita / year)
- In 2050: ~ 5 billion m³ / year (to maintain 600 m³ / capita / year)



Desalination

2030 :

Between 1.9 and 6 TWh / year

2050 :

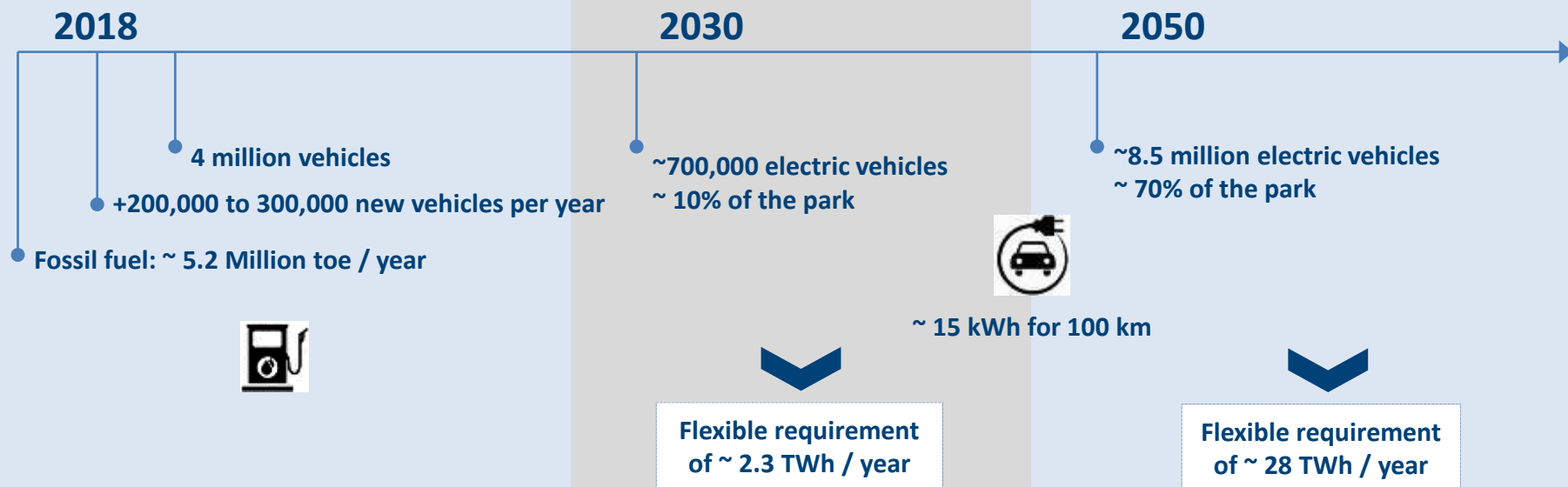
~15 TWh/year

The need for water in Morocco would become alarming. You might as well invest as soon as possible in desalination, which would at the same time make it possible to meet this need while providing flexibility to the electricity system.

ELECTRICITY-DOMINATED MOBILITY FROM ENR SOURCE

Scenario of a target of 10% e-mobility in 2030 and 70% in 2050

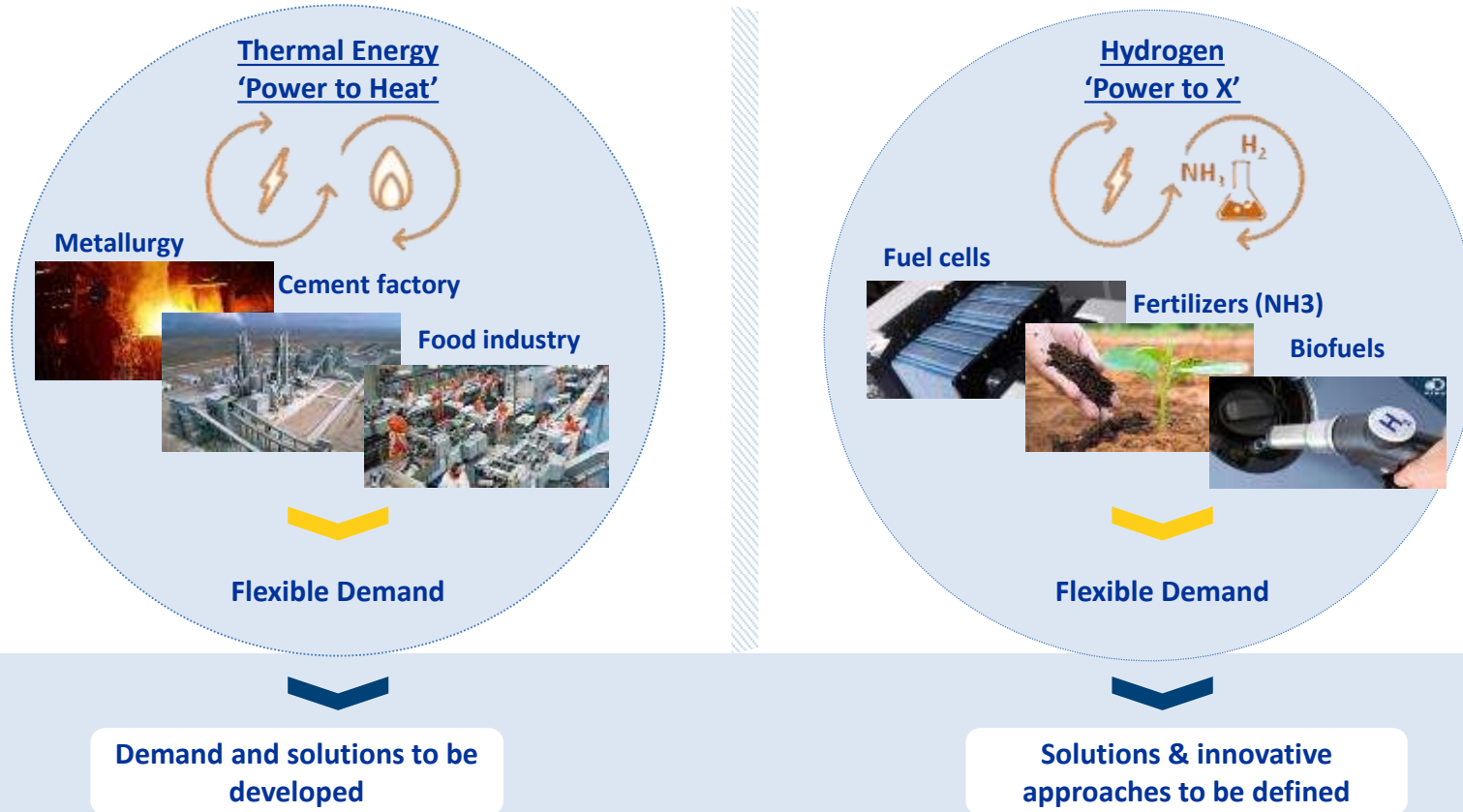
Develop electric mobility, particularly for public transport (train, tram, bus, etc.) and the electric car



Monitor developments in hydrogen-based transport

Enhance Morocco's industrialization

Opportunities to be seized in order to develop energy-intensive industries in Morocco based on REs



Study and analyze all industries that can be competitive under these conditions and promote their development in Morocco.

FOR A TRANSFORMATIONAL APPROACH TO THE ENERGY SECTOR (1/2)



**FOR A NEW MODEL OF ECONOMIC GROWTH THAT IS SUSTAINABLE,
INCLUSIVE AND MORE RESILIENT IN THE FACE OF THE EFFECTS OF PANDEMIC
AND CLIMATE CHANGE.**

**A LEADING ROLE IN THE SOCIO-ECONOMIC DEVELOPMENT OF THE COUNTRY
AND ITS TERRITORIES,
SOURCE OF MANY POSITIVE EXTERNALITIES**

- ✓ **Stimulate economic growth**
- ✓ **Create sustainable jobs**
- ✓ **Building more resilient and clean energy systems**

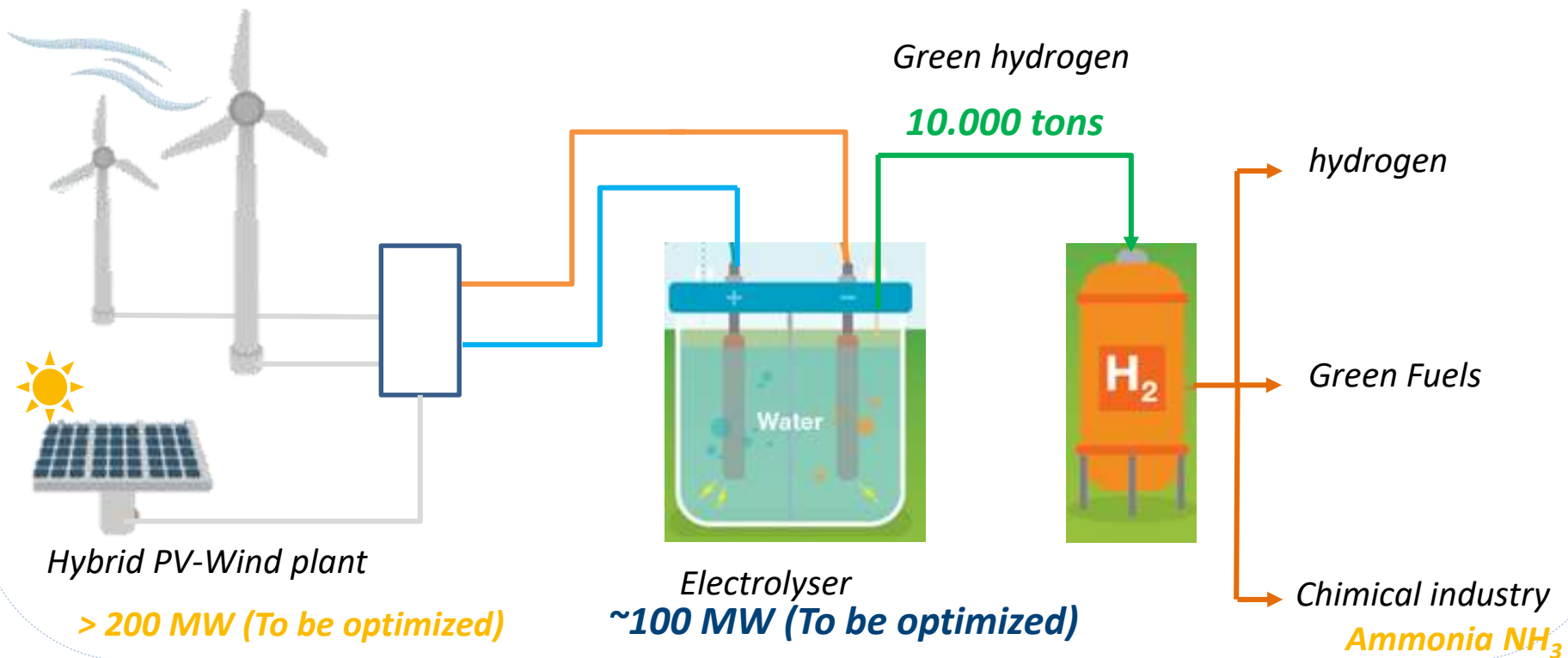
CHARACTERISTICS OF MASEN H2 REFERENCE PROJECT

Project definition

To benefit from the economy of scale relating to the production of electricity → Competitive electricity costs



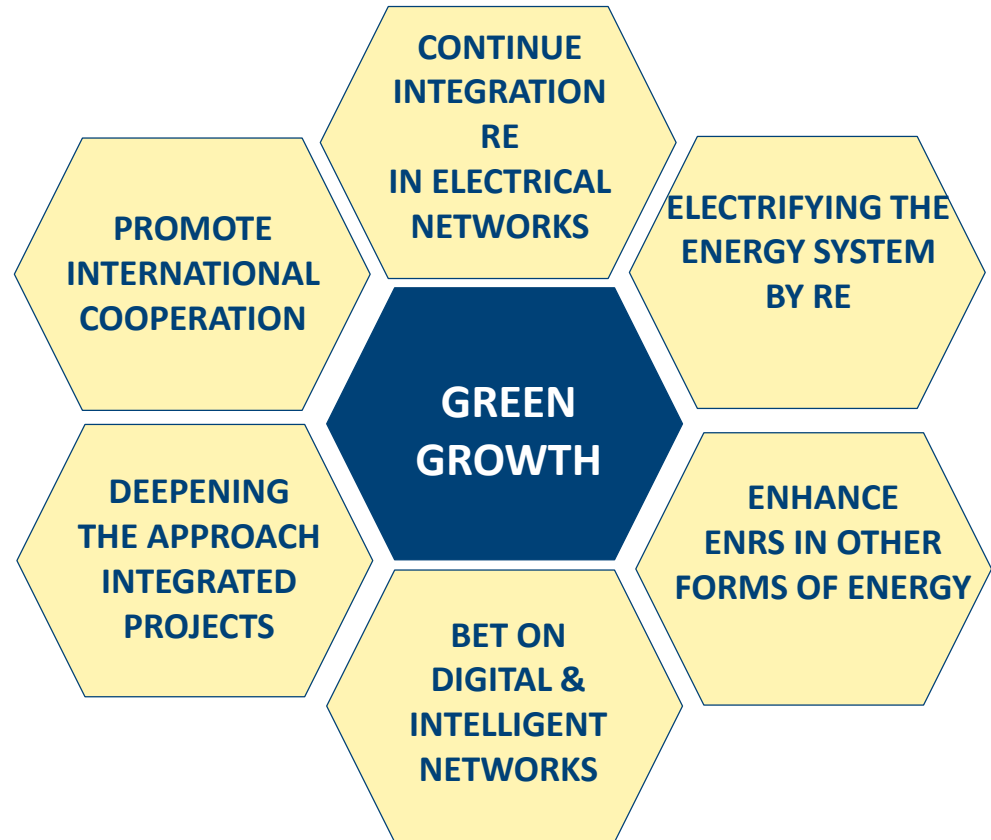
To produce a quantity of hydrogen that can be consumed locally



FOR A TRANSFORMATIONAL APPROACH TO THE ENERGY SECTOR (2/2)

BEYOND ELECTRICITY PRODUCTION, IT IS NOW ESSENTIAL TO DEEPLY DECARBONISE THE MOST POLLUTING ECONOMIC SECTORS.

**6 AREAS FOR THE
TRANSFORMATION OF THE
KINGDOM'S ENERGY SECTOR**



The deployment of a set of measures and initiatives as well as the establishment of an associated regulatory framework, with the aim of installing a cleaner, resilient, secure and affordable energy system, while stimulating the creation of employment and economic growth.



masen

endless power for progress