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Deployment of Concentrated Solar Power (CSP) in the Middle East and North African (MENA) region and the need of water-energy nexus

Nadejda Komendantova

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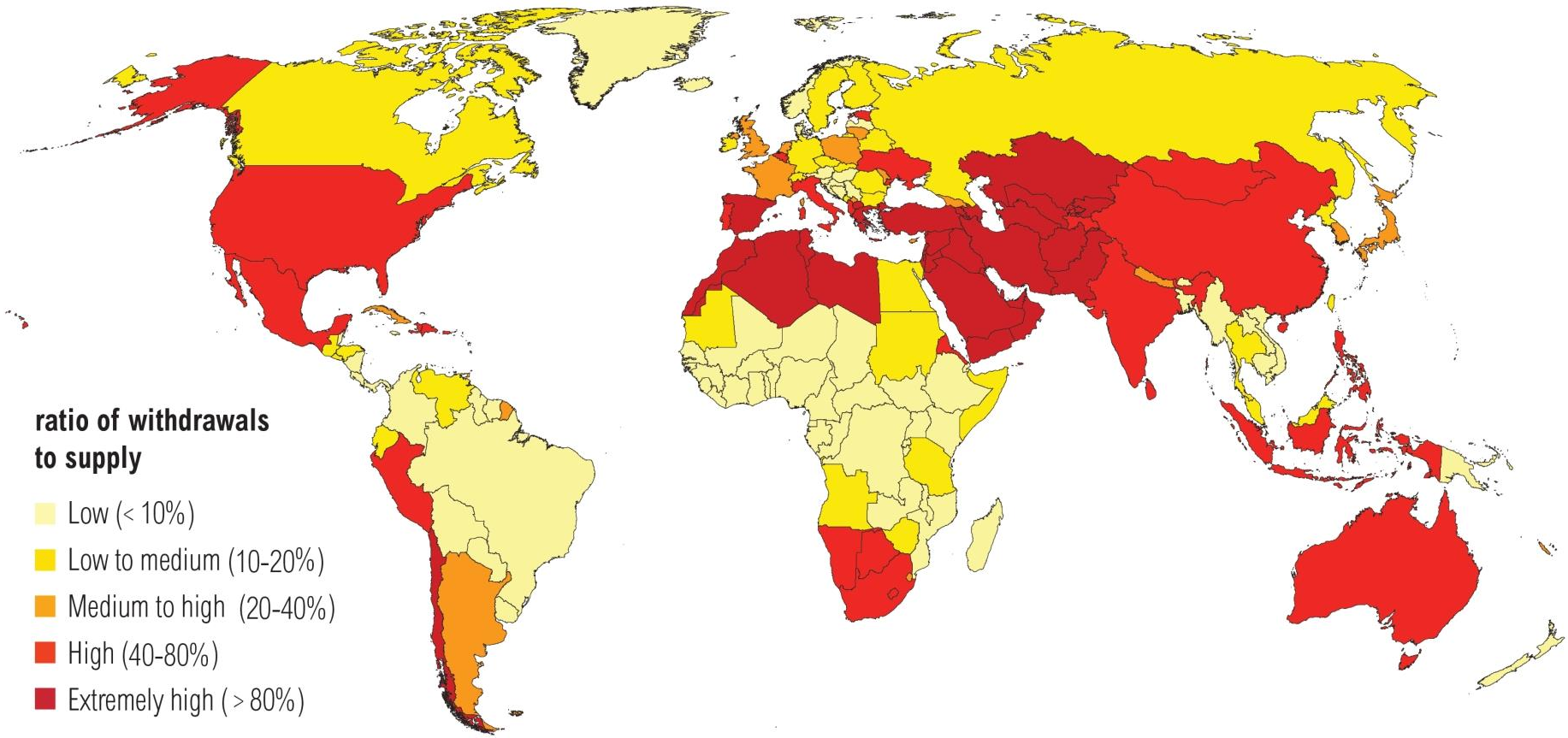
Case studies: Water-energy nexus in Morocco and Jordan and deployment of concentrated solar power (CSP)

- MENA region – one of the most water scare regions (565 m^3/year)
- Around 50% of population lives in conditions of water stress (Terink et al., 2013)
- Growing middle class clamors for more water-intensive food production and electricity generation
- Increased risk of widespread water scarcity due to higher temperatures, reduced precipitation and occurrence of droughts (Schilling et al., 2012)
- Will face extreme water stress due to depletion of surface water and water supply and demand patterns

Water Stress by Country: 2040



NOTE: Projections are based on a business-as-usual scenario using SSP2 and RCP8.5.

For more: ow.ly/RiWop

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Risks

- MENA region is already now heavily dependent on desalination for water extraction
- Water is a significant dimension of conflicts among countries in the region
- Dependence on grain imports
- Water issues can become a driver for political instability and civil unrest
- On-going energy transition might increase the existing pressure on water resources
- Example of concentrated solar power technology

Water consumption by CSP technology

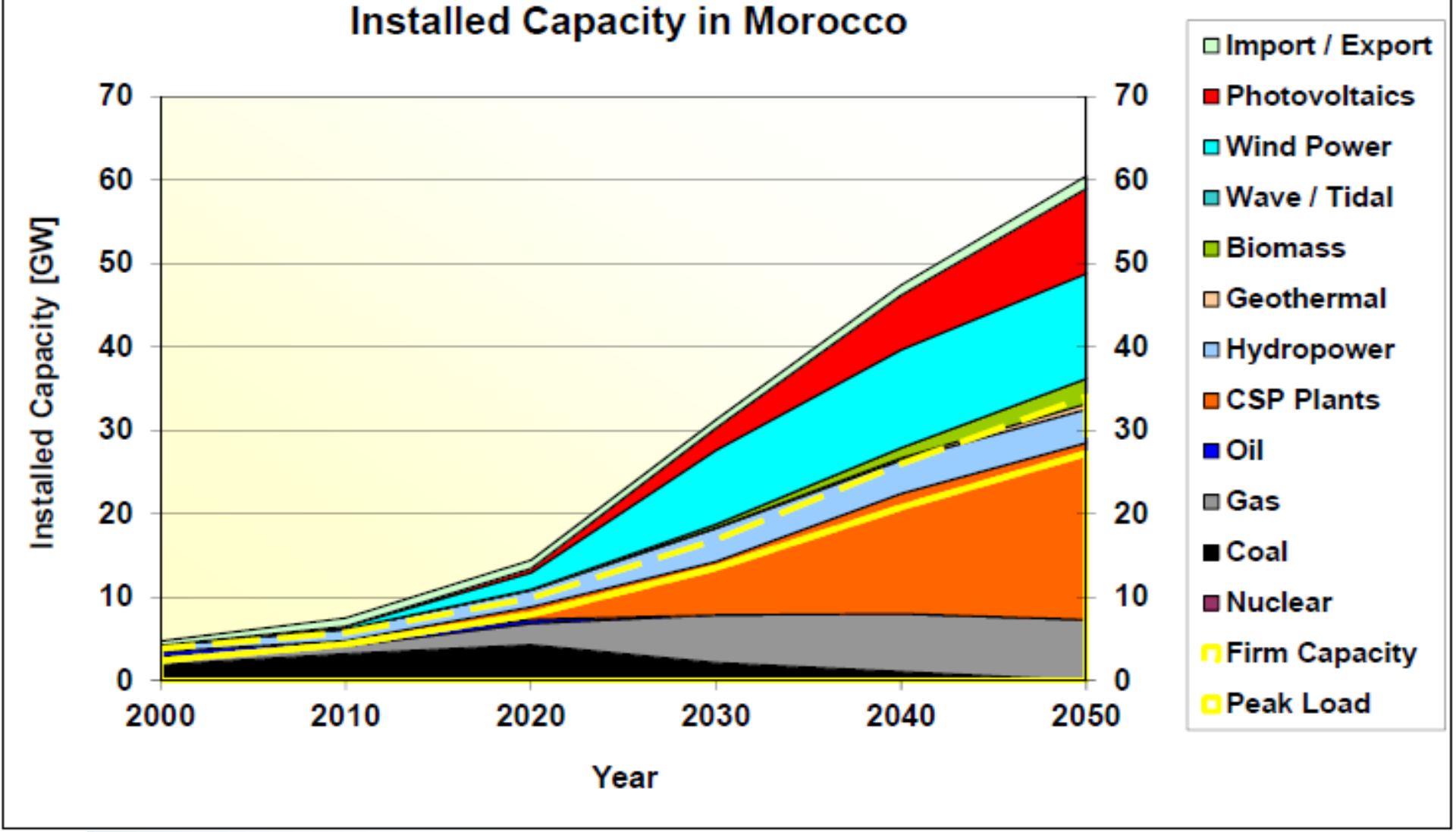
CSP technology	Cooling system	Water consumption (range) [m^3/GWh]
Power tower	Closed-loop (wet) Dry	2,910 - 3,570 100 – 350
Parabolic trough	Closed – loop (wet) Dry	2,810 – 4,295 165 – 305

Source: Crossover, PSU

Solar (PV and CSP) capacities in the MENA region (centralized and decentralized)

Country	Operational	Under execution	Tendered in 2016	Percentage Target in 2020
Morocco	160	350	245	12%
Algeria	270	80	2000	15%
UAE	128	200	1150	10%
Jordan	30	320	120	12%
Egypt	70	1800	250	8%
Saudi Arabia	23	62	170	8%
Kuwait	12	60	85	10%

Source: MESIA Outlook 2016

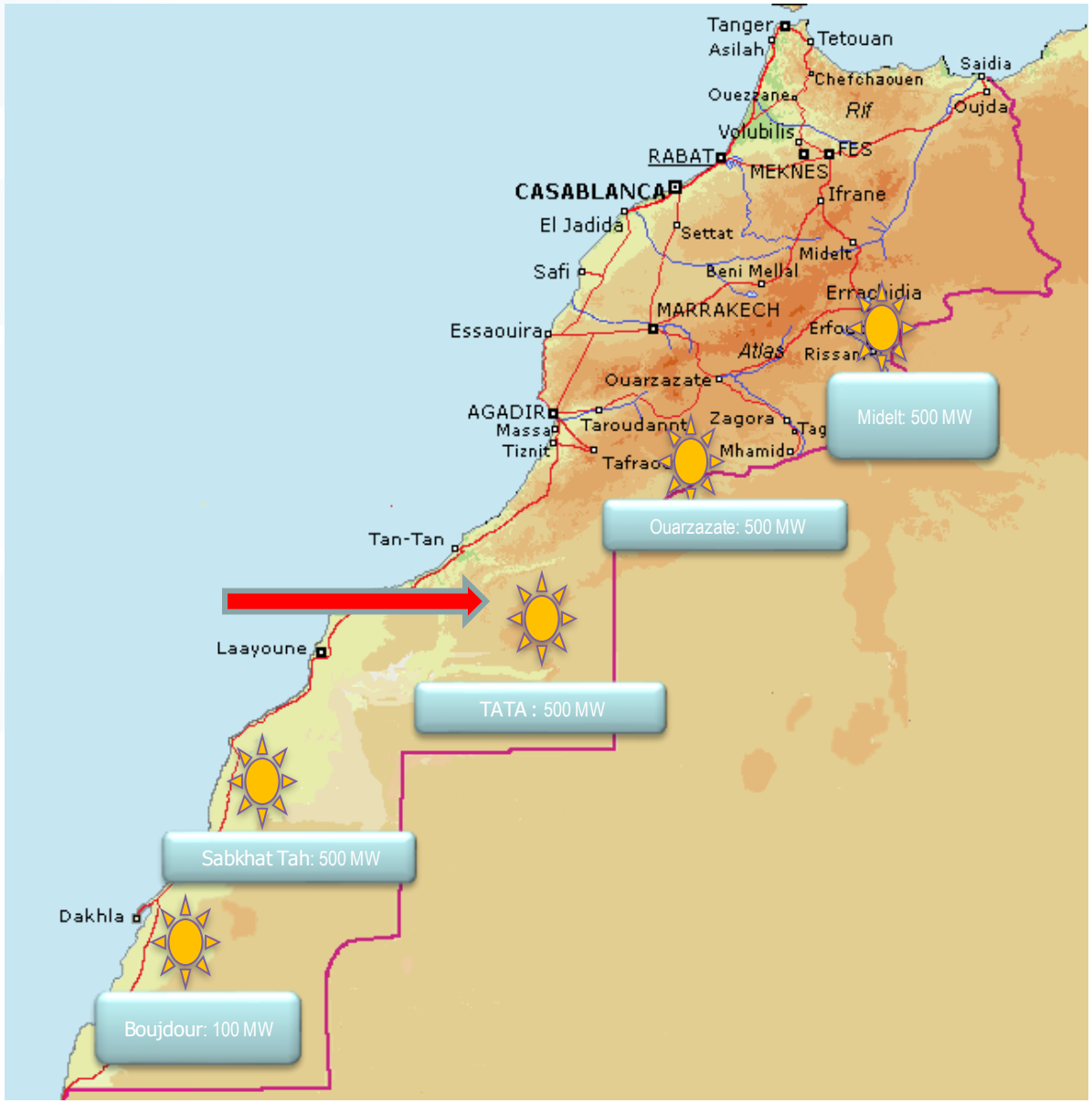


Morocco is currently the leader in the MENA region on CSP deployment. Noor I (250 MW) being a best case project

Source: DLR - F. Trieb & al.

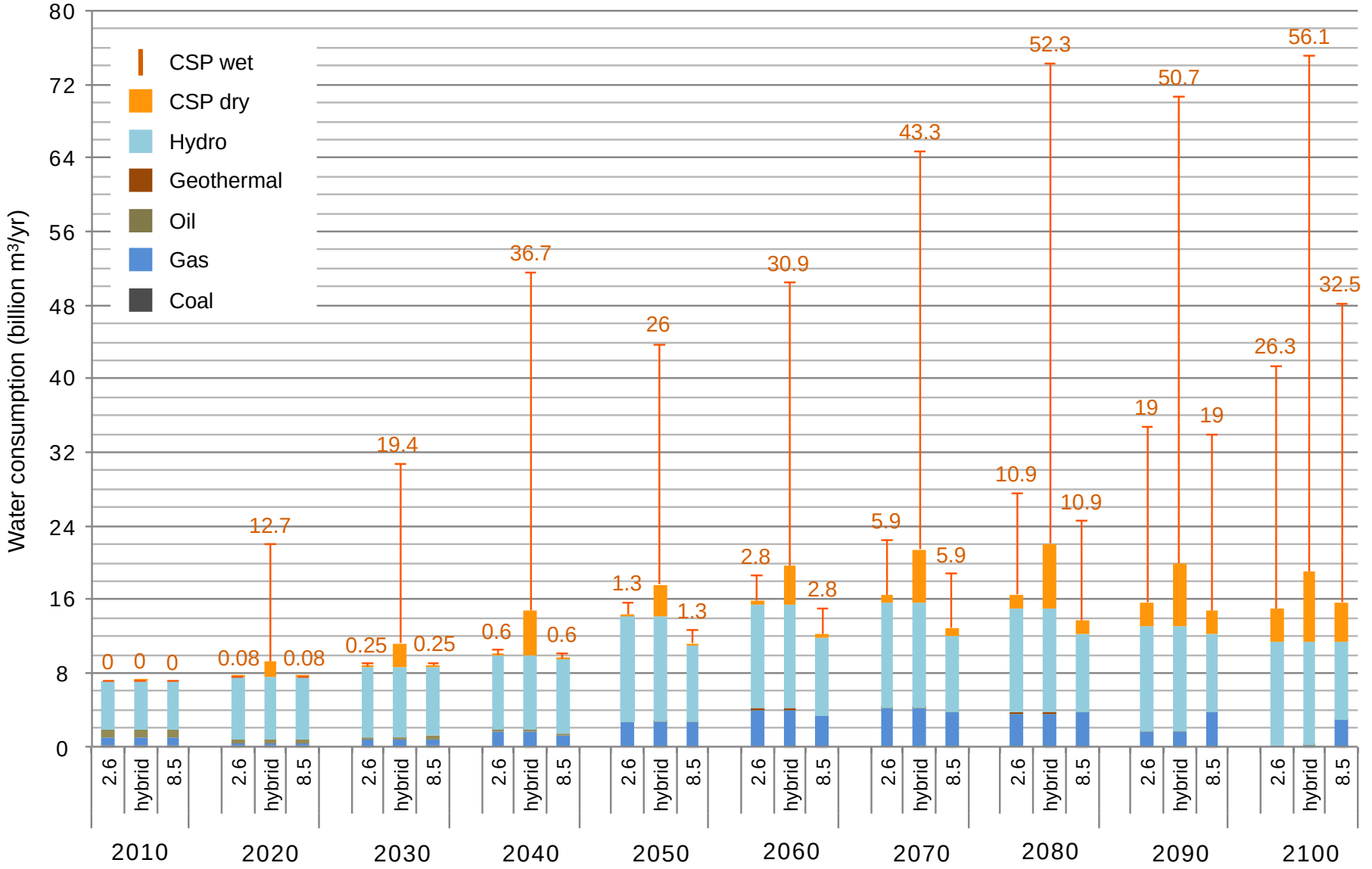
MOROCCO'S SOLAR ENERGY INTEGRATED PROJECT: new CSP projects

Installed capacity by 2020	•2000 MW •Ouarzazate : The first solar plant under operation in 2015
Generation	• ≈ 4500 Gwh per year
Estimated investment cost	• 9 billions of US$
Fuel annual save	• 1 million of TOE per year
CO_2 emission avoided	• 3,7 millions Tons per year



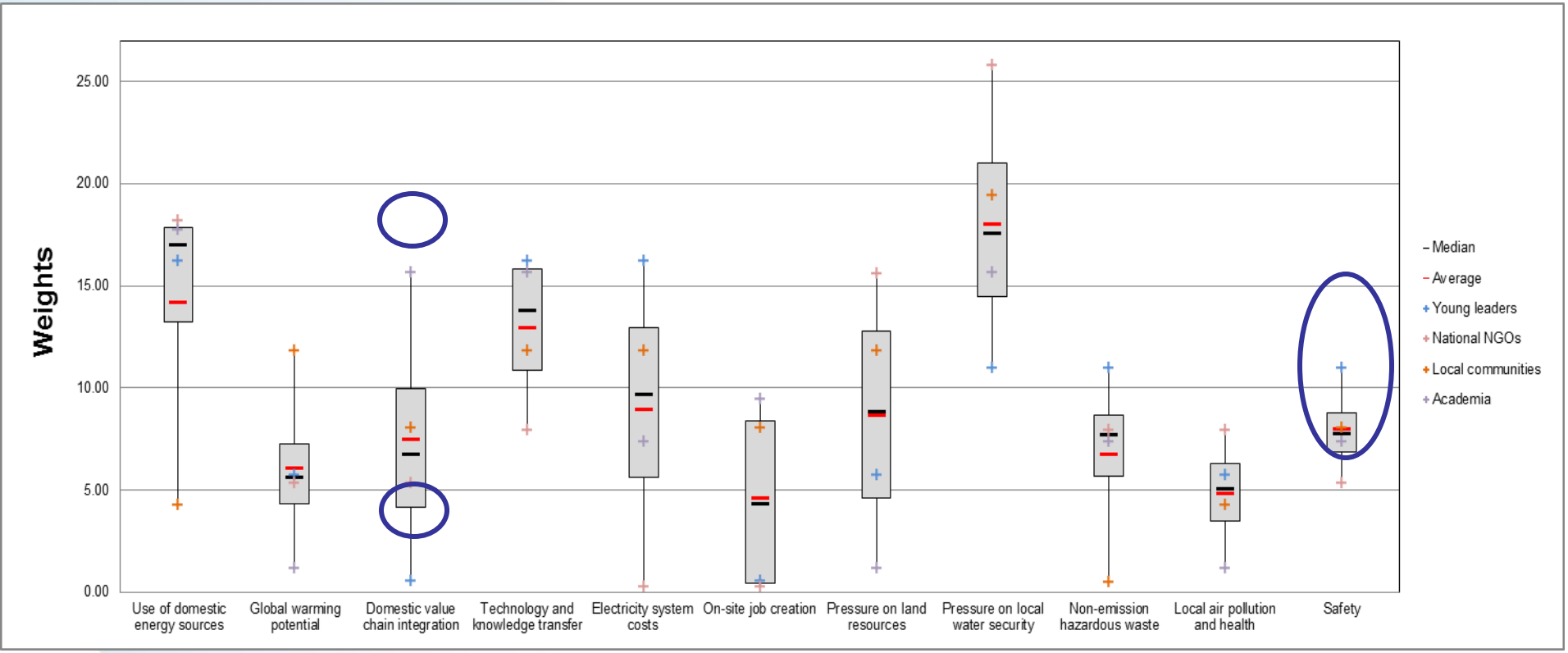
Source: MASEN

Alternative electricity scenarios and water usage in MENA region



Source: Desertection project

Water usage by electricity generation technologies is already intensively discussed topic among experts and organized stakeholders in the MENA region



	Use of domestic energy sources	Global warming potential	Domestic value chain integration	Technology and knowledge transfer	Electricity system costs	On-site job creation	Pressure on land resources	Pressure on local water security	Non-emission hazardous waste	Local air pollution and health	Safety
Quantil 1 (25%)	13.23	4.32	4.16	10.86	5.61	0.47	4.62	14.51	5.67	3.50	6.89
Min	4.27	1.18	0.54	7.93	0.26	0.26	1.18	10.99	0.49	1.18	5.37
Median	16.99	5.57	6.71	13.76	9.62	4.30	8.80	17.55	7.66	5.02	7.72
Average	14.12	6.04	7.41	12.92	8.93	4.58	8.60	17.98	6.70	4.79	7.95
Max	18.22	11.84	15.68	16.22	16.22	9.46	15.60	25.83	10.99	7.93	10.99
Quantil 3 (75%)	17.87	7.28	9.96	15.82	12.94	8.40	12.78	21.02	8.70	6.30	8.79

Source: MENA-SELECT Project

Existing challenges

- High water consumption by CSP, however, still lower than of fossil fuels and nuclear

But

- Most of existing studies deal with reduction of costs and not of environmental impact of CSP technology
- Costs of wet cooling are lower then of dry cooling
- Most policy recommendations are about capital costs reduction, efficiency improvement and economies of scale
- This might increase pressure on local water resources

Conclusion

- Electricity demand is growing significantly in the MENA region. CSP is one of the available options to cover it
- Costs of wet cooling are much lower then of dry cooling
- Costs and economic feasibility are currently major barrier for CSP deployment
- Most recommendations on CSP deployment are about capital costs reduction, efficiency improvement and economies of scale
- Large scale deployment to reach economy of scale and costs minimization task might increase pressure on local water resources

Contact Information
Nadejda Komendantova
komendan@iiasa.ac.at