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Waste-to-Energy Technologies: A Sustainable Approach for Circular Economy and Renewable Energy in Water and Food Systems

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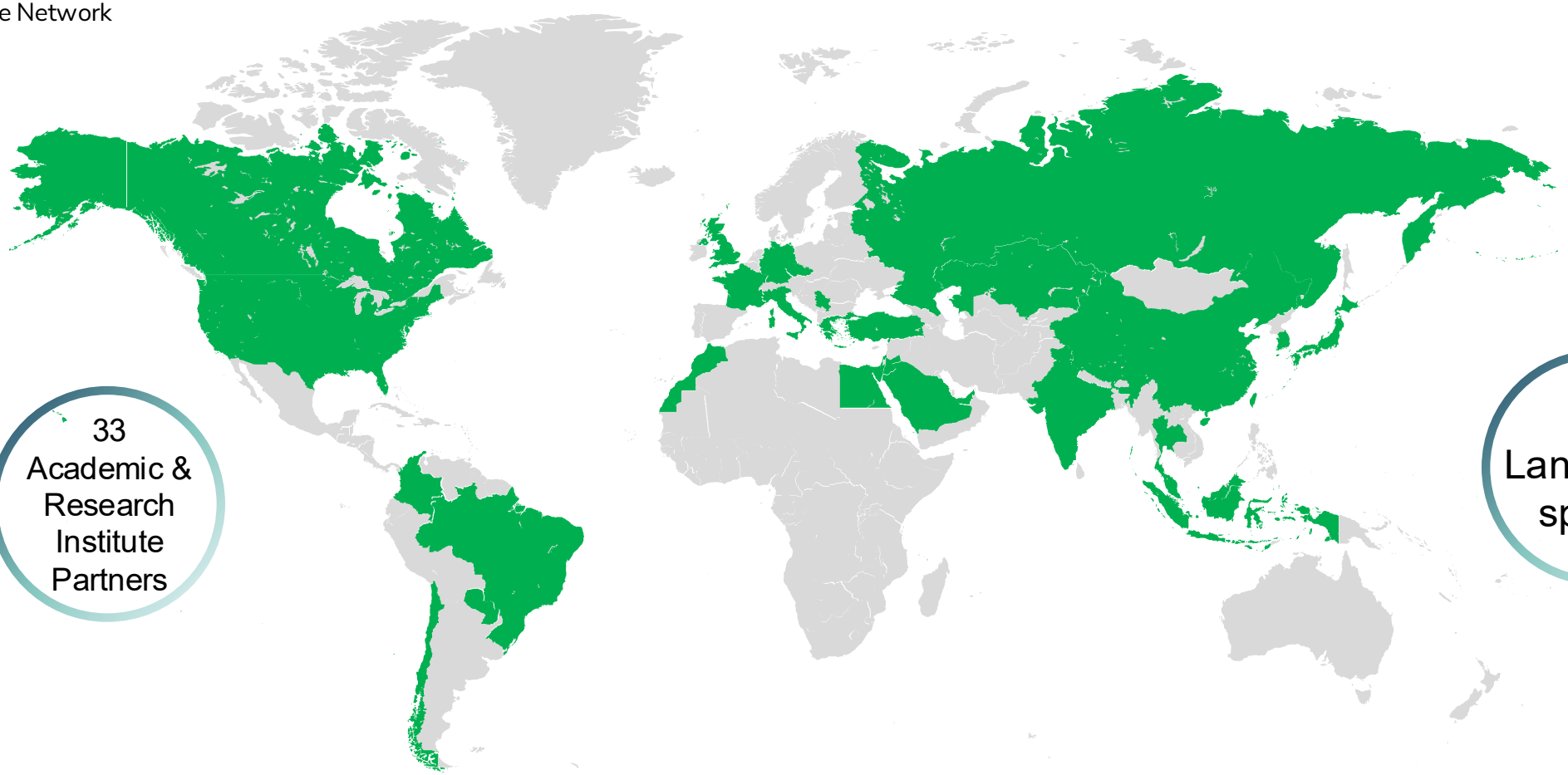
Board, Member, responsible of International Relations, Global WtERT Council – WtERT®

WtERT Global Reach

Worldwide Network

30 Nations

33 Academic & Research Institute Partners



5 Continents

22 Languages spoken

Brazil, Canada, Chile, China, Colombia, Czech Republi, Egypt, Franc e, German y, Greec e, India, Indonesi a, Israel, Italy, Japan

Jorda n, Kazakhsta n, South Korea, Malaysia, Morocco, Paraguay, Russia, Saudi Arabia, Serbia, Singapo re, Thailand, Türkiye, U.K., UAE, USA

WtERT Snapshot Activities highlights

WtERT in numbers

25 **Years of Research**

In dept studies in all aspect of waste management

24 **Academic Partners**

Global network of universities from around the world

30 **Industry partners**

Unique academic-industry consortium collaboration

+100 Thesis

Contributions from the Earth Engineering Center, Columbia University

+500 Technical Papers

Accumulated several papers from conferences and research projects

Training & Education

3 decades of educating researchers, engineers, and policy makers

+30 Meetings

Since 1993, 21 NAWTEC Conferences & 17 WtERT Congresses

Contents

Part 1

1 Overview of Morocco

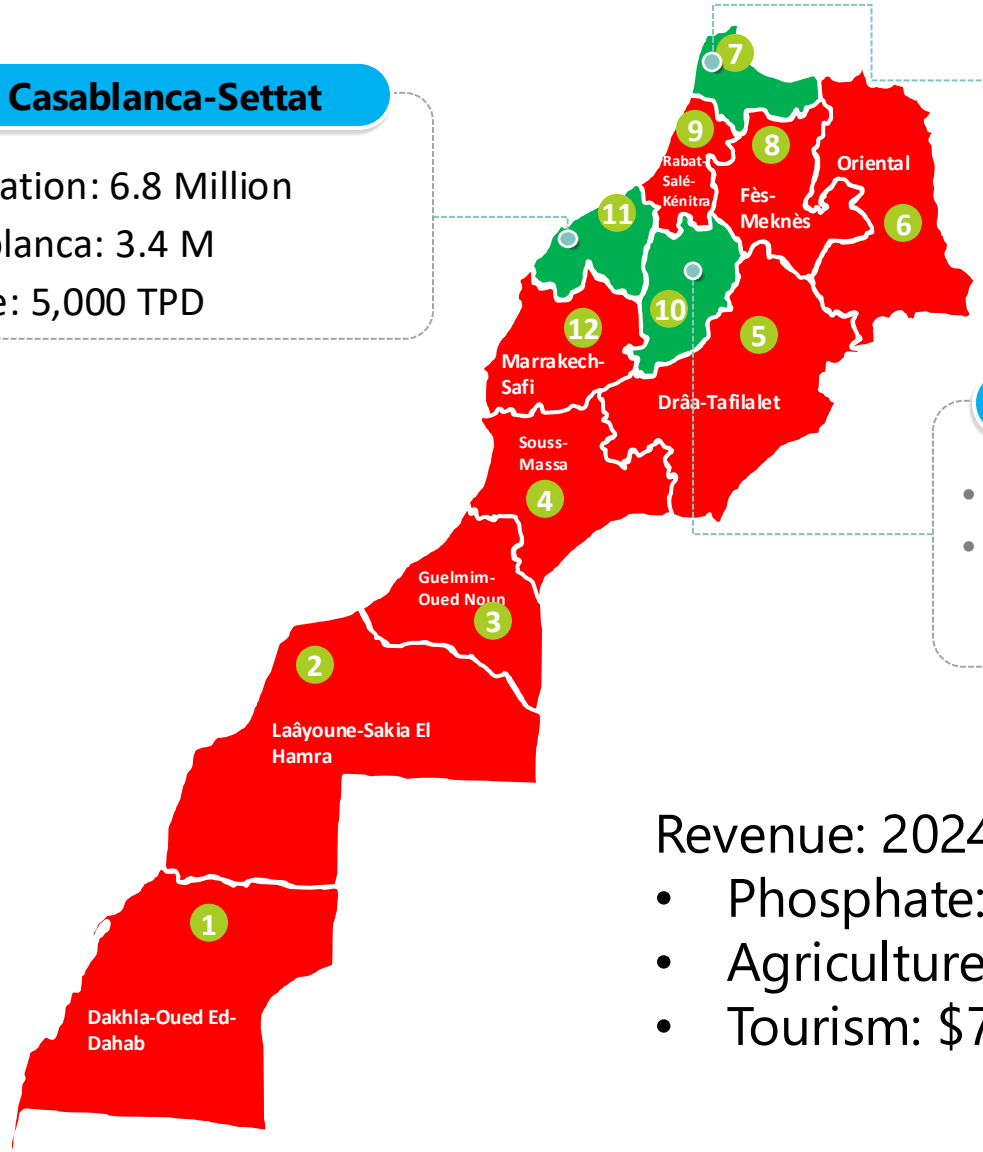
Overview of Morocco

Casablanca-Settat

- Population: 6.8 Million
- Casablanca: 3.4 M
- Waste: 5,000 TPD

Tanger-Tétouan-Al Hoceïma

- Population: 3.5 Million
- Focusing on Industrial waste
- Mohammed VI Tangier Tech City Project



Béni Mellal-Khénifra

- Population: 2.5 Million
- Landfilling is complex due to geographical constraints

Revenue: 2024

- Phosphate: $2 billion
- Agriculture: $10 billion to $15 billion
- Tourism: $7 billion to $10 billion

- Position: North Africa, 14 km from Europe
- Area: 710 850 km2
- Population: 37 millions
- Climate: Mediterranean
- Parliamentary, democratic and social constitutional monarchy
- Growth: 3-4 % per year
- SW Production: 5 M tons/y (0.8 Kg/cap./day)

Overview of Business environment in Morocco

BUSINESS-FRIENDLY ENVIRONMENT

EASINESS FOR BUSINESS TO **GROW**

MORE THAN 50 NON DOUBLE TAXATION AND INVESTMENT PROTECTION AGREEMENTS

NO RESTRICTIONS ON CAPITAL FOR NON-RESIDENTS

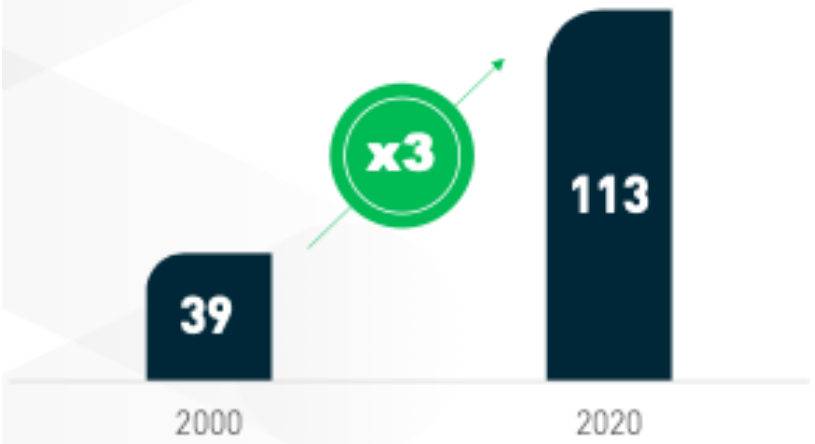
FREE REPATRIATION OF PROFIT AND CAPITAL FOR NON-RESIDENTS

Source : WEF / RMB

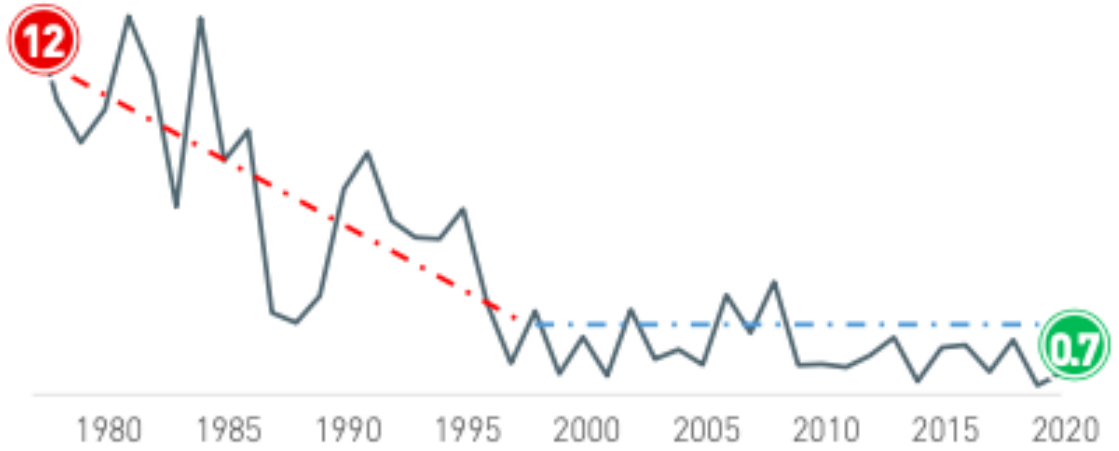
Overview of Macro-Economics of Morocco

STRONG MACRO-ECONOMIC FUNDAMENTALS

GDP has tripled in less than 20 years
(USD Billion)



Stable inflation rate maintained under 2% since 2010
(annual inflation %)



Source : The World Bank / Global Competitiveness Report WEF 2019 (* Among the countries ranked first)

Overview of Infrastructure in Morocco

1ST IN NORTH AFRICA IN TERMS **OF INFRASTRUCTURE**

Part 2

2

Waste Management & Collection System

Overview of Waste composition & GHG Emissions in Morocco

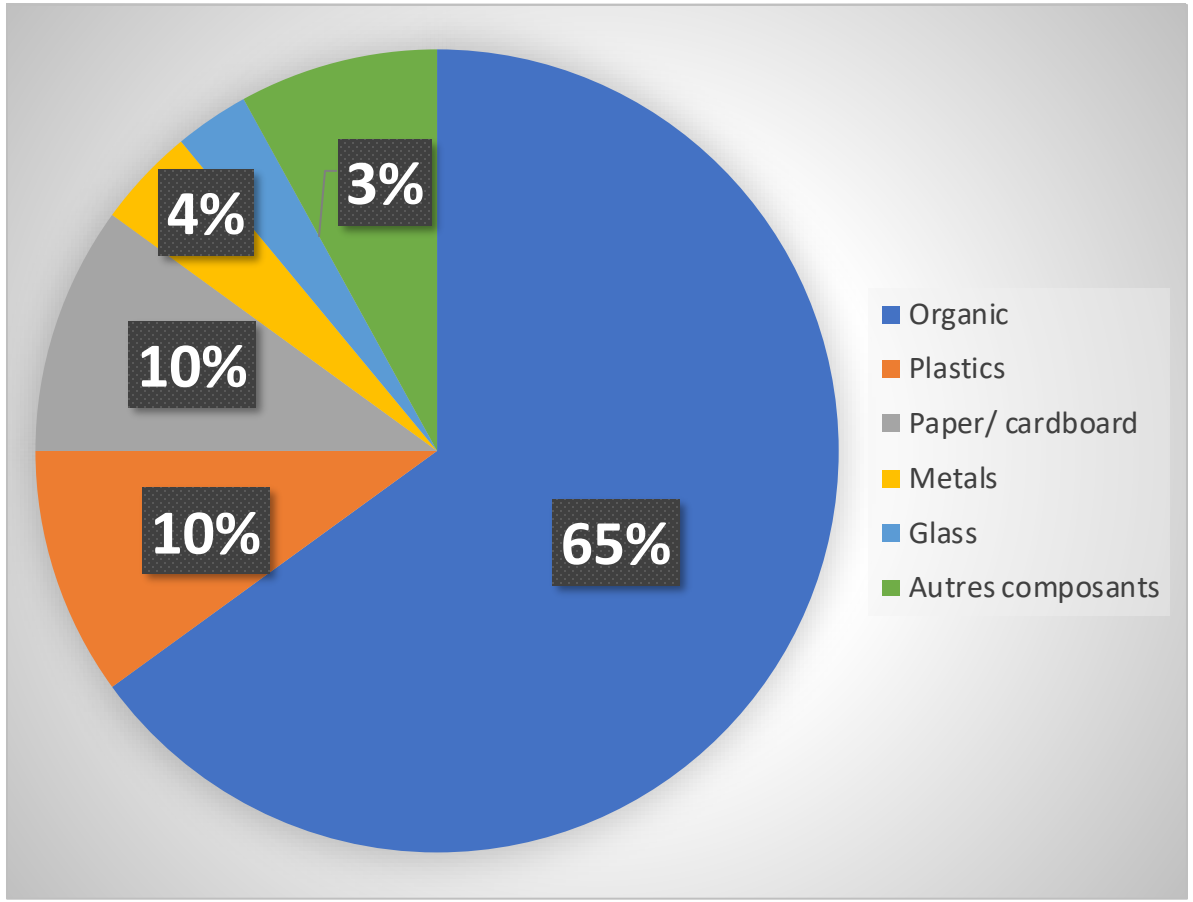


Figure 1: Composition of household waste (source: second biennial report, BRU.2, updated December 2019)

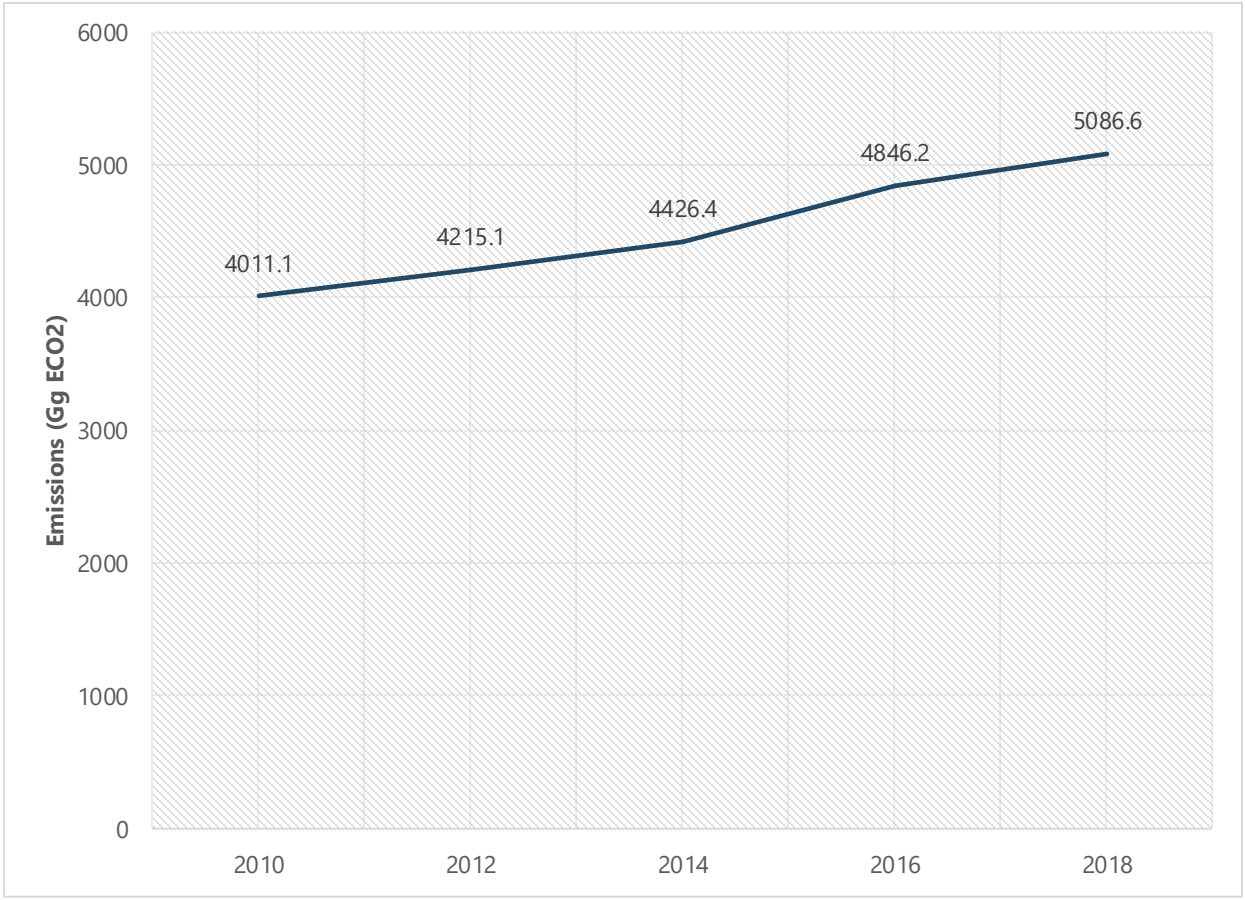
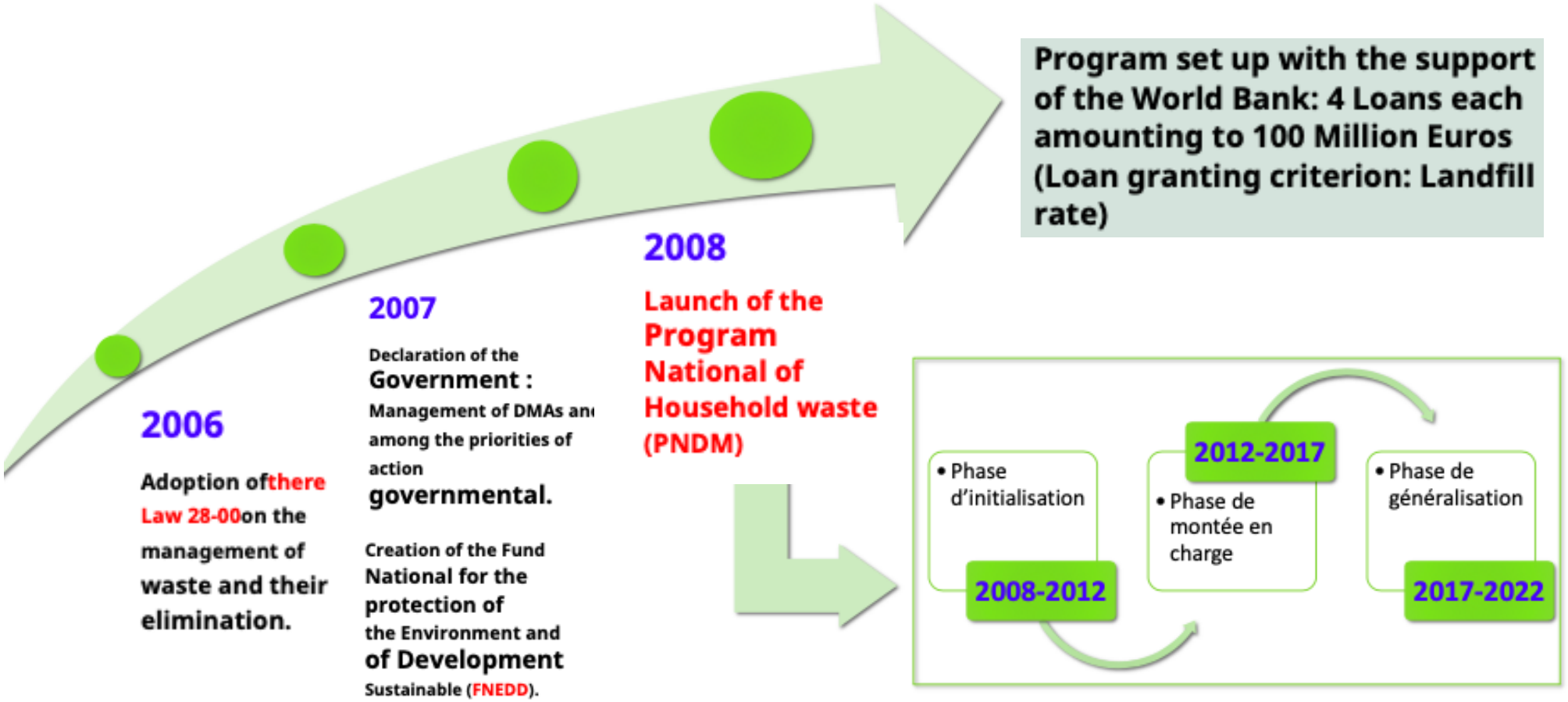


Figure 2: Evolution of GHG emissions related to the waste sector in Morocco (source: third biennial report Morocco 2022)

Waste management in Morocco

Institutional framework/ Collection System Success



Waste management in Morocco

Deposit in 2015

Composition of municipal waste

Household and similar waste (DMA) deposit produces:

- DMA in urban areas: 5.9 MT/year.
- DMA in rural areas: 1.5 MT/year.

Situation before PNDM in 2008

- 44% Collection rate professionalized
- 6% Rate of implementation controlled landfills
- 220 illegal dumps listed
- 64 master plans in elaborate

Status of progress until 2022

- 96%
- 63% 26 discharges controlled and CEVs achieved
- 66 dumps wild rehabilitated
- 52 completed and 12 in course

Part 3

3

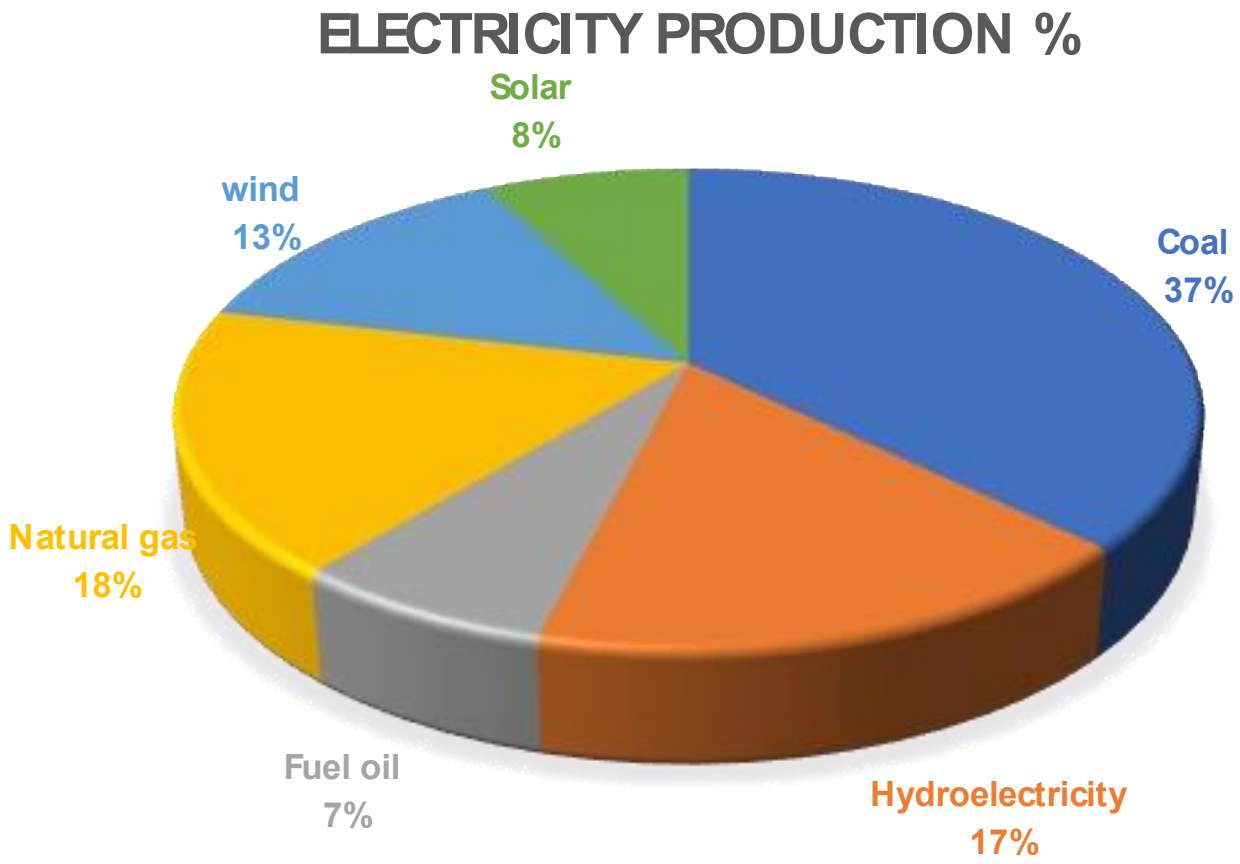
Energy & Water challenges

Electricity production in Morocco

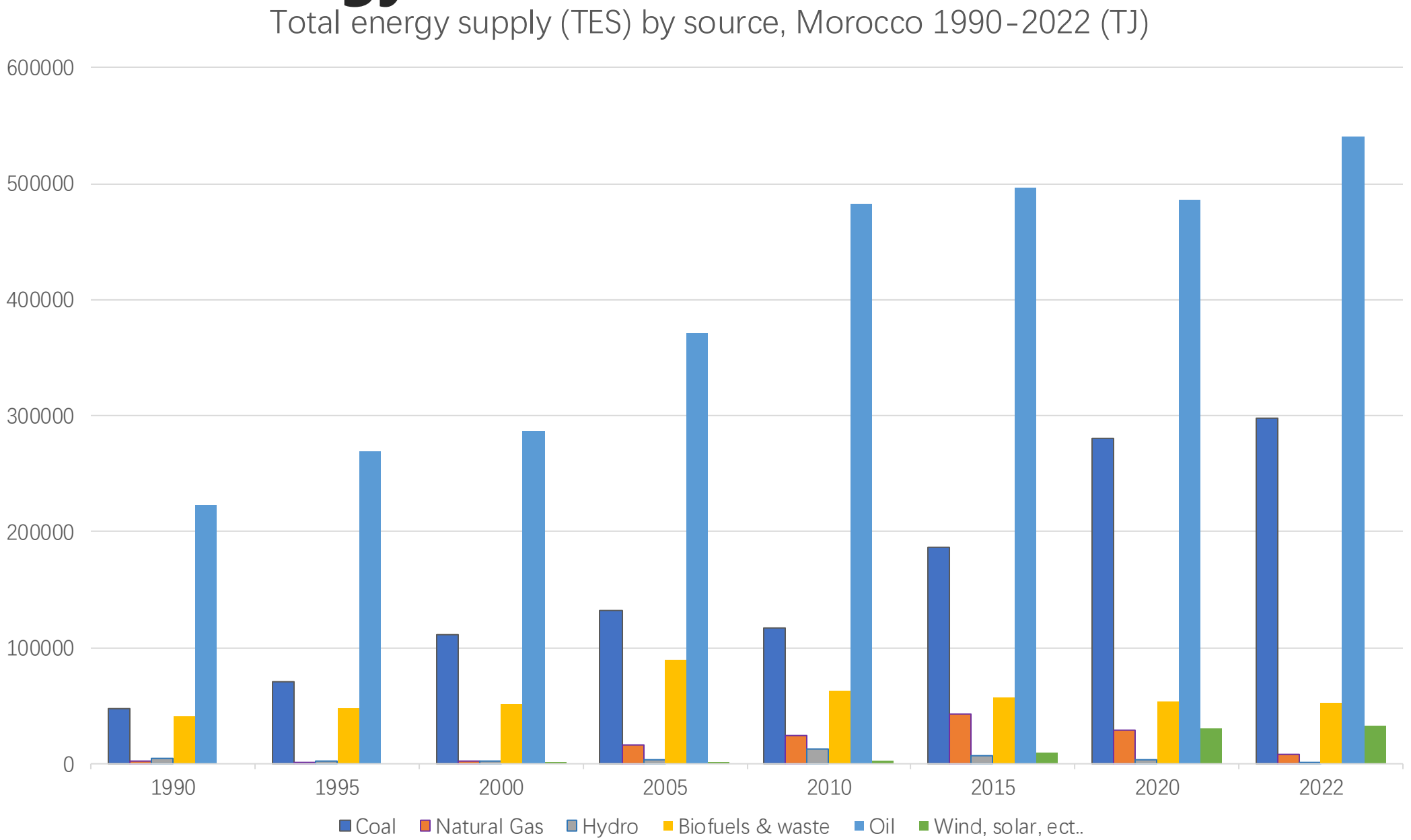
Energy bill is a real burden for the national economy

Morocco's energy sector depends heavily on imported hydrocarbons. Currently, the country imports approximately 90 percent of its energy needs.

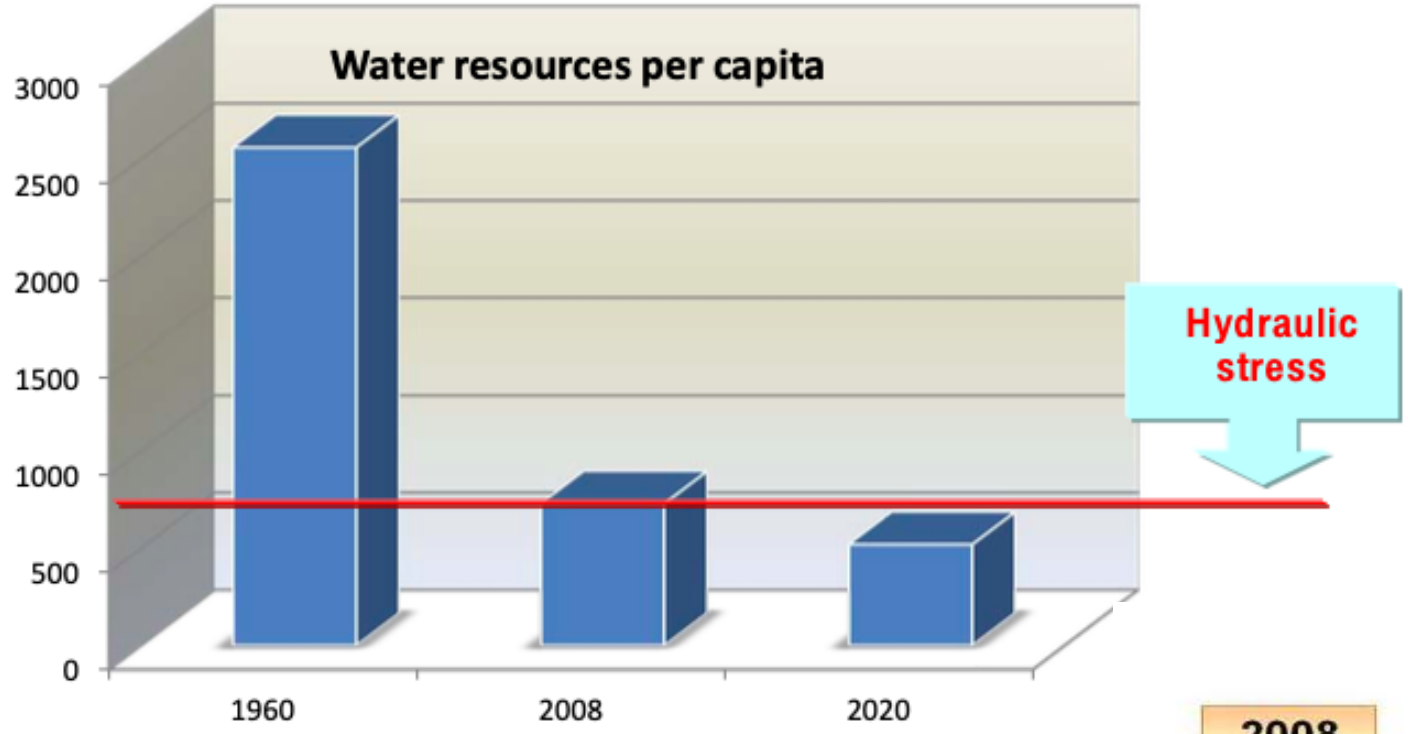
Total primary energy consumption has increased by about 5 percent per year since 2004, but Morocco plans to decrease energy consumption by 15 percent from 2016 levels by 2030 through energy efficiency measures.



Morocco Energy Mix

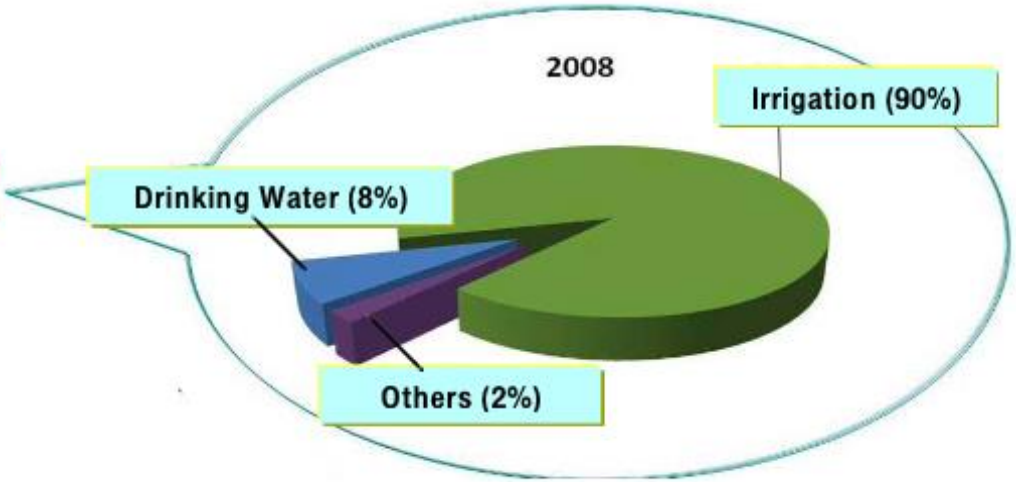


Key challenges in water scarcity and growing demand for water in agricultural regions



2008

13.7 milliards m³



Water strategy

Mobilization of conventional water: 130 large dams with a total capacity of nearly 18 billion CM

Mobilization of non conventional water: Desalination water

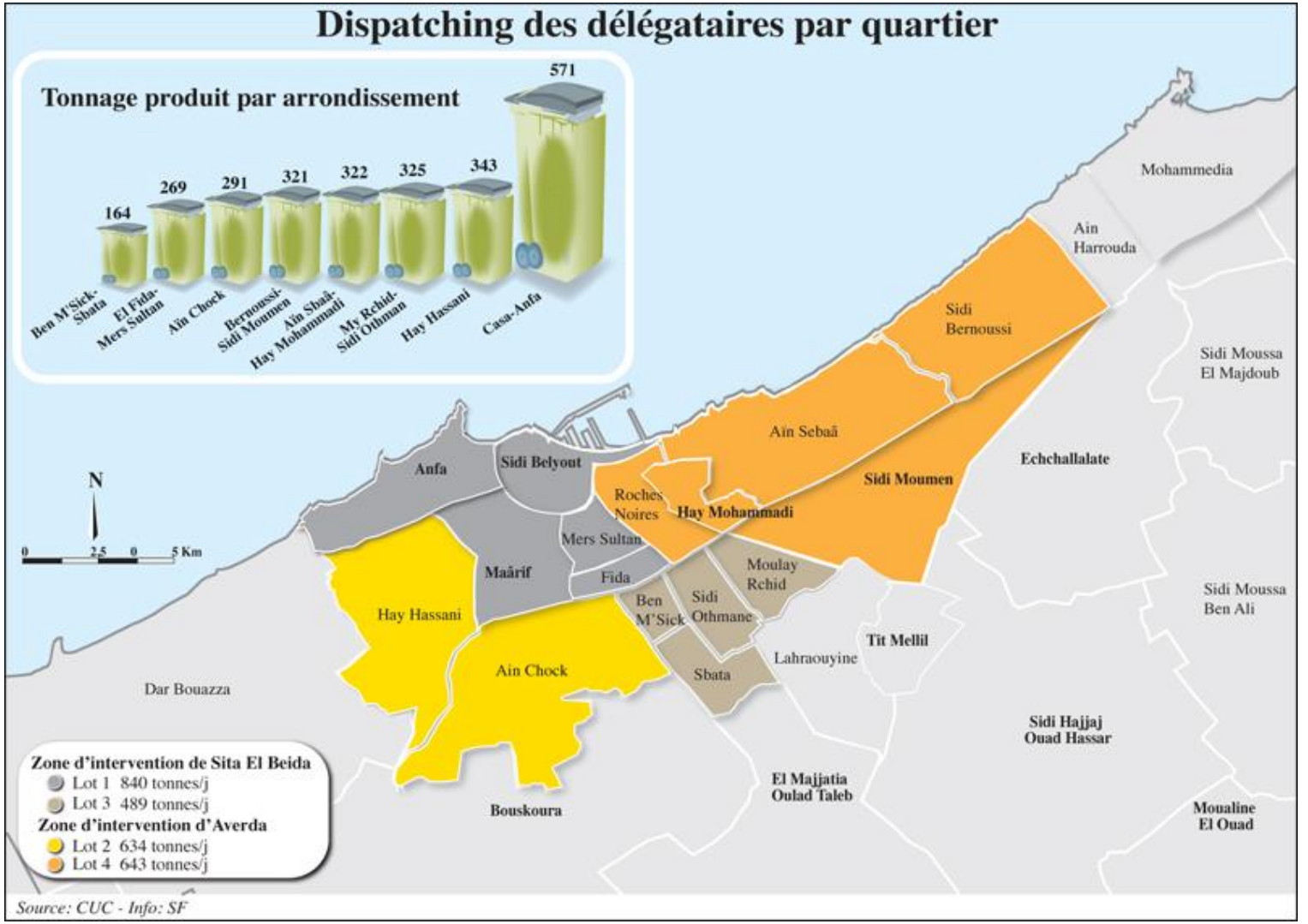
Part 4

4

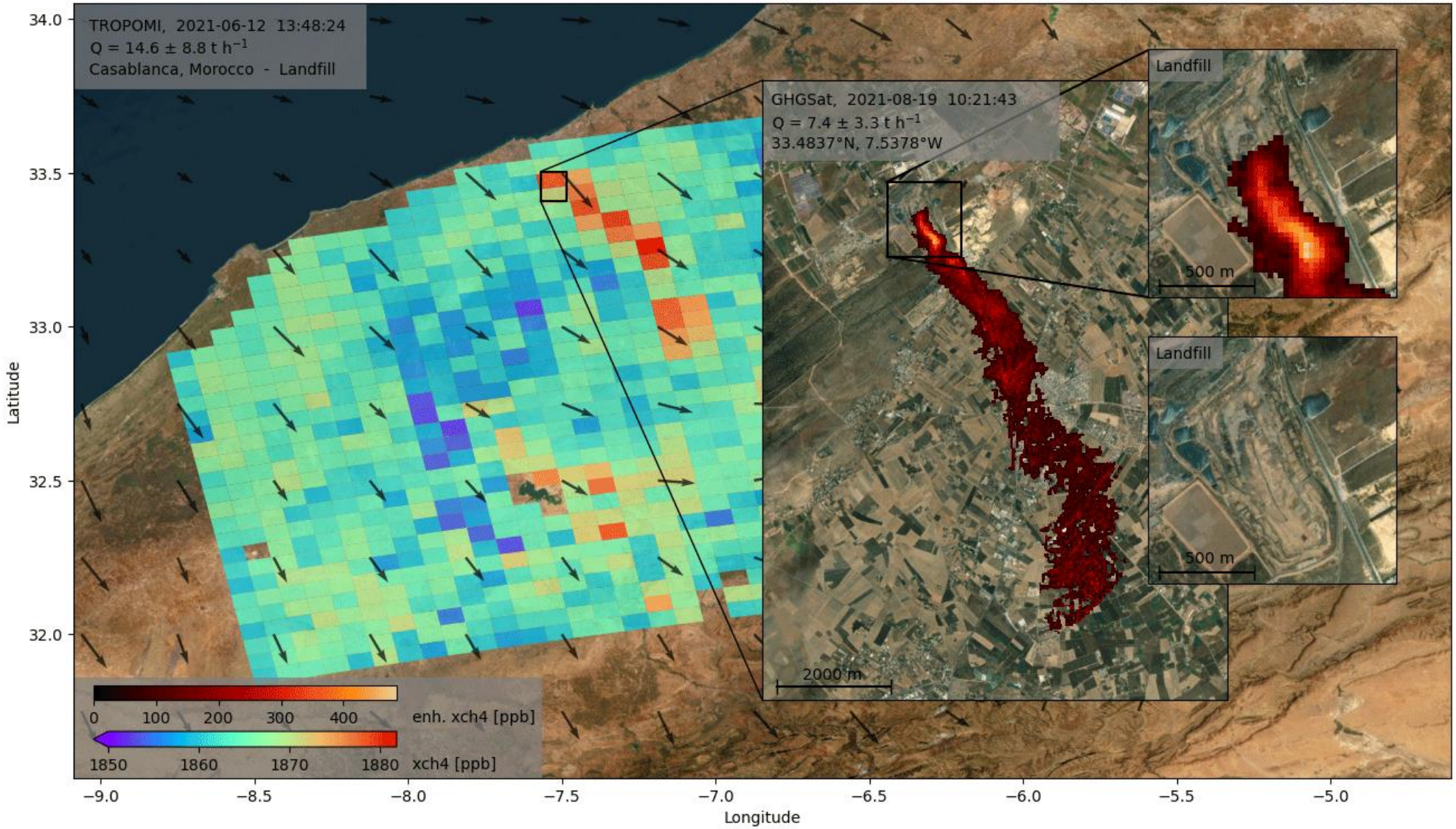
Waste-to-Energy to Water?

Waste-to-Energy-and-Water, Using WTE to meet water and energy challenges in Morocco

- Casablanca (4.5 millions inhabitants)
  1.5 million tons MSW)
- Largest seawater desalination plant in Casablanca
- Budget $1.05 billion
- Planned to be delivered in 2027
- Producuction ~ 300 million m3 of wate/year



Methane Emission from Casablanca Landfills



Circular Economy Concept

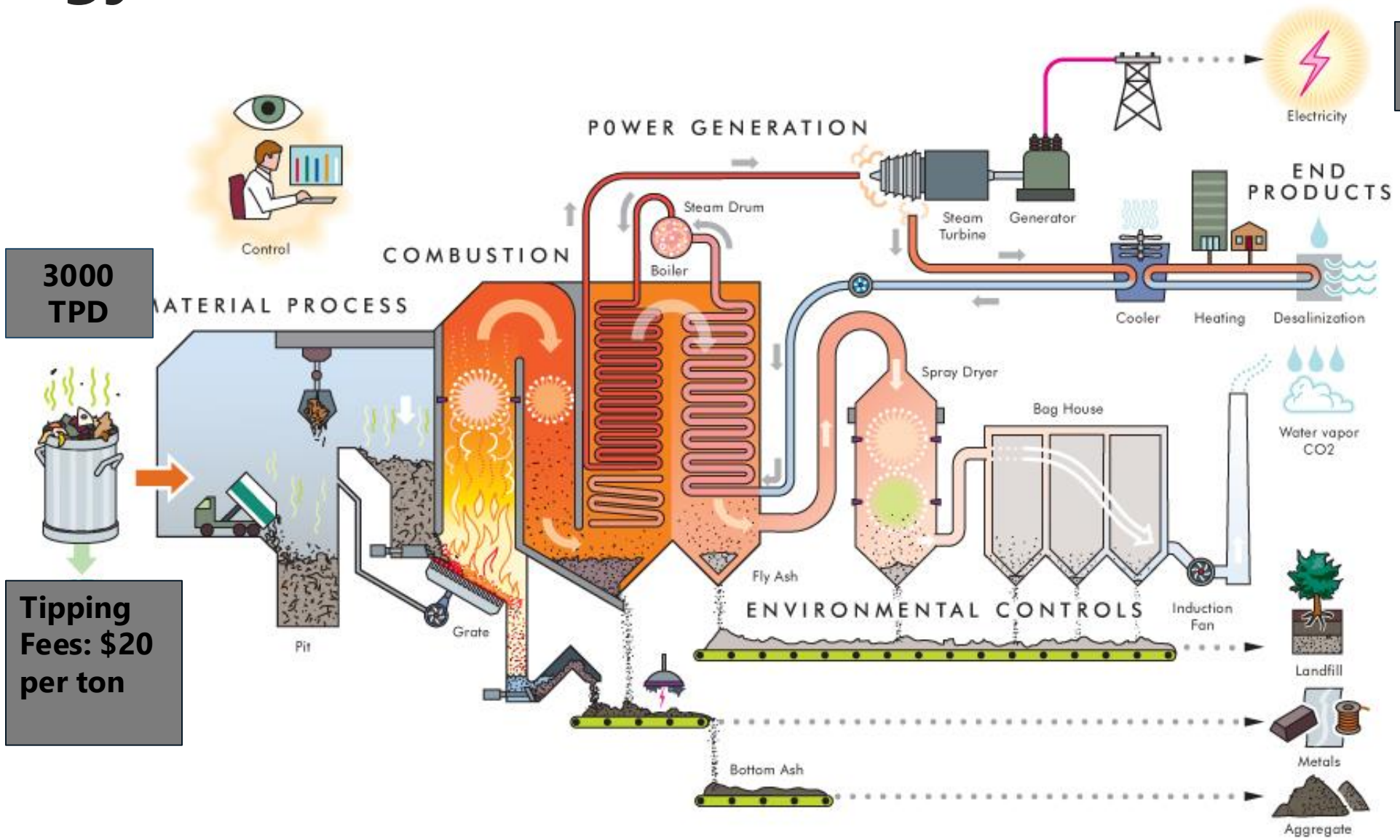
Implementing Waste-to-Energy Plant

Phasing out Landfill

Supply Energy to Desalination plants

Feed-in Tariff Model for Casablanca's Waste-to-Energy Plant

$0.07 per kWh



3000 TPD

Tipping Fees: $20 per ton

Feed-in Tariff Model for Casablanca's Waste-to-Energy Plant

Key Assumptions:

- **Waste Capacity:** 3,000 tons/day
- **Tipping Fee:** $20 USD/ton
- **Electricity Price:** $0.07 USD/kWh
- **Electricity Generated:** 600 kWh/ton
- **Operating Costs:** $30 USD/ton
- **CAPEX:** $300 million USD

Financial Overview:

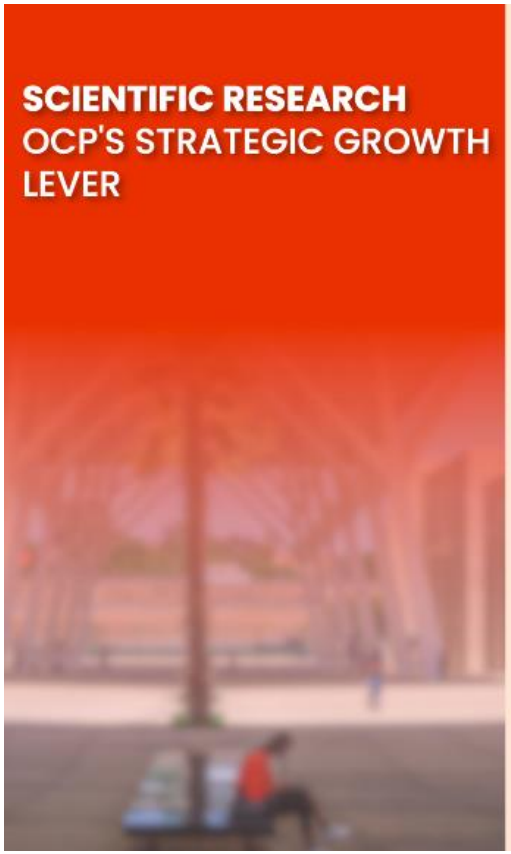
- **Annual Waste Processed:** 990,000 tons
- **Electricity Produced:** 594 GWh/year
- **Electricity Revenue:** $41.6 million/year
- **Tipping Fee Revenue:** $19.8 million/year
- **Operating Costs:** $29.7 million/year
- **Net Revenue (Pre-FiT):** $31.7 million/year
- **Annual ROI Required:** $24 million/year

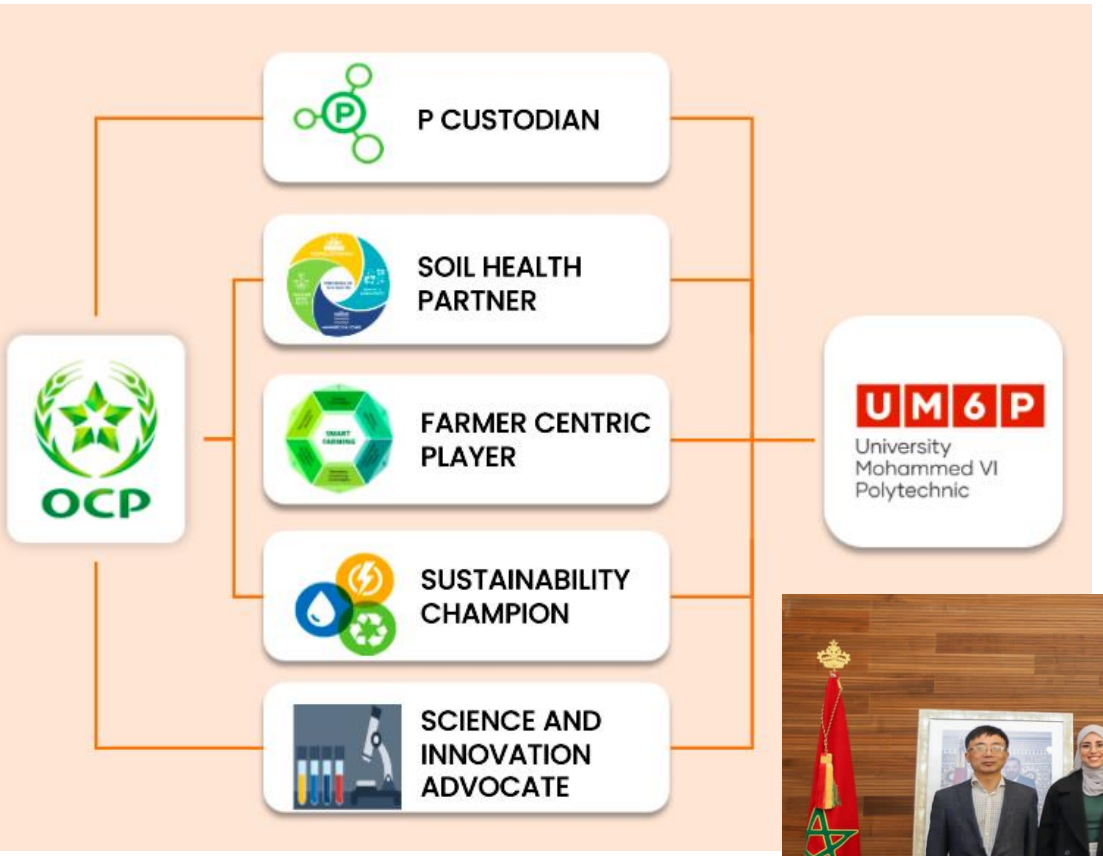
Feed-in Tariff (FiT) Requirement:

- **Required FiT: $0.04 USD/kWh (4 cents/kWh)**

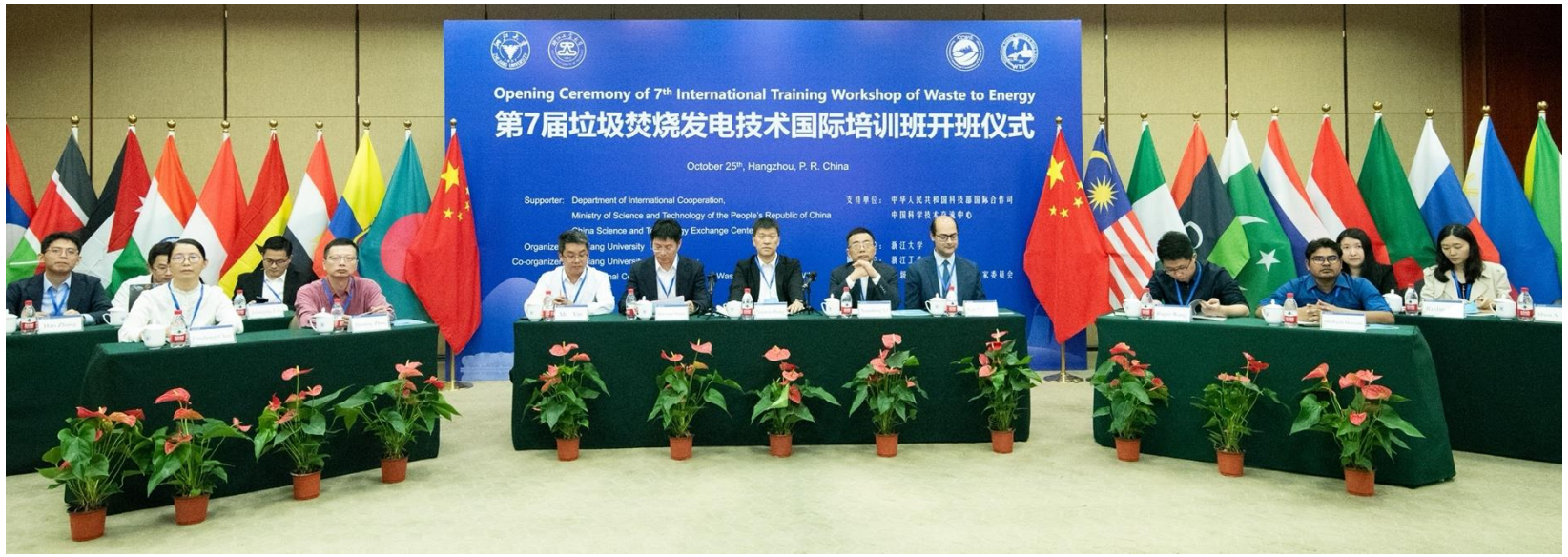
To make the Casablanca WtE plant economically feasible, a feed-in tariff (FiT) of approximately $0.04 USD/kWh would be required. This FiT could be funded in part by revenues from the agricultural sector ($10 billion)

Partnership with UM6P WtERT Morocco network

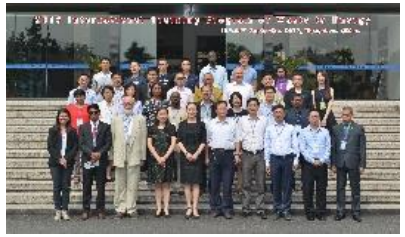


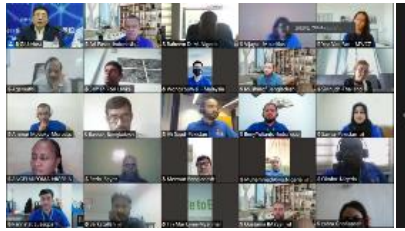


International Training Workshop



Since 2016





The training workshop will help improve their skills and promote international cooperation.
Since 2016, six WtE training workshops benefitting 151 participants from 27 developing countries.

Two candidates from UM6P will take part of the 8th edition

Thank You

Thoughts & Suggestions?

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