

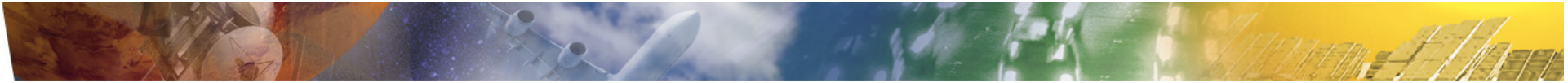
Energy Generation: CSP Technology and Systems

Dr.-Ing. Markus Eck, DLR



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Renewable Energy Concepts for Mega Science Projects, Berlin 7.4.2011 (1)

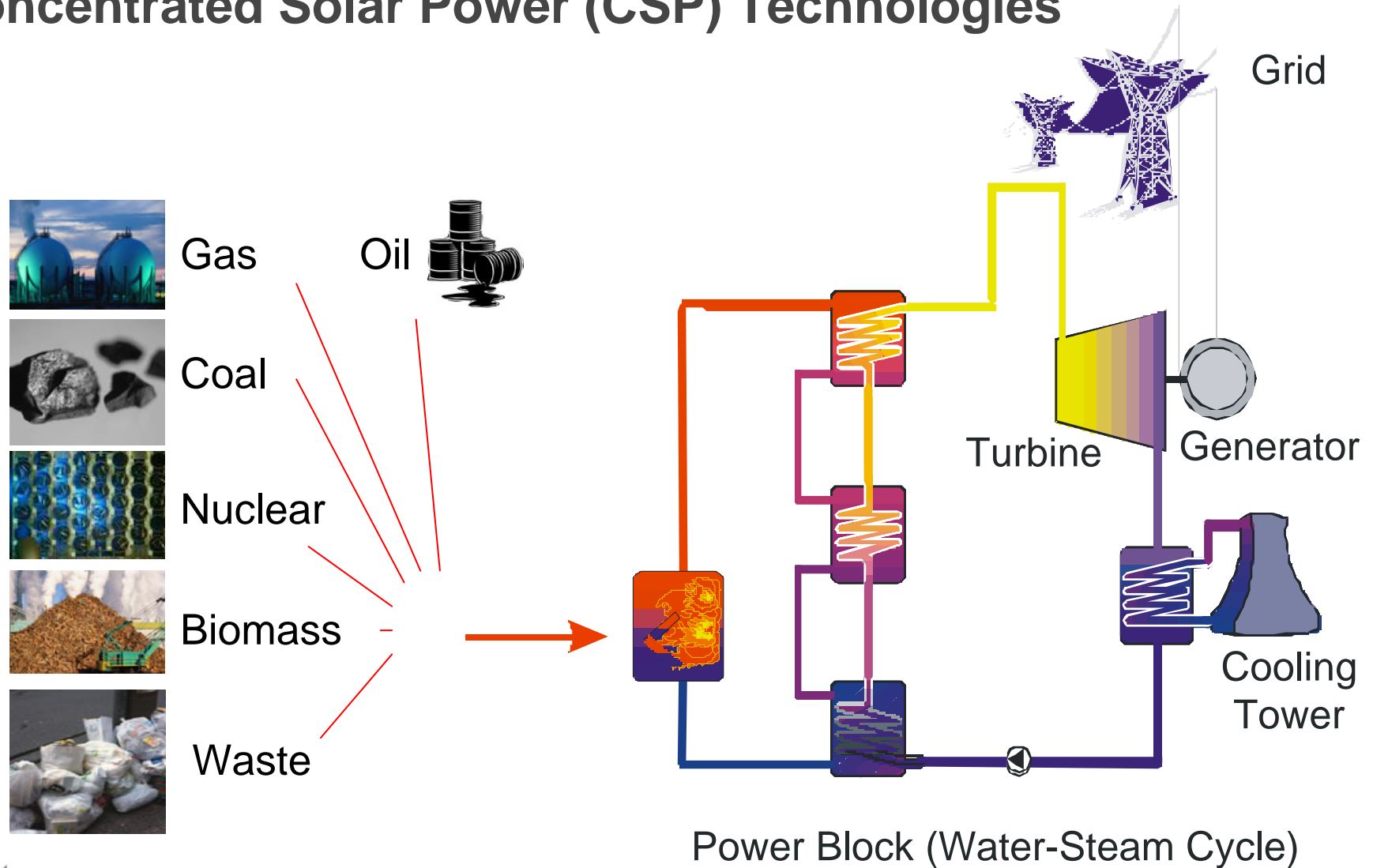


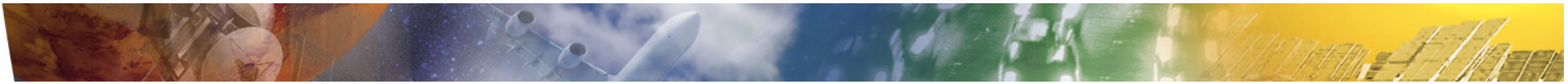
Outline

- CSP Technologies
- Storage Systems
- Potential and Sites for CSP Technologies
- Summary

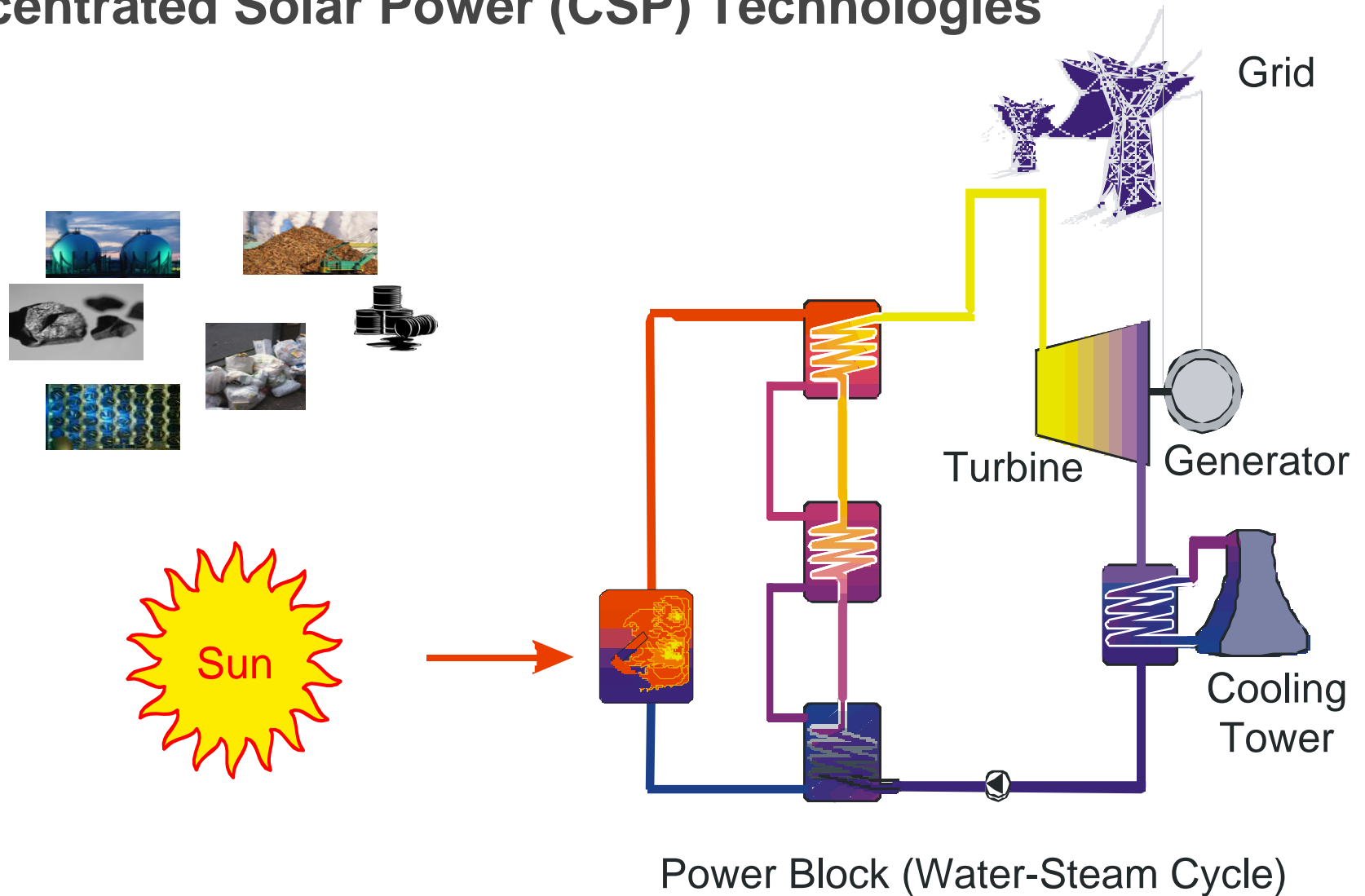


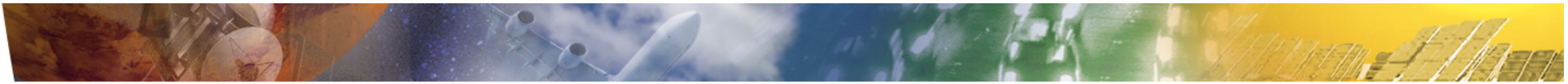
Concentrated Solar Power (CSP) Technologies



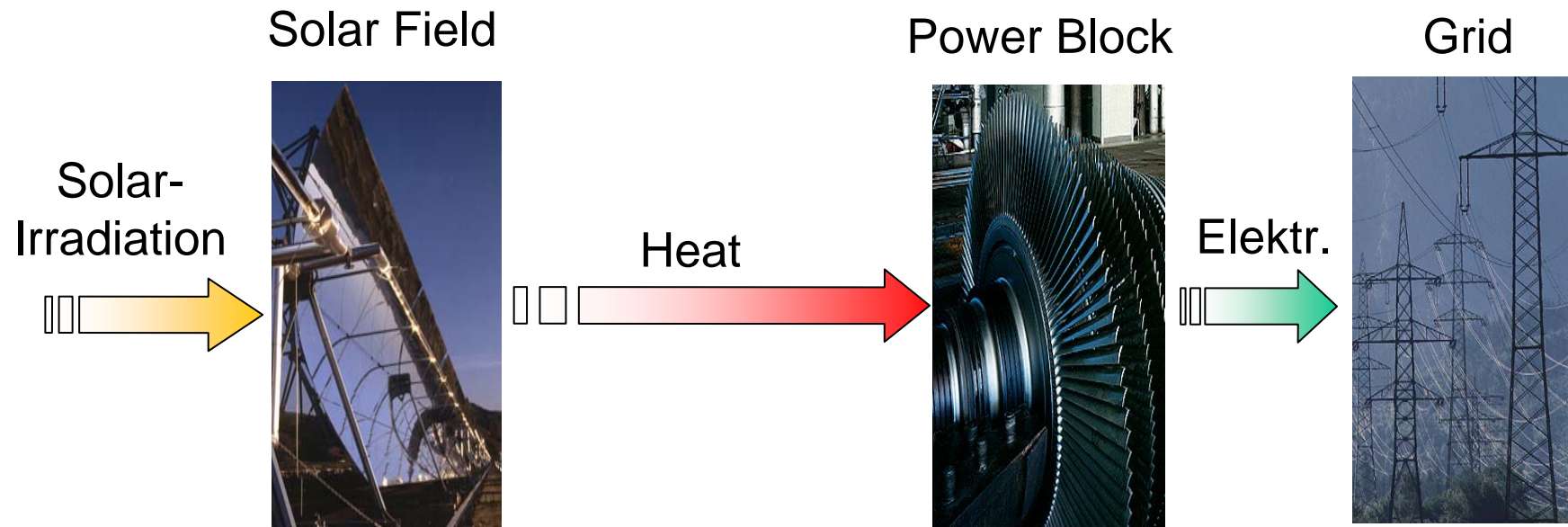


Concentrated Solar Power (CSP) Technologies



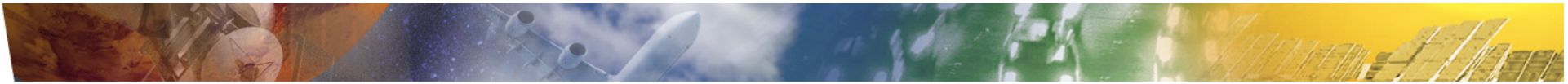


Concentrated Solar Power (CSP) Technologies

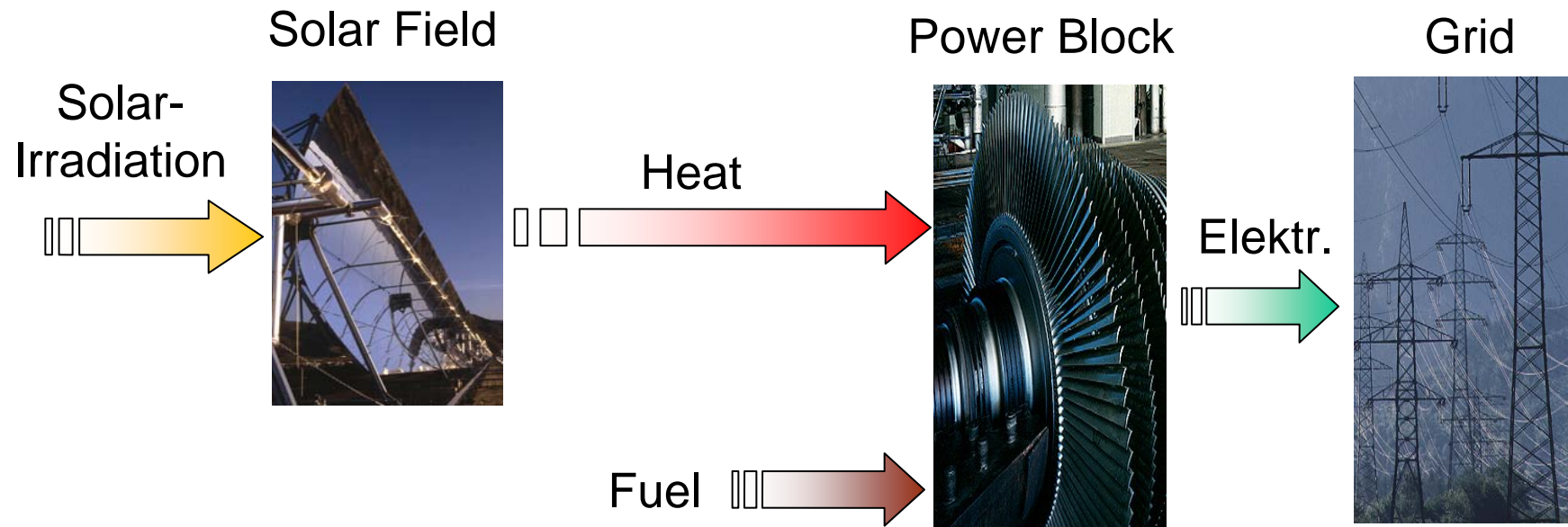


Pure solar operation

Additional back-up capacities required in the grid



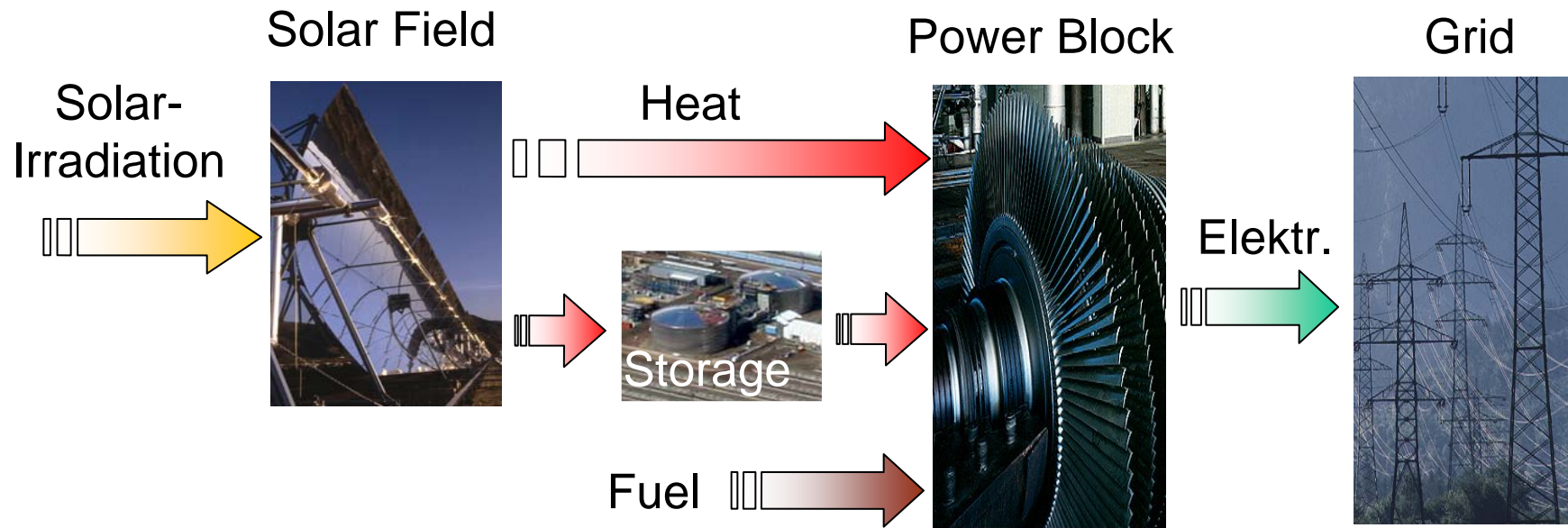
Concentrated Solar Power (CSP) Technologies



Solar electricity production

Integrated fossil back-up capacity for power on demand

Concentrated Solar Power (CSP) Technologies



Solar electricity production

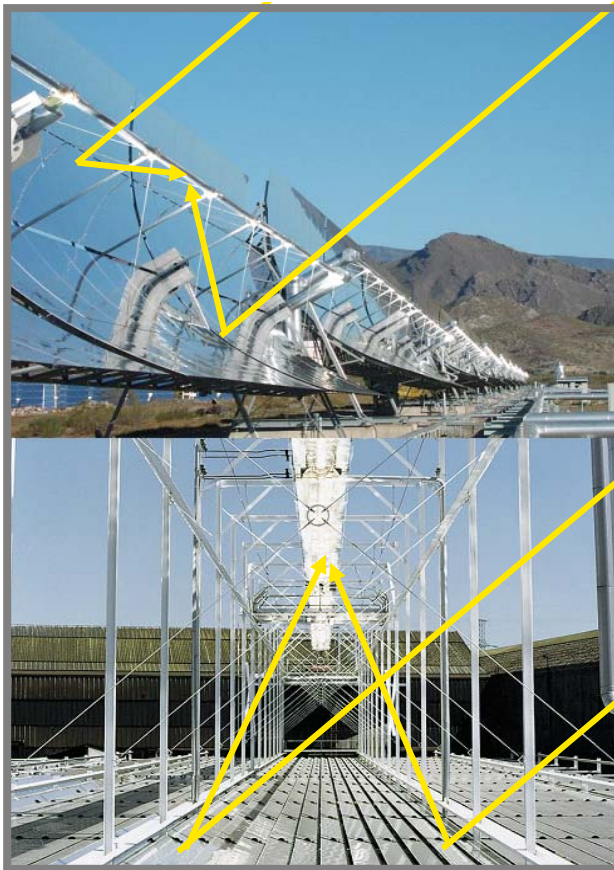
Integrated storage for increased capacity factor and electricity on demand

Additional fossil back-up

Concentrated Solar Power (CSP) Technologies

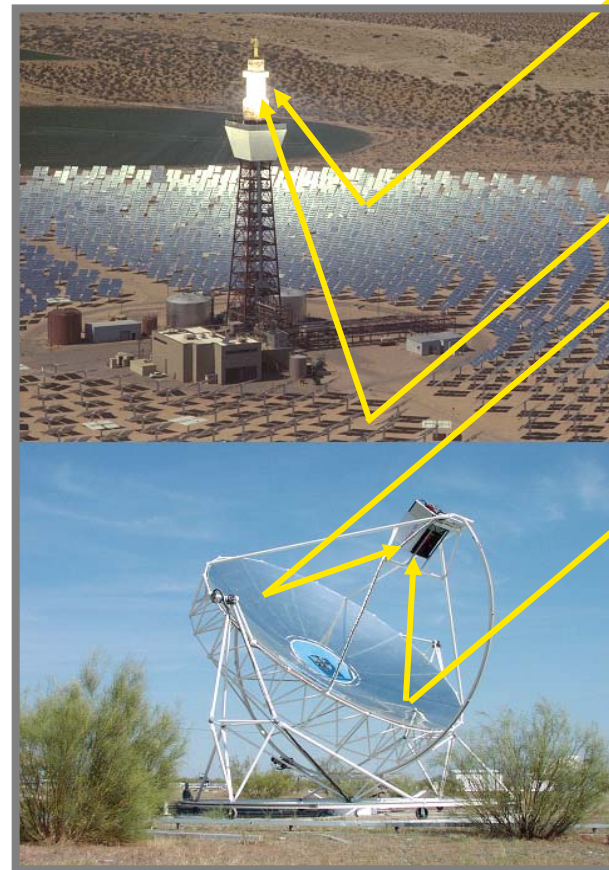
Parabolic Trough (PSA)

up to 550 °C steam turbines



Linear Fresnel (MAN/SPG)

Solar Tower (SNL)



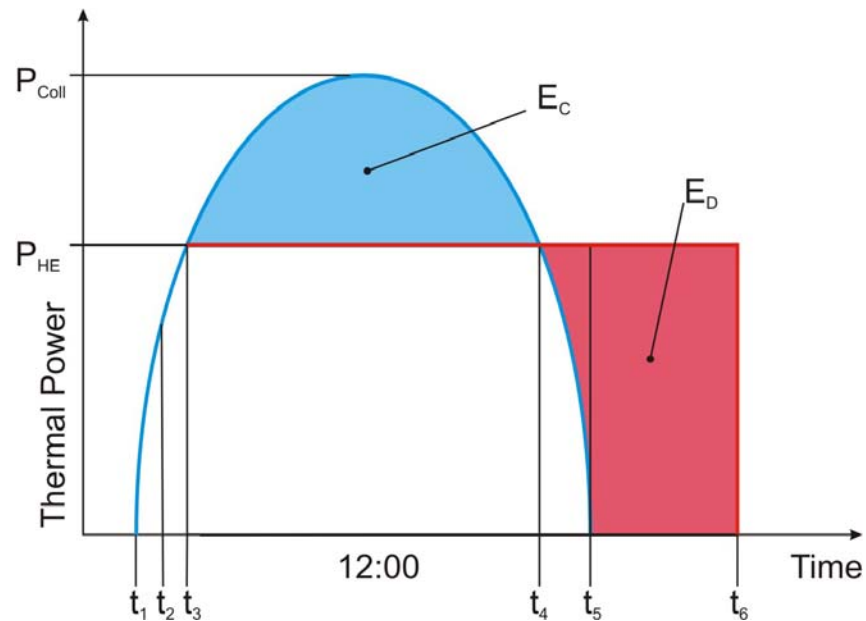
Dish-Stirling (SBP)

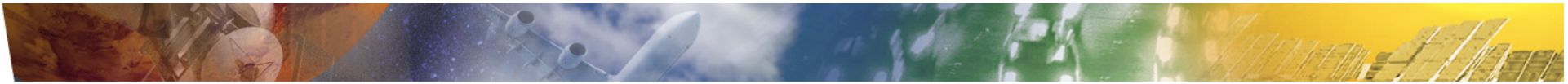
up to 1000 °C gas turbines, motors



Storage Systems

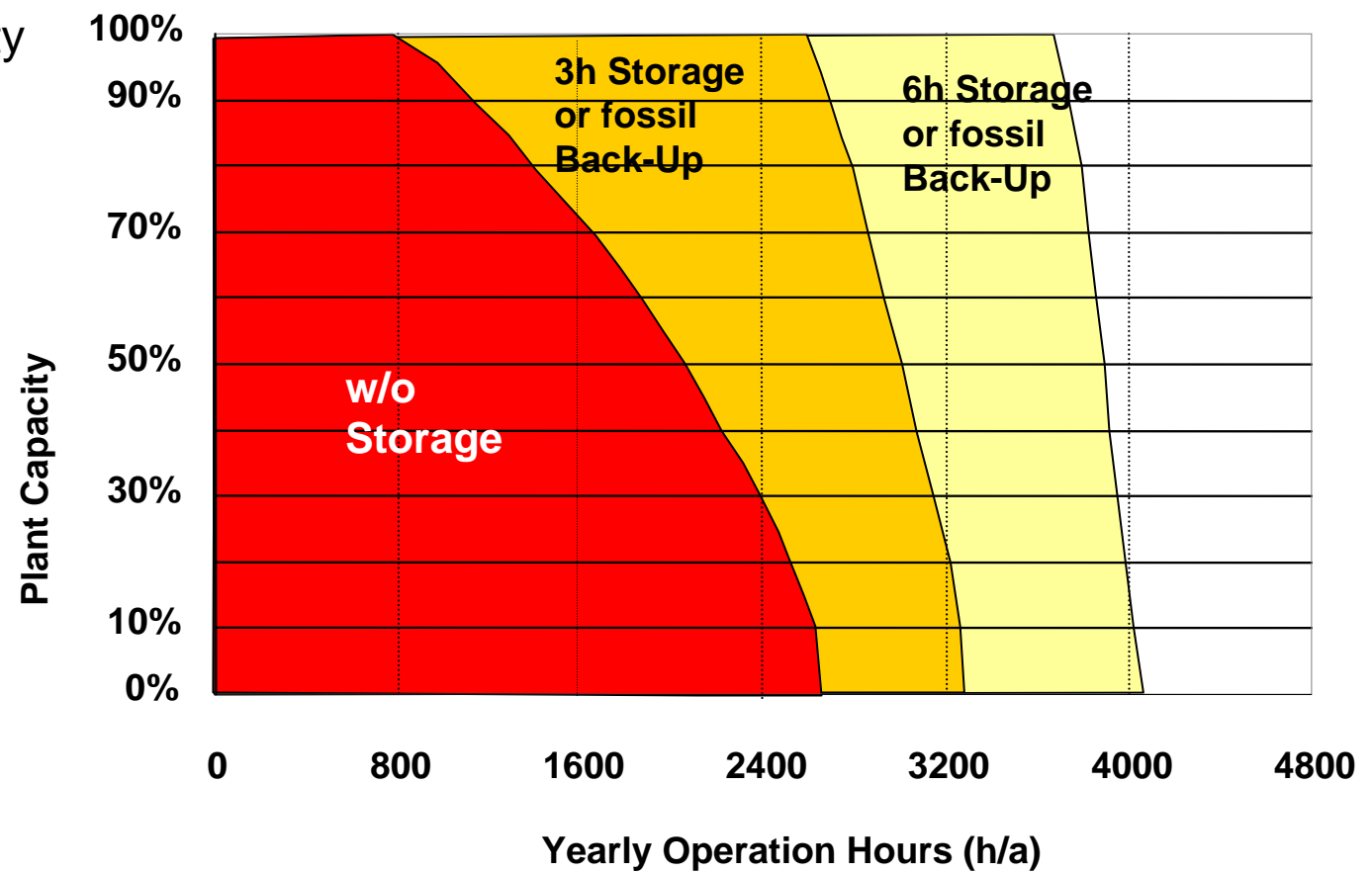
- Increases dispatchability
- depends on application
- sensible/latent
- direct/indirect

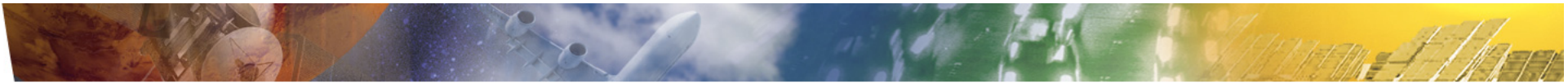




Storage Systems

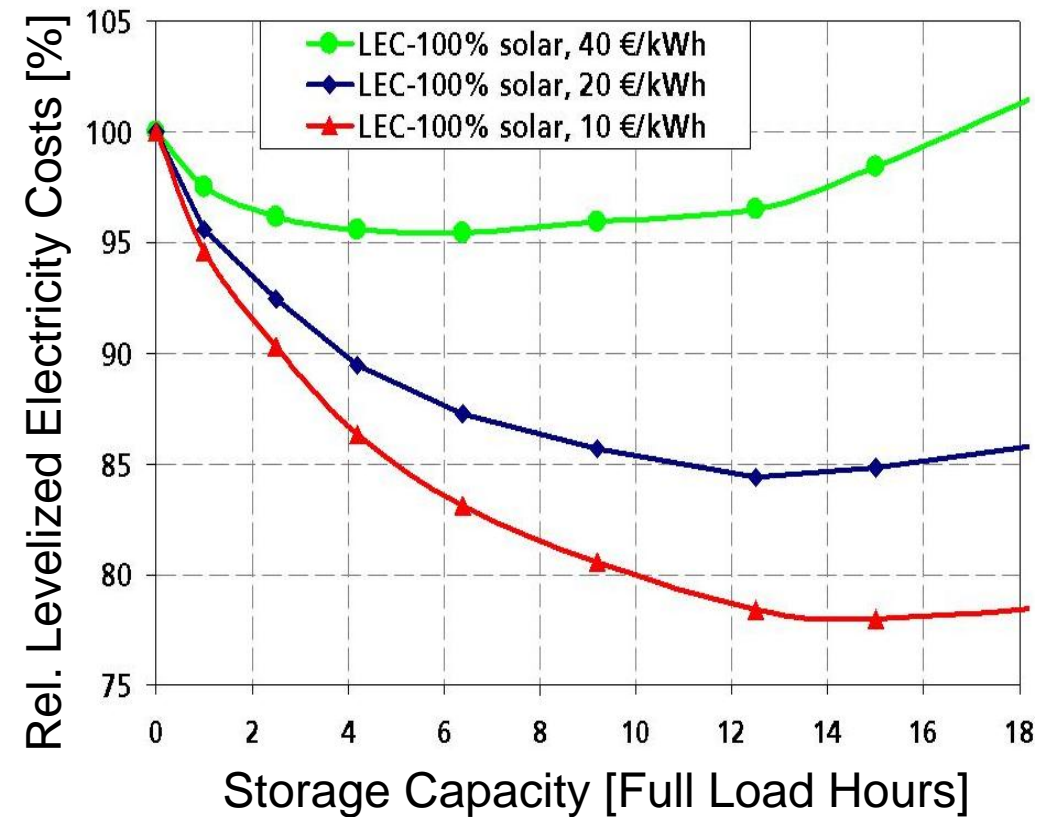
- Is scalable
- Increases capacity factor



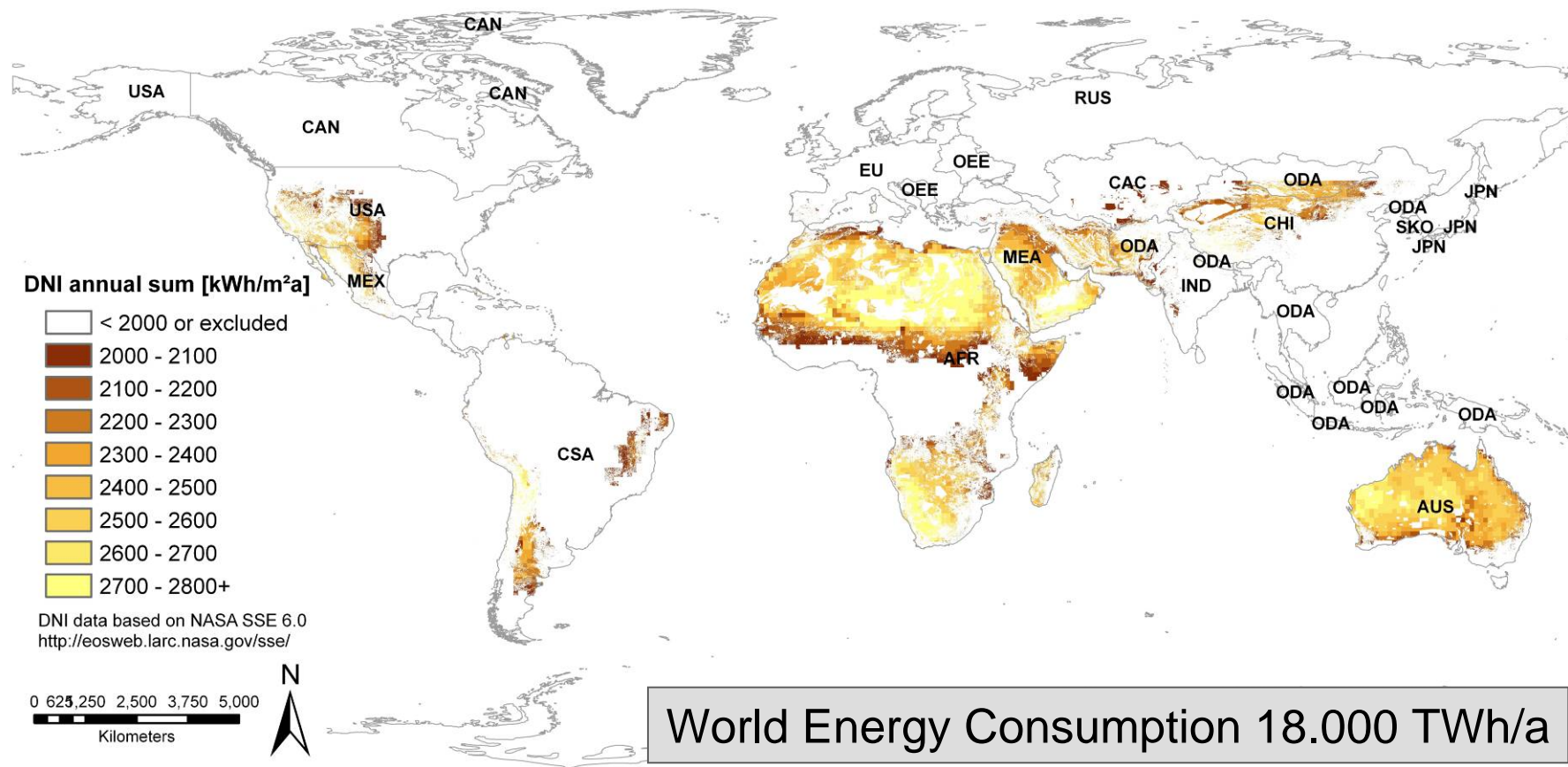


Storage Systems

- Reduces costs



Potential and Sites for CSP Systems



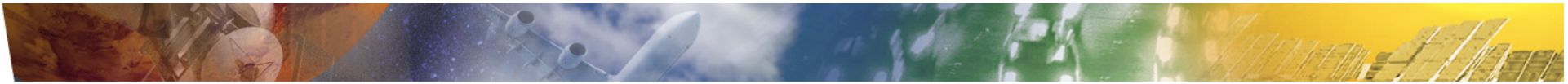
World Energy Consumption 18.000 TWh/a

Technical Potential 3.000.000 TWh/a

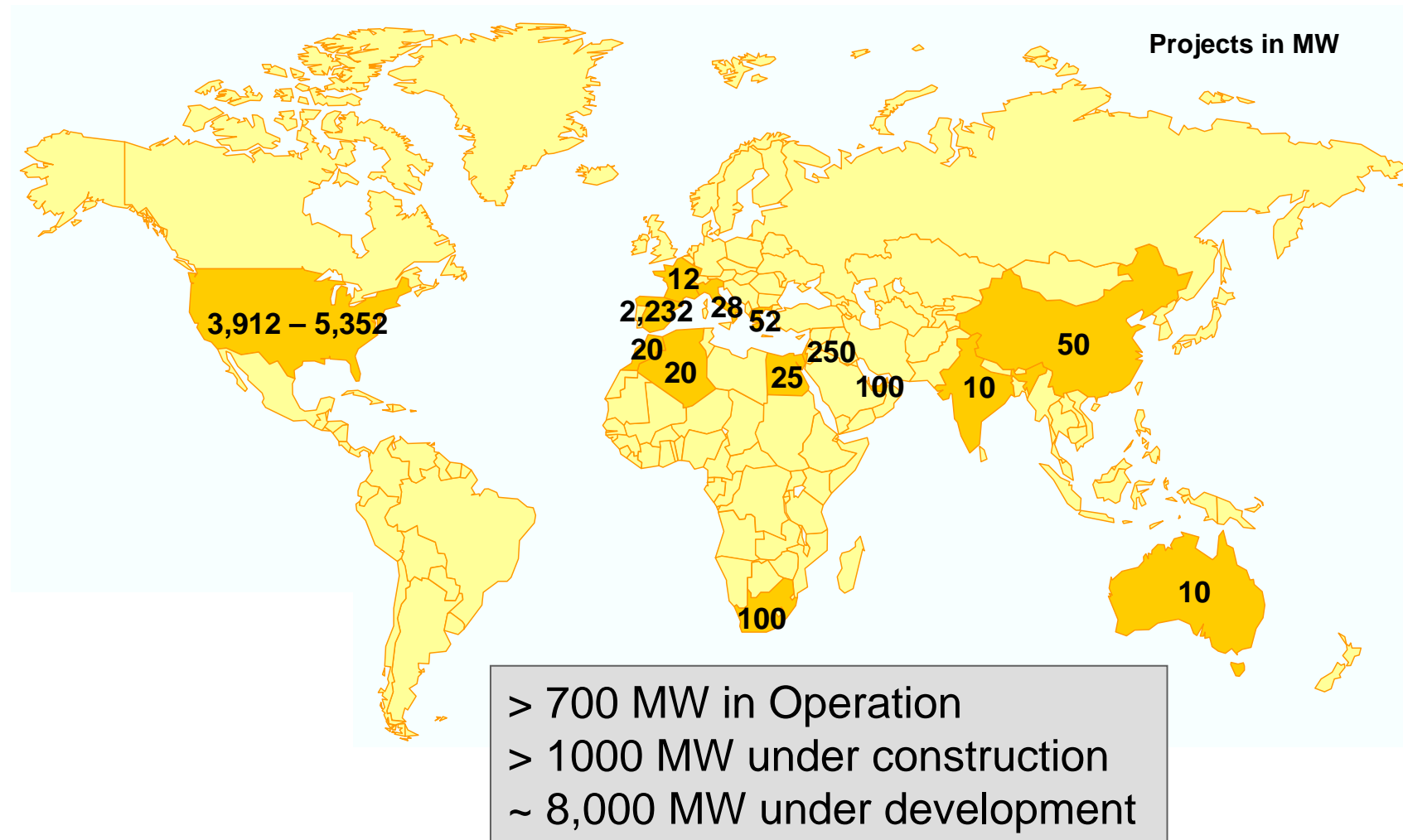
Data provided by  (2008) for EU-project REACCESS

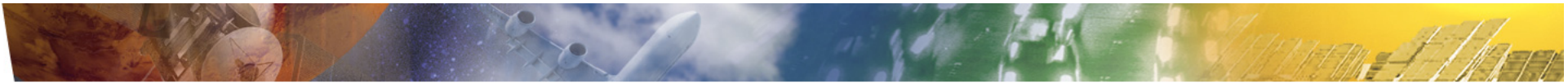
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 CSP exclusion criteria s. www.dlr.de/tt/med-csp



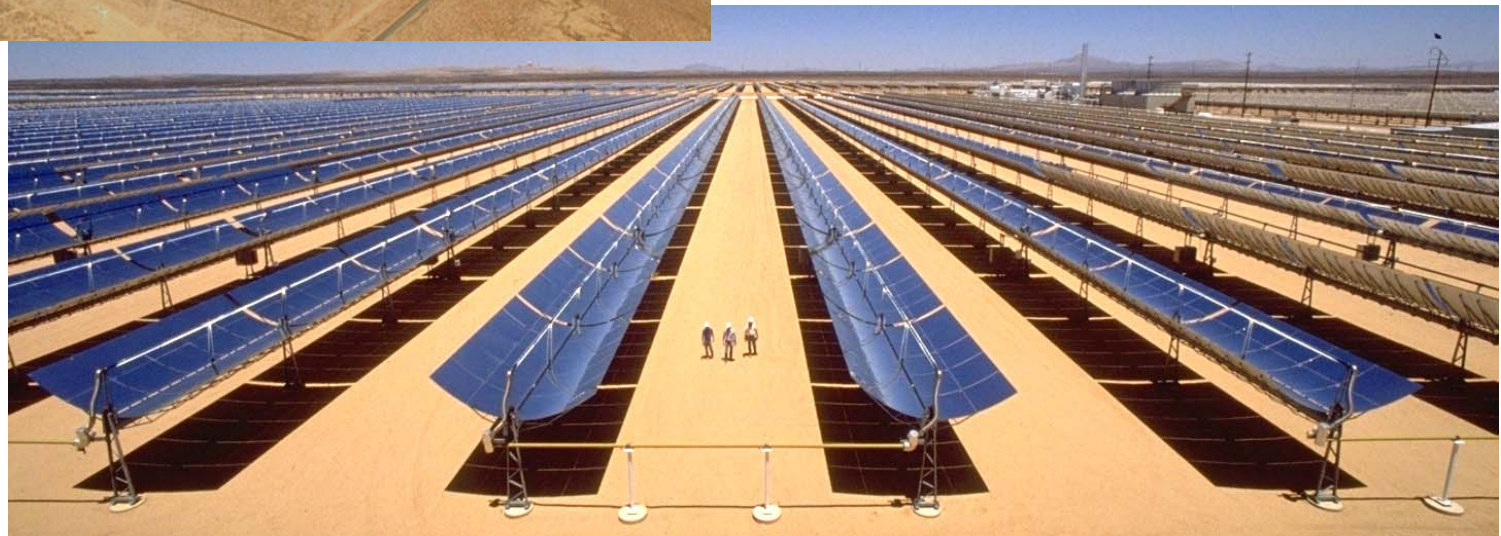
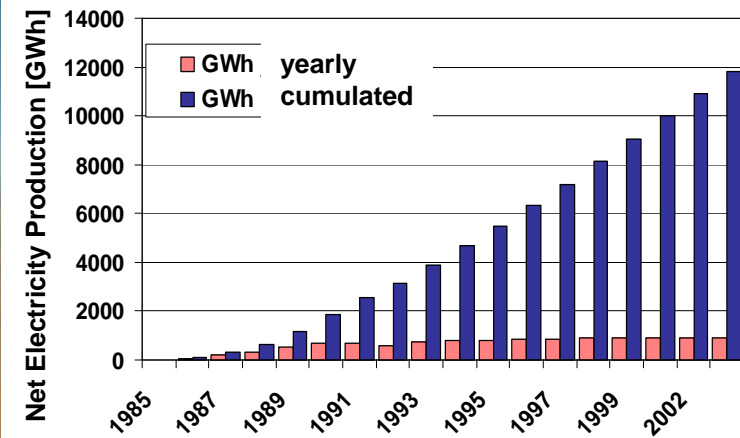
Potential and Sites for CSP Systems

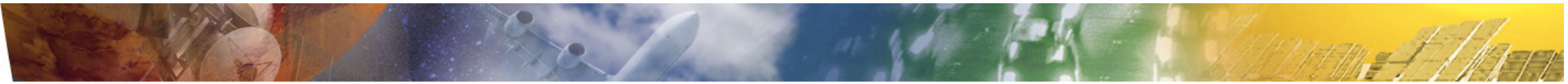




Potential and Sites for CSP Systems

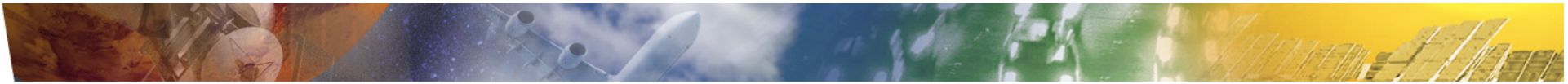
SEGS I - IX, California, USA
in total 354 MW (14 to 80 MW)





Potential and Sites for CSP Systems





Potential and Sites for CSP Systems



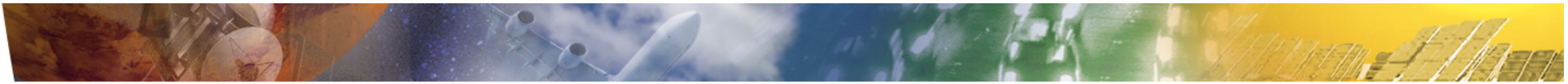
Nevada Solar One
Las Vegas, USA (64 MW, 2007)



Source: www.acciona-energia.com

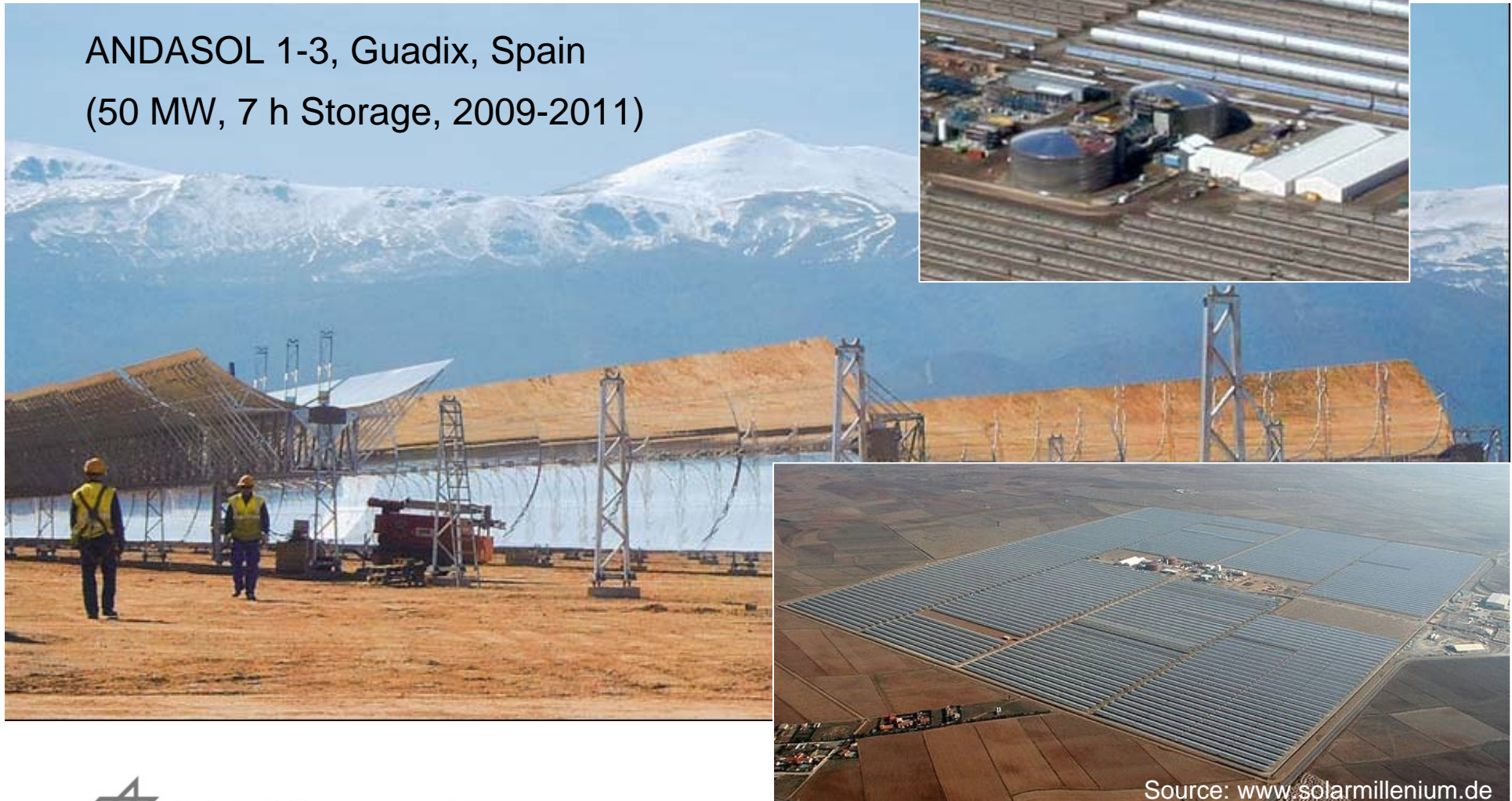


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Potential and Sites for CSP Systems

ANDASOL 1-3, Guadix, Spain
(50 MW, 7 h Storage, 2009-2011)



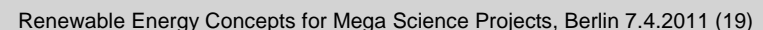
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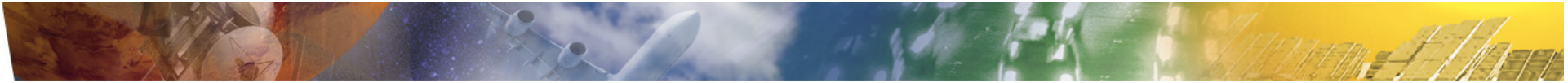
Source: www.solarmillennium.de

- mature technology
- increased capacity factor and electricity on demand due to storage integration
- good solar resources in Australia and South Africa



Source Figures: CSP Today





Summary