CONCENTRATING SOLAR POWER

Dr. Tom Fluri

Fraunhofer Institute for Solar Energy Systems ISE

CSET Seminar

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www.ise.fraunhofer.de

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AGENDA
CONCENTRATING SOLAR POWER

- Technology overview
- Market overview
- Why CSP?
- CSP for Chile
- Challenges

Technology Overview
CSP Collector Technologies




	Parabolic trough	Linear Fresnel	Dish Stirling	Central receiver
Conc. Factor	70 – 90	60 – 120	300 – 4000	500 – 1000
Status	commercial	commercial	commercial	commercial
Annual efficiency	14%	12%	18%	17%
Current max. plant capacity	280 MW	30 MW	1.5 MW	126 MW
Max. storage	up to 8h	0.5h	-	up to 18h

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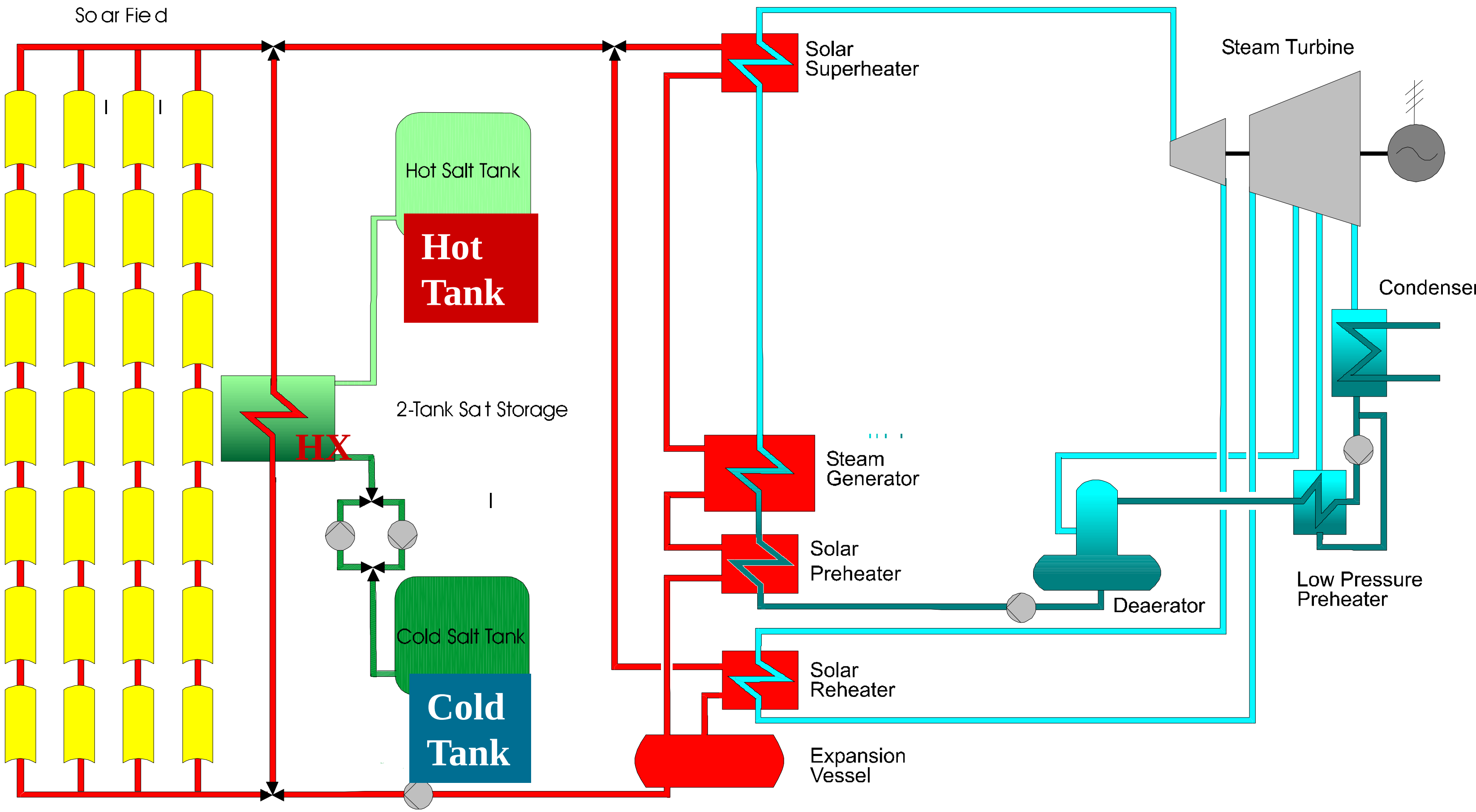
Technology Overview
CSP Plant with Thermal Storage



Source: DLR, IRES 2009

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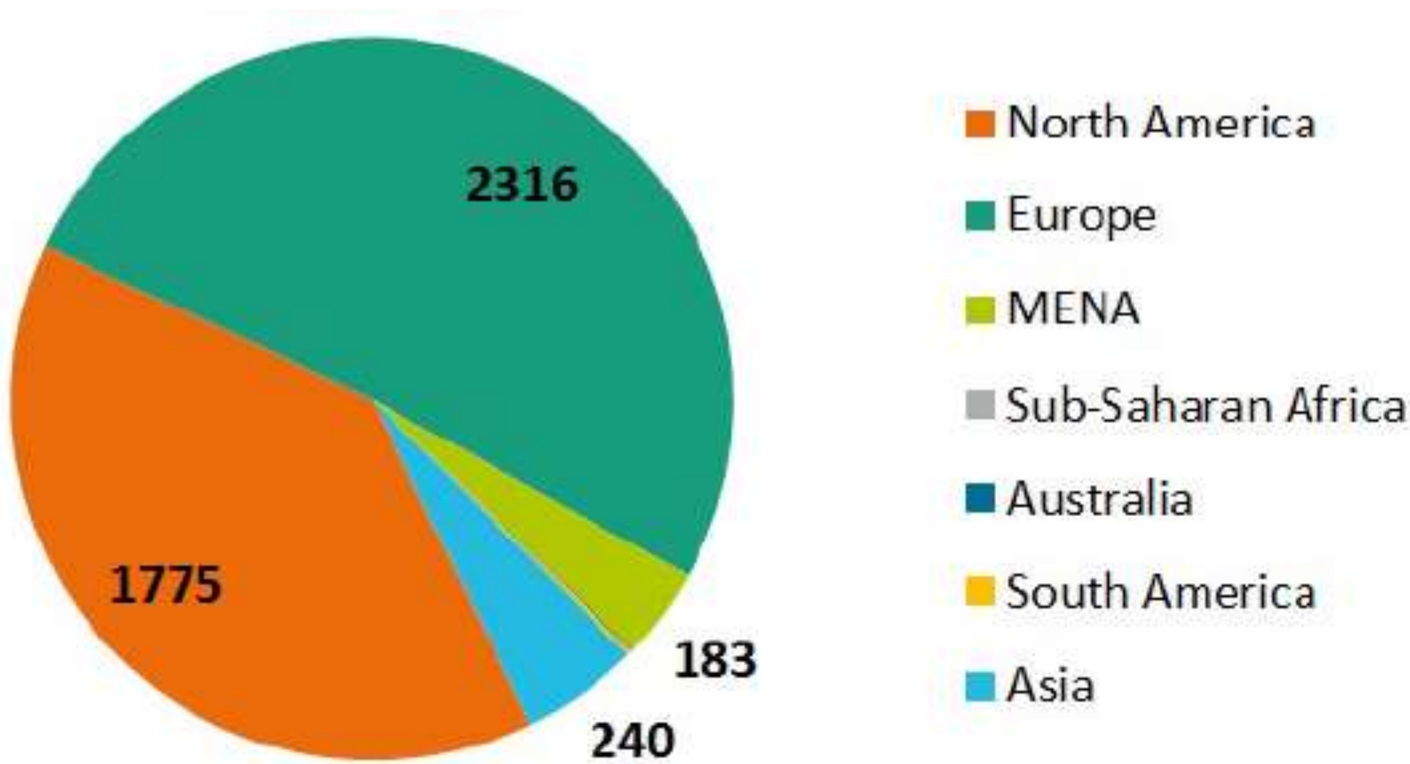
Market Overview
Plants in Operation (Nominal Capacity (MW) per region)



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Market Overview
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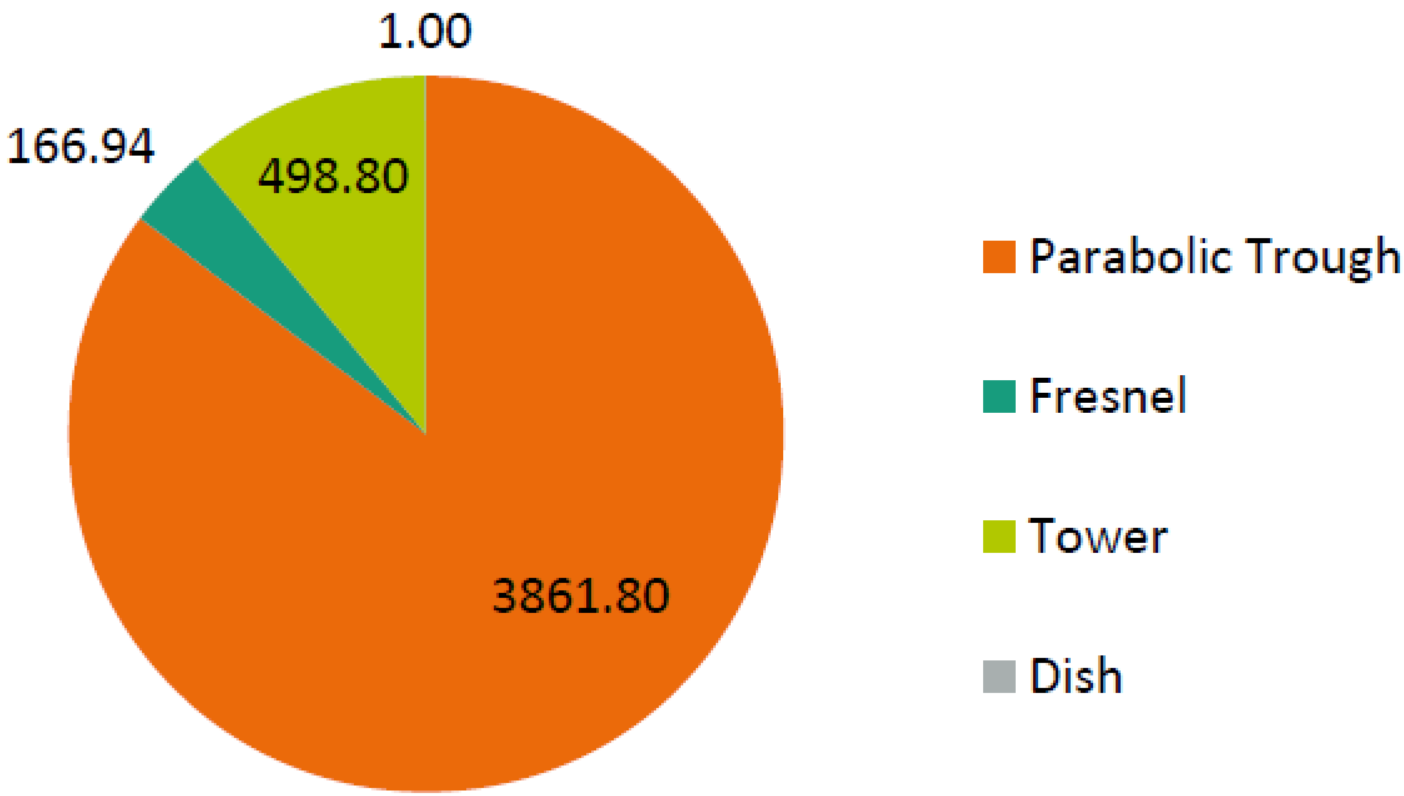

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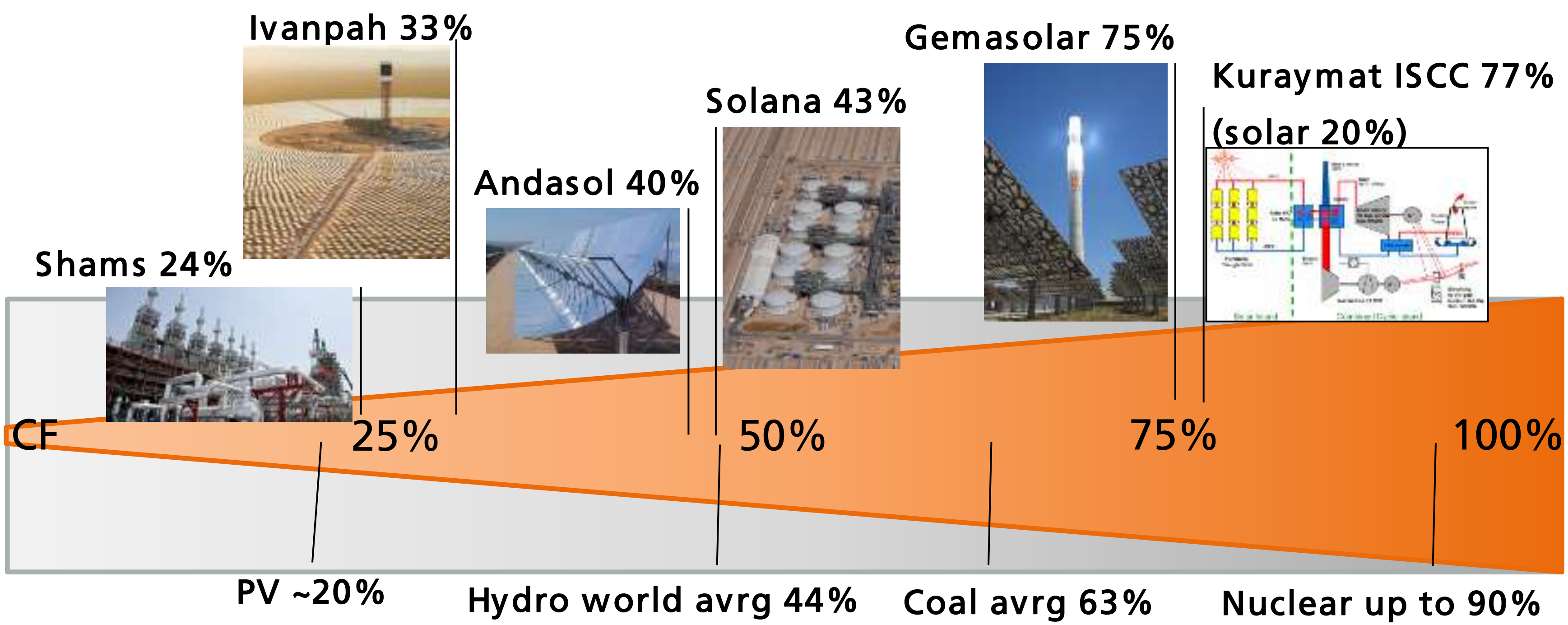
Why CSP?
High capacity factor

- Capacity factor describes ratio between actual annual output and maximum theoretical output (continuous operation at nominal capacity throughout the year)
- Optional storage integration (e.g. Gemasolar) or co-firing allows for range of achievable capacity factors



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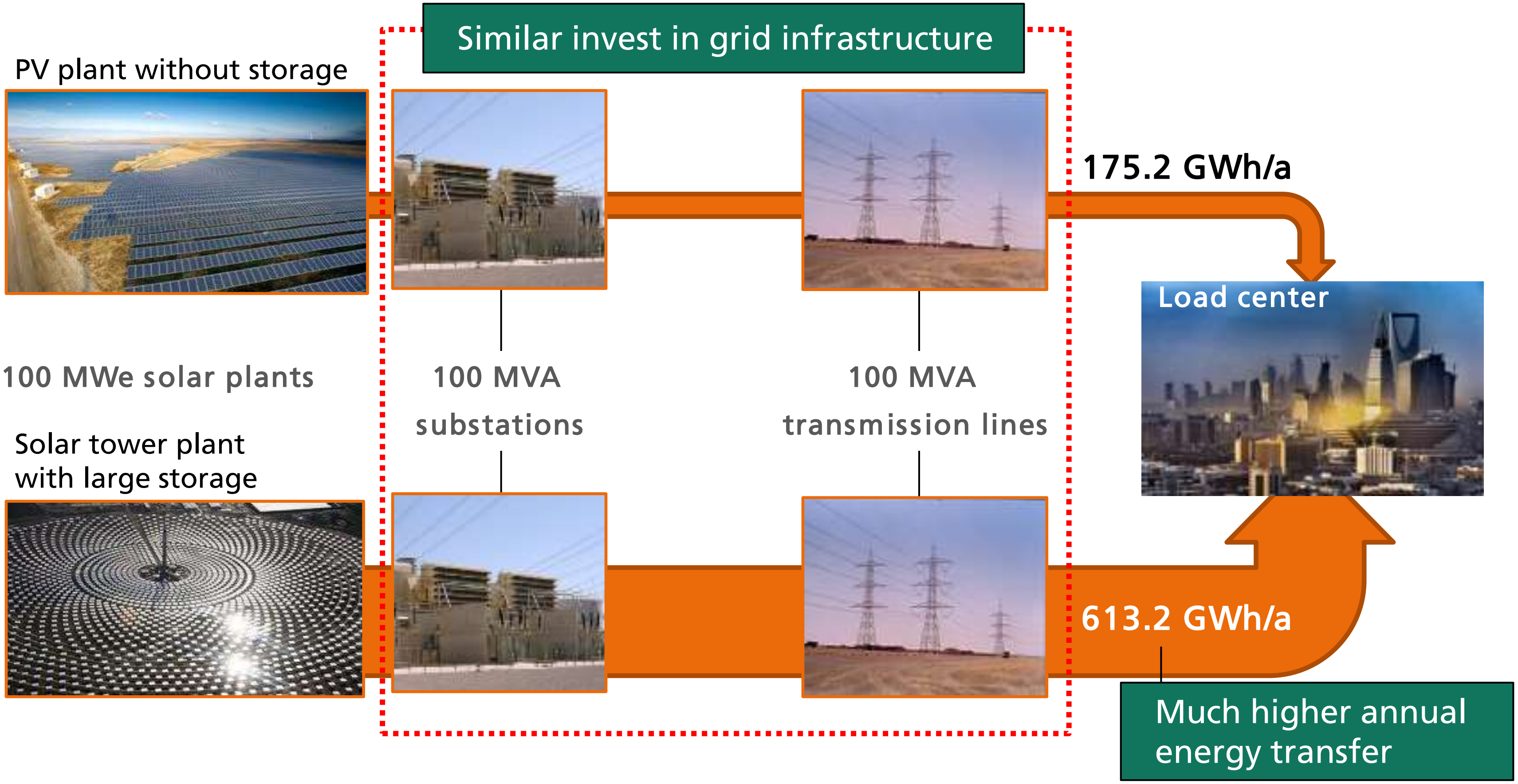
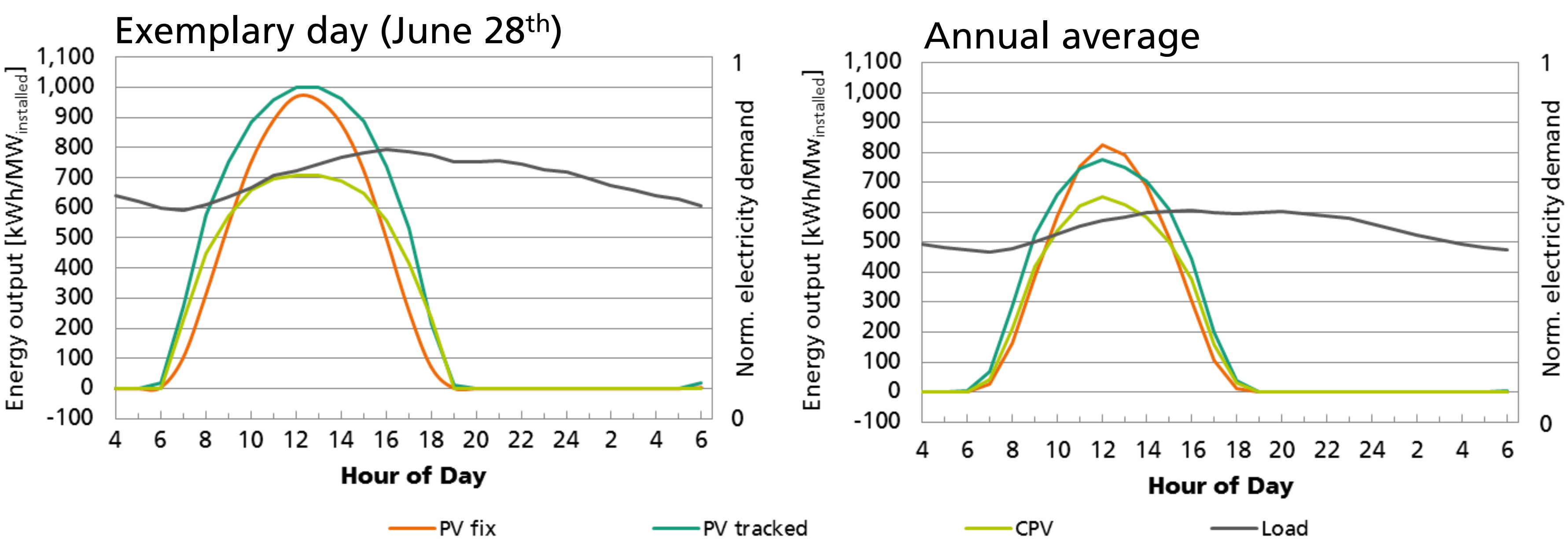
Why CSP?
Impact on grid infrastructure utilization

- Due to the higher capacity factor the **grid infrastructure is used much more effectively** with CSP than with plants without storage



Why CSP? Case study – RE-mix at middle east site
PV power production profile vs. load

- PV production follows irradiation with peak at noon
- CPV has slightly lower output because it only uses direct irradiance



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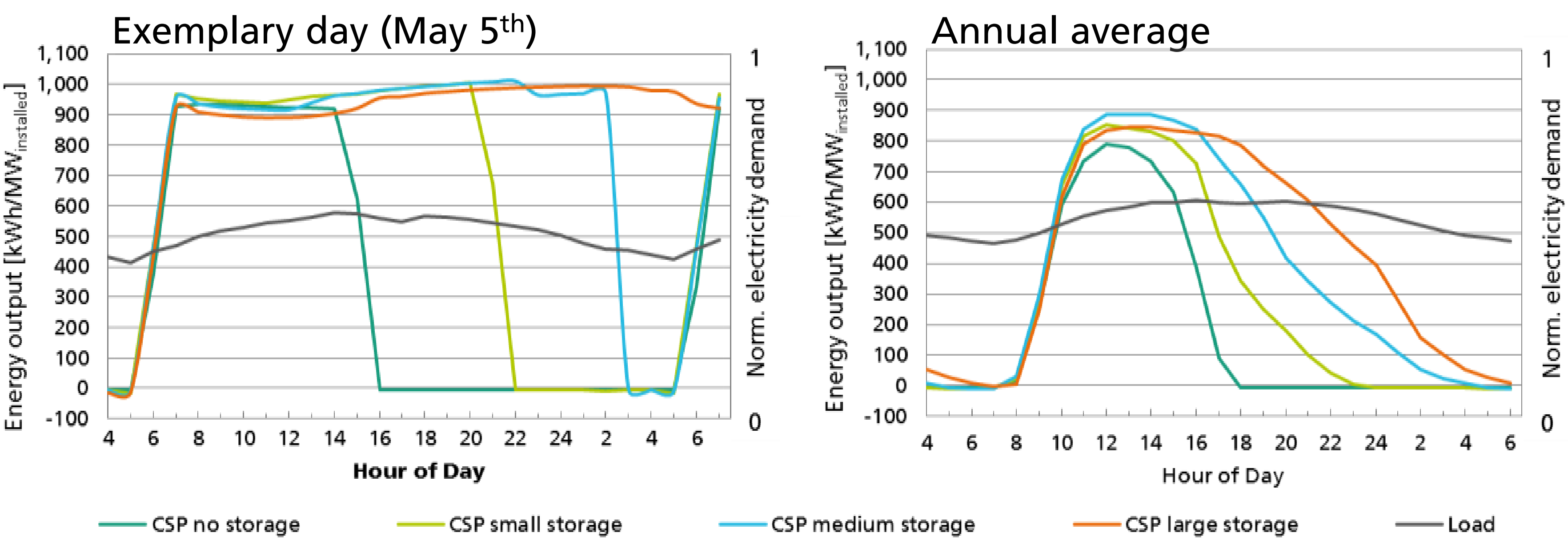
Why CSP? Case study – RE-mix at middle east site

CSP production profile vs. load

- On a good solar day, CSP storages are filled and the complete period of high load can be covered
- With large thermal storage, even 24/7 operation is possible
- Also the annual average shows the positive influence of storage



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Why CSP (after announcements on low battery cost)?

Rough comparison of Investment Cost for 100 MW Plant

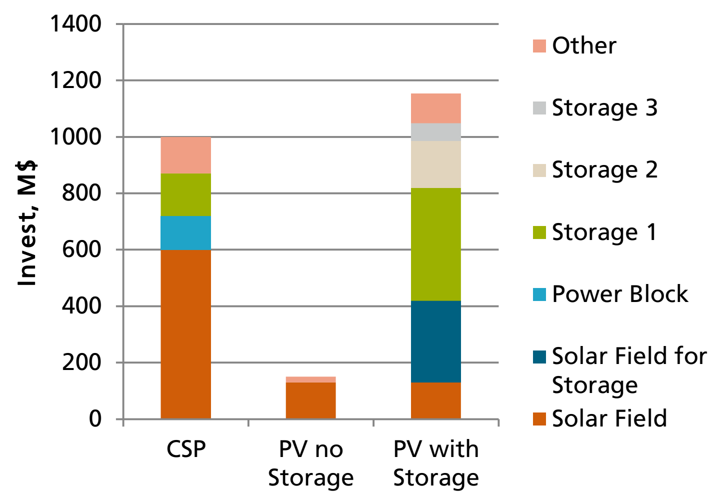
Assumptions:

- Solar Multiple of 3 sufficient for 24h operation

Important to note:

- Additional Solar field capacity is required for storage charging
- Storage efficiency is not 100 % but rather 90 % in case of batteries
- Batteries need to be replaced at least once during power plant life time
- CSP still competitive for dispatchable power

→ Detailed comparison warranted



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Potential of CSP in Northern Chile
Case Study

- Technologies considered:
  - parabolic trough collector (PTC) & linear Fresnel collector (LFC)
- On 1 km² a PTC plant could have:
  - 52 MW nominal capacity
  - 120 GWh/year annual production
- On 1 km² a LFC plant could have:
  - 67 MW nominal capacity
  - 130 GWh/year annual production
- CSP Potential for Northern Chile:

Slope		< 1%		< 3%	
Proximity to transmission		< 20 km	< 50 km	< 20 km	< 50 km
Area [km²]		1235	1508	15894	23748
Equivalent installed power [GW]	PTC	64.7	79.0	832.1	[illegible]
Generation [TWh]	PTC	147.4	180.0	1897.3	2834.8
Equivalent installed power [GW]	LFC	82.8	101.1	1065.3	1591.7
Generation [TWh]	LFC	160.6	196.1	2066.6	3087.9

28 times current ann. electricity production

Fluri, T. P.; Cuevas, F.; Pidaparthi, P. & Platzer, W. J.: “Assessment Of The Potential For Concentrating Solar Power In Northern Chile”
Proceedings of the 17th SolarPACES Conference, 20. - 23. September 2011, Granada, Spain, **2011**

Challenge I
Becoming a Water Producing Technology

- Currently CSP is consuming significant amounts of water during operation
  - Steam cycle make up water
  - Cooling water replenishment
  - Mirror cleaning

→ Alternative approach: Using waste heat to drive thermal desalination

Challenge II
Adaptation to small off-grid load centers

Demonstration in Egypt

- Demonstration of a small (< 10 MW_{th}) solar thermal power plant
- Tri-generation: electricity + desalination + district cooling
- Parabolic trough CSP plant with molten salt as heat transfer and direct storage fluid (stratified storage tank)
- Pilot plant at Borg El Arab (Egypt)
- Project's key facts:
  - Plant construction start in 2015
  - Fraunhofer ISE responsible for e.g. plant simulation
  - Project coordinator: ENEA (Italy)
  - http://www.mats.enea.it/

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Challenge III
Adaptation to local climate and industry

- Assessing sites in detail
  - Soiling rates
  - Earth quake potential
  - Corrosion potential

- Assessing local industry
- Dedicated capacity building

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Concentrating Solar Power

- …has a special role to play in facilitating high renewable energy penetration in Chile
- …has to become a water producing technology
- …has to adapt to small load centers
- …has to adapt to local climate and industry

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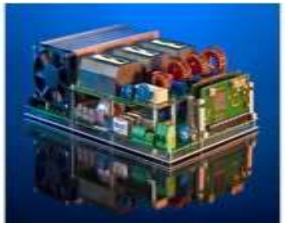
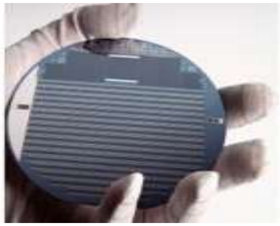
¡Muchas gracias!

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Tom.Fluri@ise.fraunhofer.de

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