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Spreading Awareness of Wind Opportunities…

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Energy Development Project

WWEC 2003

Cape Town, South Africa
November 24, 2003

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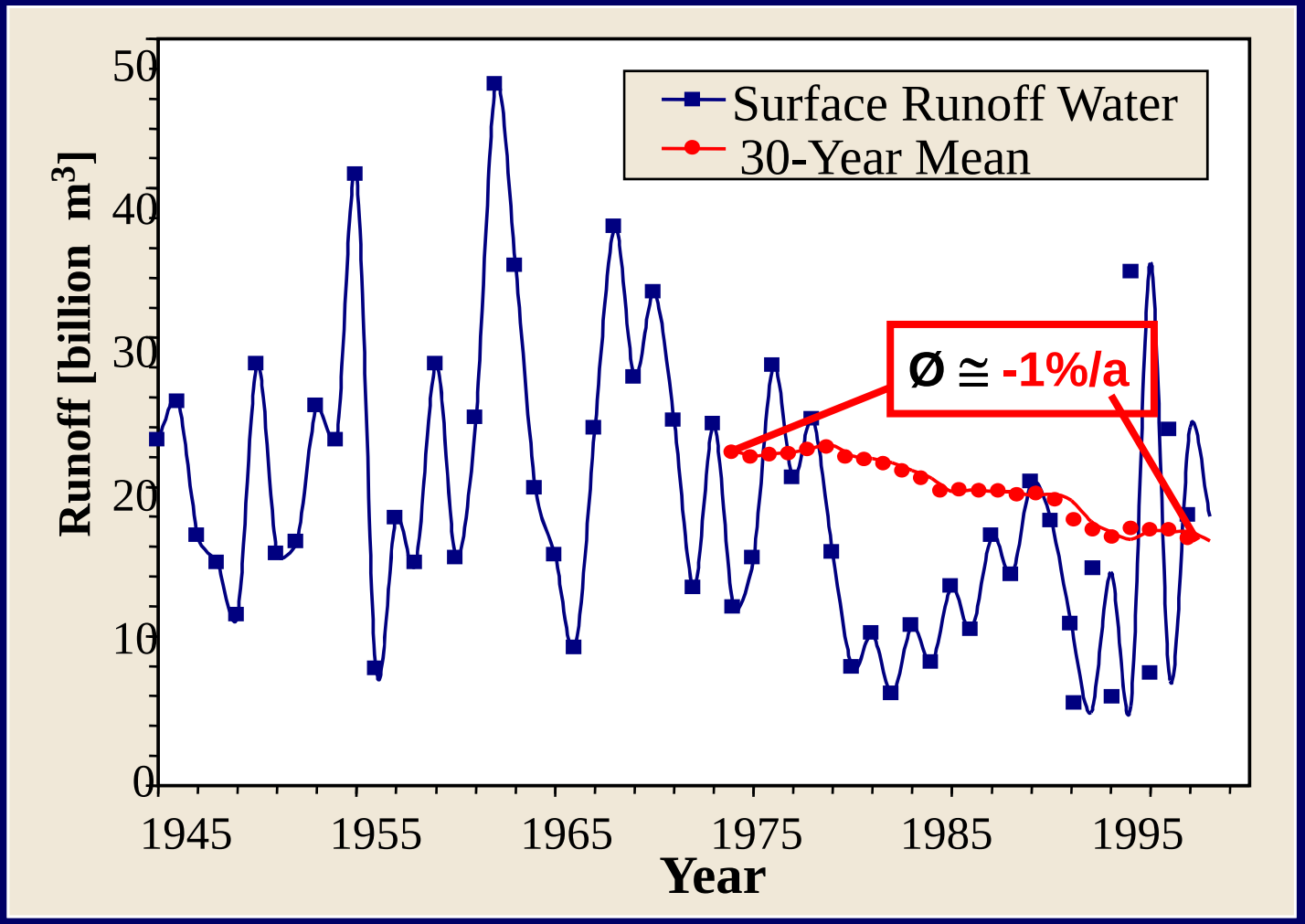
Background on Renewable Energy Use

Current Energy Issues:

- Depletion of Fossil Fuels Worldwide
- Heavy & Increasing Dependency of Supply
- Growing Need for Electricity Worldwide
- Concerns over Carbon Densities in the Atmosphere
- Unpredictable Consequences on the Environment…

Evidence of Climate change:

Rainfall Drop Leading to Desertification in Morocco



Source: A. Bennouna, G. Knies, 2002

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Sustainable Energy Future Means:

- Greater Share of Renewable Energy in Global Energy Mix

- Of which, Wind Power is one of the Least Expensive...

=> The Price of Wind Energy has been divided by 4 in the last 20 year

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Wind Power is a **European** “Success” Story:

World Installed Wind Power Capacity: 31,128 MW (Start 2003)

Europe (EU) :	**23,056 MW (74%)**
USA :	4,685 MW (16%)
Rest of the World:	3,387 MW (10%)

Latest Trend: **88%** of the wind power installed in 2002 has been added in Europe (EU) !

Europe’s Wind Power potential is Characterized by:

- Low Wind Resource
- Limited Space
- High Population Density

Wind Resource

• In Europe, local Winds are influenced by local climatic conditions & topography.

The Trade Winds are a Powerful Wind System driven by 'Global' Temperature & Latitude differences over the Earth.
They are the result of:

- Direct Sunlight over the **Equator** versus 'none' on the Poles.
- Rotation of the Earth (Coriolis force).

On the Saharan Coastline, Trade Winds & Local Winds are Superimposed ...

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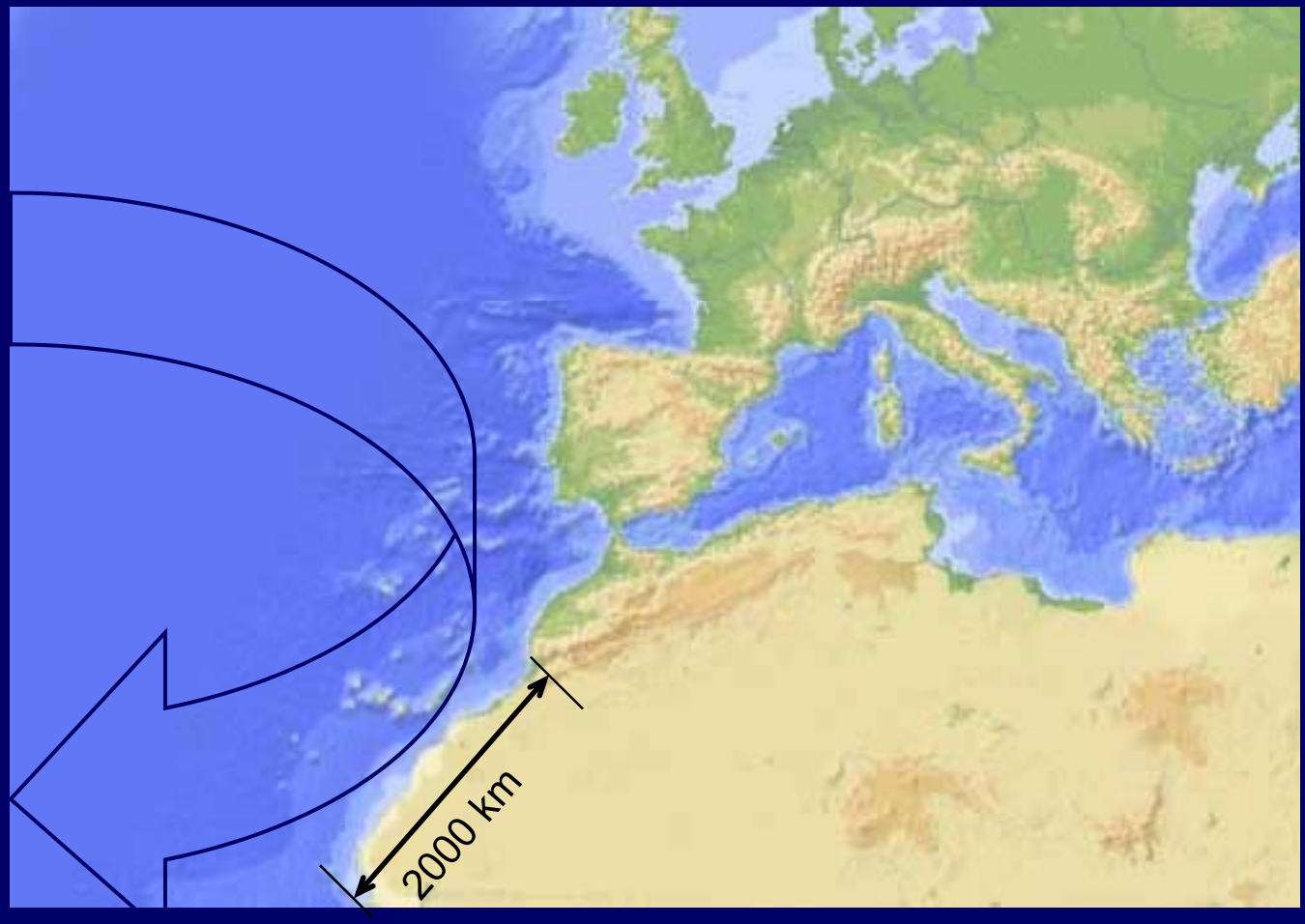
Space Availability

In a few EU countries, (Germany) the Saturation of usable sites will happen within a few years, unless...

Trade Winds



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Population Density

Sahara Desert: Extremely Low Population Density !

- Large Area, flat eroded plateaus
- Coast: 2000 Km / 1,300 miles Long
- Over 95% stone “Martian looking” surface
- No rainfall, no vegetation
- Life & Economic activity hardly sustainable
- Sparsely inhabited Territory
- But : High Steady Winds...

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Saharan West Coast Wind Energy Potential

Possible Production of **over 1000 TWh/year**
(EU Total Electrical production : 2100 TWh/year)

This represents several dozen times the **COMBINED** Electricity Requirements of **North Africa**

No on-site demand for electrical load:

- Major cities far away North (1000 km+)
- Population of less than 1 habitant/km^2
- Very Small Economies
- Desalination for Agriculture still remote...

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Test Site : Tiniguir Farm

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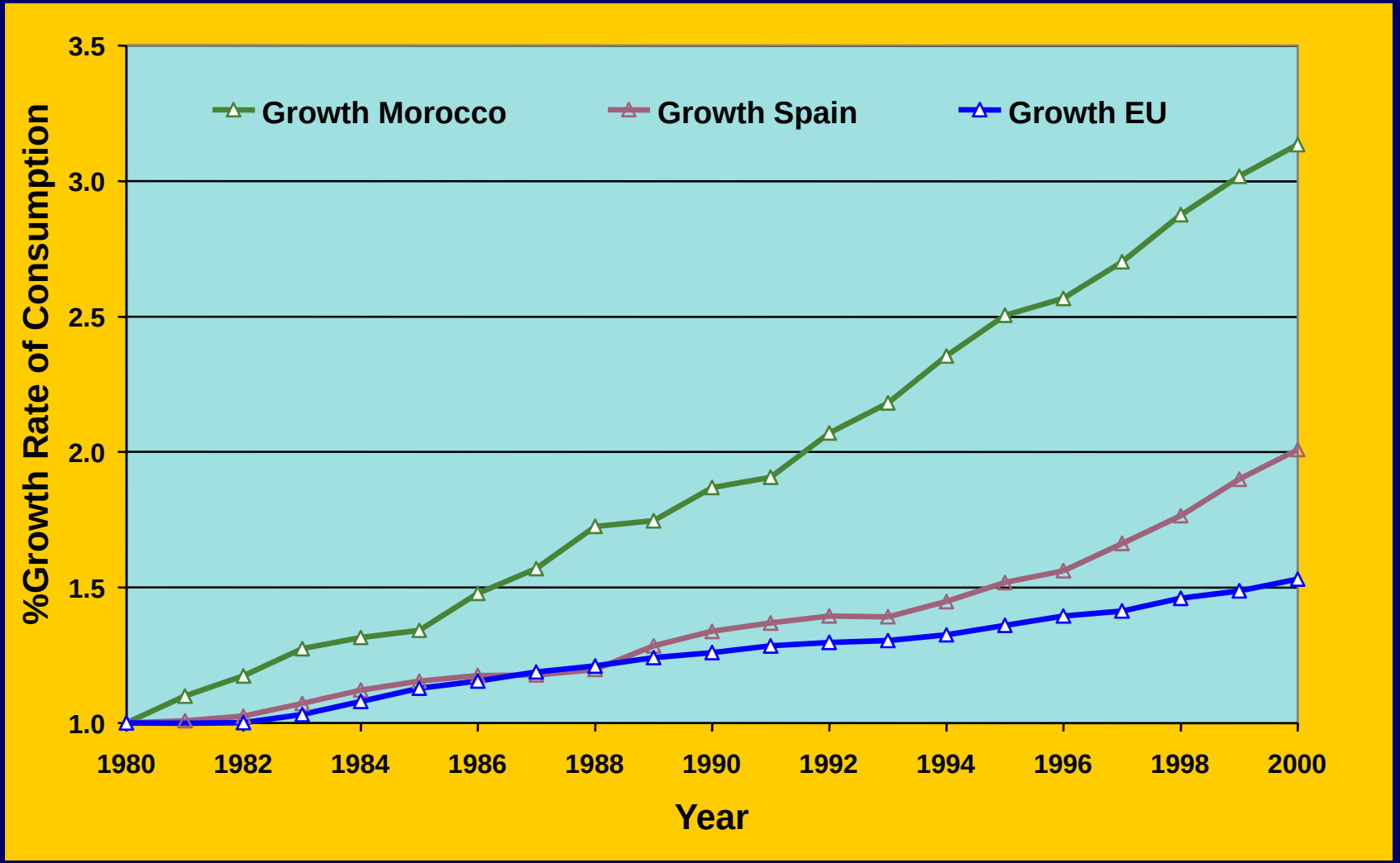
Electricity Growth Rate



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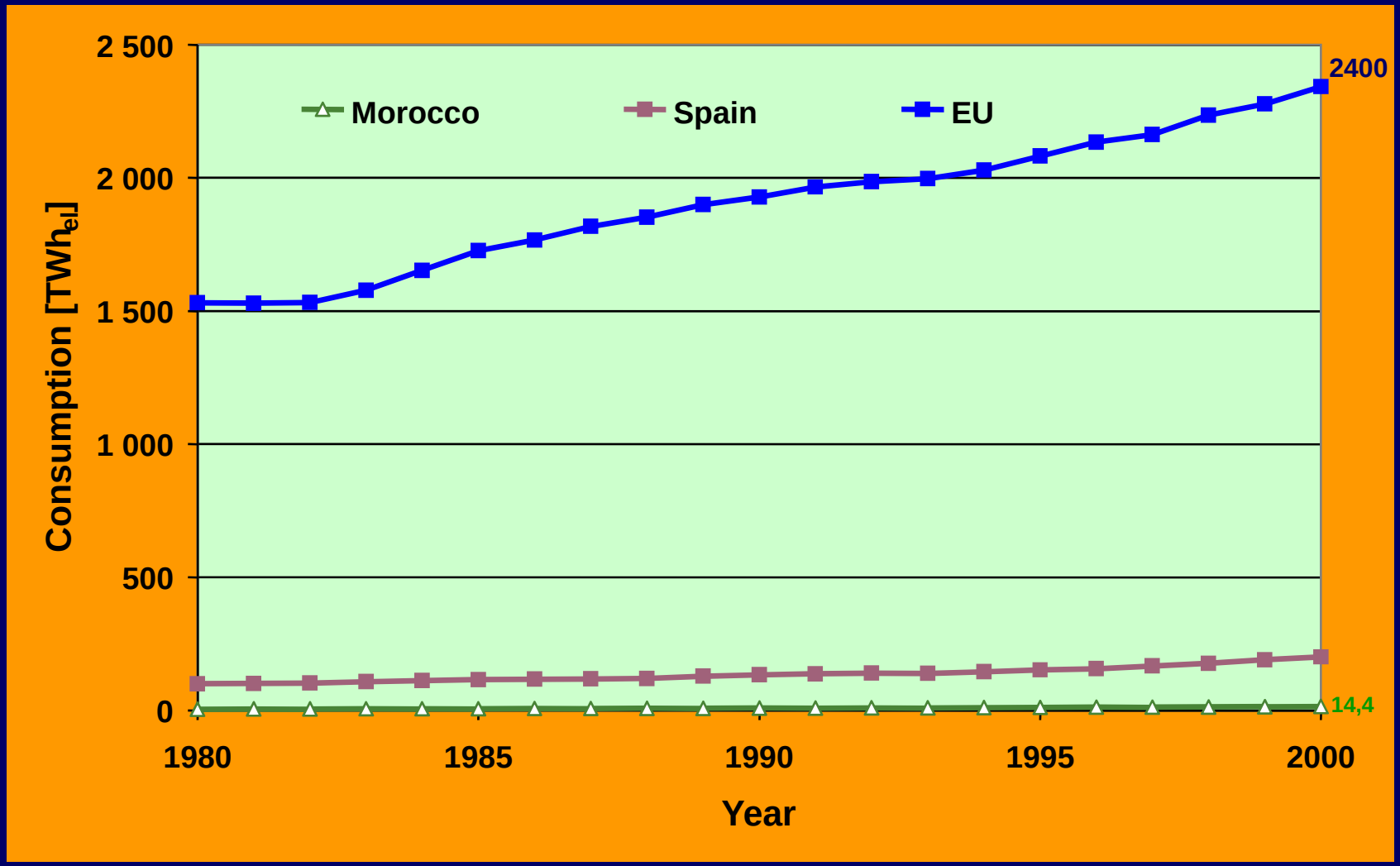
Comparison of Electricity Consumption



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Power generation capacity by type of plant in EU-25, 1995-2030.

	GWe					%Share	
	1995	**2000**	**2010**	**2020**	**2030**	**2000**	**2030**
Nuclear	134.7	140.3	129.8	108.0	107.8	21.4	9.5
Large Hydro (pumping excl.)	91.0	93.9	95.8	96.3	97.0	14.3	8.6
Small Hydro	2.0	2.1	8.1	12.2	14.5	0.3	1.3
Wind	2.5	12.8	73.5	104.7	135.0	2.0	11.9
Other renewables	0.0	0.2	0.5	0.7	14.3	0.0	1.3
Thermal plants	381.4	406.1	484.8	639.0	762.9	62.0	67.4
of which cogeneration plants	80.7	93.2	117.6	150.9	179.5	14.2	15.9
Open cycle - Fossil fuel	339.4	335.2	278.9	210.0	196.8	51.1	17.4
Clean Coal and Lignite	0.0	0.0	0.0	0.8	5.5	0.0	0.5
Supercritical Polyvalent	0.0	0.0	0.8	55.3	126.3	0.0	11.2
Gas Turbines Combined Cycle	20.0	47.3	173.3	313.8	367.4	7.2	32.5
Small Gas Turbines	21.2	22.7	30.6	57.8	65.5	3.5	5.8
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.7	1.0	1.2	1.3	1.4	0.2	0.1
Total	**612**	**655**	**793**	**961**	**1132**	**100**	**100**
current EU	539	579	689	813	951	88	84
acceding countries	73	77	104	148	181	12	16

Source: PRIMES, ACE.

From the latest report ‘Trends to 2030’ of the EU Energy and Transport Directorate

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High Voltage Direct Current (HVDC) Technology

- Over 60 GW, in 80 Projects installed Worldwide.
- Low Transportation Costs per kWh for Large Capacities.
- Low losses over Long distances.
- At Full load, Estimated losses are less than 15% over 4500 Km with a 5 GW aerial line.
- The Itaipu HVDC 6,3 GW Hydro Transmission Project in Operation since 1987 with line Voltage ± 600 kV, supplies up to 1/3rd of Brazil's Electricity.
- Many other examples…

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Detailed Investment Costs of 5 GW Sahara Wind-EU (Spain)

In the year 2000: Spain´s Average Installed Wind Turbine Costs = **850 € / kW_{el}**

Features	base informations	Investment Costs
Wind Turbines	5 GW	1000 €/kWel.ratedpower
Rated voltage	+-600 kV	
Type	Double bipol	
Converting station	2 * 60 €/kW	120 €/kWel. ratedpower
Line Distance	1300 km	
Aerial line (2000 km)	70 €/(kW * 1000 km)	91 €/kWel. ratedpower
Sea cable (40 km)	700 €/(kW * 1000 km)	28 €/kWel. ratedpower
Total Investment cost		**1239 €/kWel. ratedpower**
Life time	20 (25) years Wind (HVDC)	
O & M Costs	2% of investment costs / year	
Real Interest rate	5.0%	
Transmission losses	6,5%	

Sahara Wind Cost per kWh: Euro 3.9 € cents

Current price paid within the EU: Euro 5.0 - 9.0 € cents

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Sea cable (40 km)	700 €/(kW*1000 km)	28 € /kWel
Total Investment cost		**1239 € /kWel**
Life time Wind	20 years	
Life time HVDC	25 years	
O & M Costs Wind	2.0%	
O & M Costs HVDC	1.0%	
Interest rate	5.60%	
Transmission losses	6.50%	
Full Load Hours (FLh)	3400 hrs	
	Share	Rate
Equity capital	30%	7.0%
Credit capital	70%	5.0%
Cost of Electricity		**3.92 € cents/kWh**

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5 GW Wind Power Project

Large Business Investment: 5-6 Billion EURO

Economically “Competitive”

Enhances Energy Security of Europe by adding new “clean” Elect. capacity with a diversified source of supply to its Grid.

Creates Industry & Jobs that match very well with North Africa’s socio-economic environment & provides new perspectives.

Enables Climate Change Mitigation Mechanisms through Sustainable Development Alternatives to be addressed on an Unprecedented Scale.

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Environmental Impact of a 5 GW Wind Power Project

If the production of this project was to be supplied by a Coal fired Plant:

- 21 Millions tons of Carbon Dioxide would have been released in the atmosphere every year.
- To offset these effects:

1,1 Billion Trees would be Required

This would be achieved in a Desert area where not a single Tree can be planted…

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Carbon Trade & Clean Development Mechanism

- At a price rate of Euro 5.0 / Ton CO_2, the carbon credit revenues alone would represent :
105 million Euro/ year.

This would offset all Operation & Maintenance costs for the entire Project, including the power lines.

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Costs: Sahara Wind Investment Project

- Wind Turbines 5 GW:
  (700 - 1000 Euro/kW): 3.5 - 4.5 Billion Euro

- HVDC Power Lines 1300 km:
  (70 Euro/kW): 700 Million Euro

- HVDC Converting Stations:
  (300 Euro/kW): 600 Million Euro

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Sahara Wind Project

- Provides a concrete example of possible solutions to global environmental challenges.
- Small share of EU's electricity supply, larger share of the Iberian peninsula that lags behind in meeting Kyoto targets.
- Represents a large investment opportunity in North Africa with cross-fertilization & tremendous industrialization prospects for the concerned areas.
- Potential for expansion…
- Could bridge the European Wind Energy Gap with the rest of the World, enabling it to expand beyond, to the South.
- Resource cannot be utilized otherwise.

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Duration & Timing of Sahara Wind Project

- September 2003: Moroccan Utility 'ONE' agrees to support & participate in the Sahara Wind Feasibility Studies.
- November 2003: Project's Terms of Reference for Wind Farms & HVDC transfer have been established.
- January 2004: Submission of UNDP/GEF sponsored PDF-B package incl. 1.5 Million$ ++ of Co-financing for various Institutional, Financial, Market Studies, Capacity building & Industrial integration, Phasing & Threshold capacities, Complete Wind resource assessment,...
- May 2004: A first Set of Feasibility Studies for HVDC transfer & Wind Farms will be completed.
- 2004-2006: Consolidation of the project's Framework, Finances, Investment conditions, Guaranties, Support mechanisms, CDM's etc.

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Sahara Wind Project

- Objective End 2006: Start of Project

Initial Threshold capacity to come on-line within the Moroccan grid, with 8 year of Implementation for the Full Project to reach 5 GW capacity with its HVDC transfer line.

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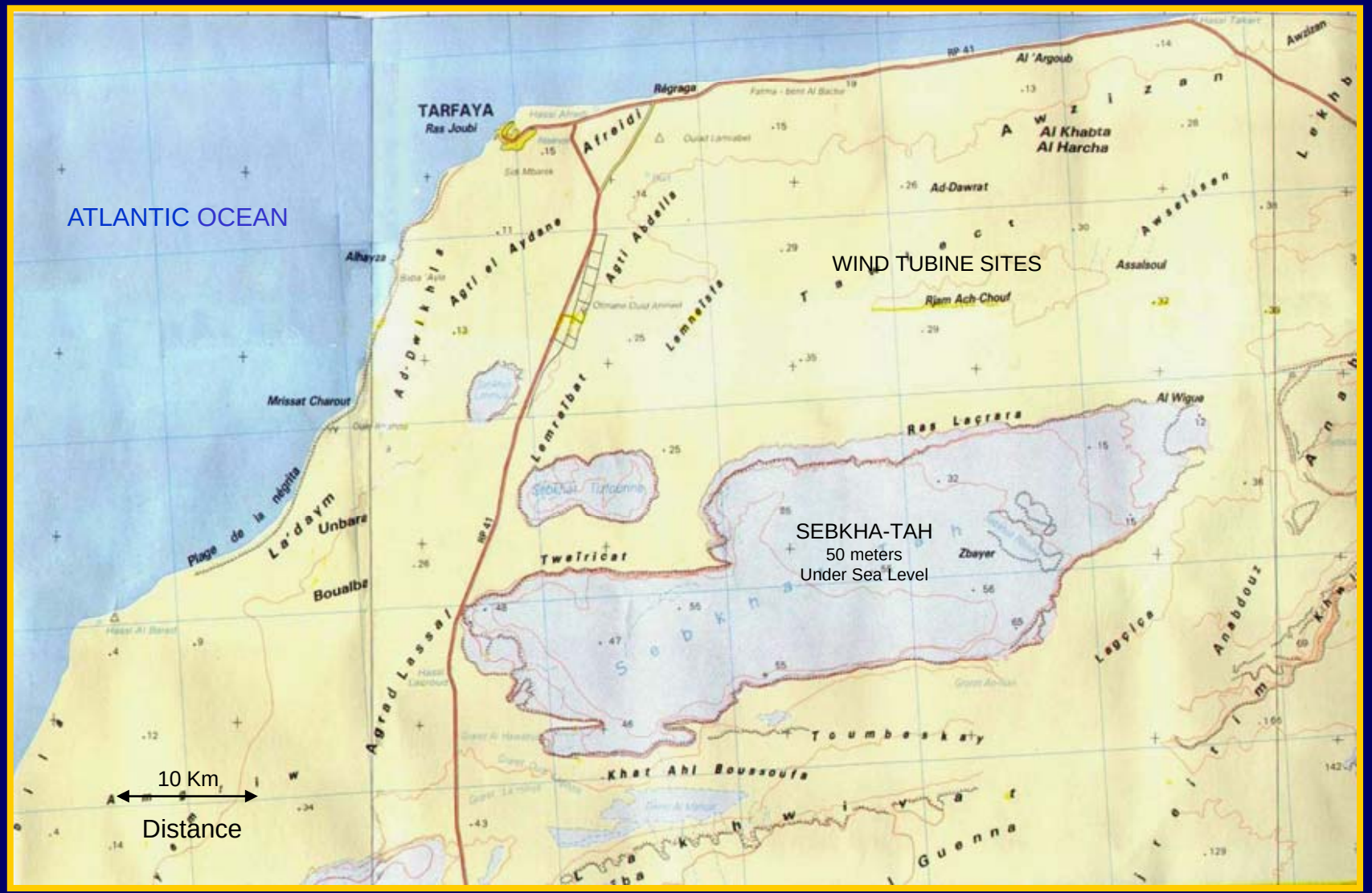
Sahara Wind Project: Tarfaya Site



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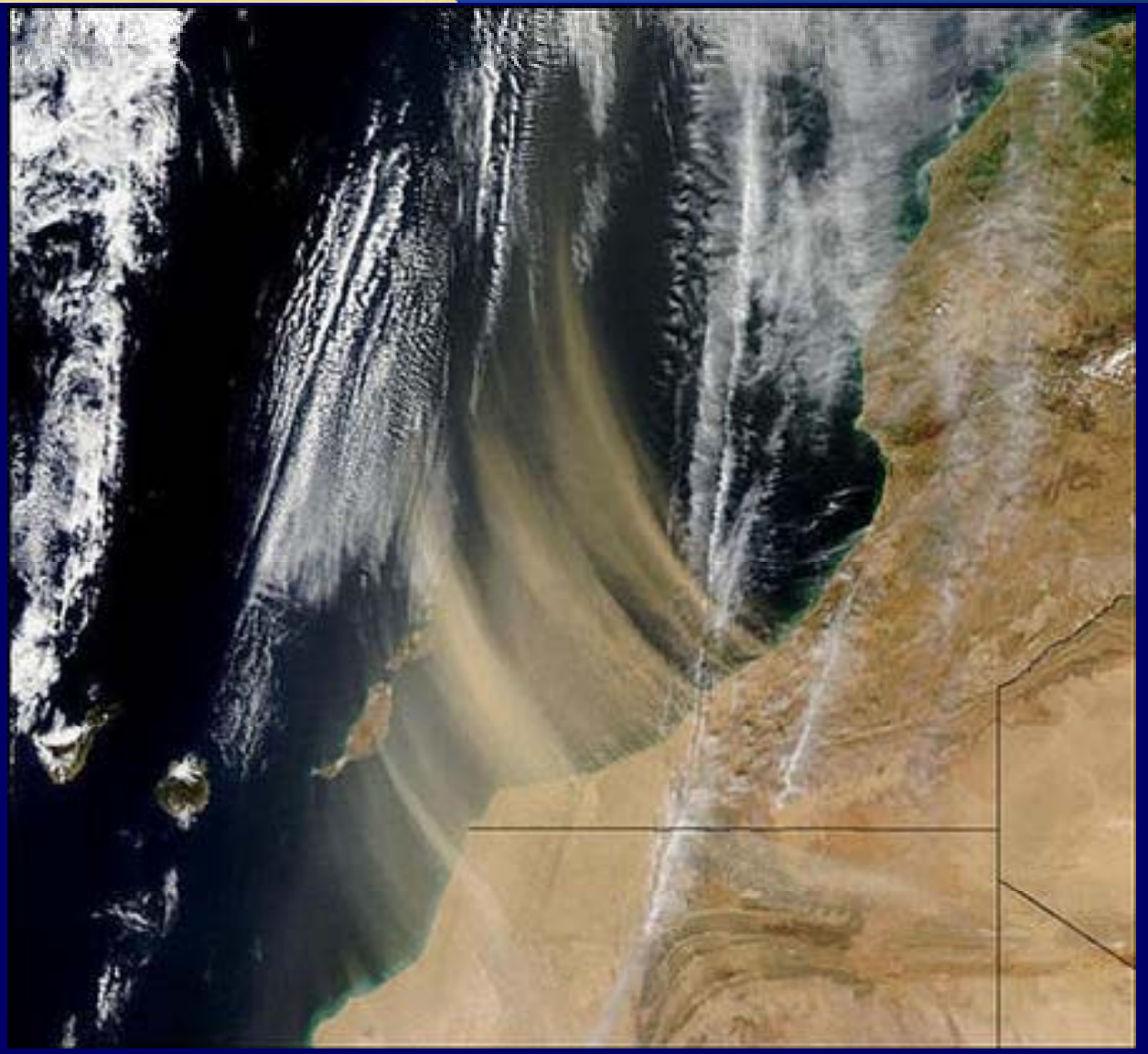

Wednesday, March 12, 2003 satellite image of a dust storm over Tarfaya, Morocco, with strong winds sweeping thick Saharan Desert dust over to the Canary Islands in the Atlantic Ocean. *(AP Photo/MODIS Rapid Response Team at NASA GSFC)*

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