

FROM ECO-FRIENDLY AND AFFORDABLE POWER GENERATION TO INTELLIGENT POWER DISTRIBUTION

About BELECTRIC

Our core capabilities

PV System Design Analysis

Engineering, procurement & construction (EPC)

Operation & Maintenance (O&M)

**1st EPC company
Worldwide
with an installed
capacity of
> 1 GW**

> 480
realized PV
Power plants

> 4.2 GW
installed
capacity

> 1,7 GW
in O&M

Since **2001**
pioneer in utility
scale solar

Since **12/2021**
Member of
Elevion Group



System Design Optimization: Beyond LCoE

COMPLEXITY OF SYSTEM DESIGN OPTIMIZATION – HOW TO DECIDE ?

Technology specific influences



Substructures



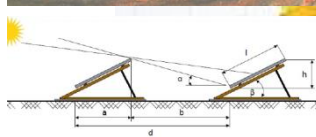
Modules



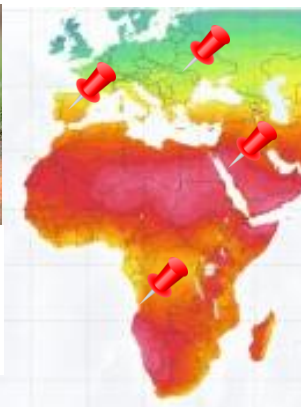
Inverters



Market- & Project specific influences



Geographical influences



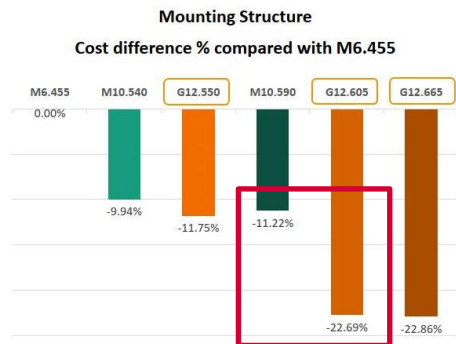
Key takeaway:

- *modelling and simulation is crucial to cope with complexity of system design optimization and holistic evaluation of components*

PV TECHNOLOGY ANNOUNCEMENTS VS. PV PROJECTS REALITY

CAPEX & LCOE Results

CAPEX break-down in Germany



G12 modules

- Longer string and longer table

→ Less amount of table

Landscape G12 + wider modules (G12.605, 665)

- Length instead of width dominates the table cost
- Higher Wp / m

→ Significantly lower € / Wp

LCOE Evaluation Report

No. TRHZHPVS11003/21TC/03

Table 2-3-2 Total Investment of Lorca Project

Module type	182-78N-610W	210-66-665W
Total Project Investment	\$0.7507	\$0.7604
1 Development Cost	\$0.1095	\$0.1095
2 Total EPC cost	\$0.6412	\$0.6509
2.1 Design Fee	\$0.0156	\$0.0156
2.2 Module cost	\$0.3000	\$0.3000
2.3 BOS cost	\$0.3183	\$0.3271

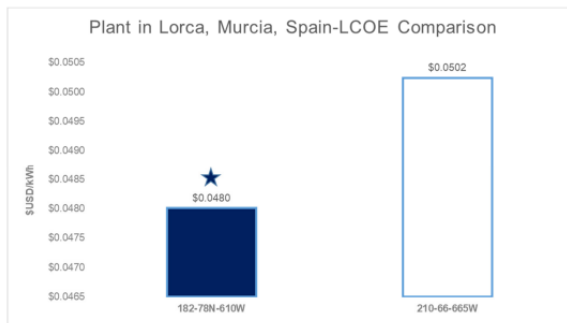


Figure 3-2-2 Comparison of LCOE of Lorca Project

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FHS-SK-DE-INTERNAL

Trinasolar

Fraunhofer
ISE

pv magazine

Single-axis bifacial PV offers lowest LCOE in 93.1% of world's land area

Key takeaway:

➤ Often misleading information in publications require proper consultancy or internal analytical capabilities

KEY PRINCIPLES OF SYSTEM DESIGN OPTIMIZATION AT BELECTRIC

➤ HIGH VOLUMES

- Analysis of all relevant system design scenarios via modelling & simulation approach



➤ APPLE TO APPLE

- Comparing optimized vs. optimized only
- Pan file sanity check before use...



➤ UP TO DATE

- Consideration of new technologies and up to date cost data / forecasts



➤ KPI DRIVEN

- Use of economic KPIs instead of LCoE



➤ HOLISTIC

- Continuous collection and consideration of relevant cost inputs CAPEX and OPEX (incl. installation, transportation, O&M, EBoS..)



➤ RELIABLE

- Interfaces with state of the art software like PV syst and PV case
- Regular model validation



SYSTEM DESIGN OPTIMIZATION: LCOE VS. NPV

CASE STUDY

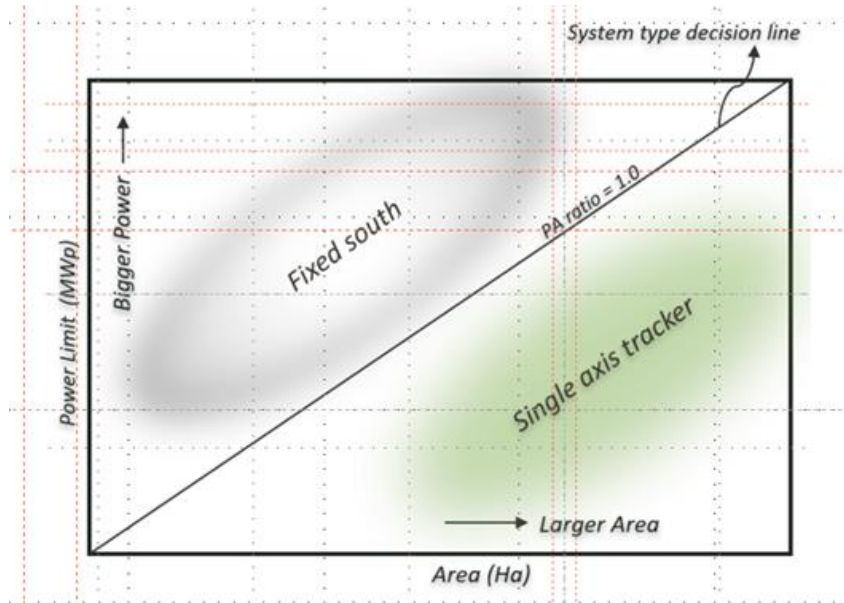
Country	Germany
Geographical Site	xxx
No. of Simulations	12,138
Discount Rate	3% / 5%
Tariff assumption (€cent/kWh)	6 / 4,8

Top System Designs			LCoE Ranking				Deviation Analysis						
No	Substructure	Module	Inverter System	Row Distance (m)	DC/AC Ratio	LCoE (€cent/kWh)	CapEx deviation (€)	OpEx deviation (€)	Nominal Power (kWp)	AC Power (kVA)	Specific Yield (kWh/kWp/a)	Sale of electricity deviation (€)	NPV deviation (€)
1	SAT, 1P, HtG15m bifacial	Y1540DF-72e0.5-182 jaing	SG501-K_bifi	5	16	3.534	0€	0€	19,703	17,133	1364	0€	0€
2	FIXSouth, 3P, 20°, HtG0.7m bifacial	Y1540DF-72e0.5-182 jaing	SG501-K_bifi	6	12	3.547	6,236,996€	943,202€	34,501	28,751	1143	1,817,590€	3,638,393€
3	FIXSouth, 3P, 25°, HtG0.7m bifacial	Y1540DF-72e0.5-182 jaing	SG501-K_bifi	6	12	3.547	6,640,657€	1,011,975€	35,149	29,291	1146	1,157,878€	3,925,245€

Key takeaways:

- Depending on the selected KPI (NPV, LCoE..) the overall ranking will be significantly different
- System Design decisions have a major impact on the business case → manifold options to tailor the business case
- LCoE is in most cases not the right KPI for System Design optimization as it is a cost-based figure not considering the revenues

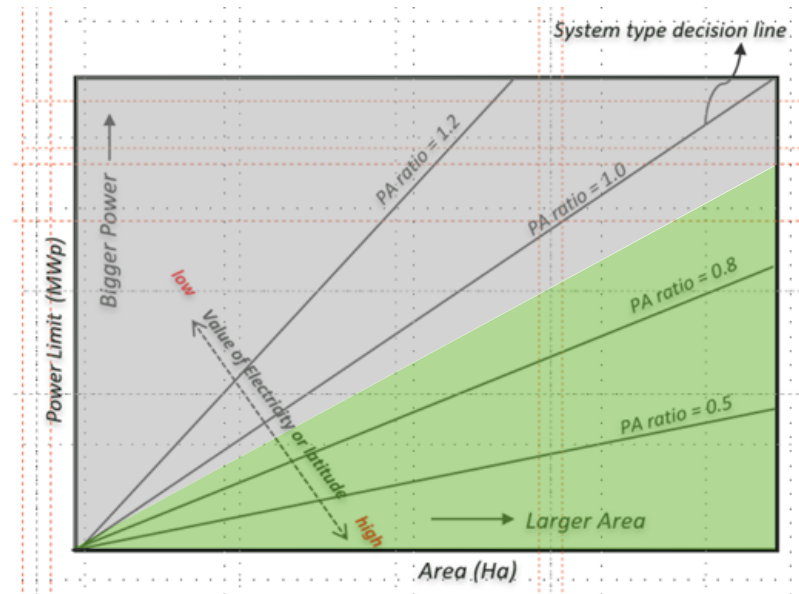
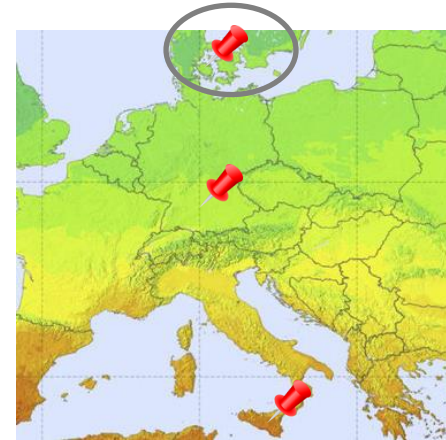
POWER TO AREA DIAGRAM BASED ON NPV RANKING



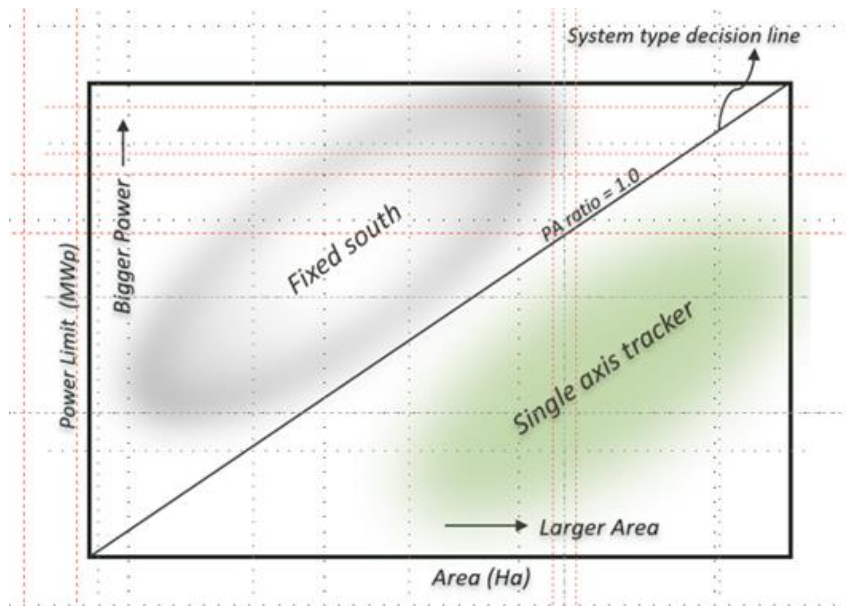
* Schematic diagram based on parametrization of power limits for a 10 ha plot at representative locations across Europe. Beside power limit and location all other parameters kept constant

* PA: Power to area

DENMARK



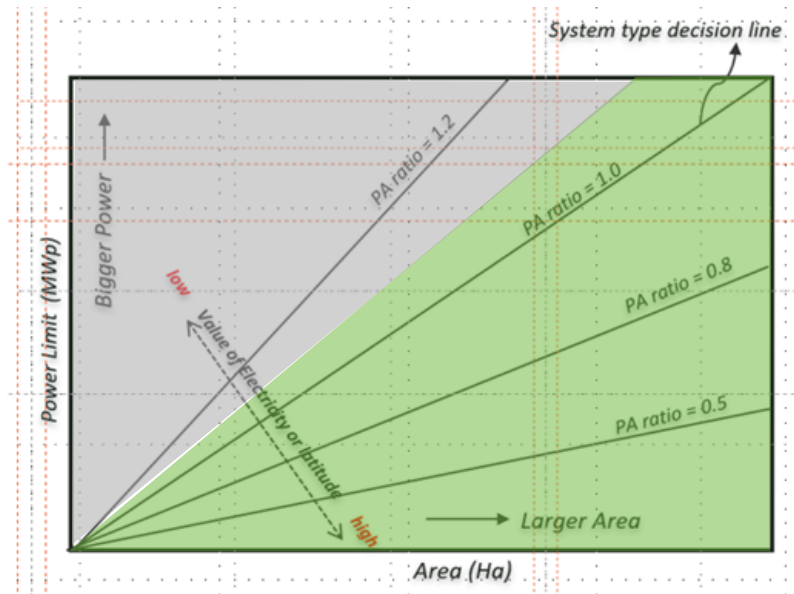
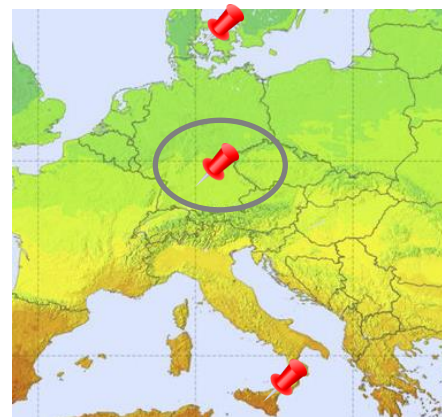
POWER TO AREA DIAGRAM BASED ON NPV RANKING



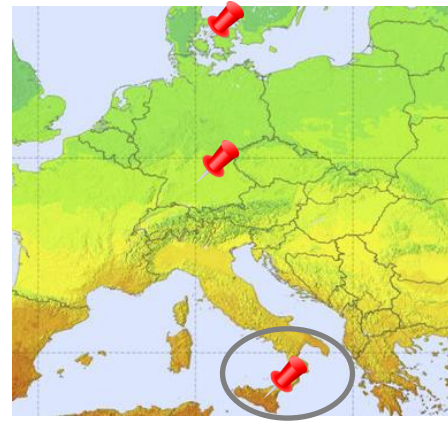
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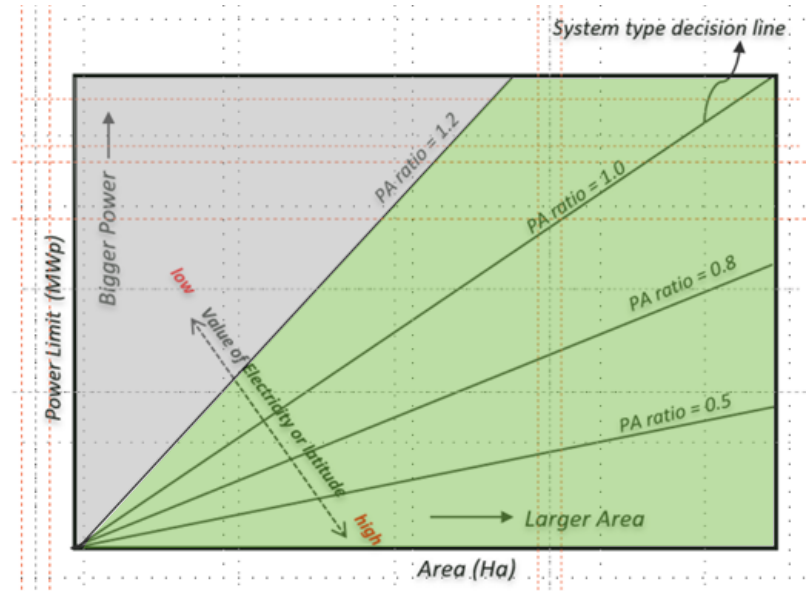
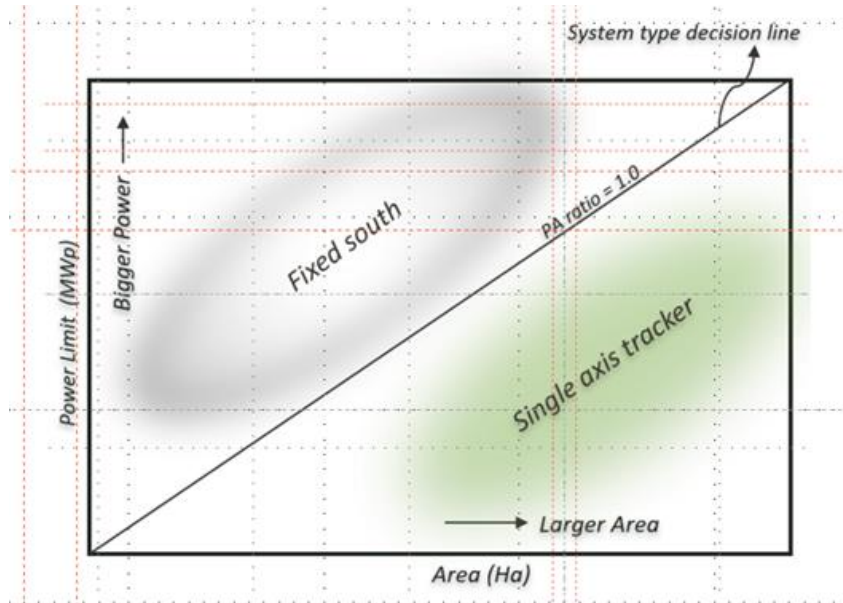
GERMANY



POWER TO AREA DIAGRAM BASED ON NPV RANKING



ITALY



Key takeaway:

- *Independently from geographic location / irradiation, the system design optimization (fixed tilt/tracker) depends strongly on the power to area ratio*

BELECTRIC SERVICES BASED ON MODELLING AND SIMULATION CAPABILITIES

- Business case tailored system designs including sensitivity analysis and robustness check
- Project portfolio analysis regarding standardization and bundling opportunities
- PV Design Configurator – LIVE DEMO „a simple solution for a complex matter“



BELECTRIC SERVICES BASED ON MODELLING AND SIMULATION CAPABILITIES

➤ PV Design Configurator – „a simple solution for a complex matter“

User Input

Zone: Mid of Germany

Allowed Configuration: All row spacing considered

Allow N-type TopCon: Yes

DC/AC Limit: AC Limit

Power limit (MWp/MVA) 40

Plot Area (ha) 50

Show Result **New Search**

