

HVDC scale-up of Africa-Europe's interconnection: The Sahara Wind project

HORIZON 2050 POWER SYSTEMS

ROLE OF HVDC TECHNOLOGIES IN A HIGHLY DECENTRALISED RES GENERATION

DG ENERGY

Tuesday February 04th, 2020

Brussels, Belgium

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Managing Director - Sahara Wind



*This project
is supported by:*

The NATO Science for Peace
and Security Programme

Morocco's Wind Power Sector

- Operational: 1.2 GW
- Under construction: + 1.2 GW (integrated wind program)
2.4 GW Total

Accessing Atlantic Trade Winds:

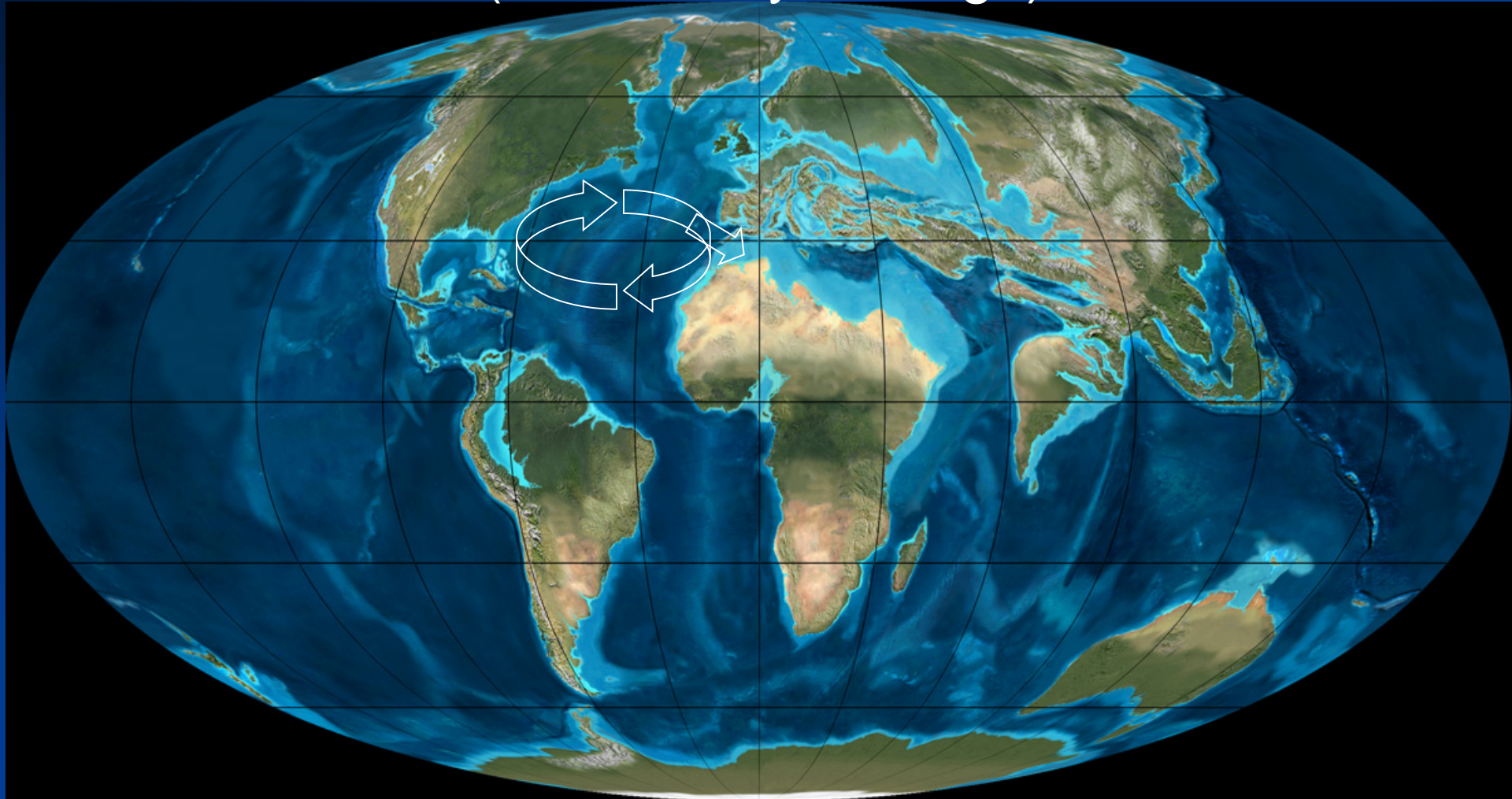
- ✓ Trade Winds 1300km Away from Loads: AC Transfer losses + Phase Shifts
- ✓ Morocco's Total Capacity 10.9 GW / Peak Load 6.3 GW
- ✓ Dispatching Challenges
 - ✓ Total by 2030: Wind 4.9GW/17.8GWh + PV 4.5GW/6.6GWh + CSP 0.7GW/1.9GWh

⇒ Regional Dimension Needed:

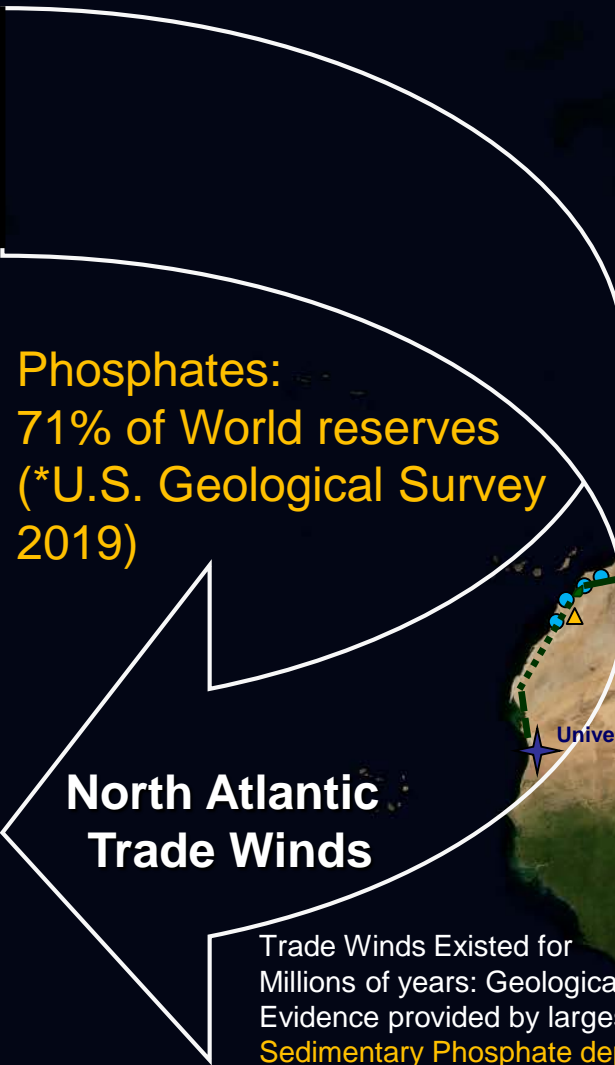
Sahara Wind Project (5~10GW HVDC Line)

- ✓ Morocco RE Law 13-09, 58-15, 40-19 self-consumption with surplus exports
- ✓ EU 3x20 Directive RE imports from 3rd countries
- ✓ Strategic long-term vision for a climate-neutral EU economy by 2050
- ✓ COP UNFCCC frameworks

Trade Wind-Currents over Paleontological Map (50 Million years ago)



Sahara Wind: NATO SfP-982620 Framework



Potash:
▲ 55% of World reserves
(*U.S. Geological Survey 2014)

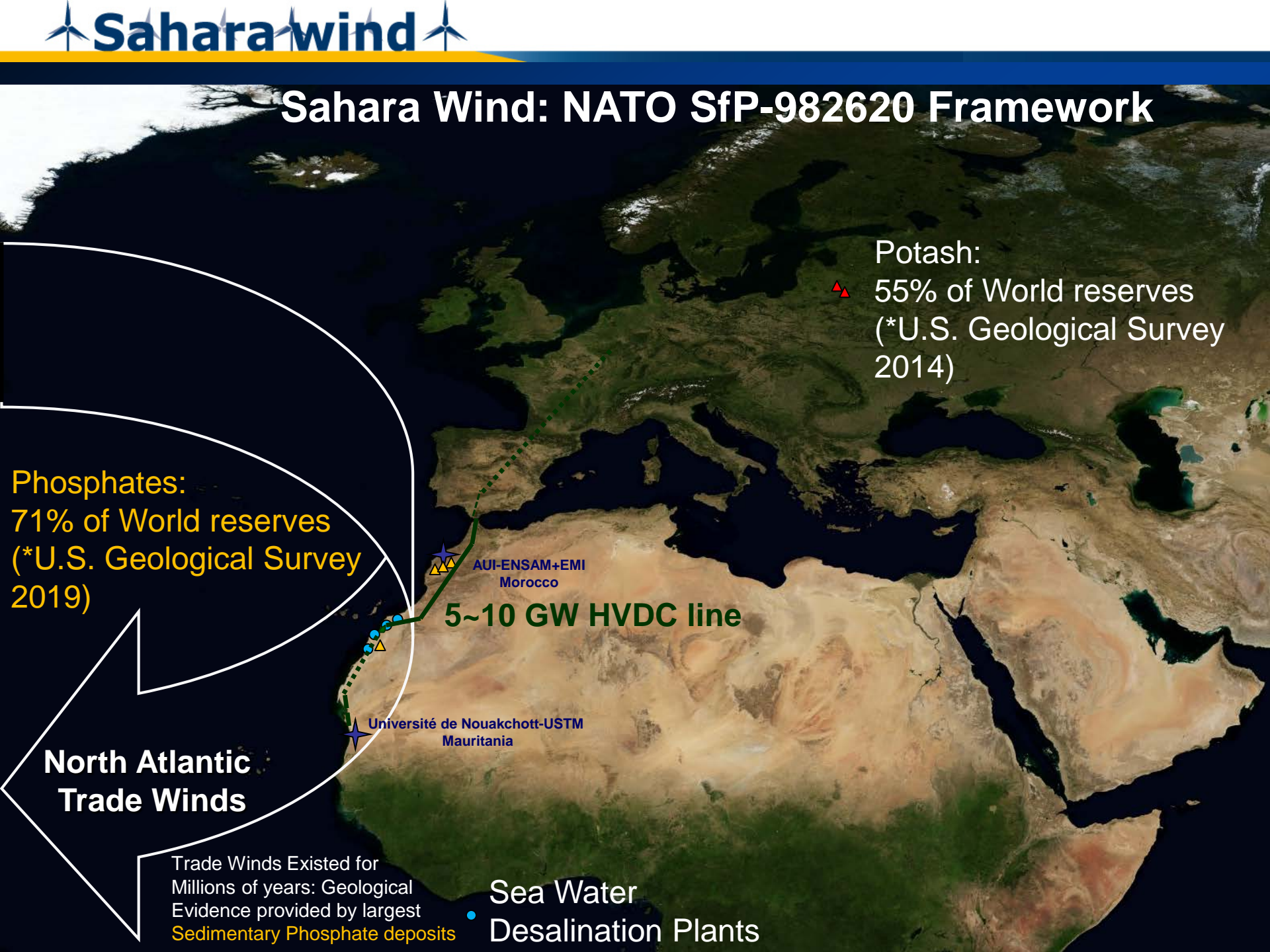
Phosphates:
71% of World reserves
(*U.S. Geological Survey 2019)

AUI-ENSAM+EMI
Morocco
5~10 GW HVDC line

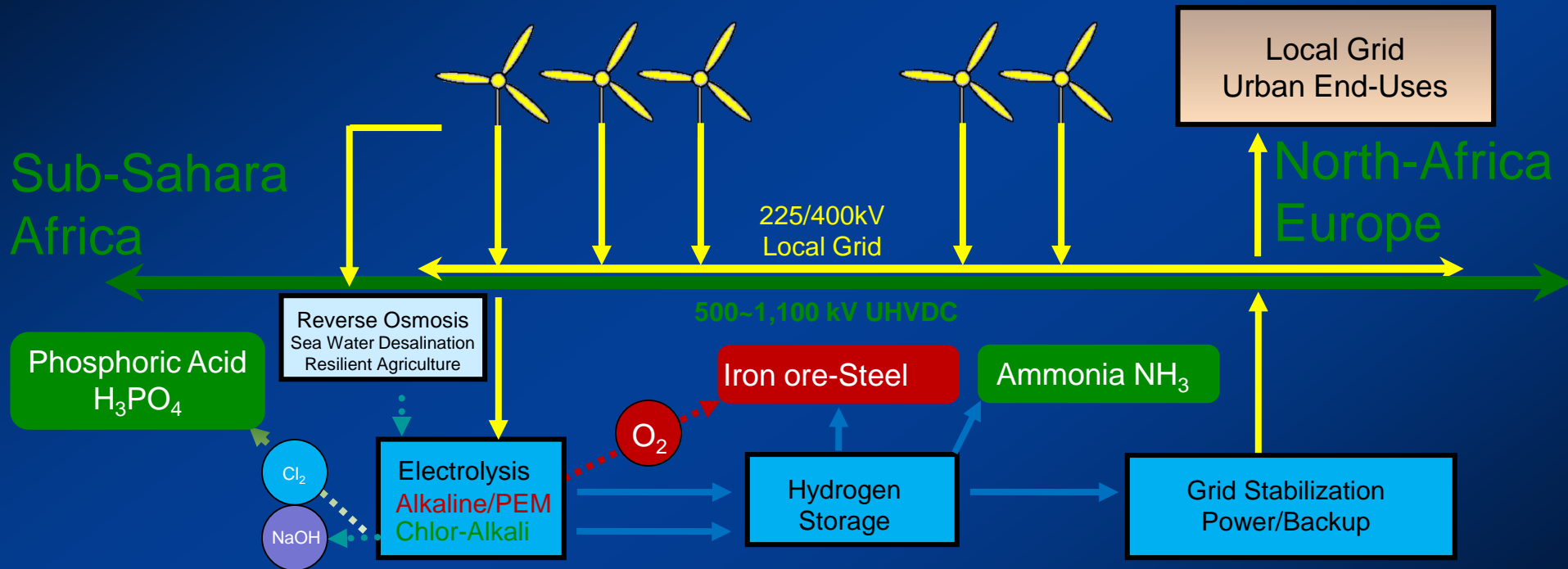
Université de Nouakchott-USTM
Mauritania

Trade Winds Existed for Millions of years: Geological Evidence provided by largest Sedimentary Phosphate deposits

Sea Water Desalination Plants



Powering Africa's Global Industries Phosphates/Fertilizer (Morocco) & Iron-Ore/Steel (Mauritania)



■ Phosphates 35%, Phosphoric Acid 52%, Fertilizer 20% (World Export Market Shares)

■ Iron-ore/Steel (Mauritania) 16~40 Mtons iron-ore exports processed into CO_2 -free steel

Sahara Wind's 5~10 GW HVDC LCC configuration

Sahara Wind Farms
(1250 MW modules)

VHV AC
Bus

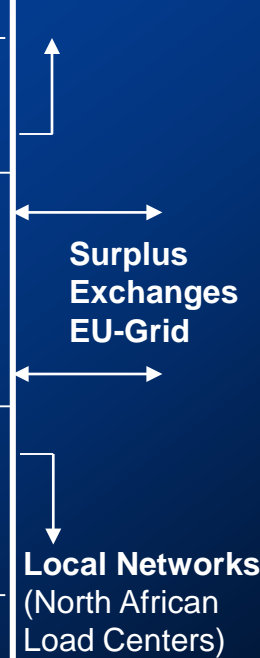
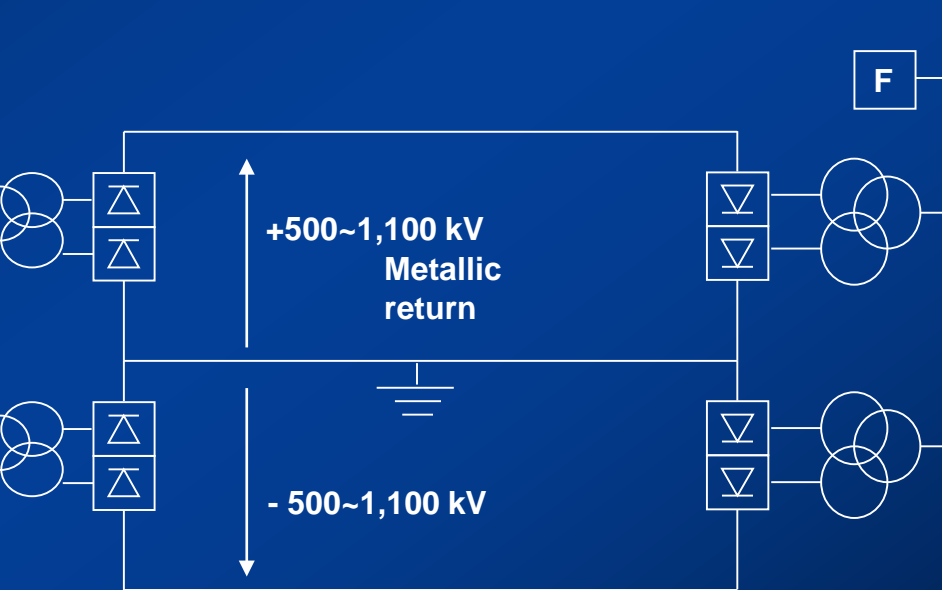
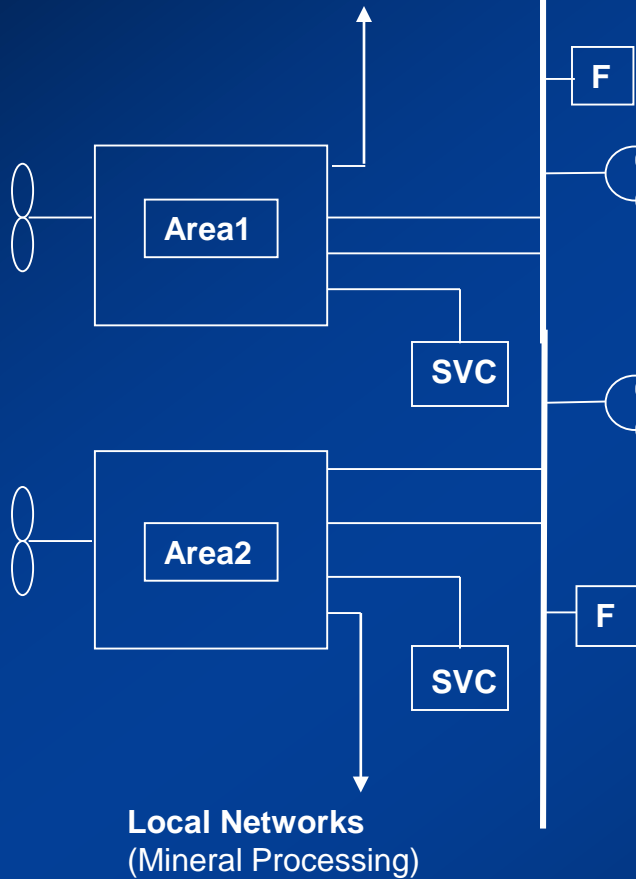
Rectifier
12 pulse
bridge

Inverter
12 pulse
bridge

VHV AC
Bus

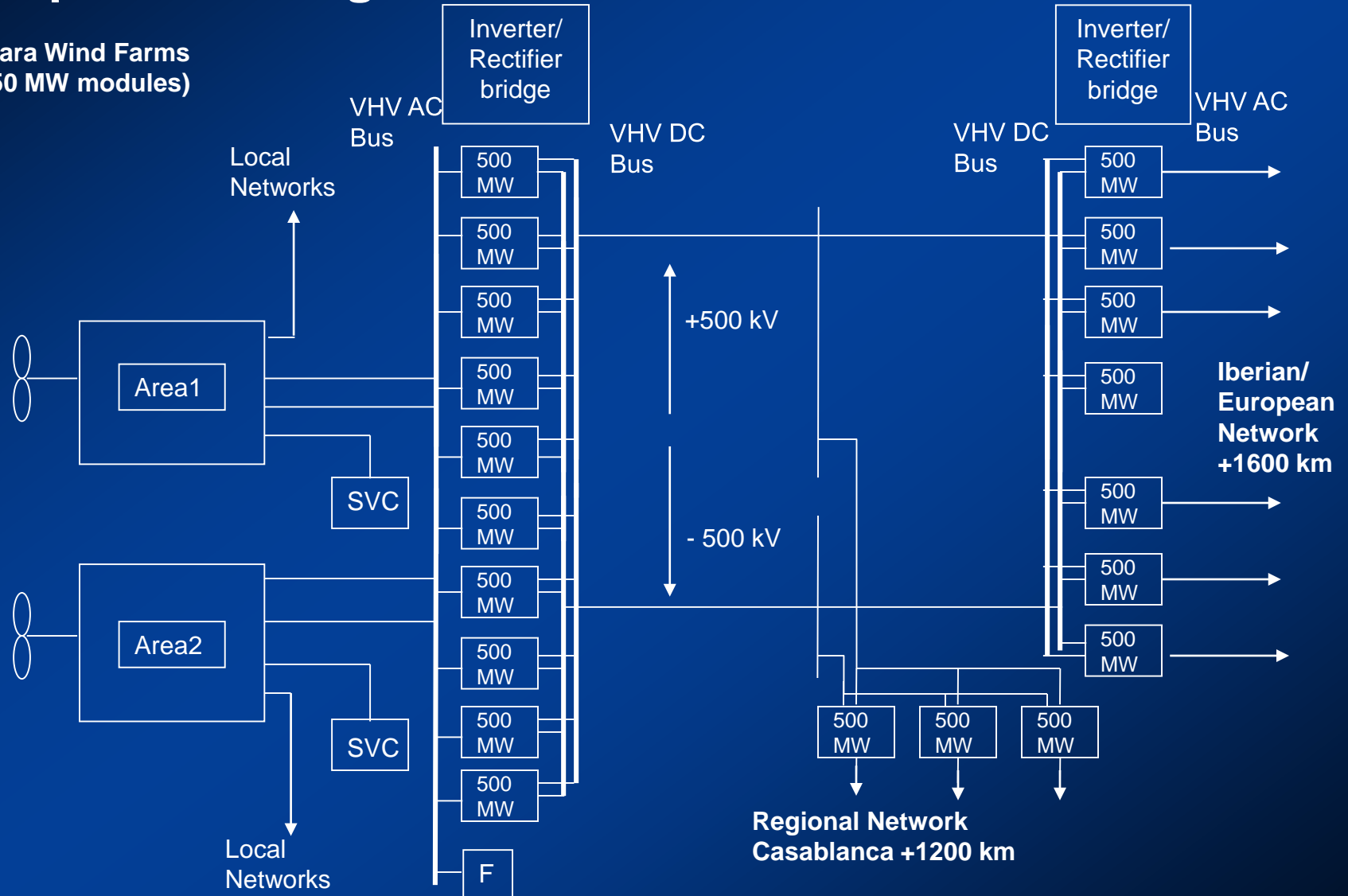
Local Networks
(Morocco
Load Centers)

Local Networks
(Urban-Industry loads / desalination)



Sahara Wind - 5 GW HVDC Alternate SVC Evolutive Multipoints Configuration

Sahara Wind Farms
(1250 MW modules)



The Sahara Wind Project (5~10GW HVDC line)

Multilateral Stage for Future Wind Developments:

Joint UNDP-GEF-WB PIMS # 3292 'Morocco: Sahara Wind Phase I/Tarfaya (400-500 MW) on –Grid Wind Electricity in a Liberalized Market' Terms of References of HVDC-line established with ONEE (Submitted in 2005)

NATO funded R&D (2006-present): Capacity Building for Sahara Wind Project

•Point to point HVDC Technology:

✓ Limited losses (3% over 1300Km \pm 500kV for 5 GW), 12 GW-UHVDC 3300km Changji-Guquan project, many others India, Brazil, USA, Canada...

- Growing African/North-African markets
- 2000 km Wind Catchment Area (Morocco, Mauritania & Senegal Onshore Wind <500GW + Offshore potential)
- Wind Capacity Factor +60% (China 22%)
- 1500km from EU & Sub-Sahara markets

