

POTENTIAL IMPORTS OF ELECTRICITY FROM NORTH AFRICA AND POLICY IMPLICATIONS

8th ENERDAY CONFERENCE



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Dresden, 19.04.2013

Agenda

Potential imports of electricity from North Africa and policy implications

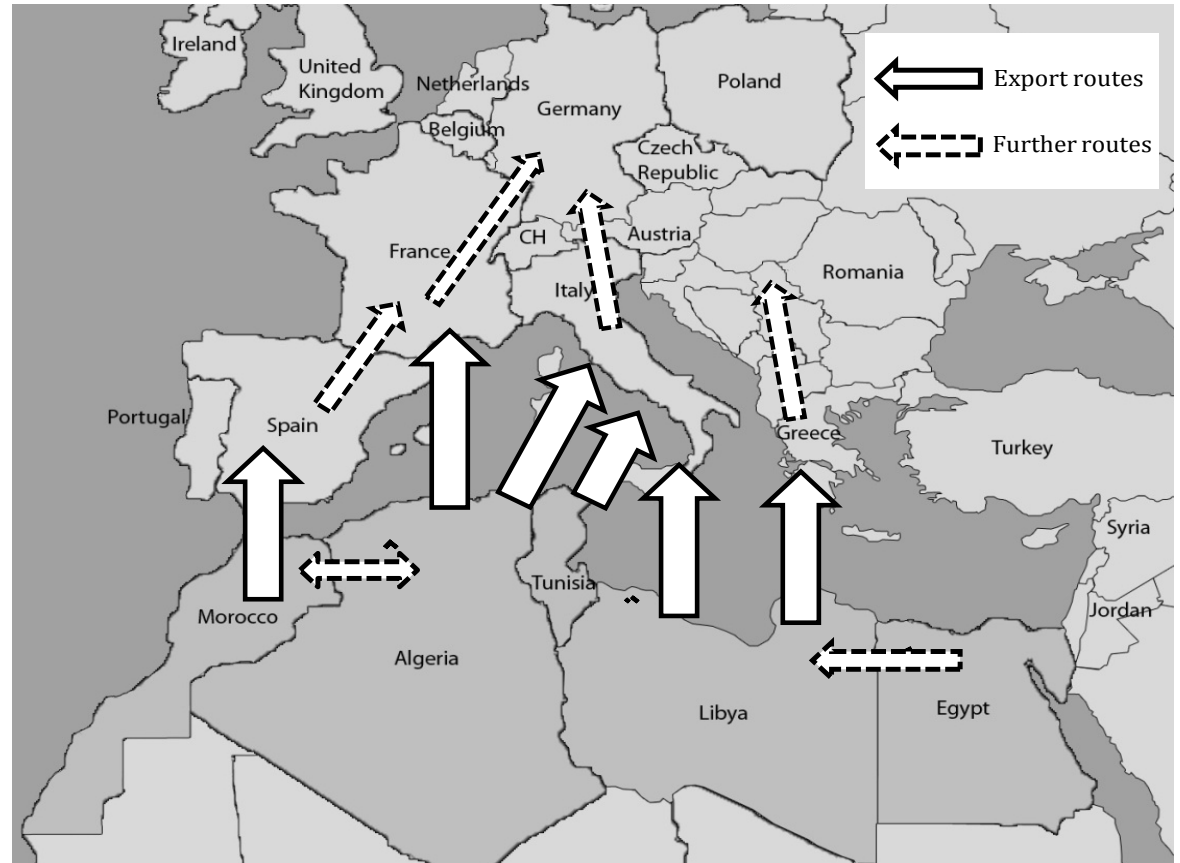
- 1) Introduction
- 2) Model RESlion
- 3) Market scenarios by 2030
- 4) Results

Electricity imports from North Africa: Short- and medium aspects

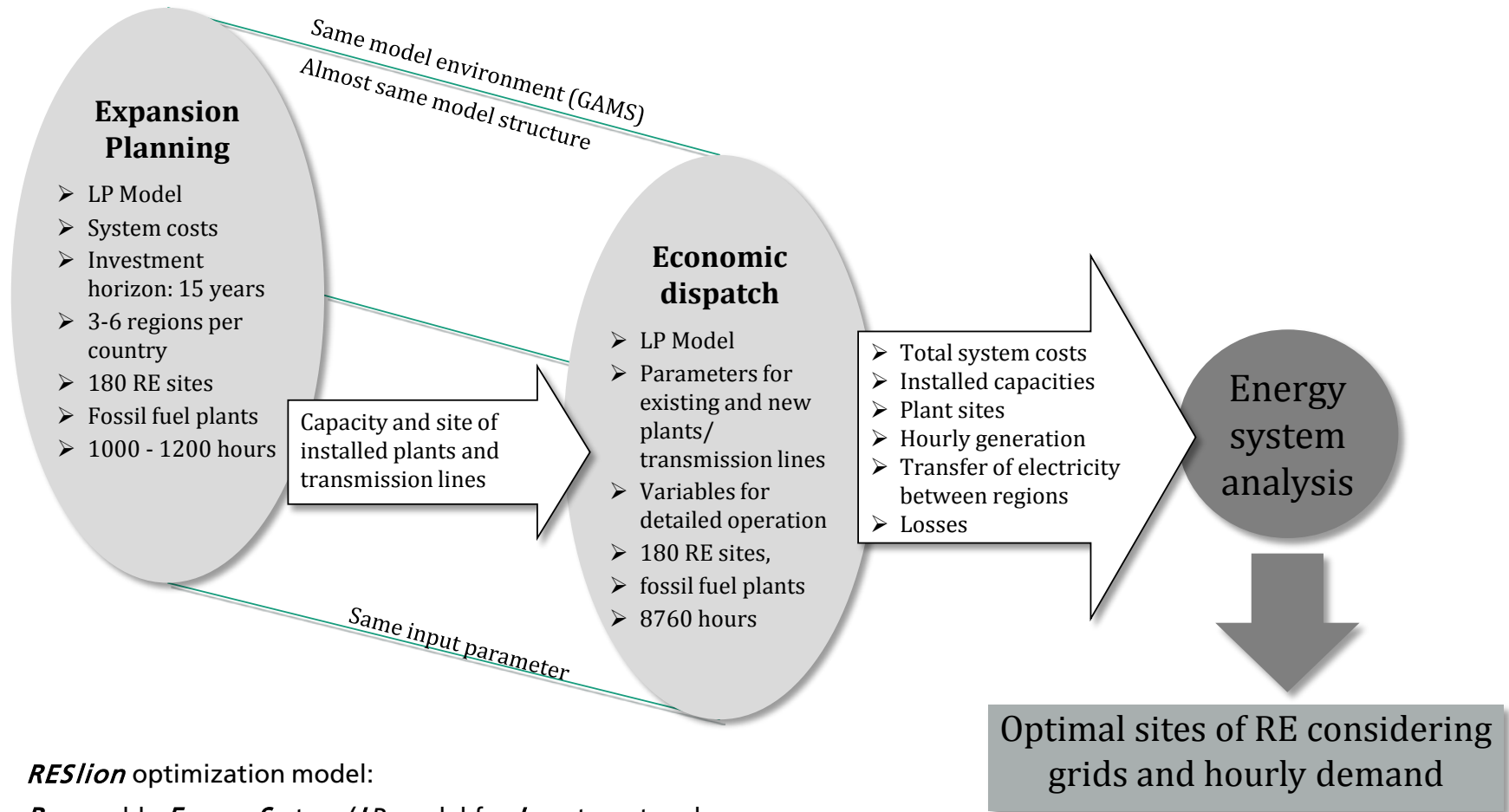
- 1) Ideas of „Desertec“
- 2) Scientific visions
- 3) Long-term targets (15%!)

Energy system analysis:

- Technology mix?
- Export routes?
- Site selections?
- Costs?



Optimization model *RESlion*: Expansion planning combined with economic dispatch

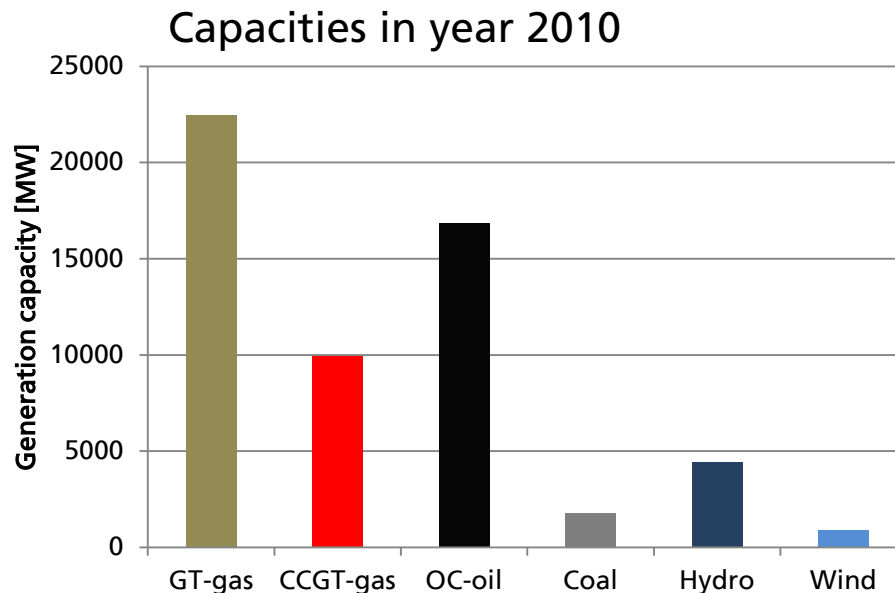


RESlion optimization model:

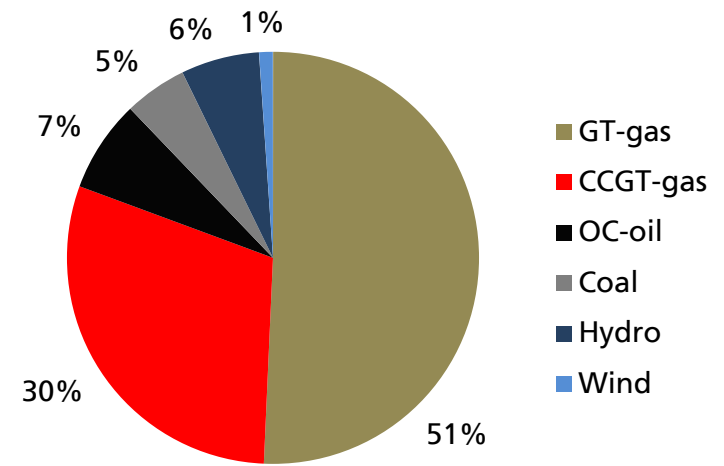
Renewable Energy System (LP model for Investment and Operation planning) in North Africa

Integrated electricity market of North Africa: Modeling of year 2010

- No import/export to North Africa allowed
- Generation deficit of Morocco is fulfilled by imports from Algeria
- Importers: Morocco, Libya
- Exporters: Algeria, Egypt



Generation in year 2010



Renewable energies in North Africa – Export as option on top?

Country	Status in 2010	Targets for 2020	Targets for 2030
Morocco	23% RE (19.5% of hydro power and 3.5% of wind power) of installed capacity	42% RE of installed capacities (2 GW of wind and 2 GW of solar)	6 GW of wind
Algeria	<1% RE (hydro power) of electricity generation	10% RE of electricity generation	37% RE of electricity generation: CSP (70%), wind (20%) and PV (10%)
Tunisia	<2% (hydro and wind power) of electricity generation	~12% RE of electricity generation (4.7% by 2014)	~12% RE of electricity generation
Libya	0% RE of electricity generation	10% RE of electricity mix	30% RE of electricity mix
Egypt	10% RE of electricity generation (8.8% based on hydro power)	20% RE of electricity generation including 7.2 GW of wind power	not identified

Short- and medium-term option for renewable energies in North Africa

Optimal expansion and operation under different export options in year 2010 to 2030

- **Reference Case 1.1: *No export to Europe***

Long-term target 32% renewable electricity in North Africa by 2030

- **Export Case 2.1: *Fixed demand (100 TWh)***

Assumed import demand of South-European countries

- **Export Case 2.2: *Fixed tariff (70 Euro/MWh)***

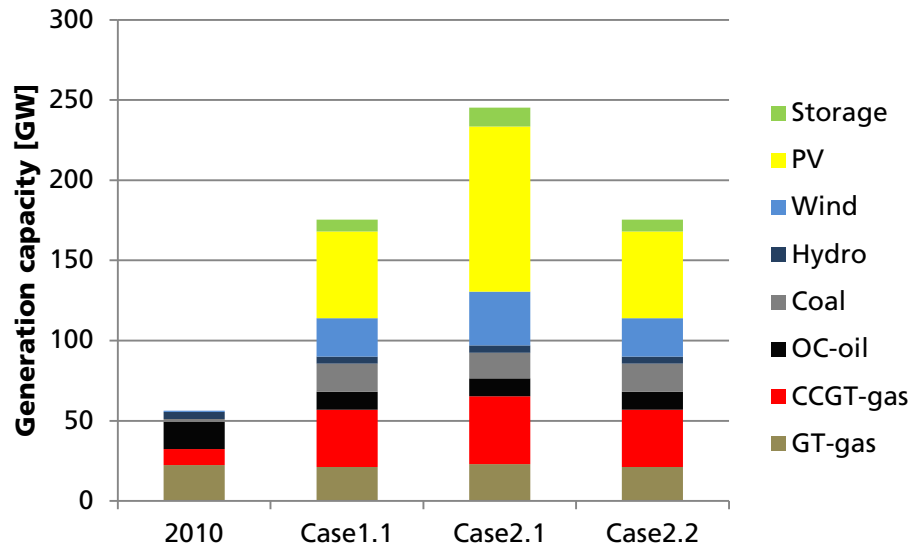
Imported electricity from North Africa obtains a fixed tariff

Model results

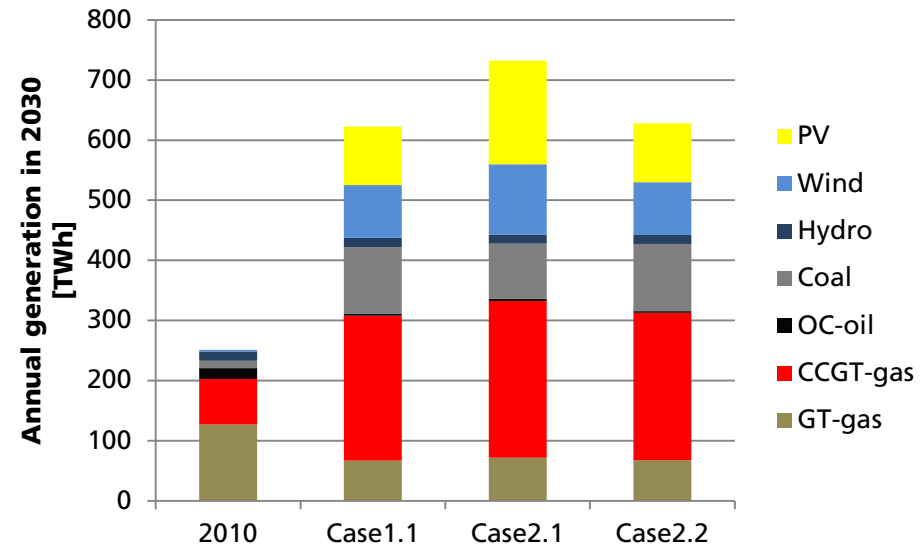
- Reference Case 1.1: *No export to Europe*
- Export Case 2.1: *Fixed demand (100 TWh)*
- Export Case 2.2: *Fixed tariff (70 Euro/MWh)*

Power plant installations and electricity generation (2030)

Generation capacities 2030

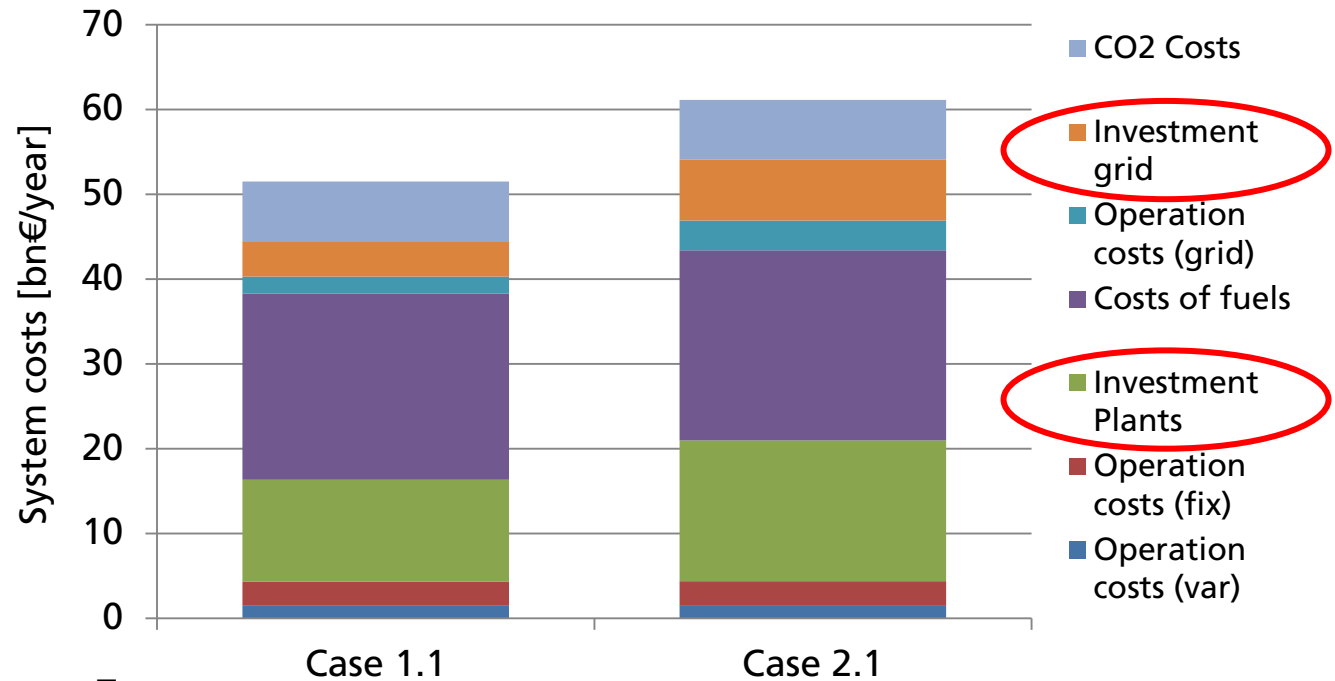


Electricity generation in 2030



- RE targets reached by a combination of PV and wind
- Add. generation in case 2.1 is highly based on PV/wind, no CSP plants
- Tariff of 70 Euro/MWh is too low to generate export capacities

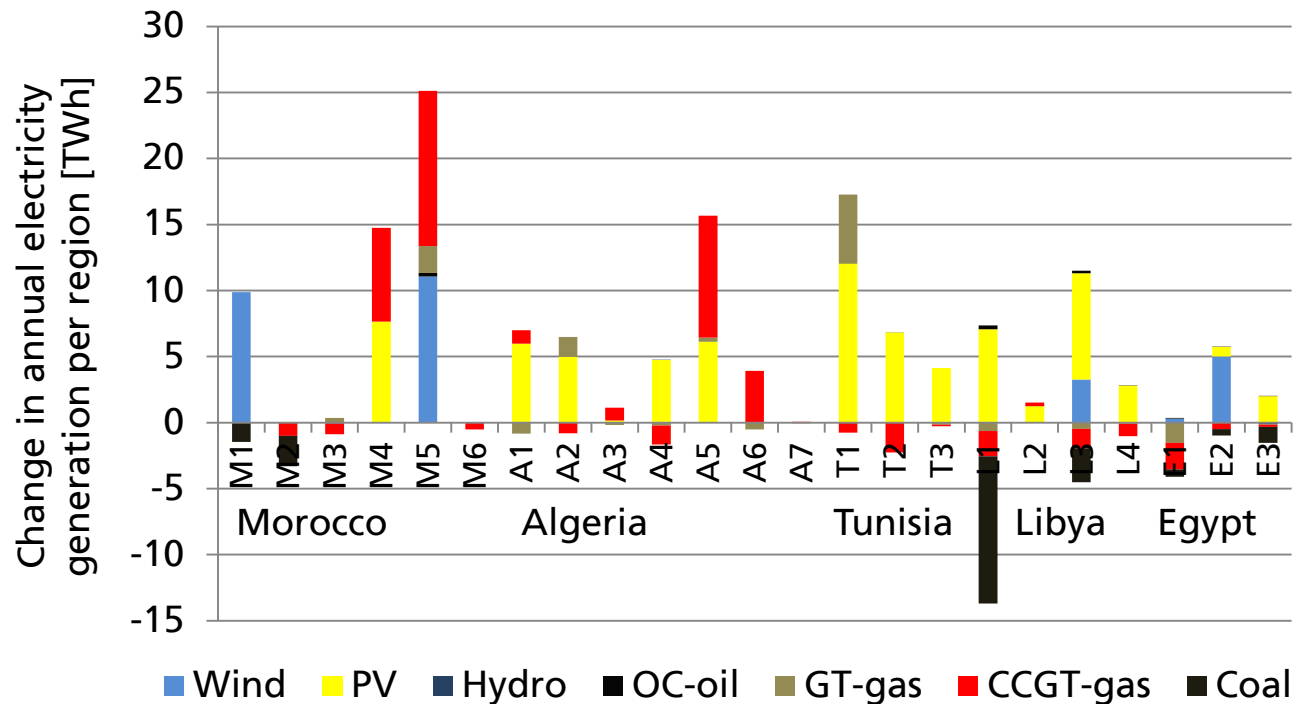
System costs are increased by expenses for new plants and new grids



- 100 TWh exports to Europe
- Additional annual costs of 10bn Euro
- Case1.1: 82 Euro/MWh produced (incl. grid)
- Case 2.1: export electricity: 96.4 Euro/MWh produced (incl. grid, HVDC)

PV and wind plants (close to export lines) with generation increase

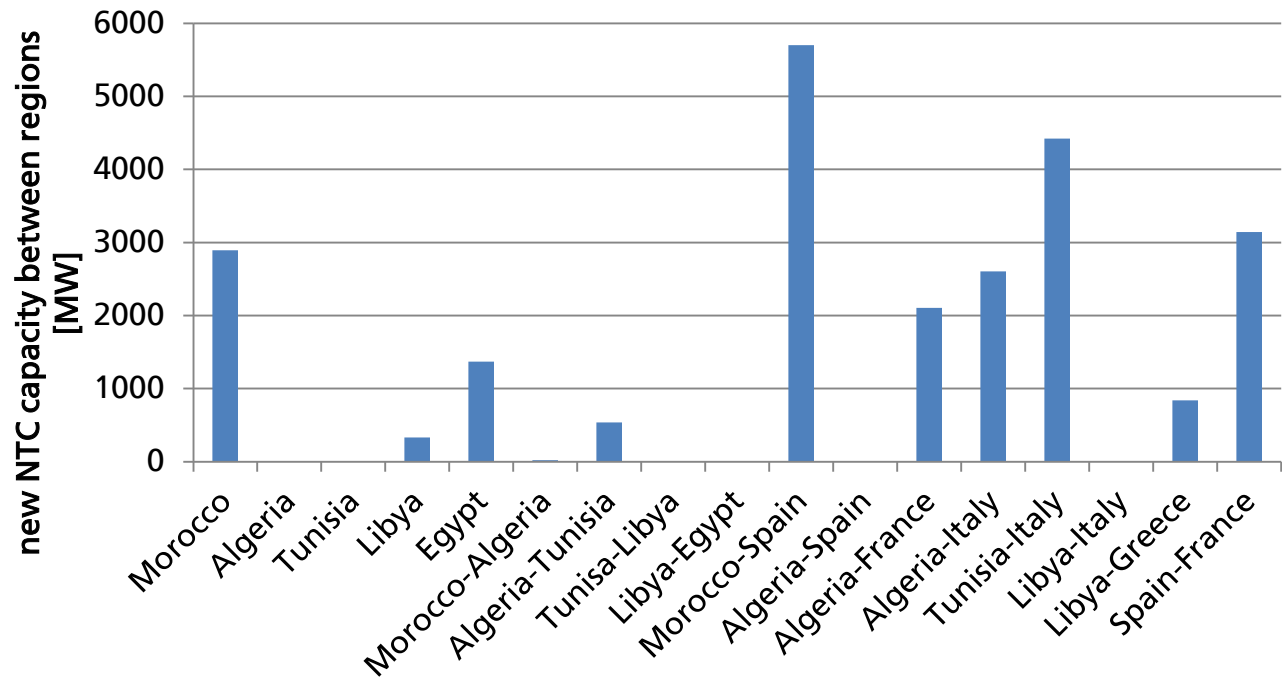
Comparison of generation in "No export" (1.1) and "Export" (2.1) in 2030



- Wide distribution of PV generation, wind more focused, CCGT back-up increased, storages added

Transmission capacity for electricity export: Priority in North Africa: Morocco and Egypt

Grid comparison between Export Case 2.1 and No-Export in 2030



- Grid expansion required in Morocco and Egypt in export case.
- Reference case (*no-export*): by 2030 strong grid expansion in Libya and between Libya/Egypt and Morocco/Algeria

Renewable energy integration and European import policies

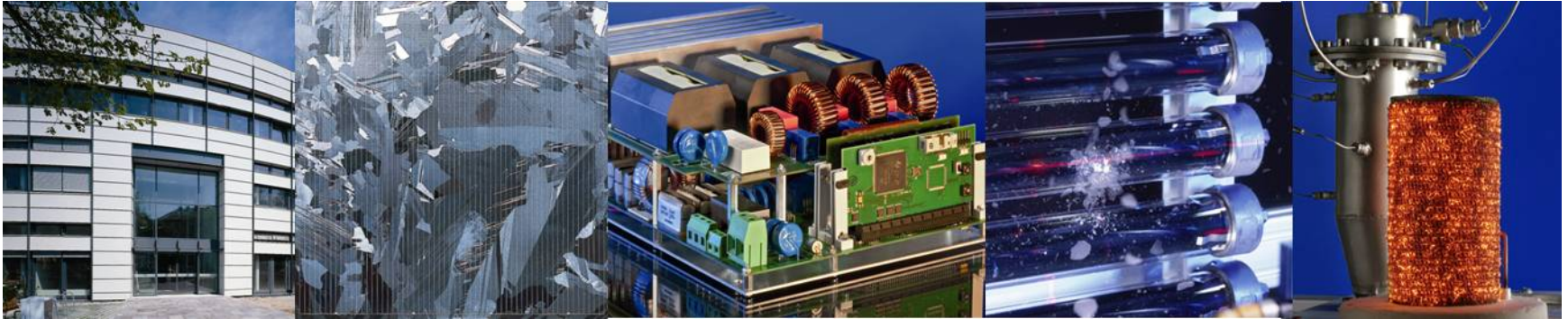
- *“What are the targets for electricity imports to Europe?”*
- Include costs for electrical grid in North Africa
- Optimal sites (resources) vs. grid costs
- Analysis on existing capacities and mid-term needs
- Integrated electricity market (increase internal electricity exchange)
- PV/wind plus storage option

Summary

Potential imports of electricity from North Africa and policy implications

- Optimization model (RESlion): Optimized expansion and operation (s.t. sites, grids)
- Optimal site selection of RE and fossil plants considering electrical grids in North Africa
- Renewable energy integration: Wide distribution of generation capacity
- Export case: 96 Euro/MWh, PV and wind
- CSP plants: not cost-efficient
- Future work: testing of different tariffs, long-term outlook 2050

Thank you for your kind attention!



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