DESERTEC – A PROSPECTIVE PILLAR OF THE GERMAN ELECTRICITY MARKET?

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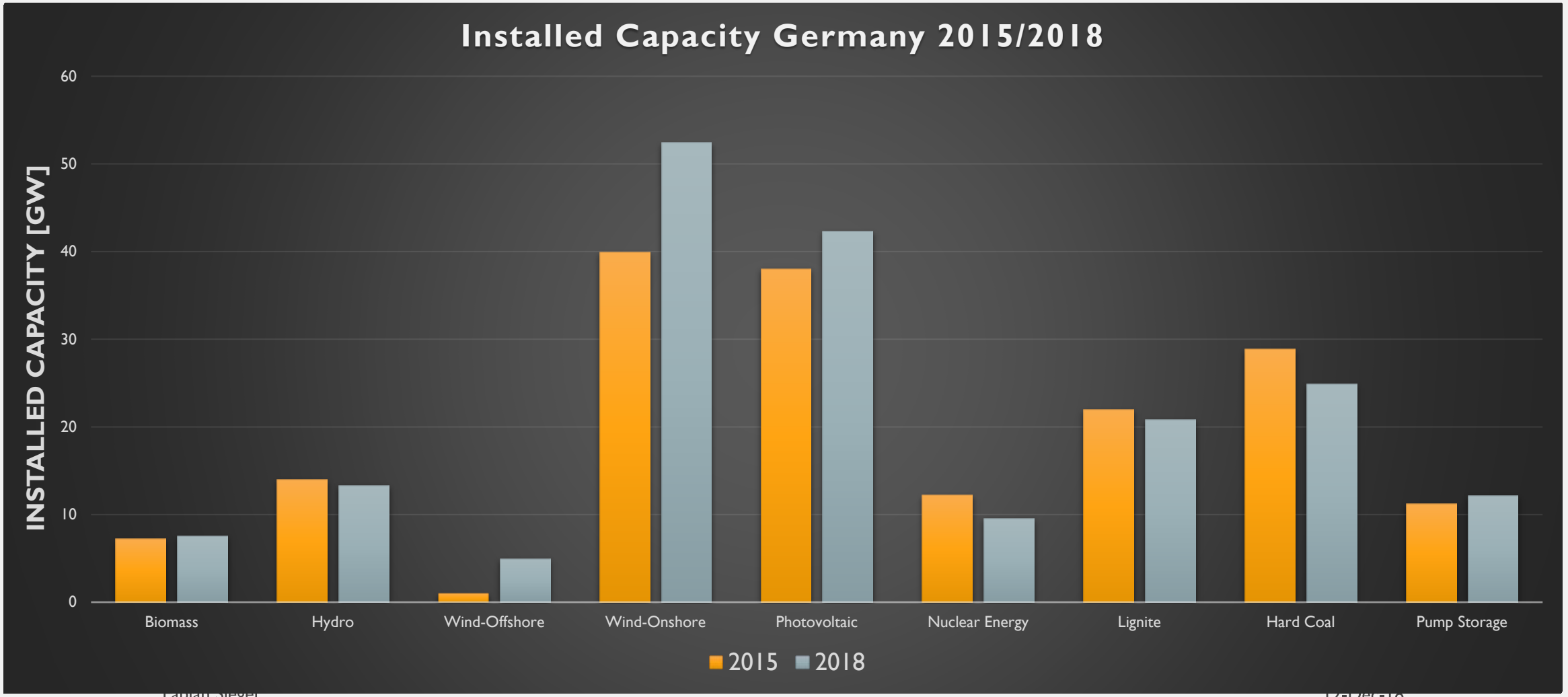
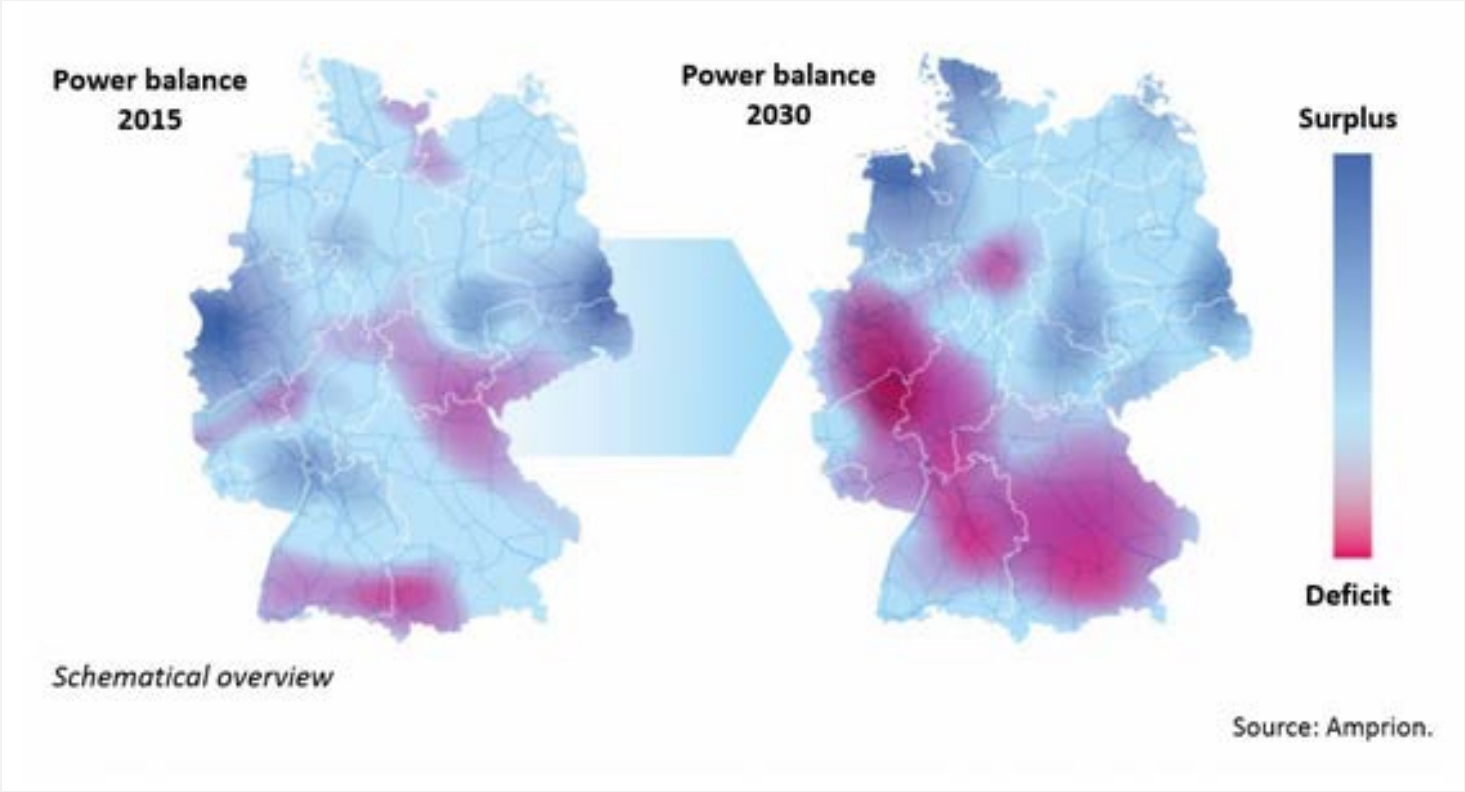
PROGRESS INSTALLED CAPACITY 2015-2018



ARISING ISSUES

- Main Problem: Having the Energy at the right **time** in the right **place**

→ Expensive grid stabilizing measures



LINEAR REGRESSION

- Independent Variable:

→ **Phelix** (€/MWh) = Average Spot Price in DE/AT/LU

- Regressors:

→ Realized **Electricity Production and Consumption** (MWh)

- Sample Range: 06.01.2015 – 27.04.2018
- Hourly Observations of all variables → **28970 observations**
- OLS: Phelix = Constant + b_1 Electricity Consumption + b_2 Biomass + b_3 Hydro + b_4 Wind-Offshore + b_5 Wind-Onshore + b_6 Photovoltaic + b_7 Nuclear Energy + b_8 Lignite + b_9 Hard Coal + b_{10} Pump Storage + ε

RESULTS

Equation: UNTITLED Workfile: DATENBANK...

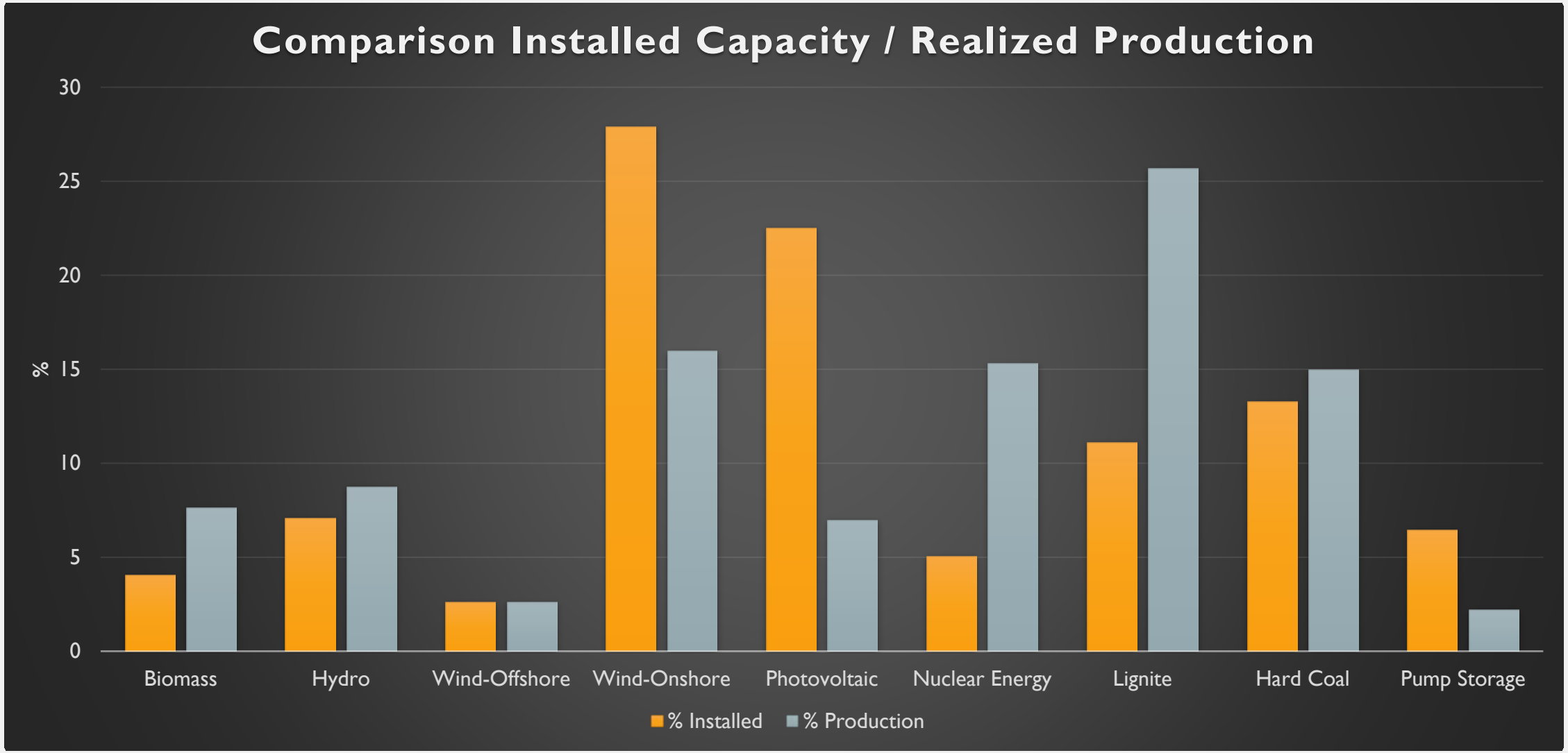
View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: PHELIX
Method: Least Squares
Date: 07/09/18 Time: 10:05
Sample: 1 28991
Included observations: 28970

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.300579	0.865893	2.656886	0.0079
CONSUMPTION	0.004356	4.44E-05	98.10505	0.0000
BIOMASS	-0.009743	0.000589	-16.52912	0.0000
HYDRO	-0.005552	0.000143	-38.68944	0.0000
WINDOFFSHORE	-0.001688	0.000197	-8.564791	0.0000
WINDONSHORE	-0.005189	5.63E-05	-92.22678	0.0000
PHOTOVOLTAICS	-0.004121	5.09E-05	-80.95831	0.0000
NUCLEAR	-0.004641	0.000134	-34.70842	0.0000
LIGNITE	0.002995	0.000119	25.07515	0.0000
HARDCOAL	-0.003120	8.29E-05	-37.65710	0.0000
PUMPSTORAGE	0.004709	0.000167	28.19974	0.0000

R-squared	0.744410	Mean dependent var	31.98558
Adjusted R-squared	0.744322	S.D. dependent var	14.71005
S.E. of regression	7.438082	Akaike info criterion	6.851483
Sum squared resid	1602159.	Schwarz criterion	6.854624
Log likelihood	-99232.73	Hannan-Quinn criter.	6.852492
F-statistic	8434.354	Durbin-Watson stat	0.246189
Prob(F-statistic)	0.000000		

INSTALLED CAPACITY 2018 / REALIZED PRODUCTION 2015-2018



STANDARD DEVIATION

	Biomass	Hydro	Wind-Offshore	Wind-Onshore	Photovoltaic	Nuclear	Lignite	Hard Coal	Pump Storage	Total
Standard Deviation	**84.95**	**390.95**	**304.95**	**1867.38**	**1570.24**	**374.67**	**575.30**	**1264.39**	**392.96**	**2192.99**

- Intermittent Energy sources: higher S.D. → higher fluctuation
- Controllable Energy sources: higher S.D. → tendentially higher Controllability

TWO SCENARIOS FOR THE ENERGIEWENDE

- Goal: Reaching a 90% share of Renewables by 2050
- *Source:* Trieb, F. (2013). „*Integration erneuerbarer Energiequellen bei hohen Anteilen an der Stromversorgung. Energiewirtschaftliche Tagesfragen*“, *7*, pp. 28-32.

TWO SCENARIOS FOR THE ENERGIEWENDE

SCENARIO 1

- Dominantly intermittent renewable energy sources (Wind, Photovoltaic)
- High need for production, transfer and storage capacities
- Estimated Electricity production cost in 2050:
  107 €/MWh

SCENARIO 2

- Well controllable renewable energy sources (Biomass, Geothermal, Hydro and **Solarthermal** Energy)
- Direct replacement of todays baseload of conventional energy sources
- Estimated Electricity production cost in 2050:
  92 €/MWh

Tab. 1: Installierte Leistungen (MW) in den beiden Szenarien von 2020 bis 2050

		Szenario 1			Szenario 2		
Jahr	2020	2030	2040	2050	2030	2040	2050
Fluktuierend / Erneuerbar (MW)	103 000	150 500	191 500	217 500	107 500	115 500	117 500
Photovoltaik	45 000	60 000	84 000	95 000	45 000	45 000	45 000
Wind Onshore	45 000	60 000	63 000	66 000	42 500	40 000	40 000
Wind Offshore	8 000	25 000	39 000	51 000	15 000	25 000	27 000
Laufwasserkraft	5 000	5 500	5 500	5 500	5 000	5 500	5 500
Regelbar / Erneuerbar (MW)	8 200	11 500	11 000	13 500	20 500	30 000	35 000
Biomasseabfälle, Müll	1 500	2 000	2 000	2 000	2 000	3 500	4 000
Holz, Energiepflanzen, Biogas	6 600	9 000	8 500	11 000	7 000	7 000	7 000
Geothermie	100	500	500	500	1 000	3 500	4 000
Import Wasserkraft	0	0	0	0	2 000	3 500	4 000
Import Solarstrom	0	0	0	0	8 500	12 500	16 000
Fossil / Nuklear (MW)	97 500	91 000	89 000	84 000	84 000	71 500	65 000
Gasturbinenkraftwerke	12 500	36 000	89 000	84 000	26 000	50 000	65 000
Kohlekraftwerke	30 000	20 000	0	0	15 000	6 500	0
GuD und BHKW	31 000	25 000	0	0	38 000	15 000	0
Kernkraftwerke	4 000	0	0	0	0	0	0
Braunkohlekraftwerke	20 000	10 000	0	0	5 000	0	0
Speicher und Netztransfer (MW)	16 000	22 000	40 000	80 000	16 000	16 000	16 000
Pump-und Druckluftspeicher	7 500	10 000	15 000	20 000	7 500	7 500	7 500
Pumpspeicherkapazität (h)	12	12	12	12	12	12	12
H_2-Speicher Leistung	0	2 000	5 000	20 000	0	0	0
H_2-Speicher Kapazität (h)	0	24	24	24	0	0	0
Netztransferkapazität (NTC)	8 500	10 000	20 000	40 000	8 500	8 500	8 500
Gesamter Kraftwerkspark (MW)	216 200	265 000	311 500	355 000	219 500	224 500	225 000

WHAT IS DESERTEC?

What is Desertec?

- **Desertec Concept:** Founded in 2003 by the Club of Rome

  → Scope: Establishing the idea of Solar Thermal power plants

- **Desertec Foundation:** Founded in 2008

  → Scope: Pivot between scientific research, commercial organizations, governments, and NGOs

- **Desertec Industrial Initiative (Dii):** Founded in 2009 by 12 major european companies (e.g. Deutsche Bank, UniCredit, RWE, Siemens,…)

  →Scope: Creation of a profitable business project

Remaining shareholders from 2015: RWE, State Grid Corporation of China, ACWA Power

→ Today the Dii operates as a Business Consultant for Solarthermal projects

CONCENTRATED SOLAR POWER

Technology: Concentrated Solar Power

1. Giant mirrors concentrate sunlight onto an absorber
2. Light is transformed into thermal energy by heating up a suitable heat transfer fluid (e.g. special salts)
3. Electricity is produced by running a conventional steam engine

- The heat transfer fluid works as a heat storage
- Advantage:

➢ CSP can provide a reliable baseload and balancing power without uncontrollable fluctuations

NECESSITY FOR HIGH SOLAR IRRADIATION

South Spain:

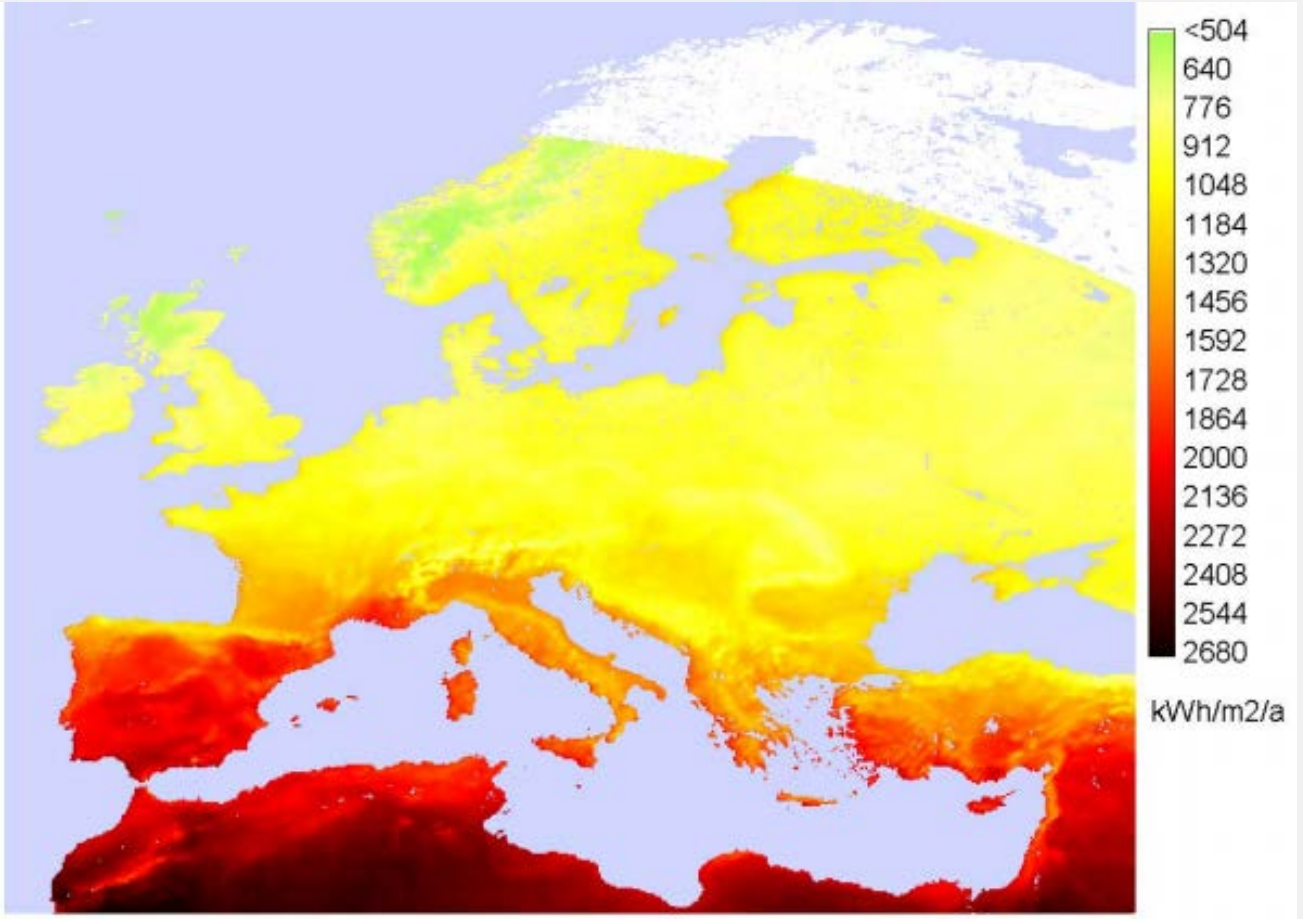
- 2000 kWh/m²/a

→ 5840 full load operating hours (66.7%)

Egypt:

- 2800 kWh/m²/a

→ 7900 full load operating hours (90.2%)



PRODUCTION SITES / CENTERS OF DEMAND

Production sites:

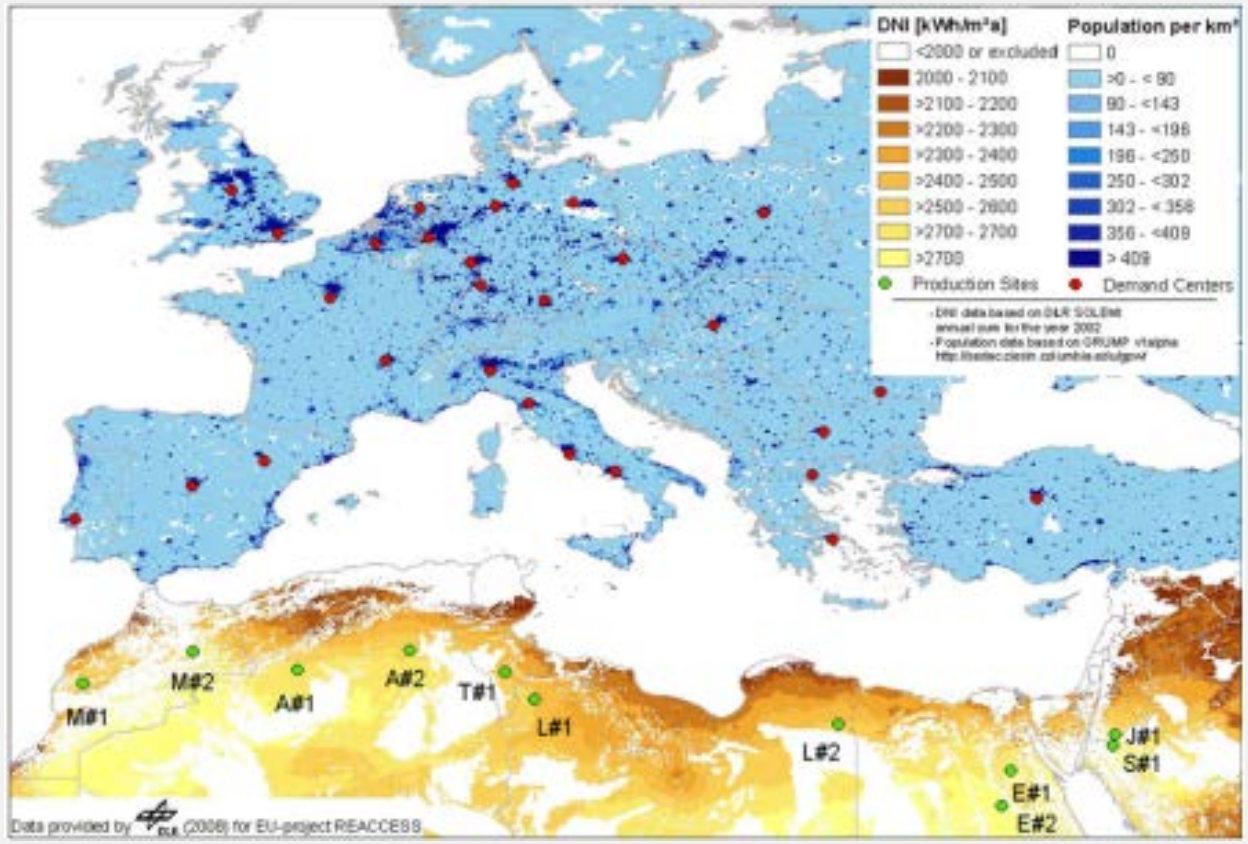
- Intensity of solar irradiation
- Availability of land resources
- Availability of road infrastructure

Centers of demand:

- Closeness to areas with a high electricity demand

(Closeness to consumers, existing grid infrastructure)

- Land availability



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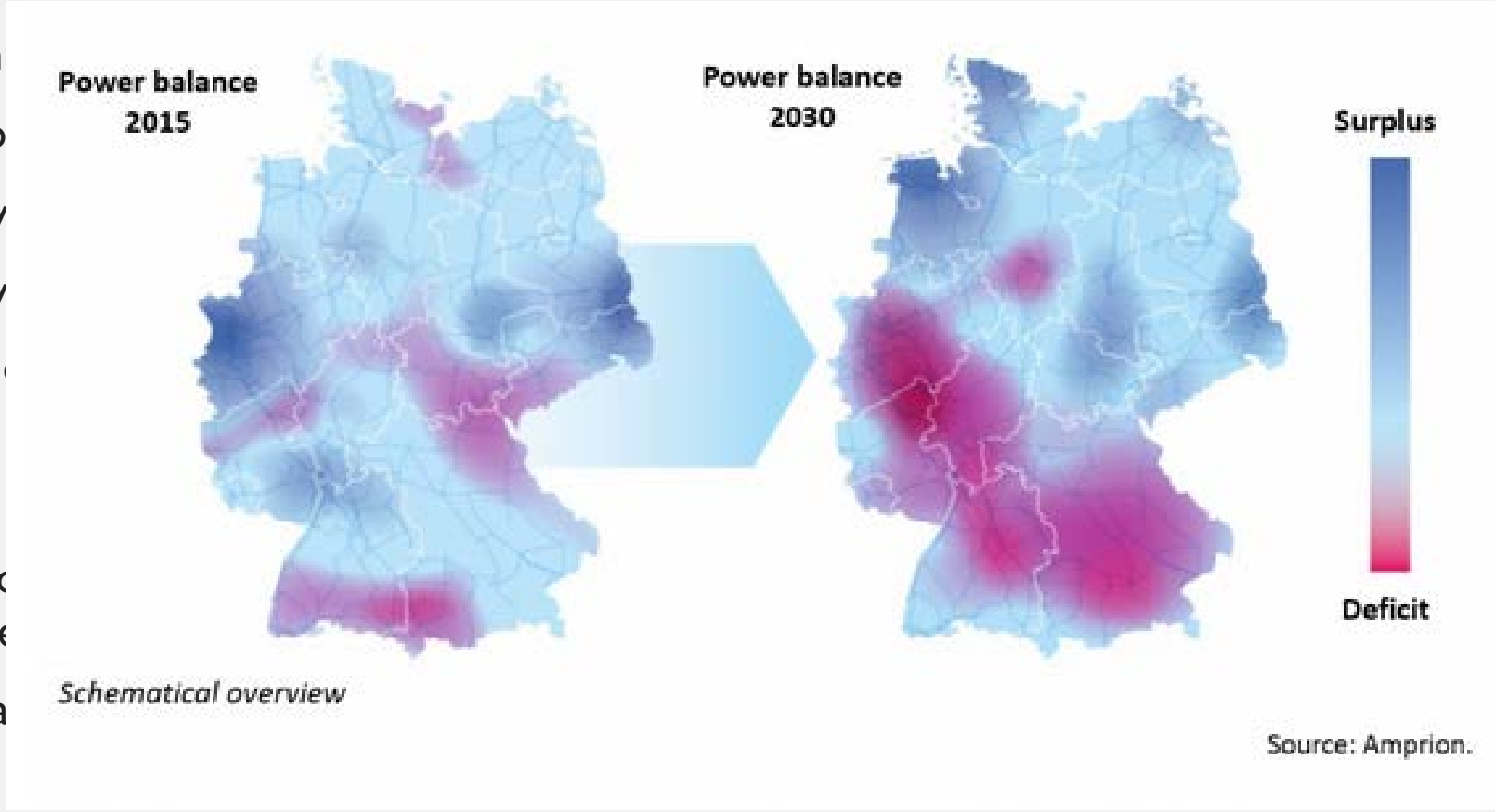
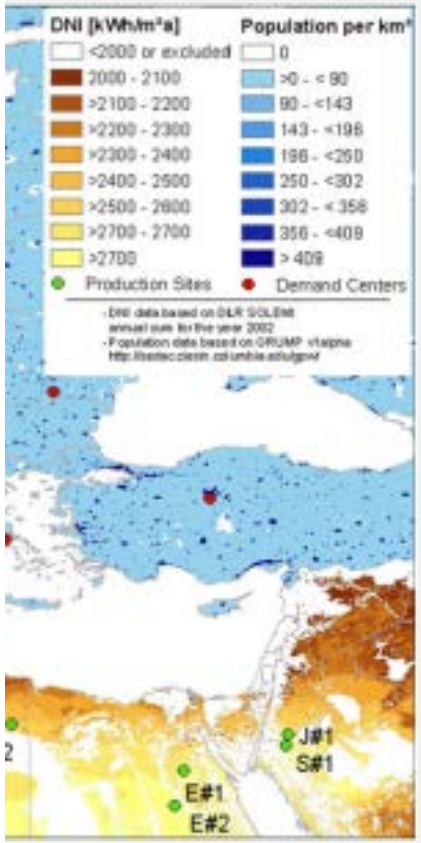




TRANSMISSION LINES

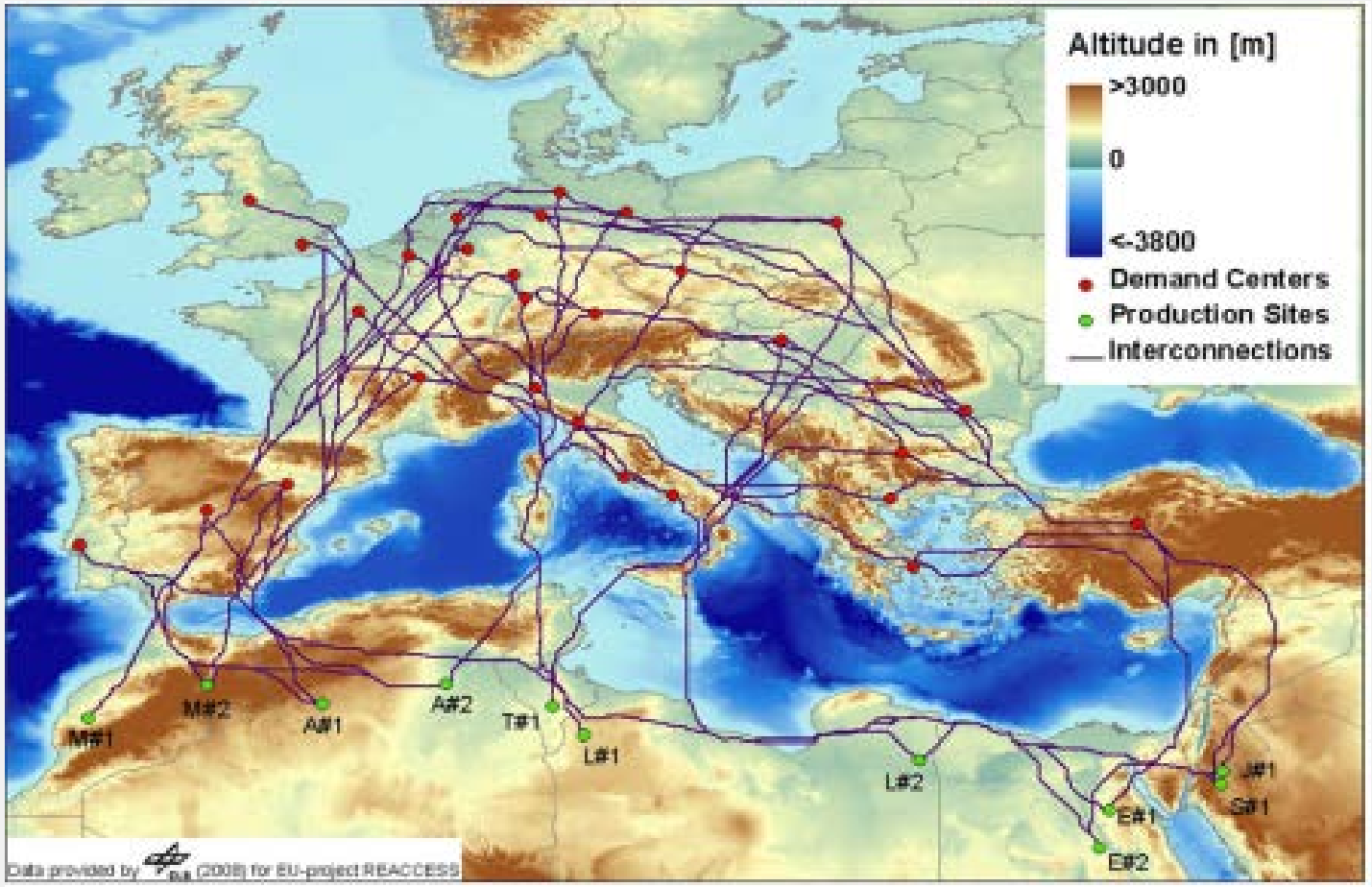
- 33 HVDC lines with a uniform voltage of ±600 kV
- Average transmission loss of 11.9 %
- Criteria: Avoid…

→ Protected areas

→ Industrial locations

→ Populated places

→ Sea areas deeper than 2000m



OUARZAZATE SOLAR COMPLEX

Noor 1 CSP:
- 160 MW with a storage capacity of 3 hours
- Activation: Februrary 2016

Noor 2 CSP:
- 200 MW with a storage capacity of 6 hours
- Activation: January 2018

Noor 3 CSP:
- 150 MW with a storagte capacity of $7\frac{1}{2}$ hours
- October 2018

→ Operators: ACWA Power, MASEN
→ Production Cost: **€2.2bn**
→ Electricity Production Cost: **64.7 €/MWh**

THANK YOU FOR YOUR ATTENTION!

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