Optimal exchanges of electricity within the Mediterranean

by Philippe ADAM, Strategy Director Infrastructures & Technologies

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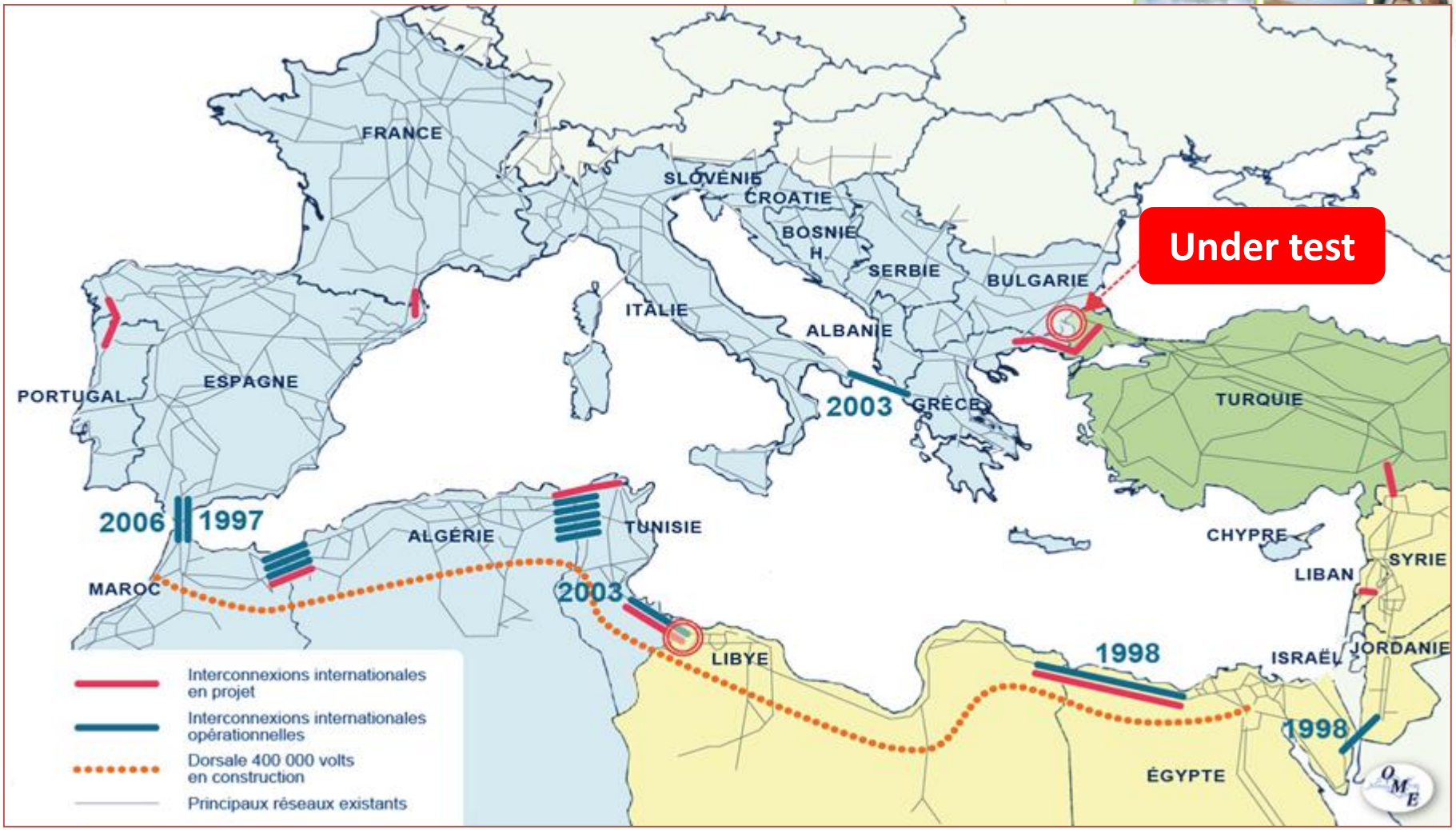
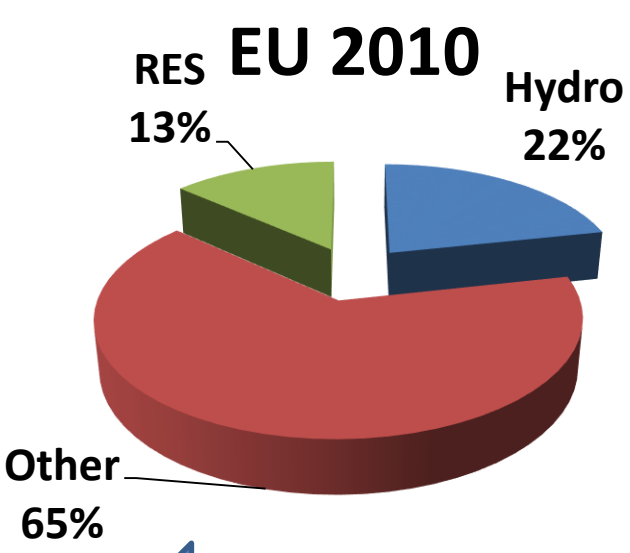
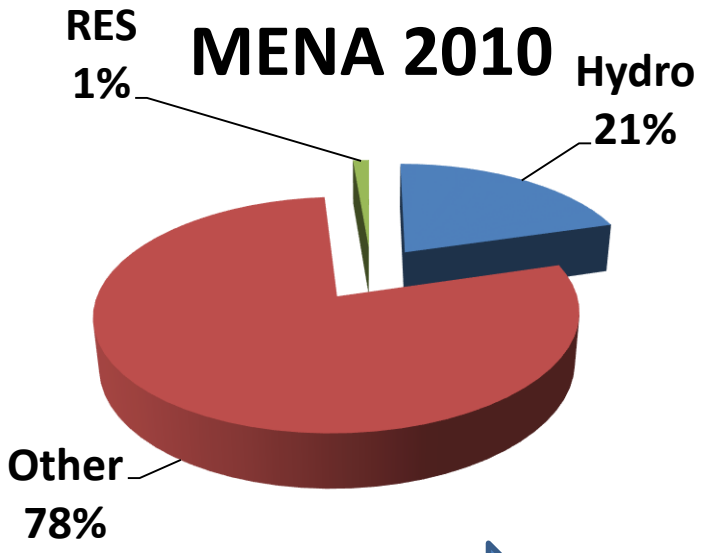
The Mediterranean grid situation in 2013



EU-MENA installed capacity in 2010

EU = 912 GW 8/1 MENA = 113 GW



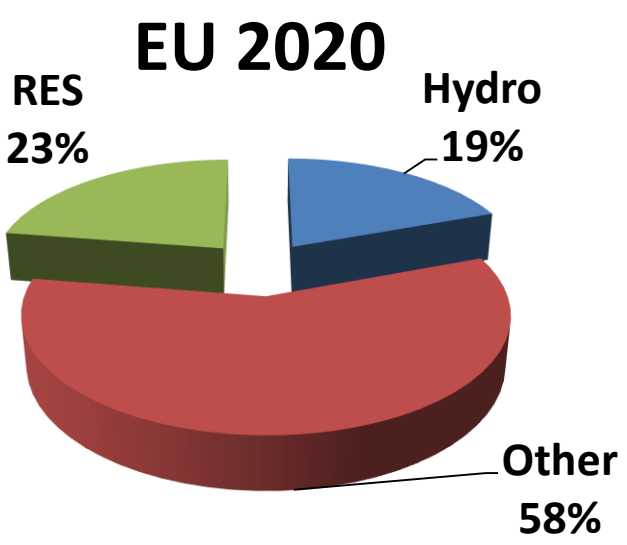


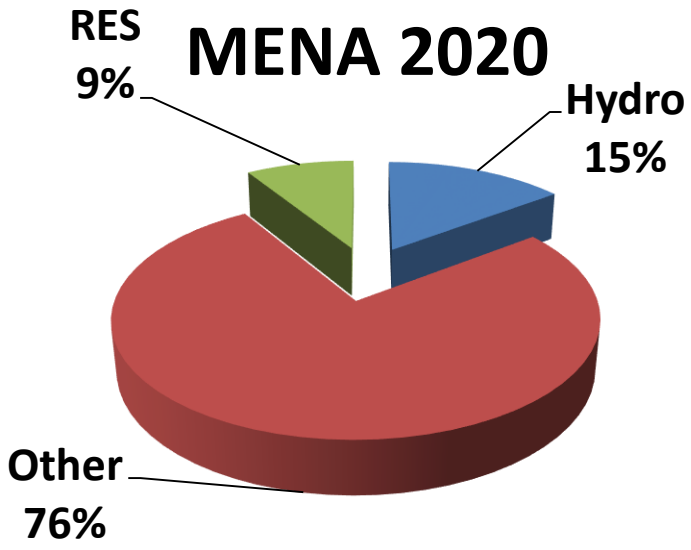
Net transfer capacity: **0,7 GW**

Sources : ENTSO-e *https://www.entsoe.eu/ et* Paving the Way for the MSP *http://www.pavingtheway-msp.eu/*

EU-MENA forecast installed capacity 2020

EU = 1163 GW **6/1** **MENA = 198 GW**



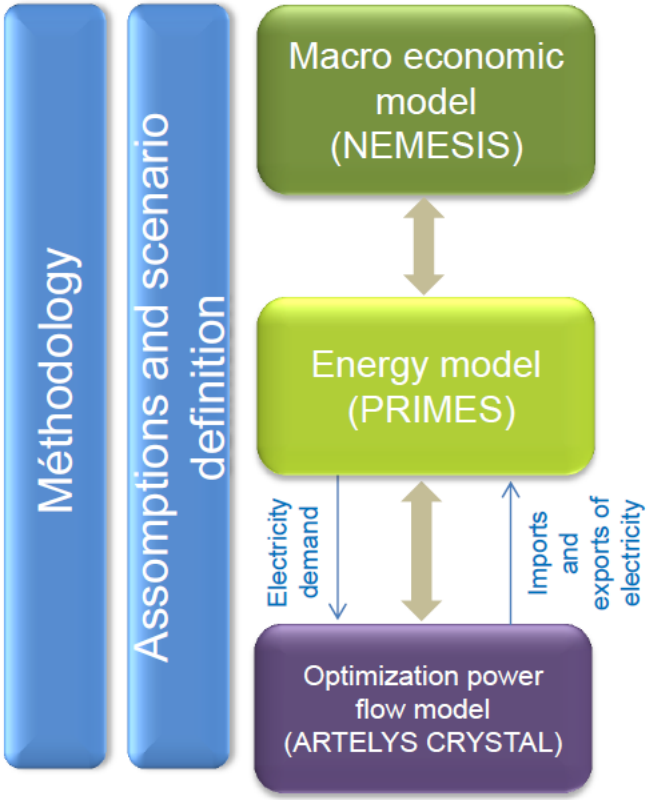


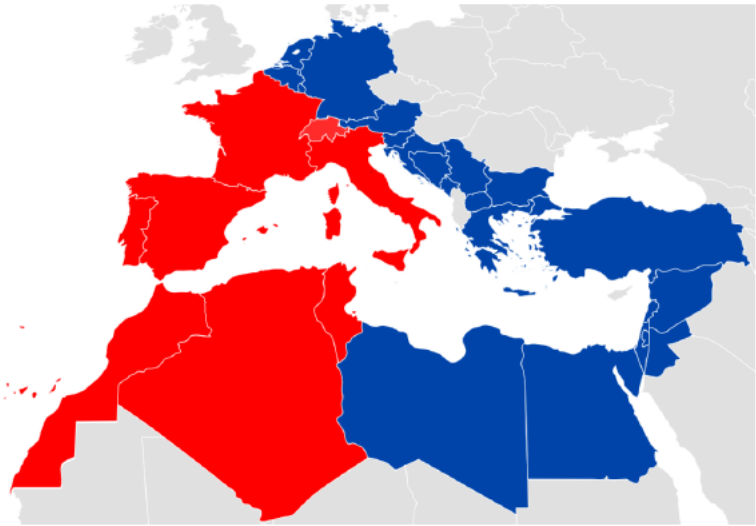
Net transfer capacity: **5 GW**

Sources : ENTSO-e *https://www.entsoe.eu/* *et* Paving the Way for the MSP *http://www.pavingtheway-msp.eu/*

Economic studies : Cost – benefit analysis

- 3 models for each country to accurately identify energy and power flows up to 2030





Area for the studies

2012 2013

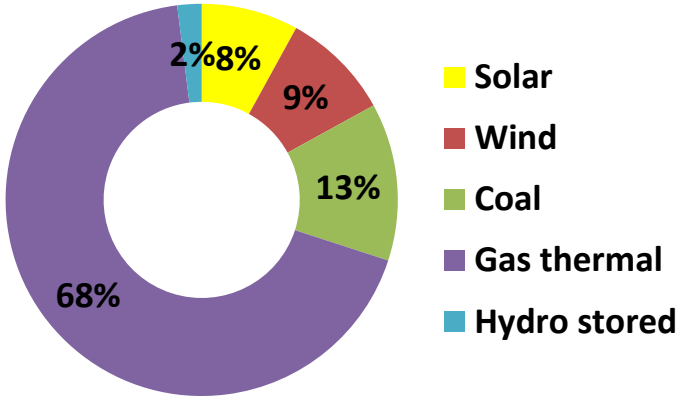
Scenarios to understand the North – South electricity exchanges

- ***"Reference" scenario*** is BAU-oriented and adds recent energy policies:
  - the reference scenario of the EU (3 : 20% targets)
  - the national energy plans in the South (PTWMSP objectives in 2020);

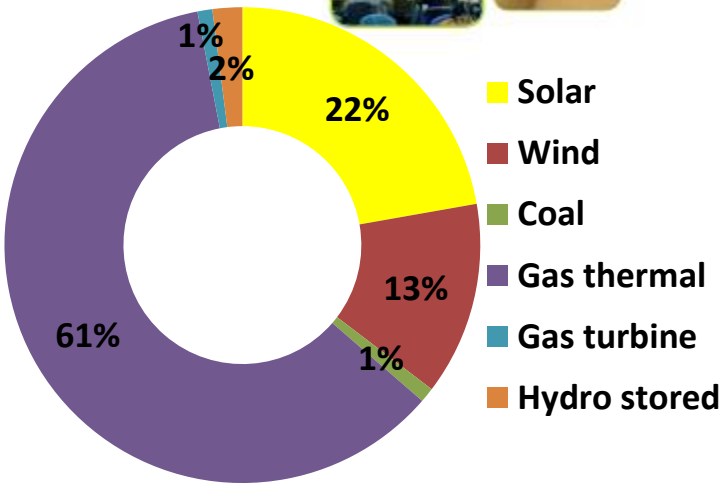
- ***"Integration" scenario,*** translates a context of economic crisis:
  - RES development is difficult and slowed down (high cost, no GES constraints).
  - Energy efficiency doesn't progress.
  - Generation is not sufficient to satisfy peak demand. An option relying upon generation + interconnections turns out to be less expensive.

- ***"Sustainable" scenario*** pushes environmental policies:
  - high carbon value choice (70 €/tCO_2 by 2030),
  - improvement of the energy efficiency,
  - important development of solar energy in the South

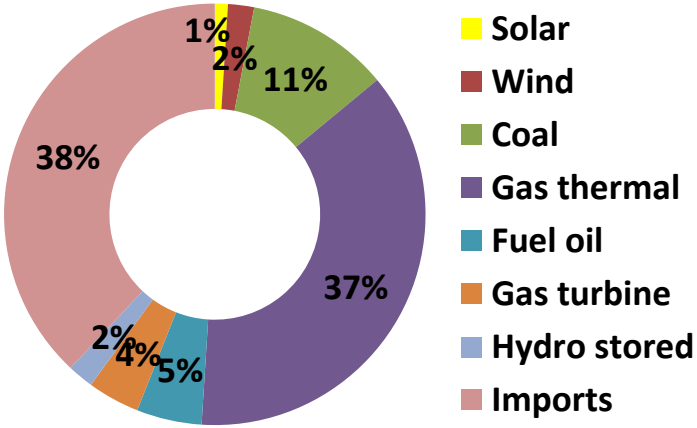
Scenarios



Reference scenario



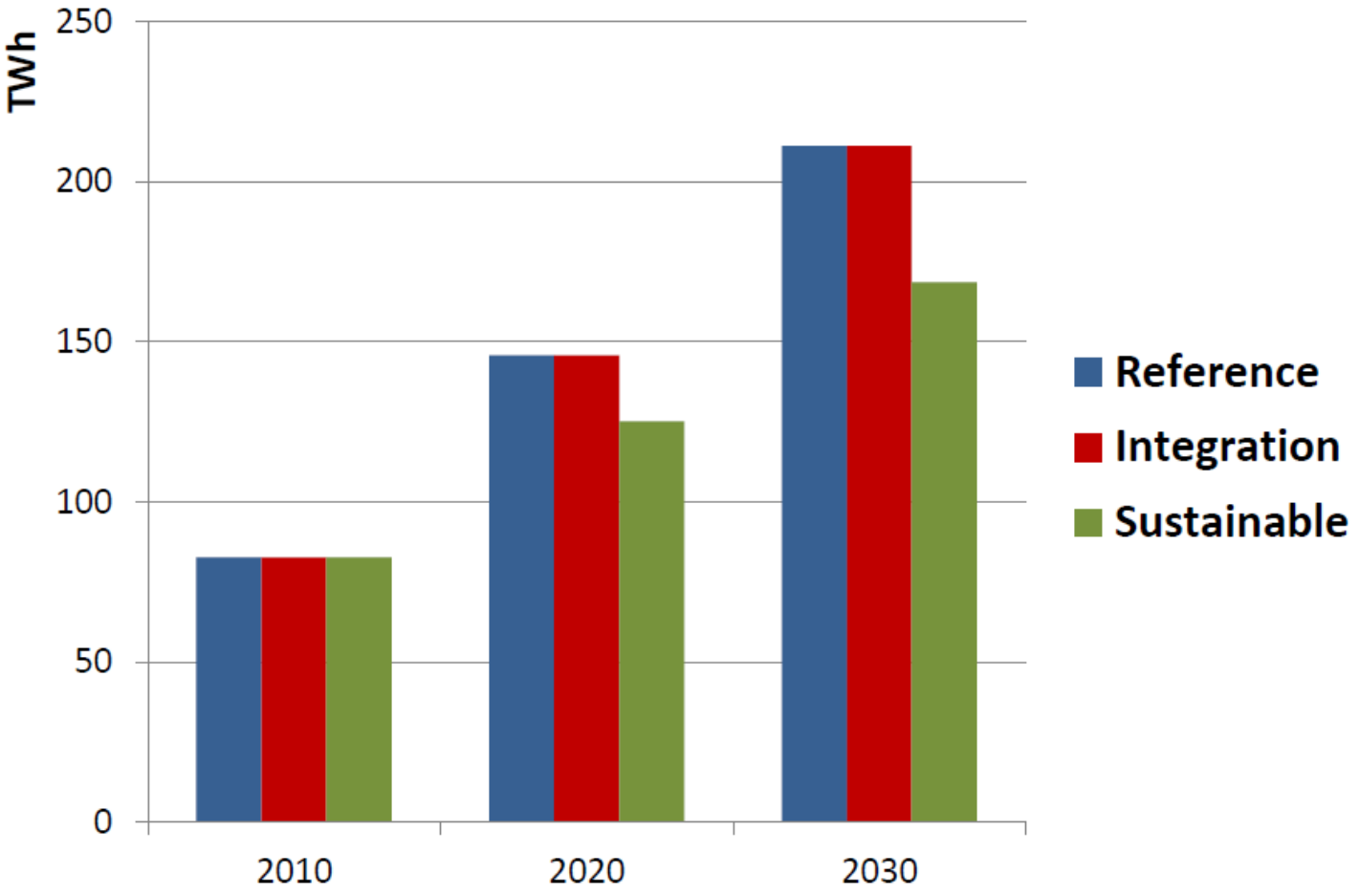
Sustainable scenario



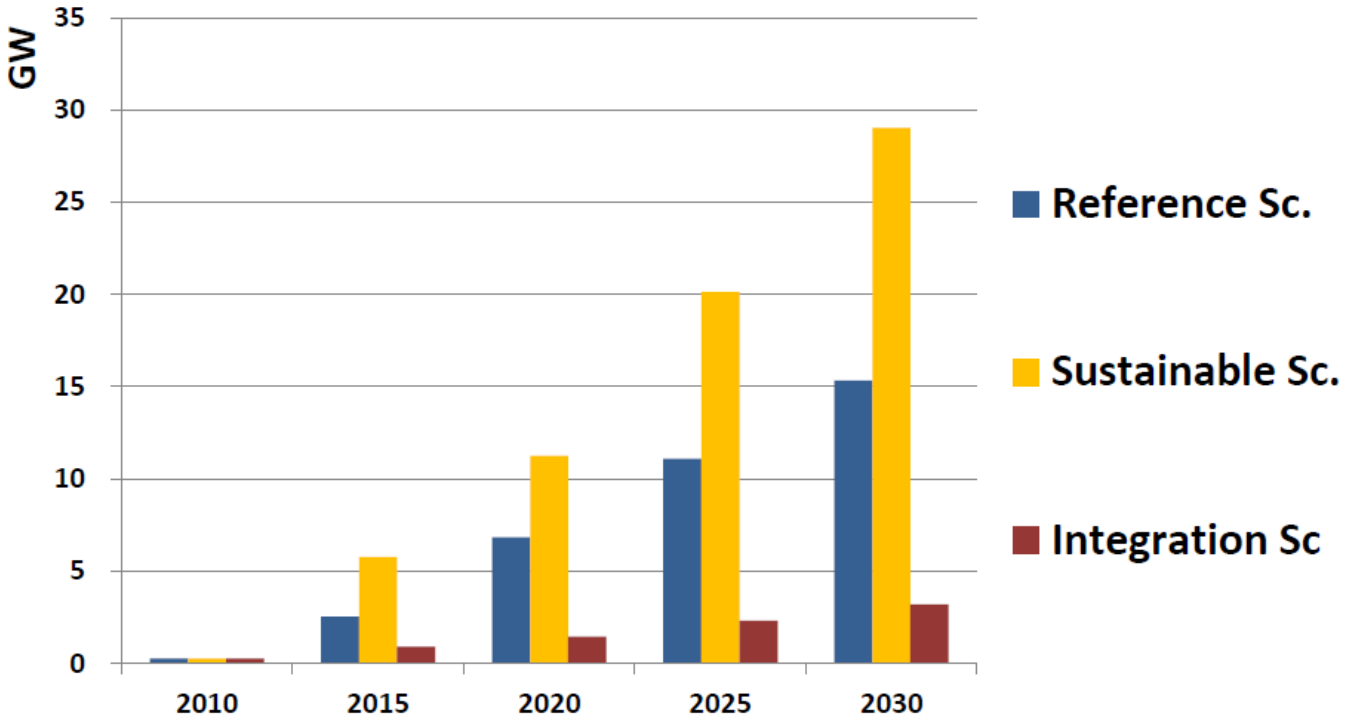
Integration scenario

Generation mix of the interconnected Maghreb countries in 2030

Total energy demand in Maghreb

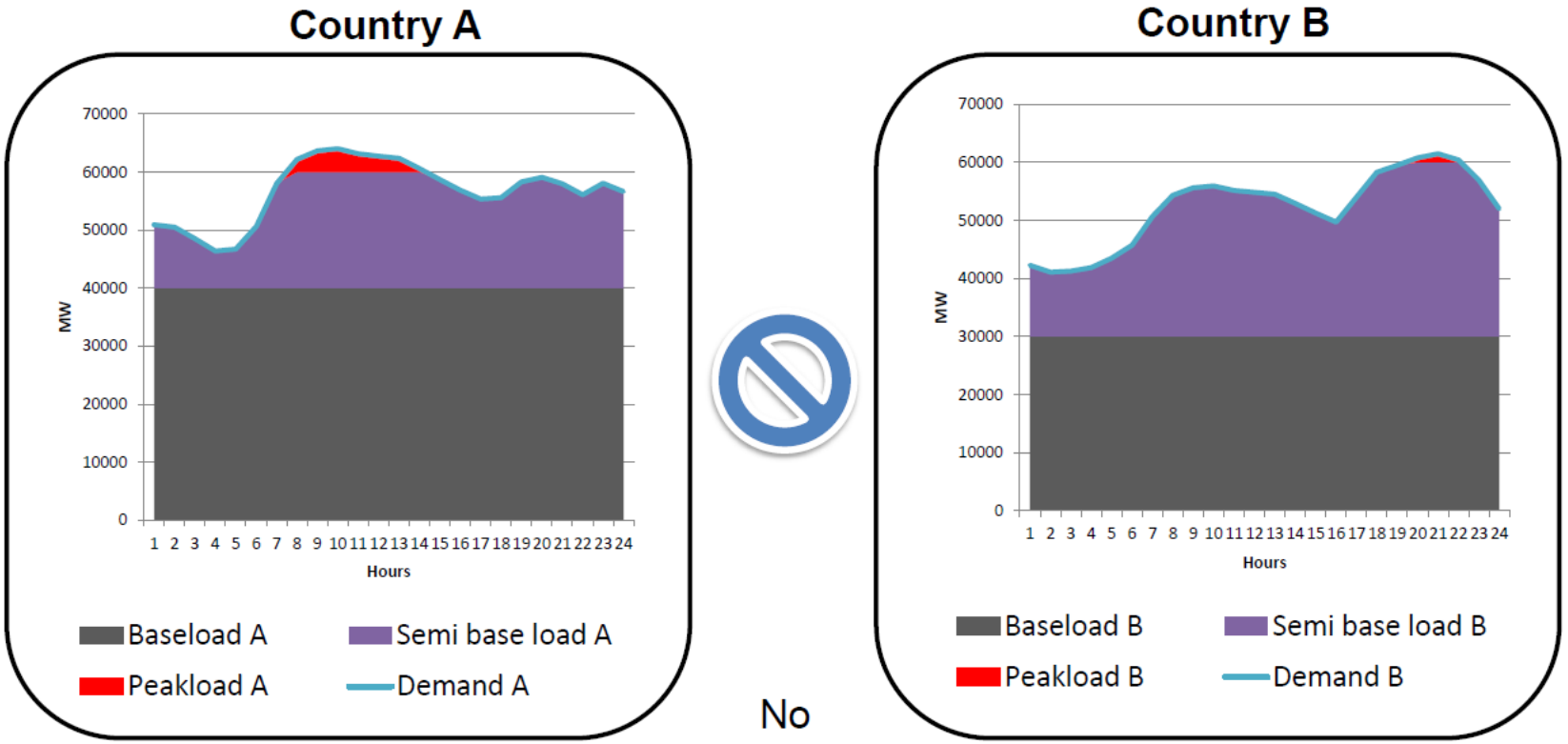


Total wind and solar in Maghreb

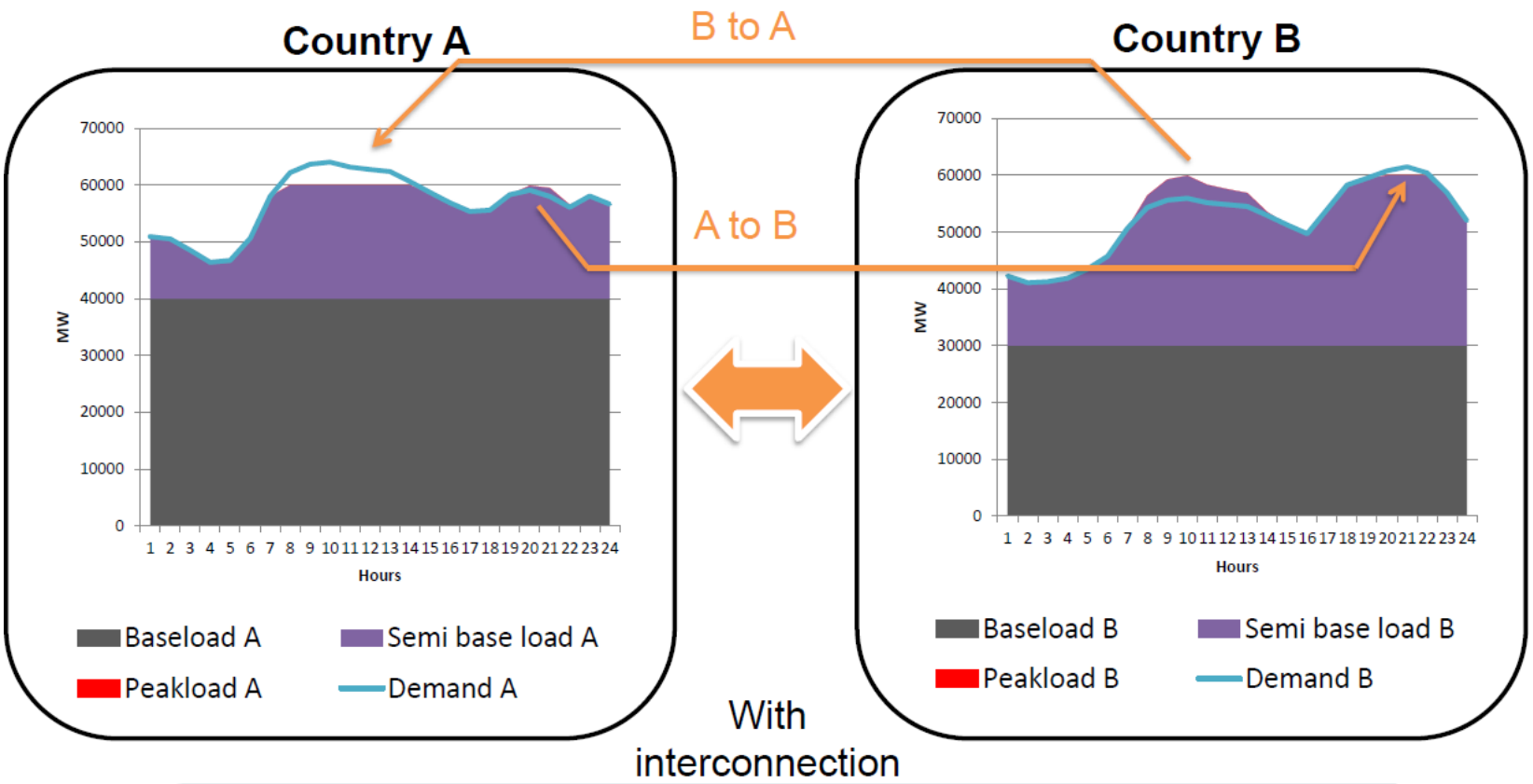


(GW)	2020	2030
Reference	6,8	15,3
Integration	1,5	3,2
Sustainable	11,2	29,0

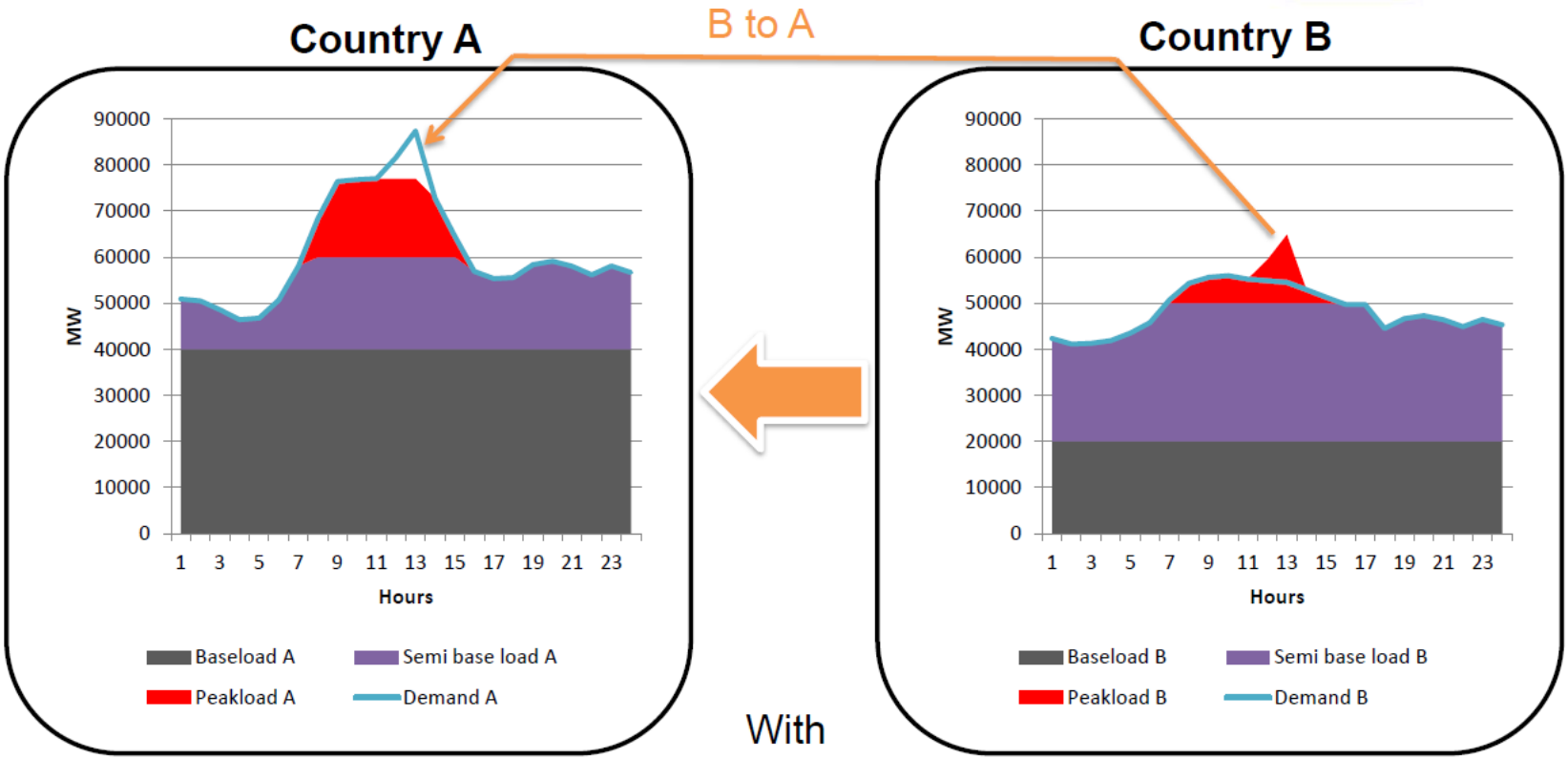
Value of interconnection



Value of interconnection



Value of interconnection



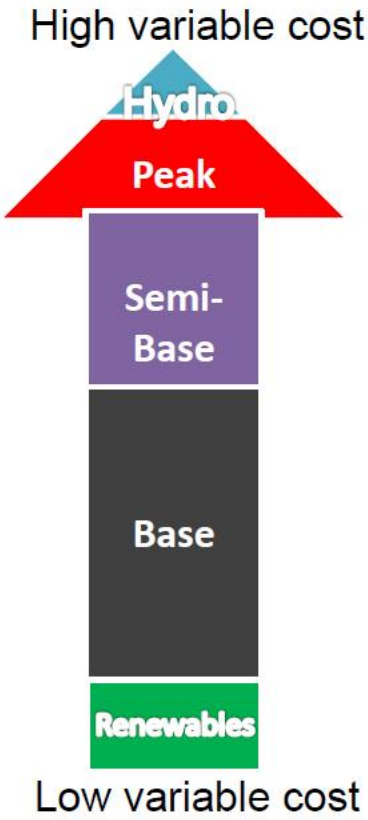
With interconnection

No need for new peak generation units: investment savings

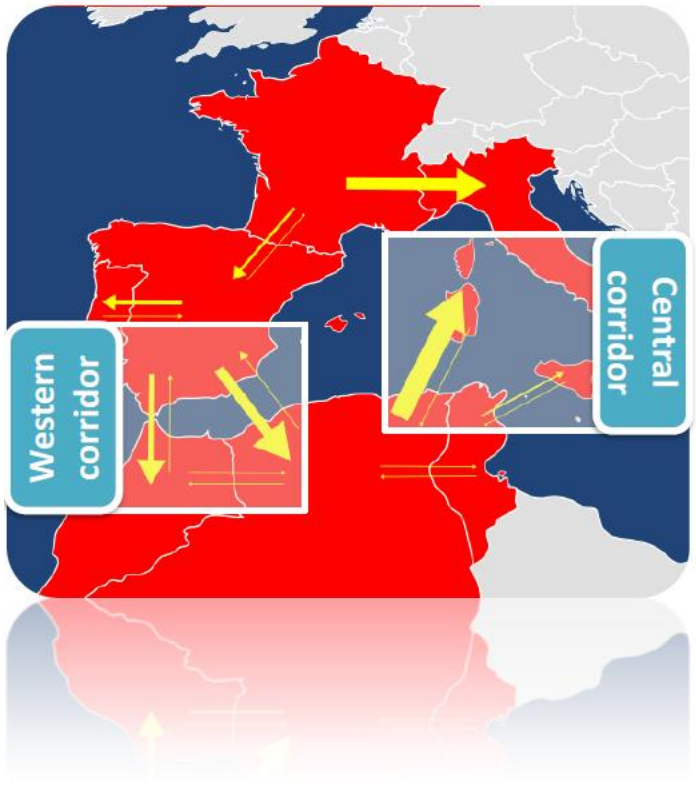
Power system model

We minimize the global Euro-Mediterranean electricity production cost.

- Supply-Demand equilibrium in each country (hub)
- Net transfer capacities within the modeled area
- Hourly simulations are necessary to evaluate the impact of the vagaries of renewable energy generation



Power flow drivers



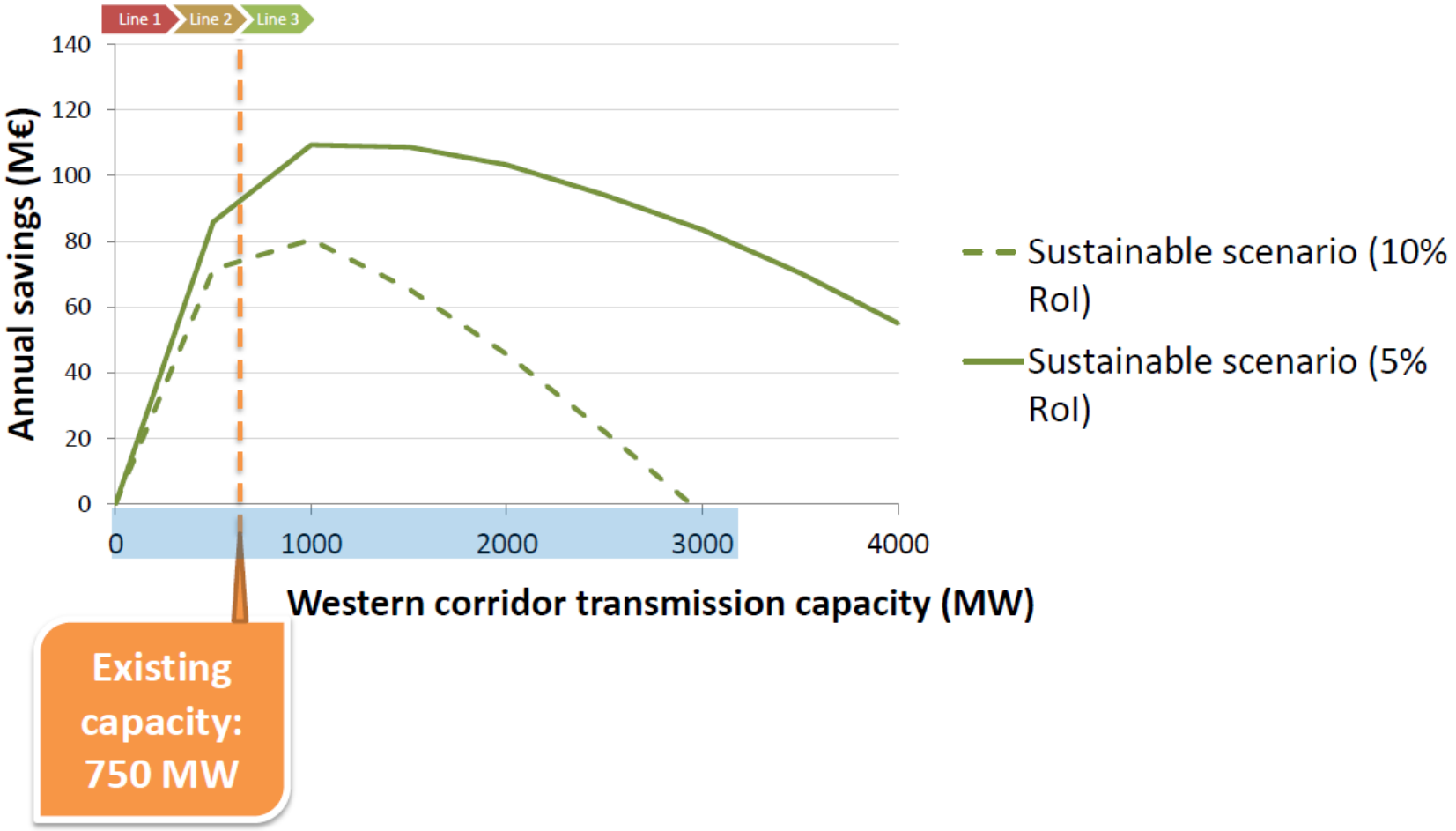
- Asynchronous peak demands
- Complementary electricity production structures
- Weather related uncertainties on renewable production
- Electricity storage opportunities abroad

Power flow drivers

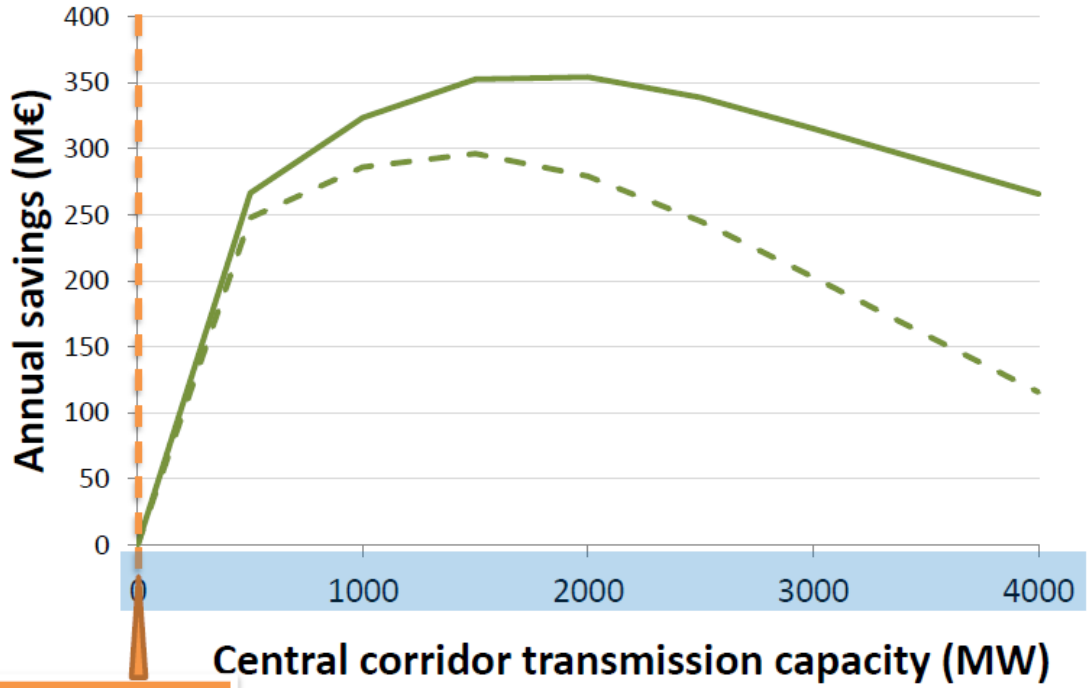
In the sustainable scenario, power flows are balanced between North and South.

2030 Scenario		Non limited interconnection capacities
Integration	N → S	102 TWh
	S → N	-
Reference	N → S	20 TWh
	S → N	19 TWh
Sustainable	**N → S**	**34 TWh**
	S → N	**46 TWh**

Optimal transmission capacities



Optimal transmission capacities



Existing capacity: 0 MW

Optimal transmission capacities

2030 Scenario	Western corridor		Central corridor	
	Optimal capacity	Maximum viable capacity	*Optimal capacity*	Maximum viable capacity
Reference	*1 000 MW*	Up to 3000 MW	*500 MW*	Up to 1000 MW
Sustainable	*1 000 MW*	Up to 3000 MW	*1 500 MW*	Up to 4000 MW+
Integration	*6 000 MW*	Up to 8000 MW+	*3 000 MW*	Up to 8000 MW+

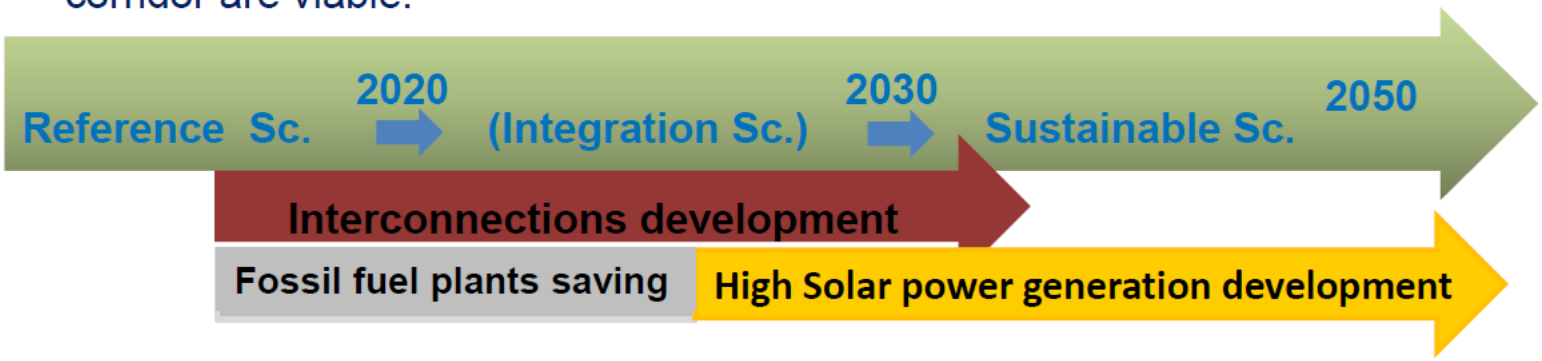
(Minimal ROI: 10%)

Conclusions

New interconnections bring **value** to the Mediterranean power system in **all scenarios**

In the sustainable scenario, where the most important benefits are observed (Energy Efficiency, CO_2 reduction from demand and interconnections):

1. Model shows important power flows - both from North to South and from South to North:
   - 20 TWh by 2030 with 10 GW interconnection plan assumption
   - 40 TWh by 2030 with no capacity limitation.
2. Transmission capacity of 3 GW in the western corridor and 4 GW in the central corridor are viable.



Thank you for your attention

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