



Analysis of Hydraulic Designs in Large Solar Collector Arrays

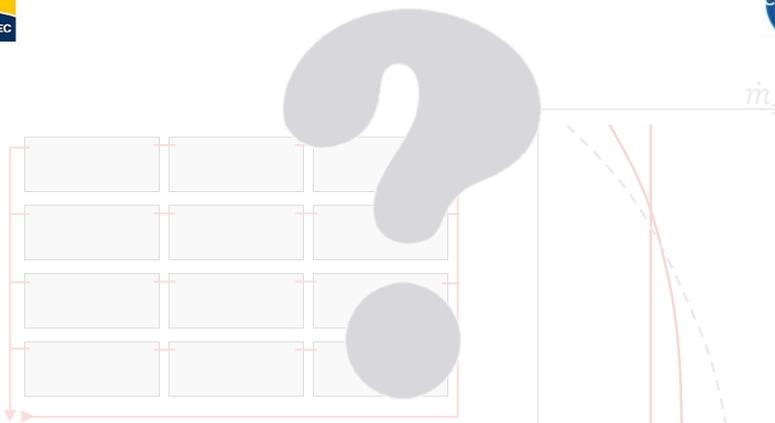
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1st SDH Conference, April 9-13 2013, Malmö, Sweden

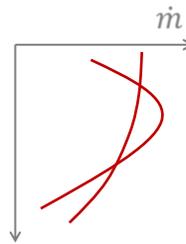
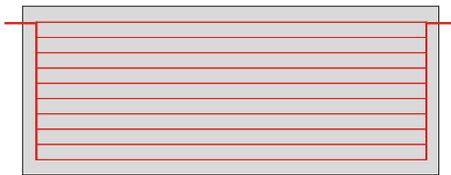
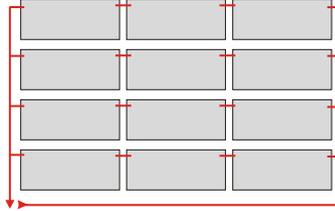


**Do we know enough about
tech. limits in collector array design?**

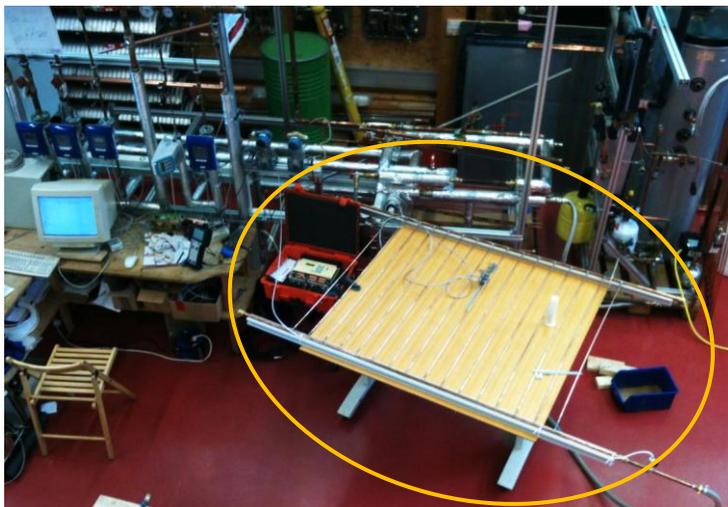
→ reduce levelized solar energy cost!

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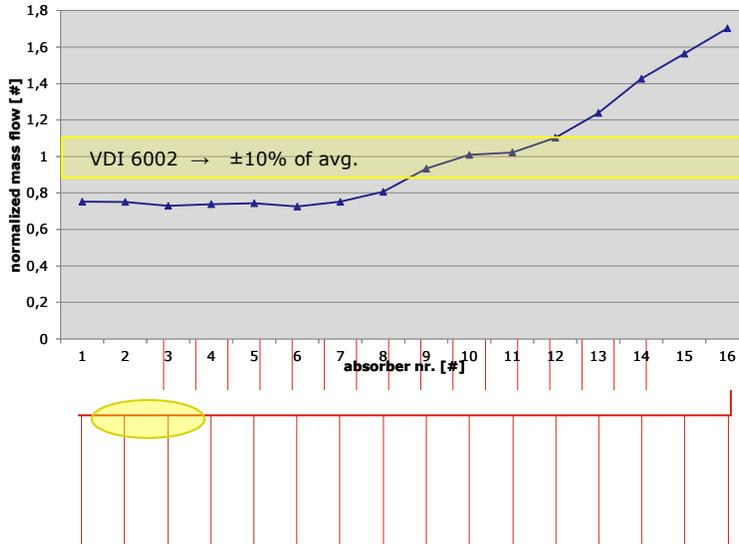
Hydraulic levels...



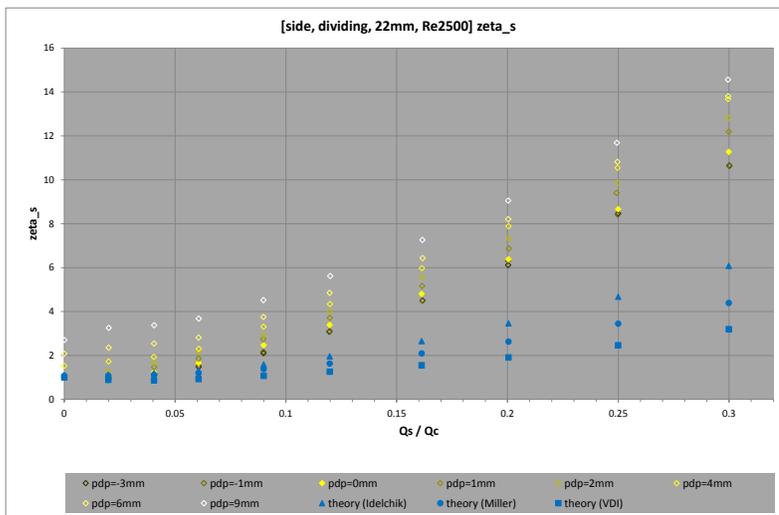
Harp flow distribution measurement

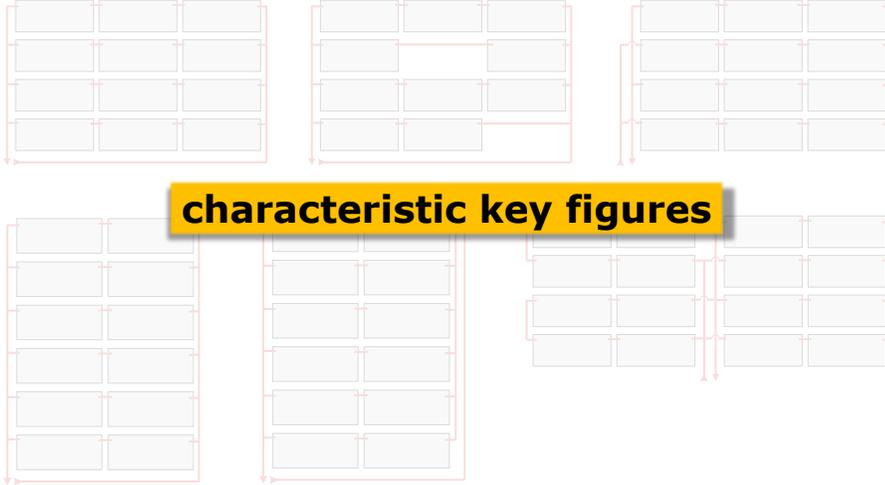


Harp flow distribution measurement



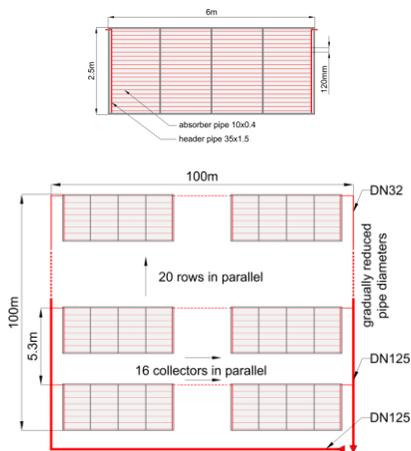
T-pieces...



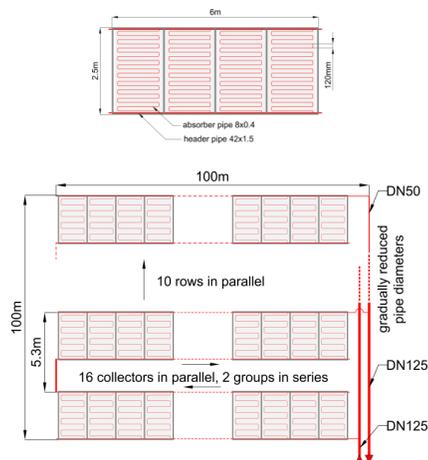


characteristic key figures

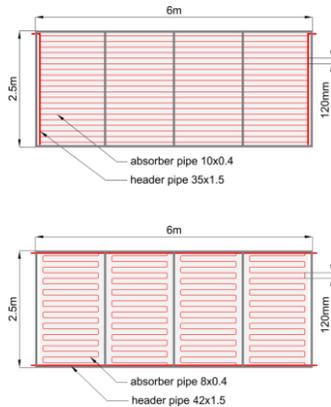
array #1
(harp)



array #2
(meander)



Reference operating conditions



Reference collectors	
gross collector area	15 m ²
aperture collector area	14.04 m ²
efficiency values ($\eta_0 / c_1 / c_2$)	0.8 / 3.14 / 0.009
absolute thermal capacity (harp coll.)	128 kJ/K
absolute thermal capacity (meander coll.)	119 kJ/K
Reference collector arrays and operating conditions	
specific mass flow	16 kg/m ² _{abs} ·h
collector tilt angle	45°
supply (inflow) temperature	50°C
ambient temperature	20°C
global radiation in collector plane	1000 W/m ²
heat transfer medium	propylene glycol
glycol concentration	40% v/v
absolute fluid pressure in collector	2.5 bar
boiling point of heat transfer fluid	130.6°C

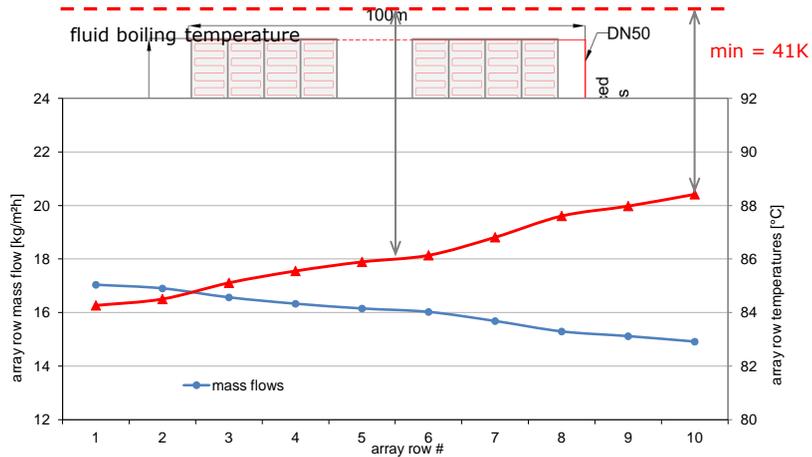
Characteristic key figures

- 1) stagnation distance
- 2) specific metal mass of array piping
- 3) piping network length
- 4) thermal capacity of the collector array
- 7) Thermal capacity of the collector array
- 8) Ratio of hydraulic to thermal power
- 9) Total pressure loss
- 10) Efficiency loss due to uneven flow distribution
- 11) Overall emptying behavior

[1/4] Stagnation distance

→ assess the risk for partial stagnation

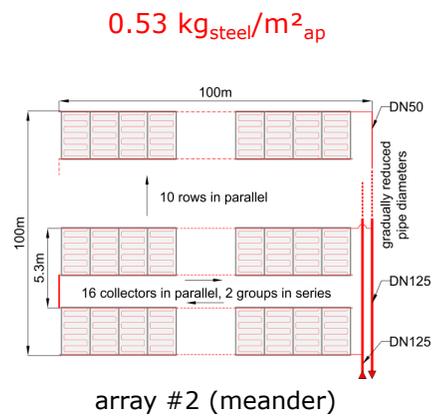
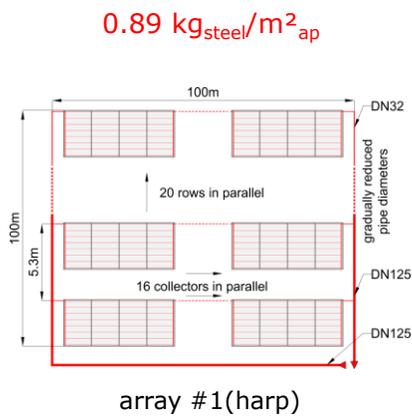
[K]



[2/4] metal mass of array piping

→ assess the effort of array piping

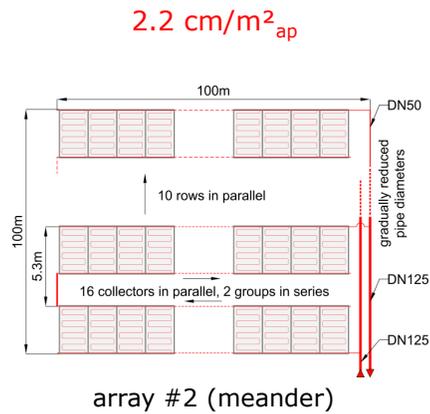
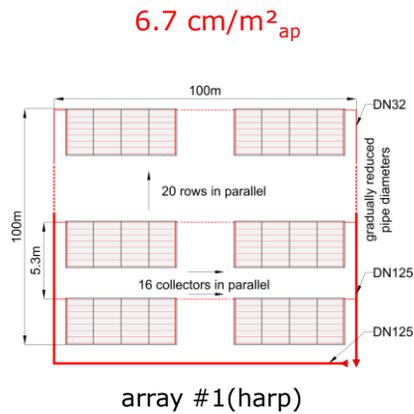
[kg_{steel} / m²_{ap}]



[3/4] piping network length

→ assess the work load of array piping

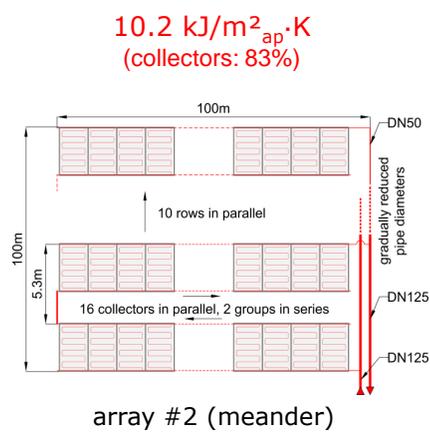
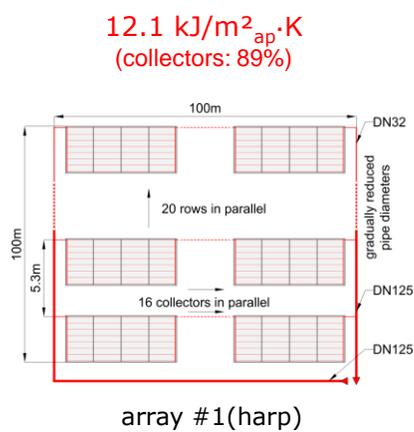
[cm/m²_{ap}]



[4/4] array thermal capacity

→ assess capacitive heat losses

[kJ/m²_{ap}·K]





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Conclusions & next steps...



- key figure framework
 - 11 characteristic key figures for comparing collector array design options
- include more collectors and array designs
- receive your feedback about our approach

Thank you!