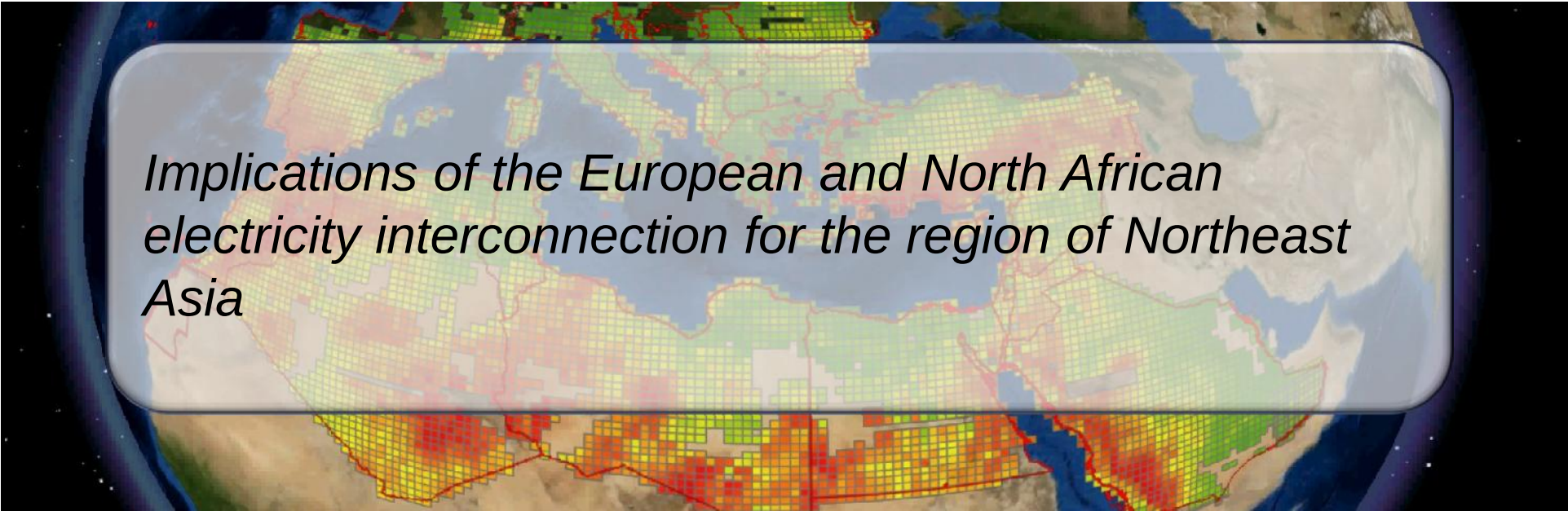

DEVELOPING RENEWABLE ENERGY
ACROSS GOBITEC AND ASIAN SUPER GRID IN NORTHEAST ASIA
26 JUNE 2014

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*Implications of the European and North African
electricity interconnection for the region of Northeast
Asia*

Source: Fraunhofer ISI

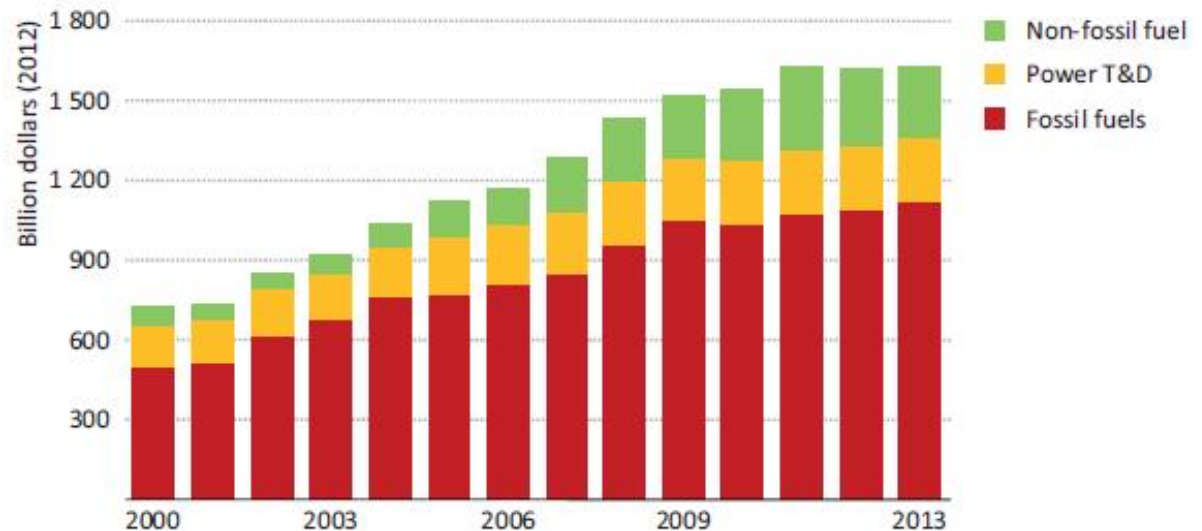
Agenda

- Introduction
 - Development of RES and their implication on the electricity network in Germany and Europe
 - Newest RES development/investment trends
 - RES Development in Germany and their economic viability
 - Policy framework and support schemes
 - RES Potentials and development
 - Implications on the grid system
 - Example of a supranational Supergrid initiative
 - Desertec – Interconnecting North Africa and Europe
 - Conclusion
-

Newest RES development trends - Key Messages WEIO 2014

- More than \$1 600 billion was invested in 2013 (estimated 2000\$ billion in 2035) to provide the world consumers with energy, a figure that has more than doubled in real terms since 2000; and a further \$130 billion to improve energy efficiency.
- RES: 60\$ billion (2000) / 300\$ billion (2011) / 250\$ billion (2013)
- Half of the investment due to demand increase

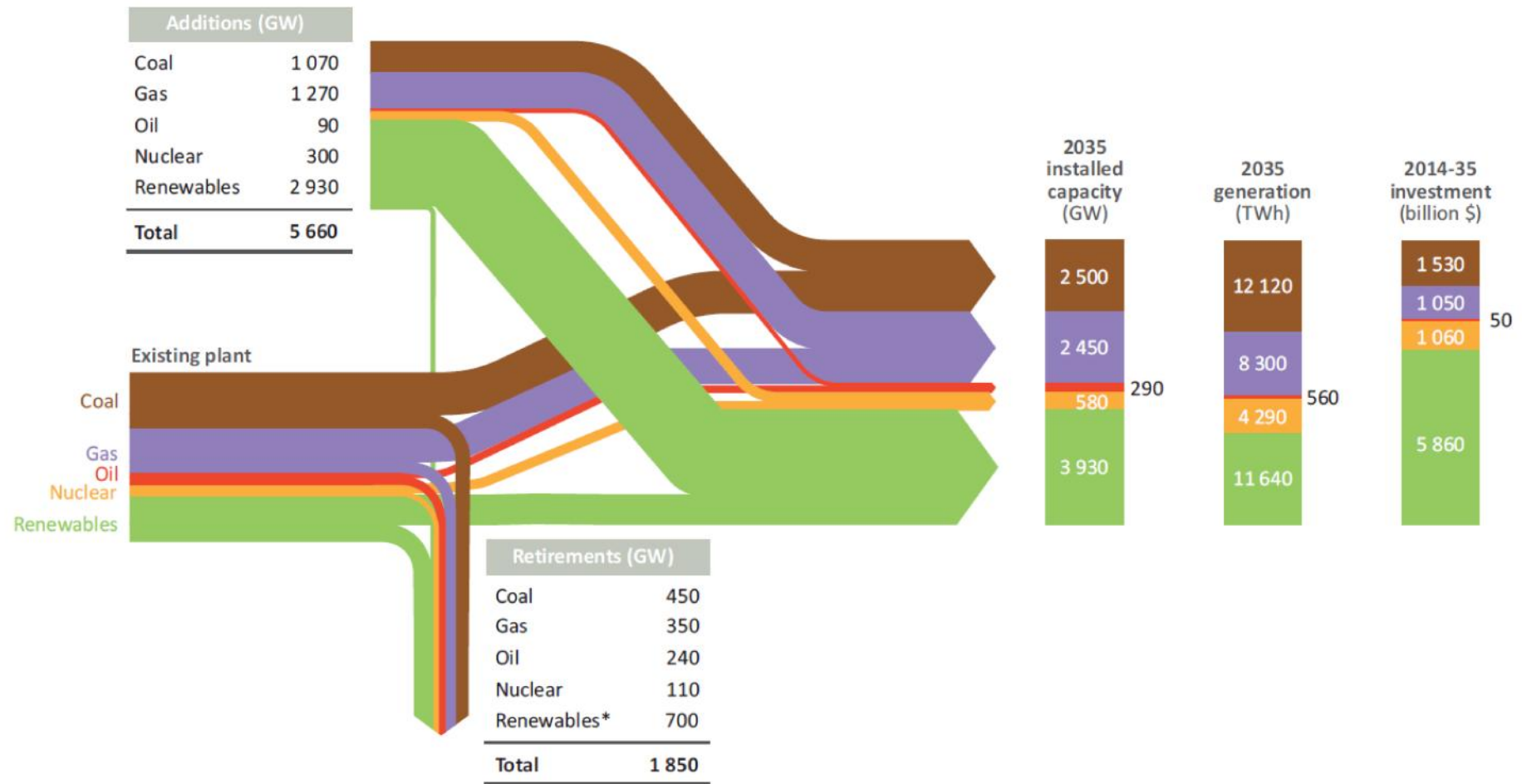
Figure 1.2 ▶ Investment in global energy supply by fossil fuel, non-fossil fuel and power T&D



Notes: Non-fossil fuel includes all renewable technologies, nuclear and biofuels. Power T&D is transmission and distribution for the power sector: this cannot be assigned to either fossil-fuel or non-fossil fuel use.

Source: WEIO 2014

Figure 3.5 ► Power generation global capacity flows and investment, 2014-2035



Note: Over the projection period, a small portion of the renewables additions is retired following the lifetime assumption for wind and solar PV of 20-25 years

Source: WEIO 2014

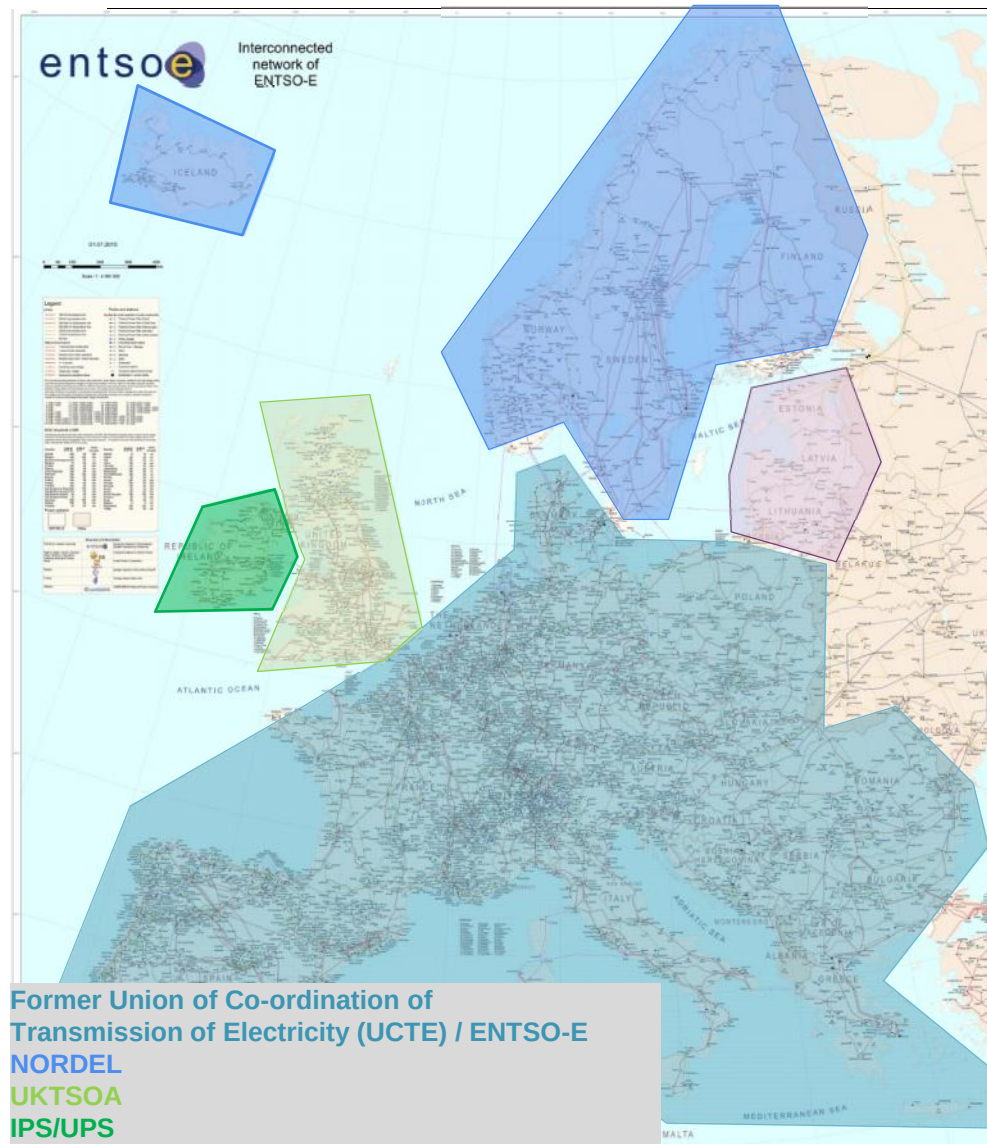
Newest RES development trends - Key Messages WEIO 2014

- Private sector participation is essential to meet energy investment needs in full, but mobilising private investors and capital will require a concerted effort to reduce political and regulatory uncertainties.
- New types of investors in the energy sector are emerging, but the supply of long-term finance on suitable terms is still far from guaranteed.
- Investment in liquefied natural gas (LNG) facilities creates new links between markets and improves the security of gas supply; but high costs of gas transportation may dampen the hopes of LNG buyers in Europe and Asia for much cheaper gas supplies. (Example of Oman)
- The investment required to maintain the reliability of Europe's electricity system is unlikely to materialize with the current design of power markets.
- The investment path that we trace in this report falls well short of reaching climate stabilisation goals, as today's policies and market signals are not strong enough to switch investment to low-carbon sources

Newest RES development trends - Key Messages WEIO 2014

- For many emerging economies, keeping up with booming electricity demand is a huge investment challenge, and current investment trends provide some warning signs for the adequacy of power supply.
- Decisions to commit capital to the energy sector are increasingly shaped by **government policy measures and incentives**, rather than by signals coming from competitive markets.
 - Only 10% of investment share in competitive markets
- Of the \$8 trillion investment in energy efficiency to 2035, 90% is spent in the transport and buildings sectors, reflecting policy ambitions and remaining efficiency potentials

Introduction – The European Electricity Network



1. Five existent electricity networks in Europe
2. Every electricity network is interconnected with high voltage transmission lines (220/400 kV)
3. **Development (continental EU):**
 1. Founded in 1951 as Union pour la coordination de la production et du transport de l'électricité (**UCPTE**)
Reorganization into the Union of Co-ordination of Transmission of Electricity (**UCTE**) due to liberalization process
4. European Transmission System Operators (**ETSO**) 1999-2009
5. Since 2009 organized in the European Network of Transmission System Operators for Electricity (**ENTSO-E**)

Development of installed capacity for renewable-based electricity generation in Germany since 1990

Data in thousand kilowatt

	Hydropower ¹	Wind energy onshore	Wind energy offshore	Photovoltaics	Biomass ²	Deep geothermal energy	Installed capacity for renewables-based electricity generation
1990	3,982	55	0	2	635	0	4,674
1995	4,348	1,121	0	18	724	0	6,211
2000	4,831	6,097	0	114	1,164	0	12,206
2001	4,831	8,738	0	176	1,281	0	15,026
2002	4,937	11,976	0	296	1,416	0	18,625
2003	4,953	14,593	0	435	1,938	0	21,919
2004	5,186	16,612	0	1,105	2,454	0	25,357
2005	5,210	18,375	0	2,056	3,525	0	29,166
2006	5,193	20,568	0	2,899	4,345	0	33,005
2007	5,137	22,183	0	4,170	4,851	3	36,344
2008	5,164	23,815	0	6,120	5,440	3	40,542
2009	5,340	25,614	78	10,566	6,096	7	47,702
2010	5,407	26,895	284	17,554	6,540	7	56,688
2011	5,625	28,730	329	25,039	7,230	7	66,961
2012	5,604	30,869	434	32,643	7,557	12	77,120

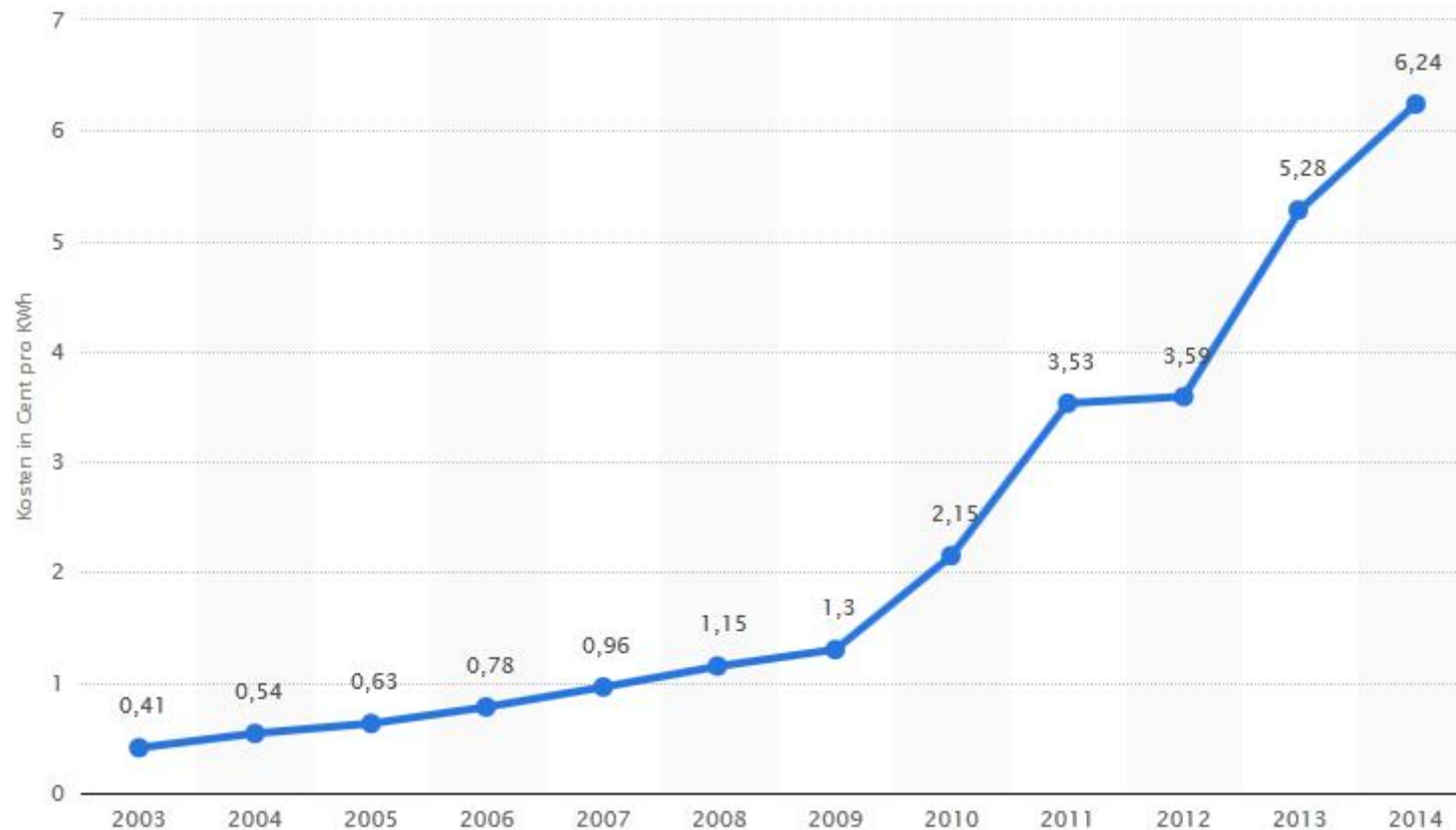
BMU - E I 1 according to Working Group on Renewable Energy-Statistics (AGEE-Stat); as at July 2013; all figures provisional

¹First-time inclusion of installed capacity of pump storage power plants with natural inflow

²Includes biogenic solid fuels and liquid biomass, biogas, sewage gas and landfill gas and the biogenic fraction of waste (biogenic components of waste in waste incineration plants estimated at 50 percent)

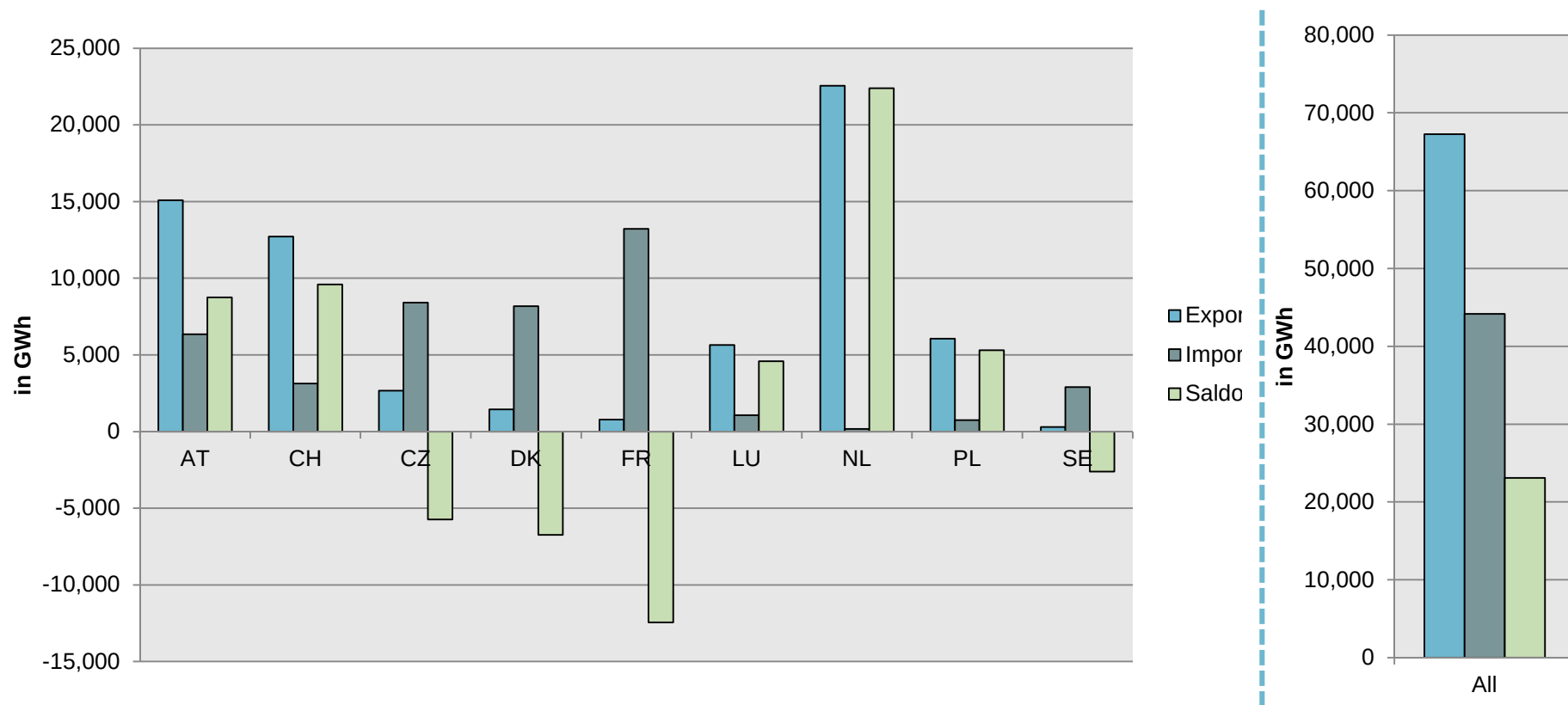
Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

Development of the cost per HH / GER Renewable Energy Act



Source: Statista 2014 / EEG-KWK

Example of German electricity exports and imports in 2012



Source: ENTOS-E 2014

Importance of interconnectors for RES implementation

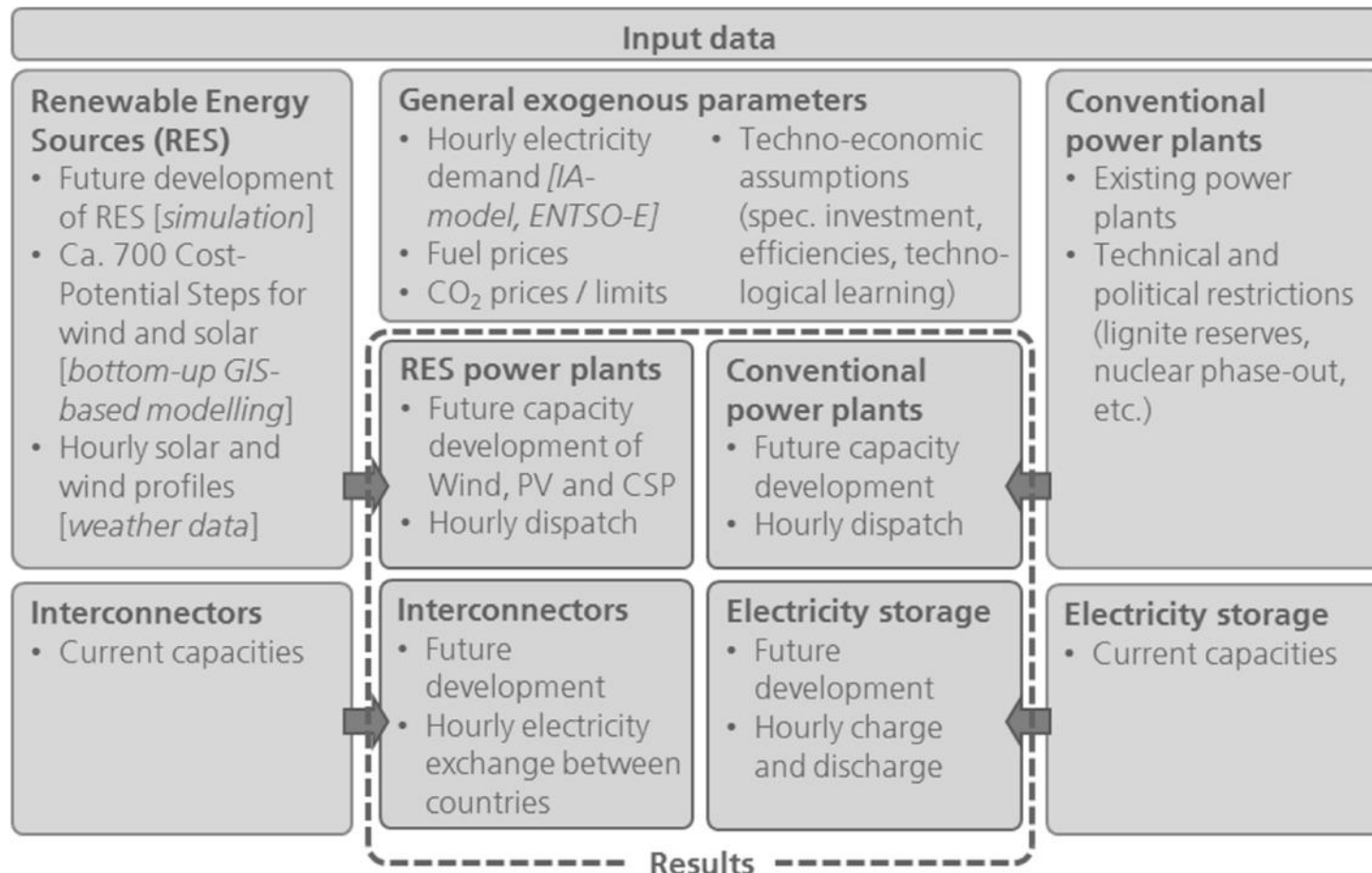
General Theses:

- Good Potential location are not necessarily near the main demand centers, however newer studies in Germany show that both options are feasible (building RES near the demand centers / building RES at the good potential locations – see <http://www.agora-energiewende.de>)
- The higher the geographic distribution of RES the easier it is possible to compensate fluctuating RES (raising capacity credit)

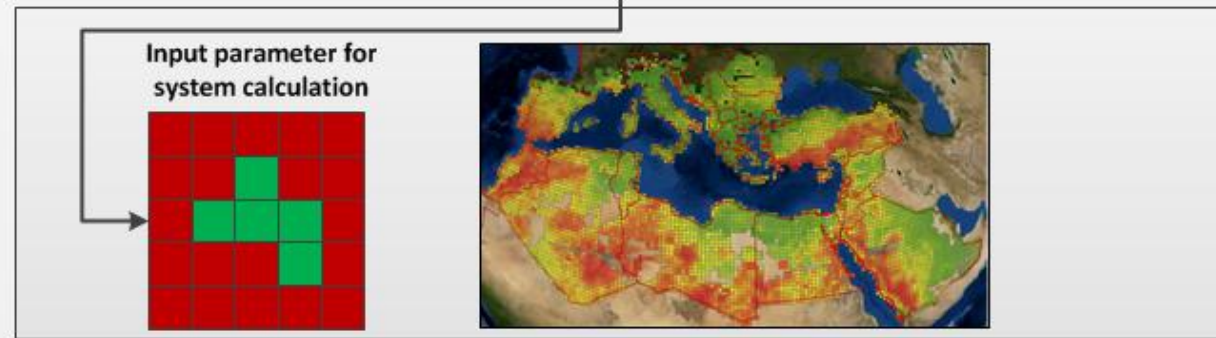
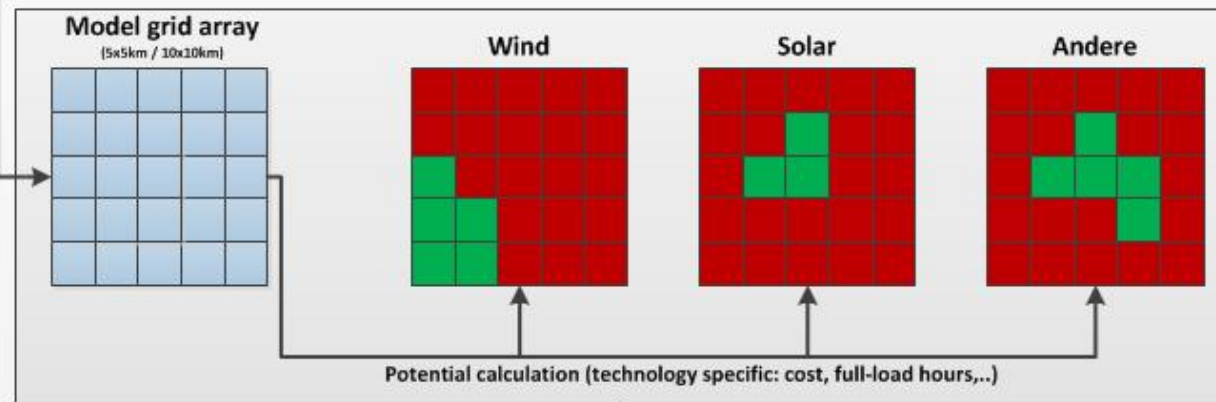
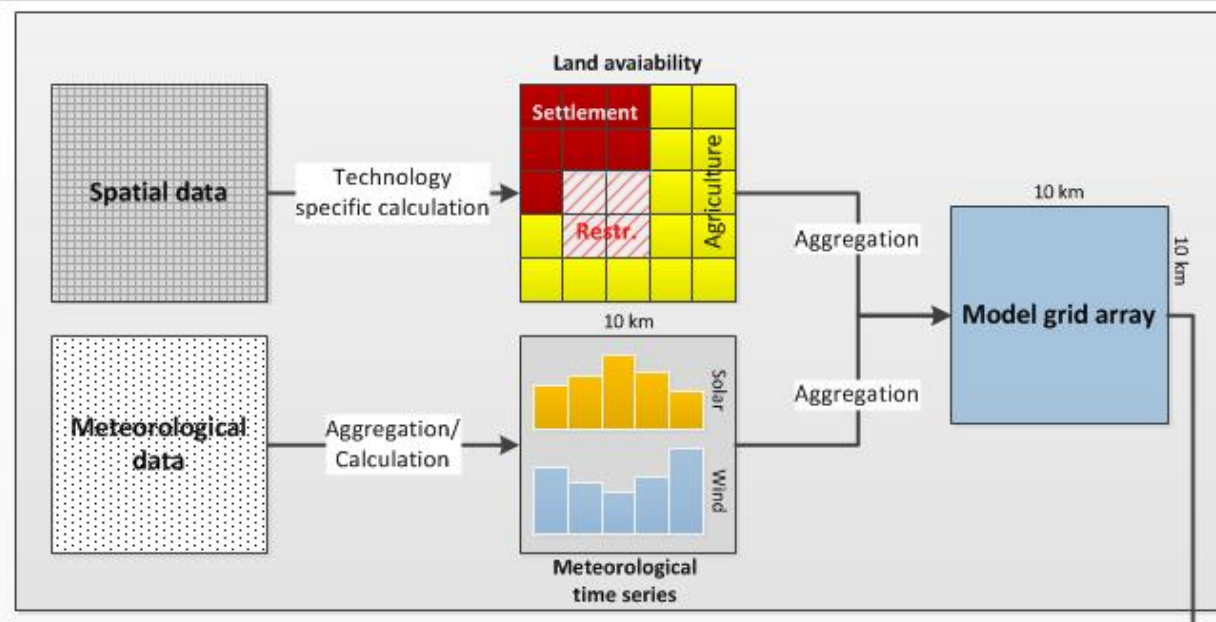
Two Examples:

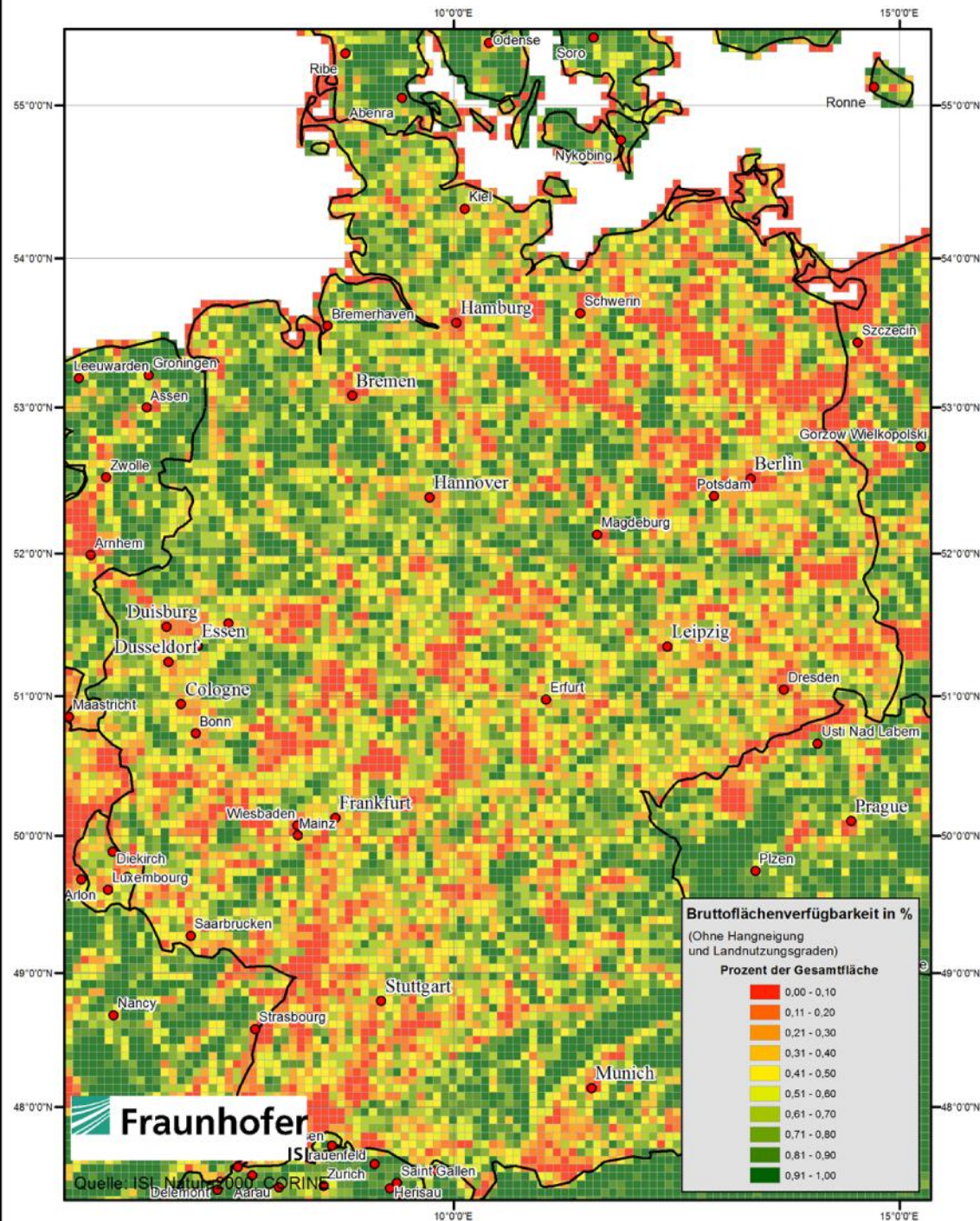
- Example of a supranational Project (DESERTEC)

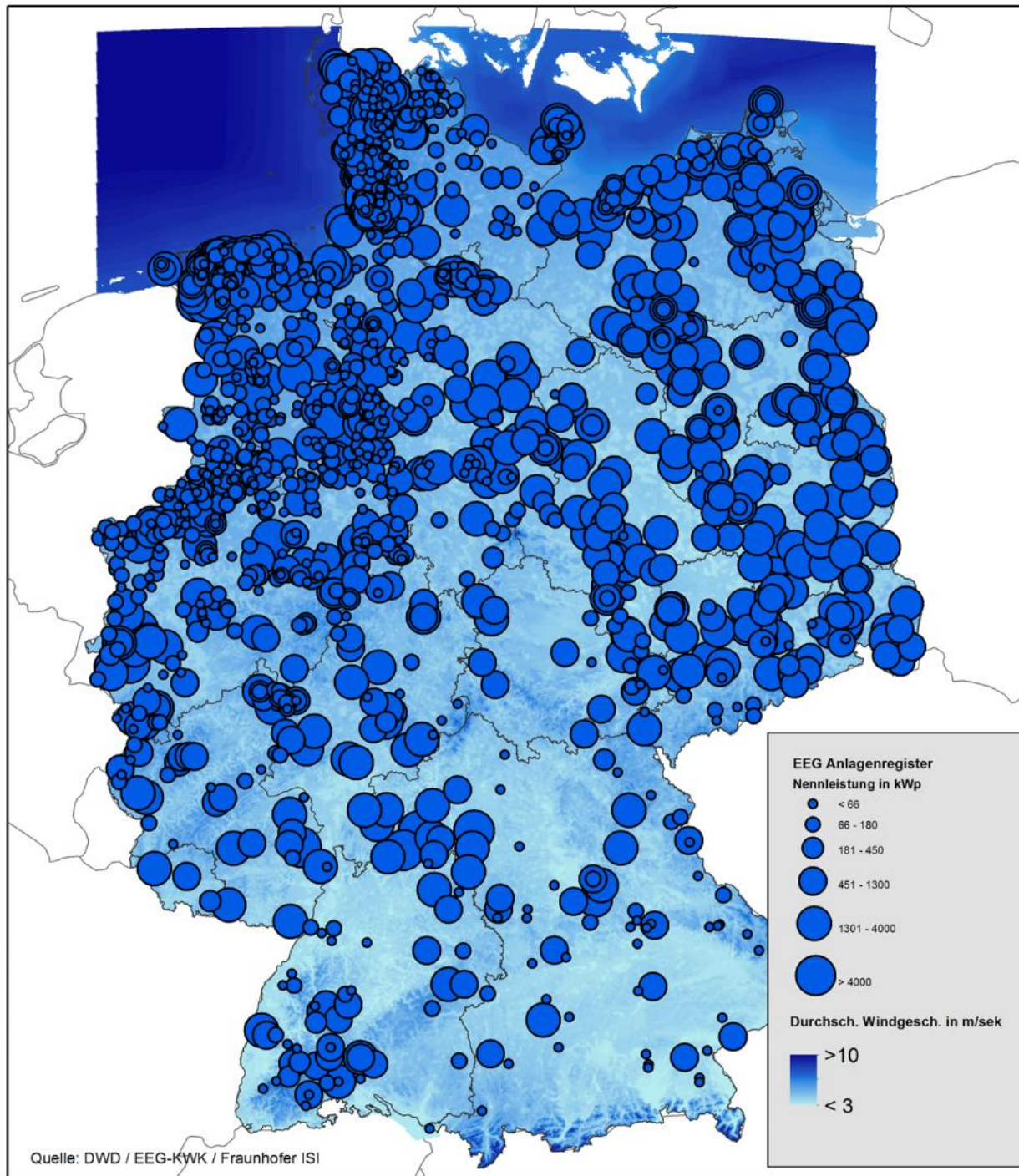
PowerACE - Model

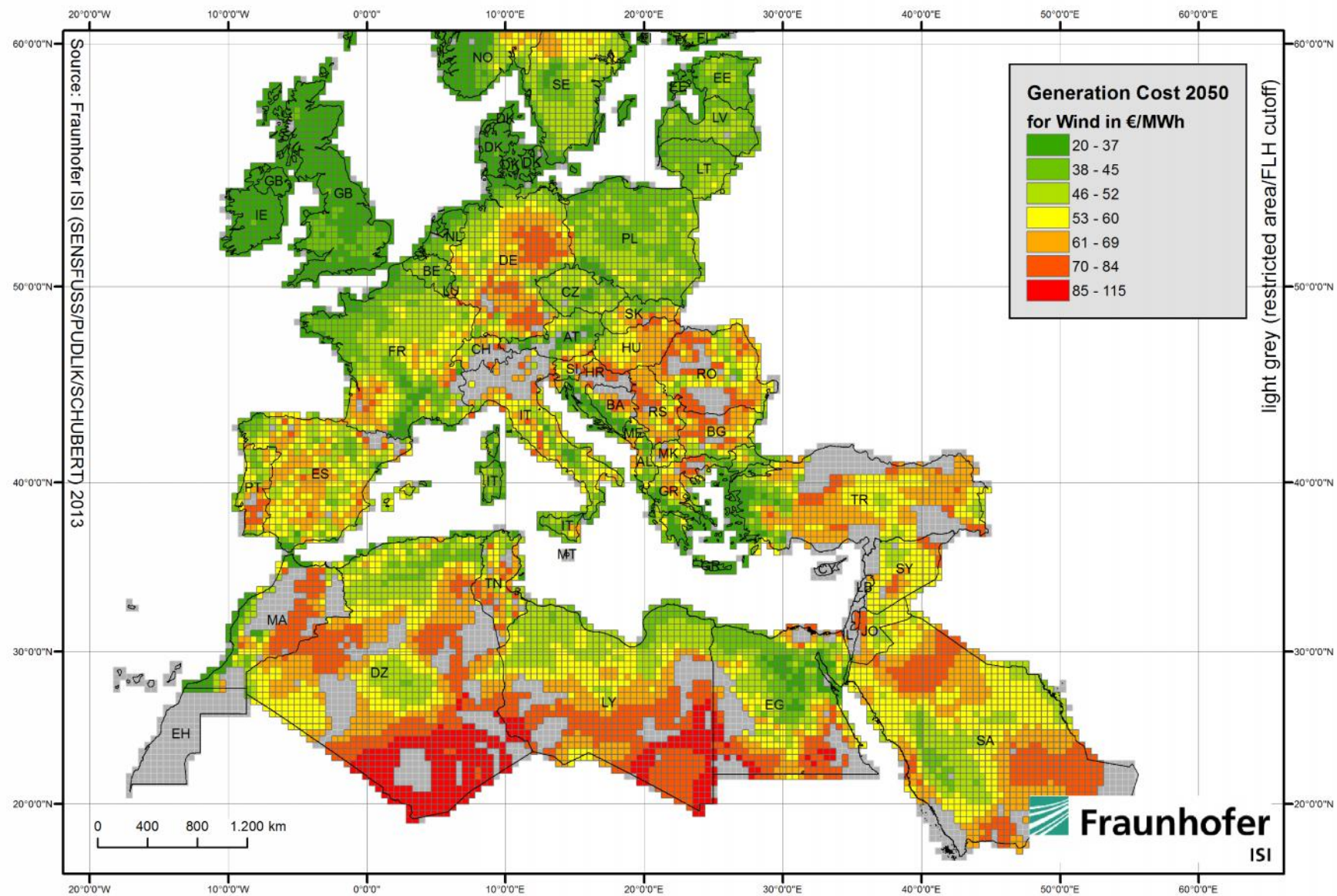


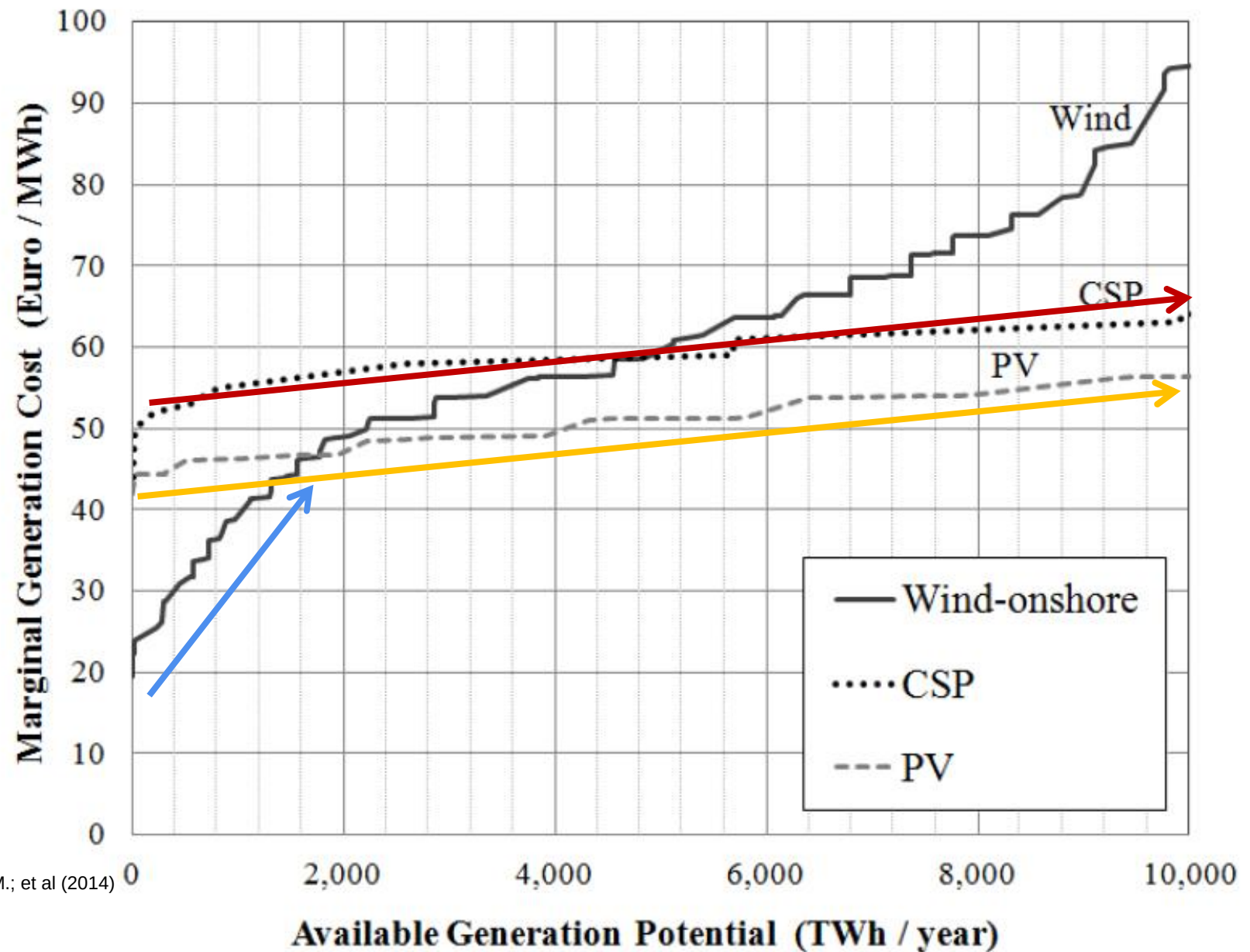
Source: Fraunhofer ISI / Pflueger / Sensfuss



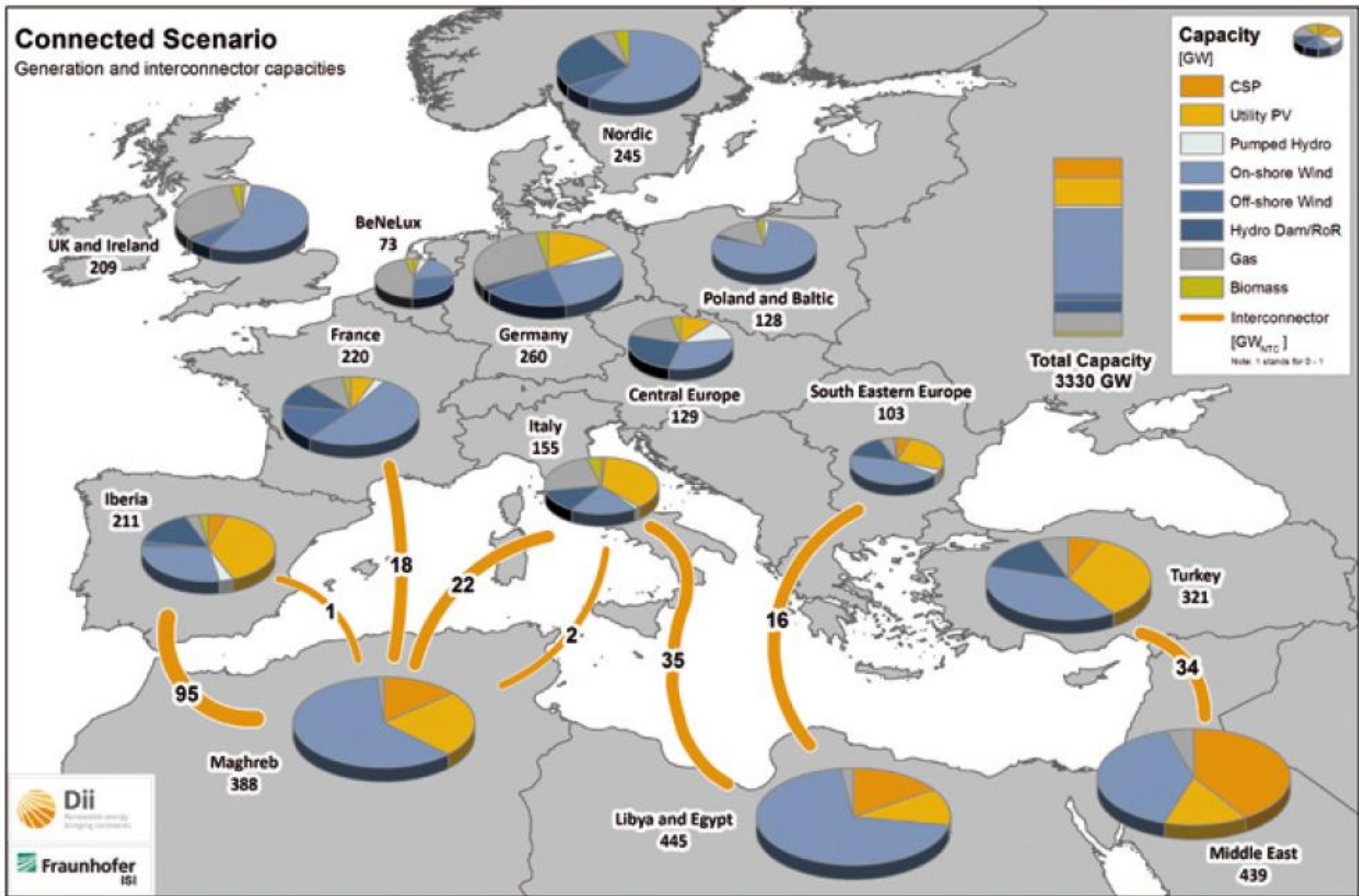








Source: Boie, I.; Pudlik, M.; et al (2014)



Source: Dii 2012 Desert Power 2050

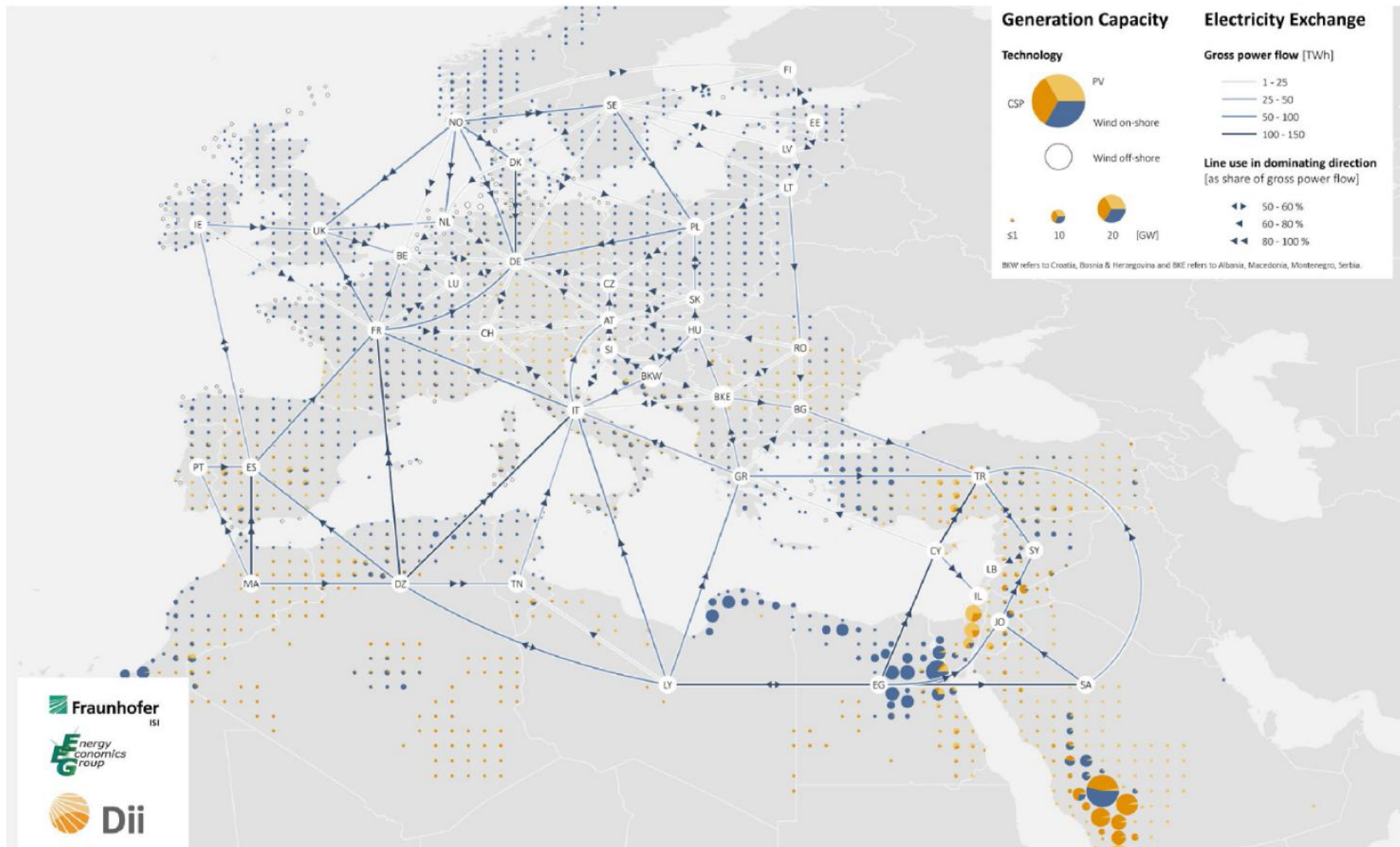
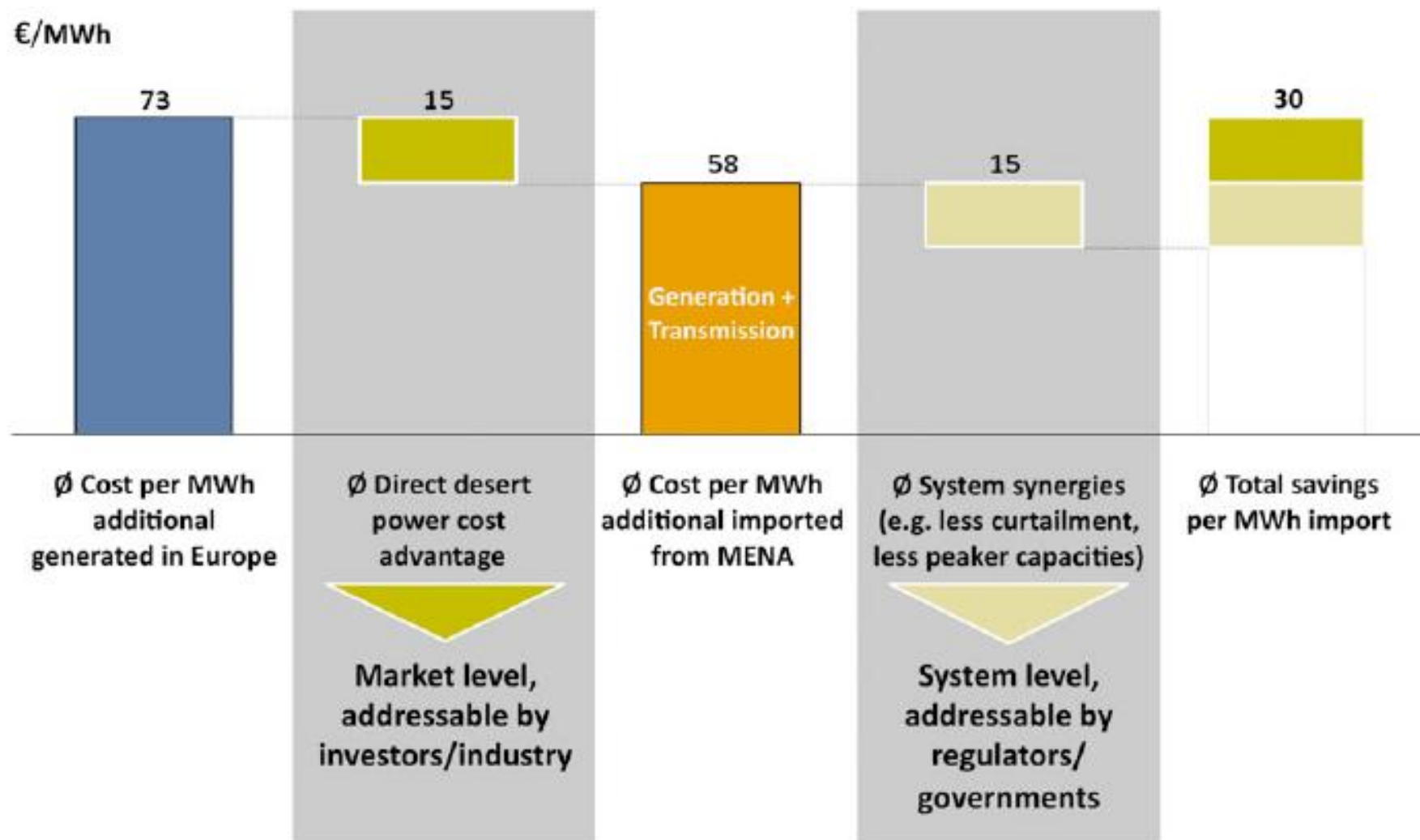


Figure 3.23 EUMENA Wind and Solar installation in 2050

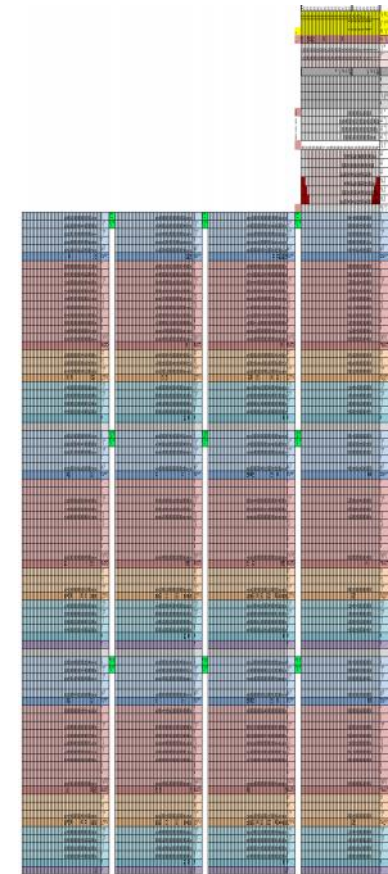
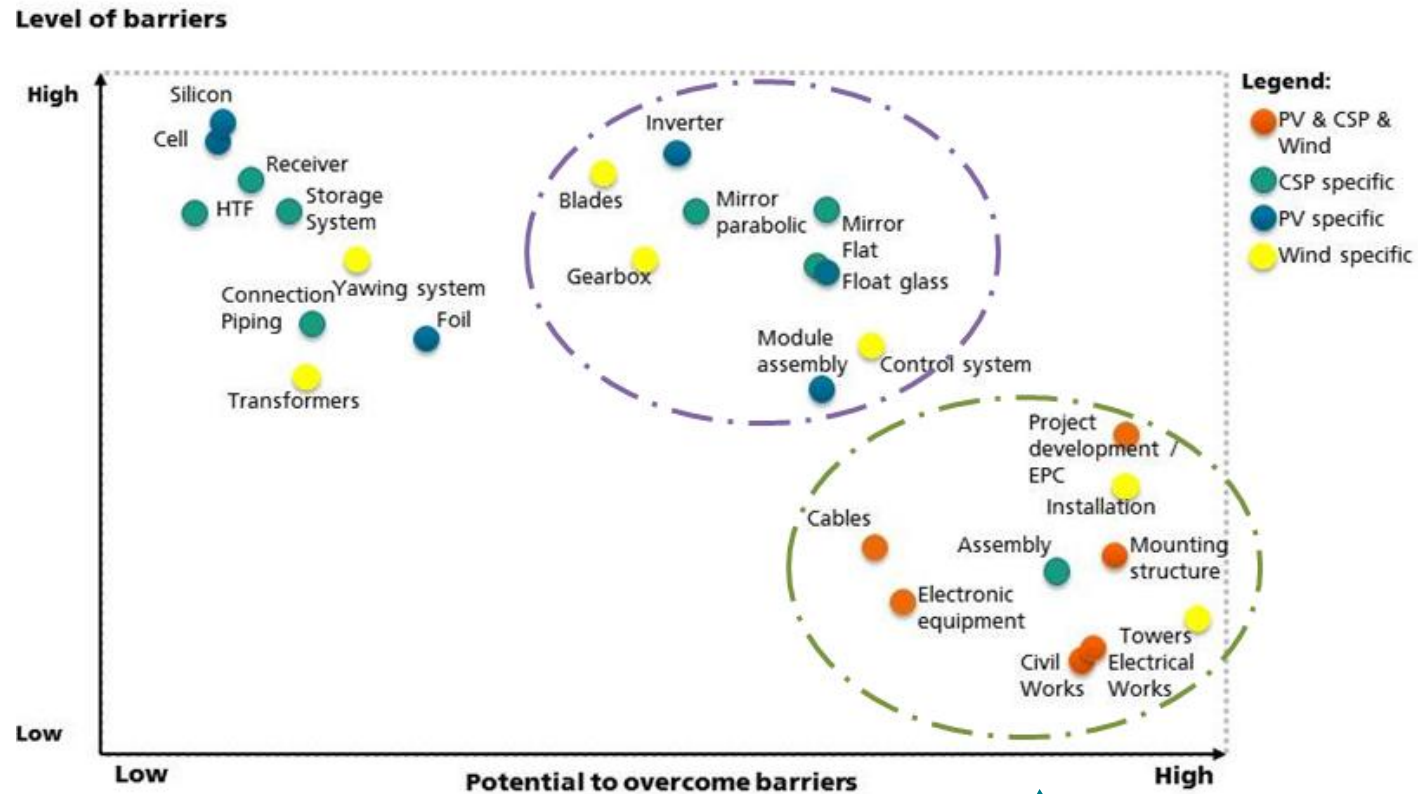
Source: Dii 2013 Getting Started



Source: Dii, Fraunhofer ISI Note: Cost of MENA exports arriving in Europe includes cost of transmission losses

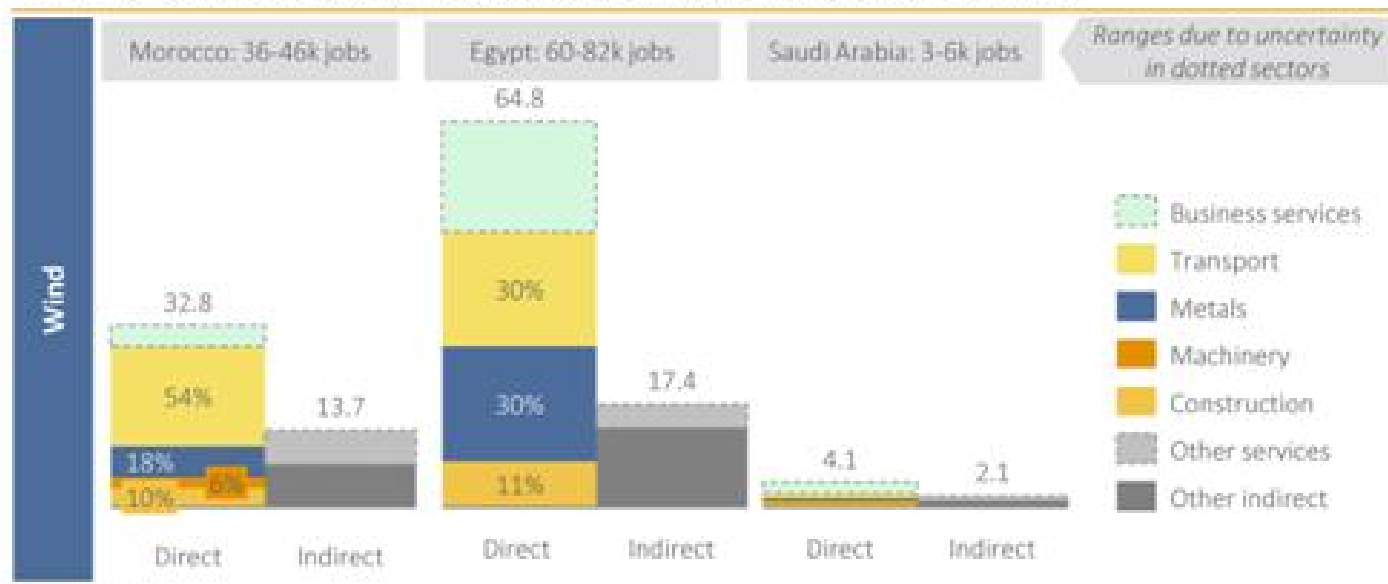
Source: Dii 2012 Desert Power 2050

Component complexity

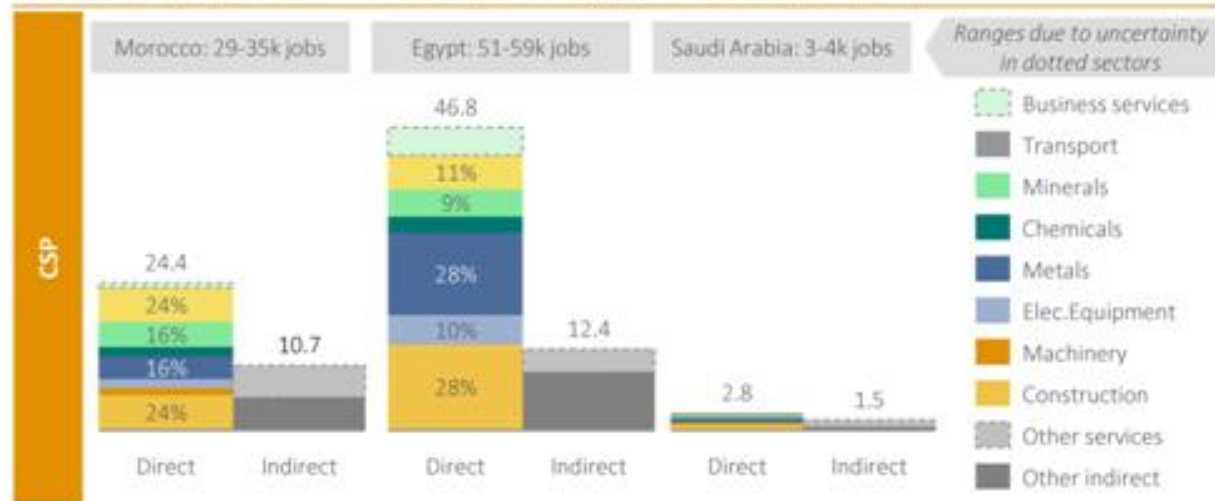


Source: Fraunhofer ISE / ISI

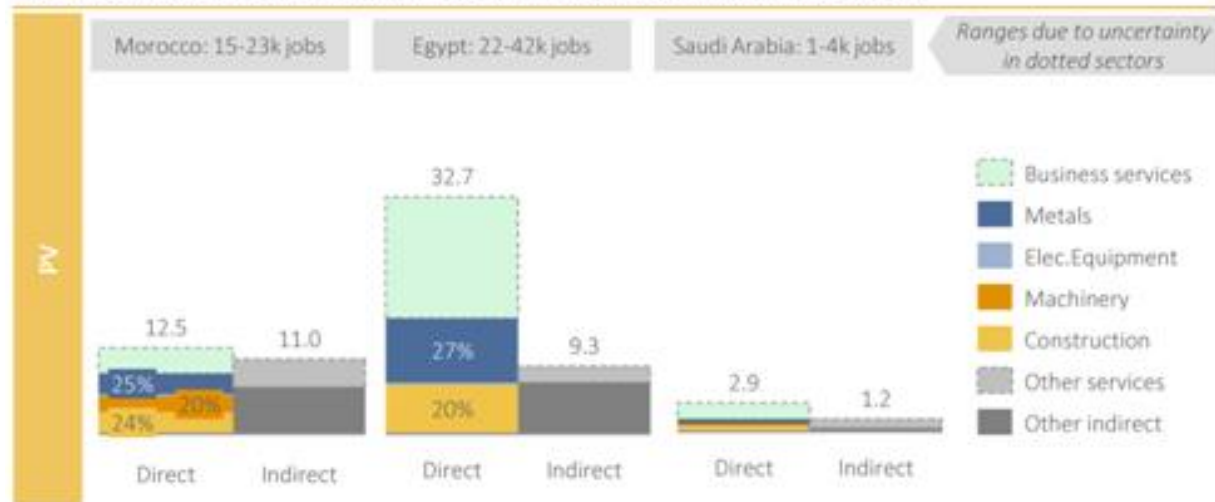
Wind: Thousand jobs per EUR 1bn investment per technology (construction of power plants)



CSP: Thousand jobs per EUR 1bn investment per technology (construction of power plants)



PV: Thousand jobs per EUR 1bn investment per technology (construction of power plants)





Thank you very much for your attention.

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