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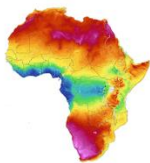


SOLAR THERMAL ENERGY RESEARCH GROUP

The effects of heliostat component cost on heliostat size

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Solar Thermal Energy Research Group (STERG)



concentrating.sun.ac.za

**2nd Annual STERG
SolarPACES Symposium**
17 July 2014
Stellenbosch, South Africa



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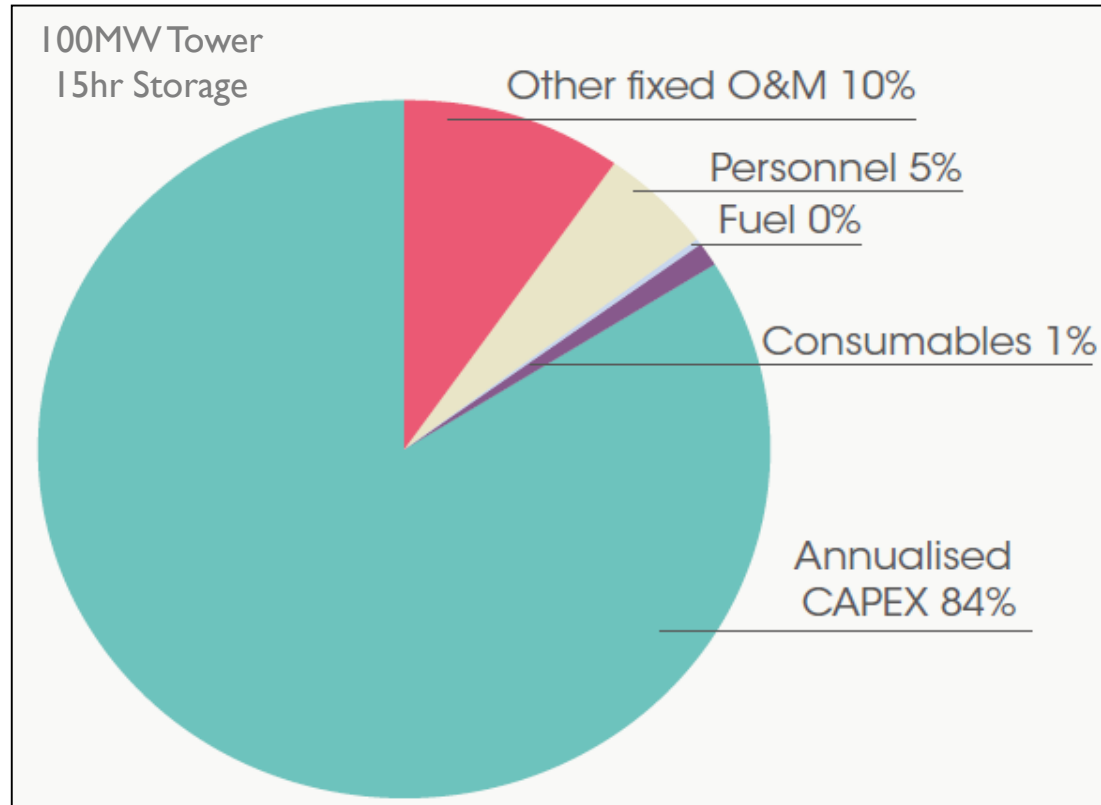


- Solar field costs
- Review of heliostat size
- Heliostat cost analysis
 - ATS I50
 - H40 HelioPOD
- Conclusion





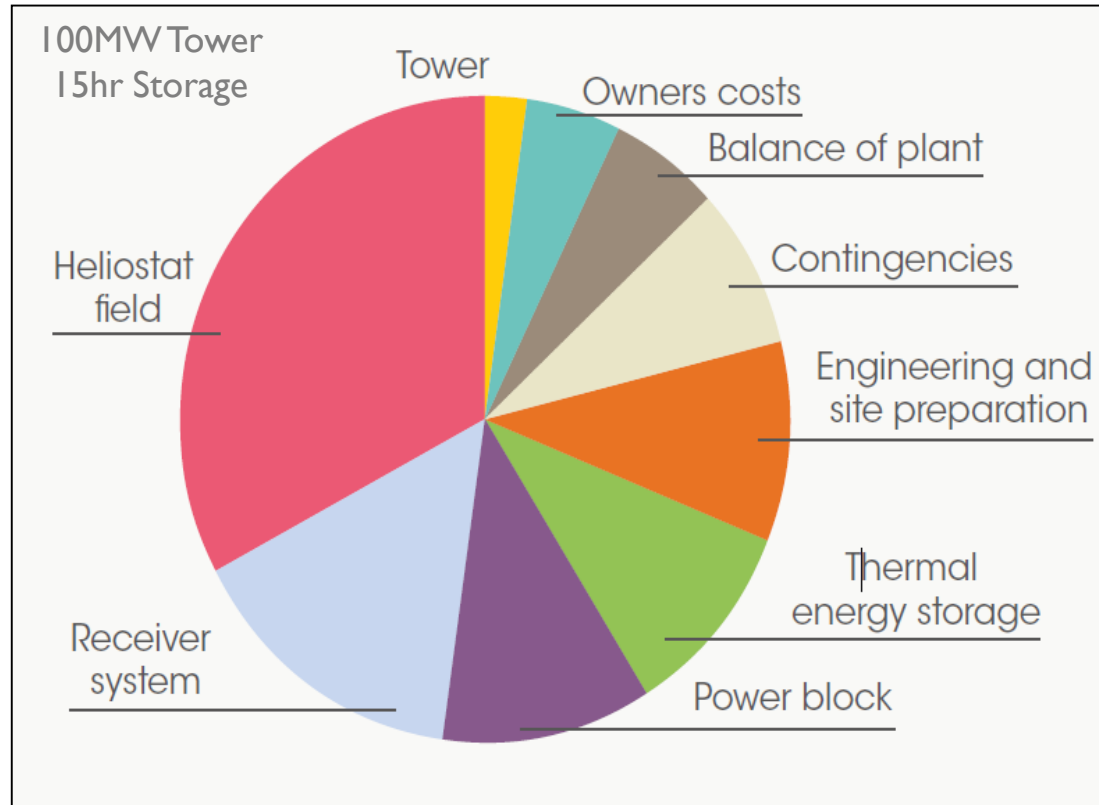
LCOE Breakdown



LCOE breakdown for a central receiver CSP plant in South Africa
(IRENA 2012)



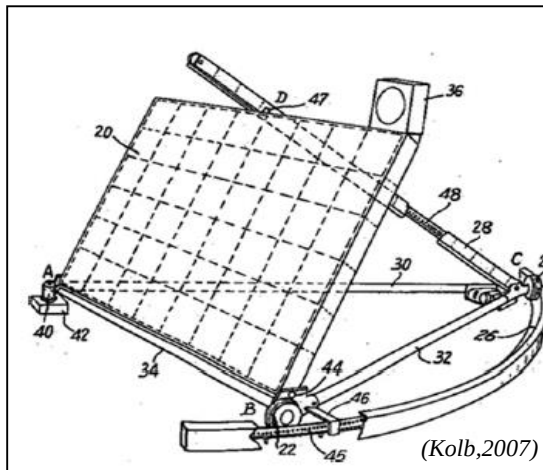
Total Installed Costs



Total installed cost for a central receiver CSP plant in South Africa
(IRENA 2012)

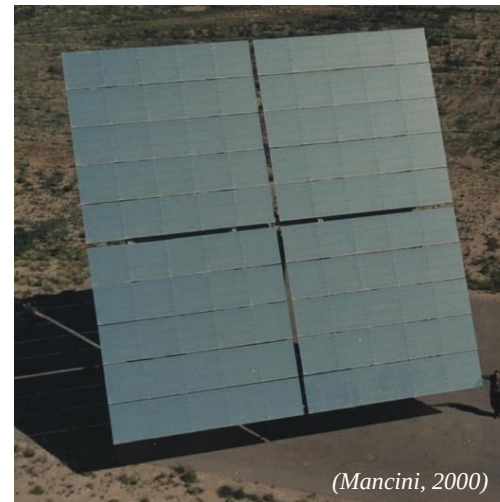
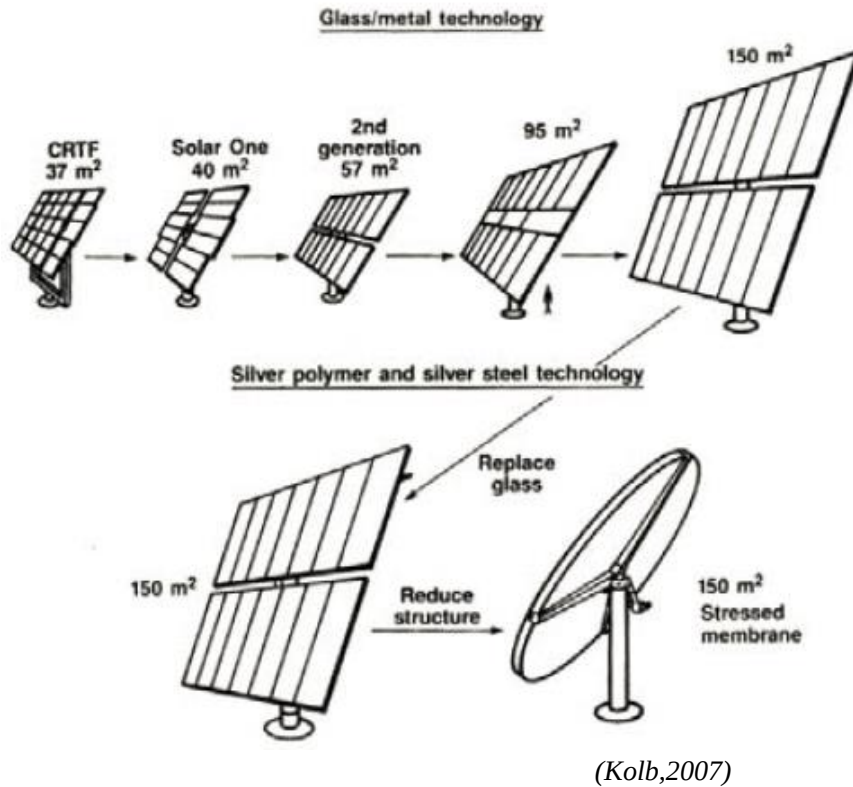


Heliostat Concepts



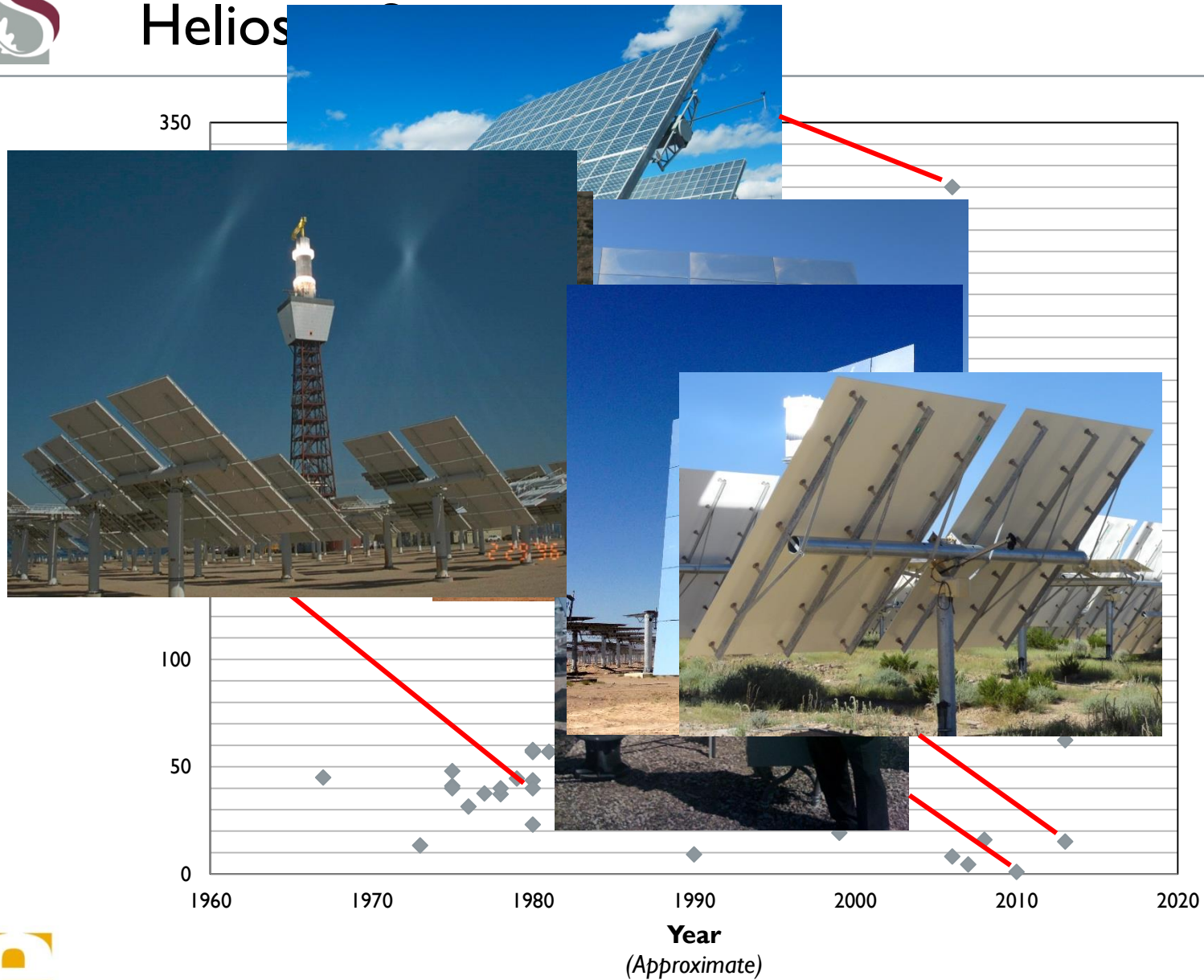


Heliostat Size





Helios



Source: Blackmon (2012), Kolb, (2007), Winter (1991), NREL(2014)



Future Heliostats



- eSolar have increase there 1m^2 facet to 2.2m^2
(Ricklin, 2012)
- Brightsource has increased there heliostat size from 15m^2 to 19m^2
(Koretz, 2014)
- Abengoa have increased form 120m^2 to 140m^2 heliostat while simultaneously developing an 18m^2 heliostat for SunShot
(Tiley, 2013)





Heliostat Cost Analysis



- Parametric method developed by Blackmon (2012)
- Heliostat component costs are divided into three cost categories:
 - Category 1: constant costs per unit area
Reflective Surface
 - Category 2: Size Dependant Costs
Drives, Structures and Pedestal
 - Category 3: Fixed Costs
Controllers and position sensors
- Each category has a particular cost to size relationship

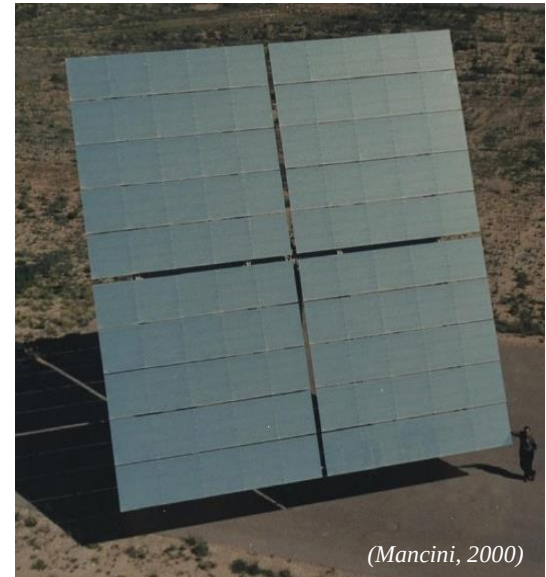




Illustrative example: ATS 150 Heliostat



- Heliostat cost details published in (Kolb 2007)
- 148m²
- Total Installed cost of \$167.47/m²
- Includes (20%) overheads and profit
- 5 000 units/year





Illustrative example: ATS 150 Heliostat



<u>Costs/Area by category [\$ /m²]</u>						
Item			5000/yr.	Category 1	Category 2	Category 3
Mirror Module			\$ 26.50	\$ 26.50		
Support Structure			\$ 23.32		\$ 23.32	
Drive			\$ 48.65		\$ 48.65	
Drive Electrical			\$ 2.67		\$ 1.33	\$ 1.34
Controls			\$ 2.10		\$ 1.05	\$ 1.05
Pedestal			\$ 18.66		\$ 18.66	
Field Wiring			\$ 8.13	\$ 2.71	\$ 2.71	\$ 2.71
Foundation			\$ 2.56		\$ 2.56	
Field Alignment/Checkout			\$ 6.98	\$ 3.49		\$ 3.49
Total Installed cost/area			\$ 139.57	\$ 32.70	\$ 98.28	\$ 8.59
Overhead/profit			\$ 27.91	\$ 6.54	\$ 19.66	\$ 1.72
Total Installed price/area			\$ 167.48	\$ 39.24	\$ 117.94	\$ 10.31
Fraction Category of total cost				0.234	0.704	0.062



Source: Blackmon (2012), Kolb, (2007).



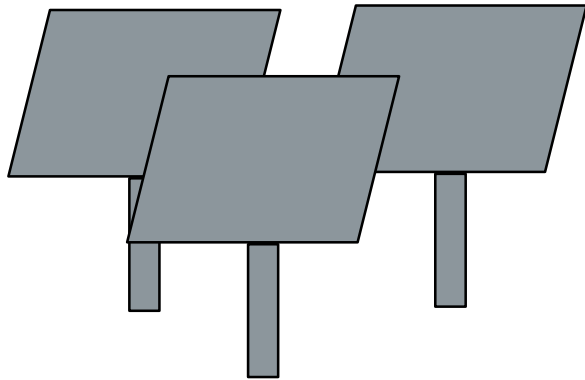
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Category I: Constant Costs

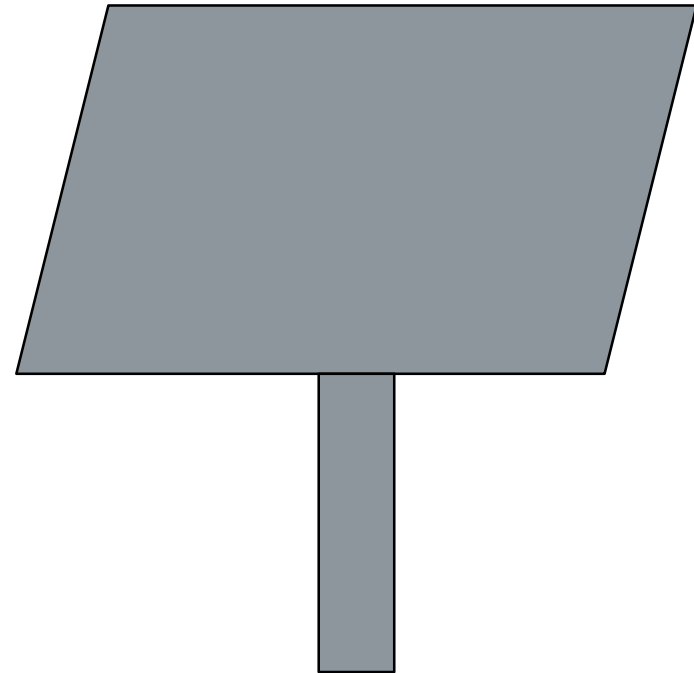


39.24 \$/m²



3X 50m²

39.24 \$/m²



150m²



Category 1: Cost/m² is constant





Illustrative example: ATS 150 Heliostat



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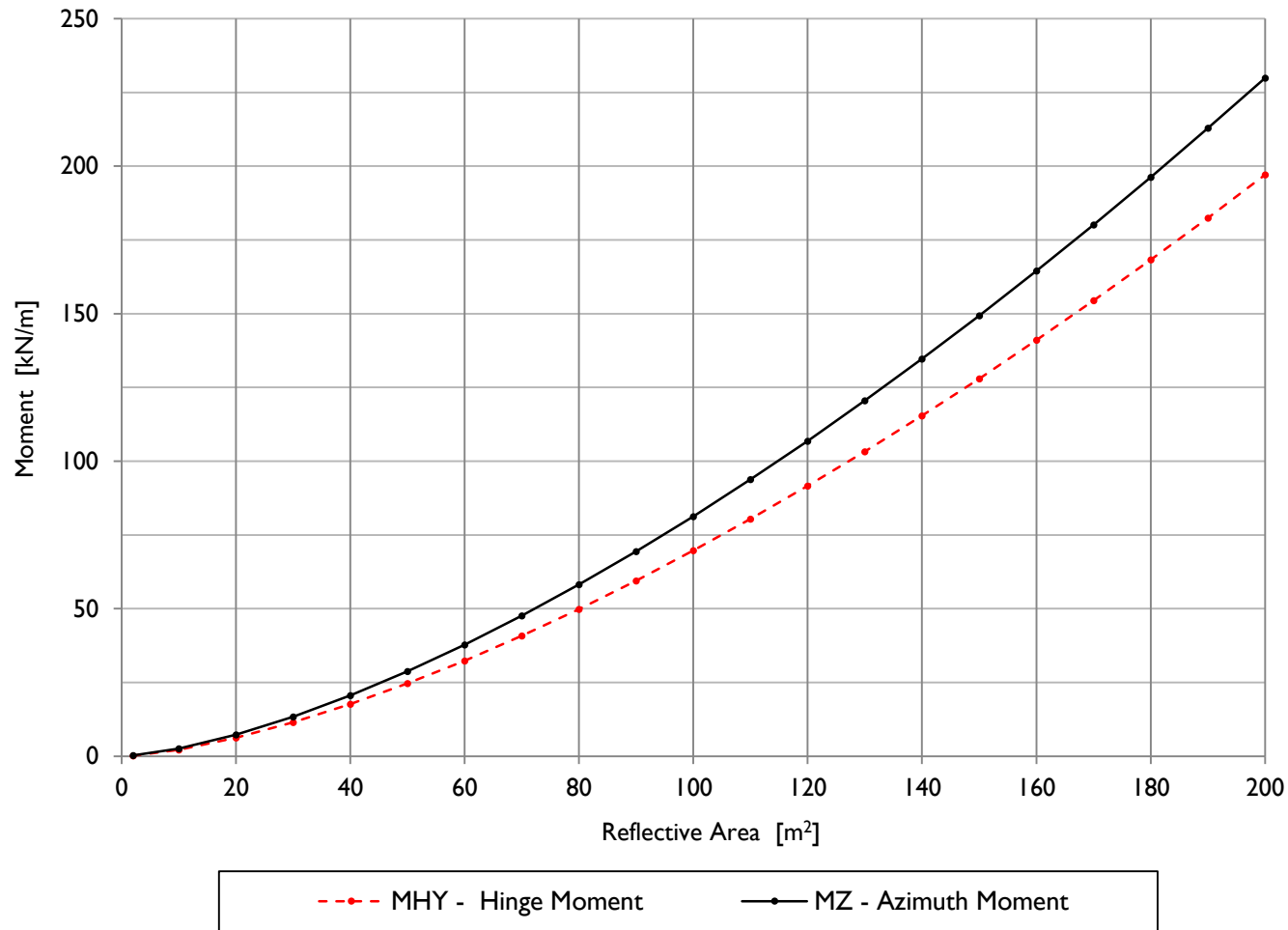
Source: Blackmon (2012), Kolb, (2007),



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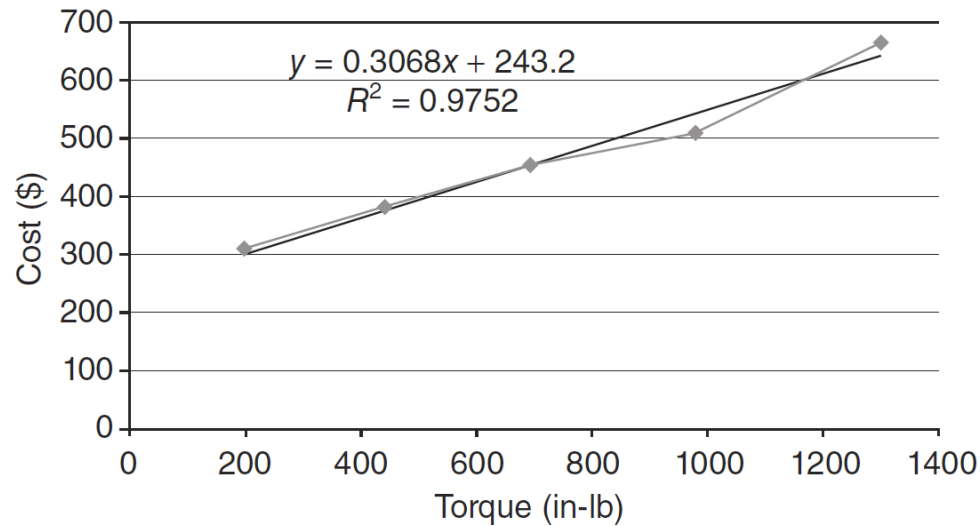


Category 2: Size Dependant Costs

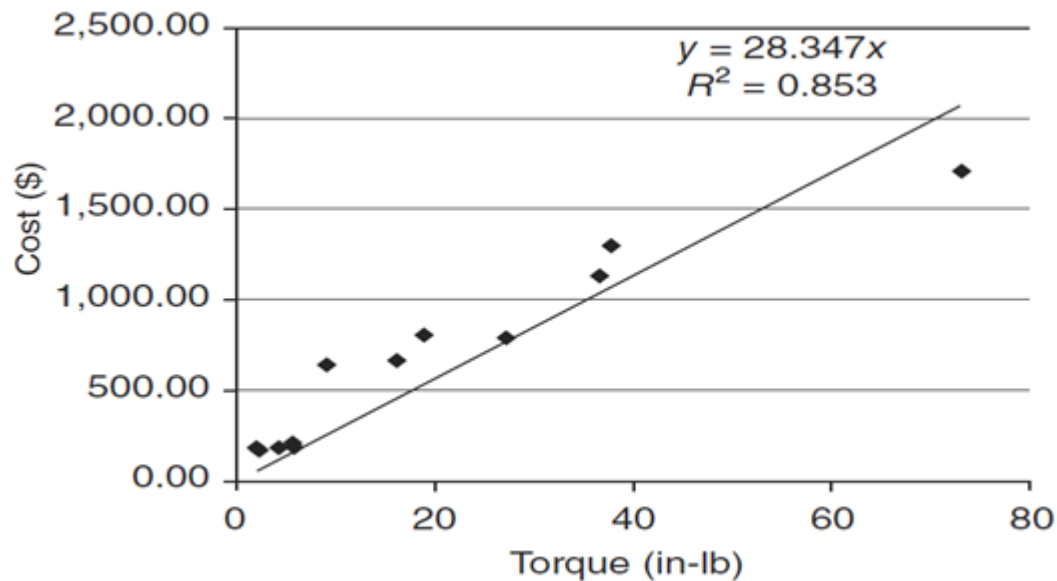




Category 2: Size Dependant Costs



Gear Reducers



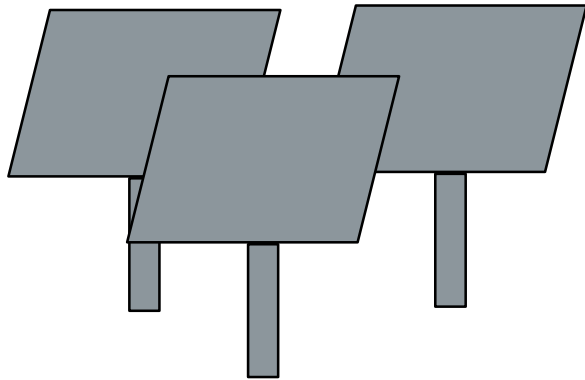
DC Motors



Category 2: Size Dependant Costs

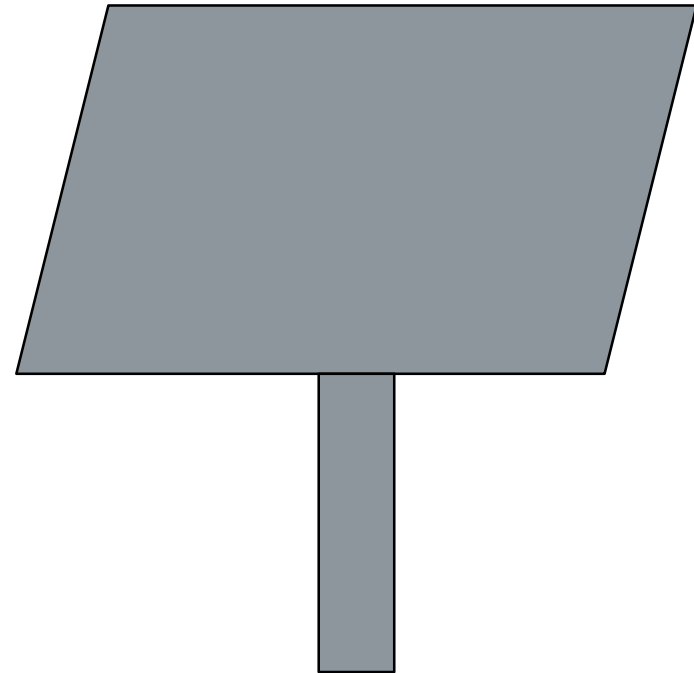


68.09 \$/m²



3X 50m²

117.93 \$/m²



150m²

Category 2: Cost/m² $\sim KA^{\frac{1}{2}}$



Illustrative example: ATS 150 Heliostat



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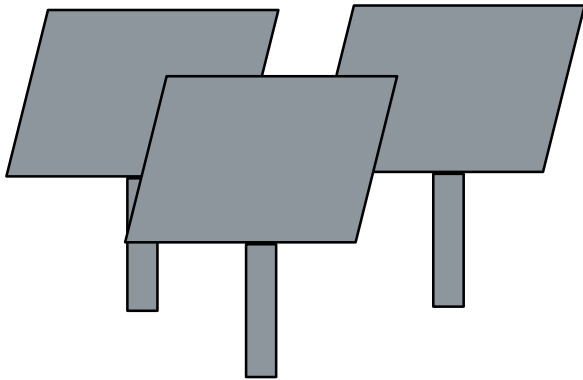


Category 3: Fixed Costs

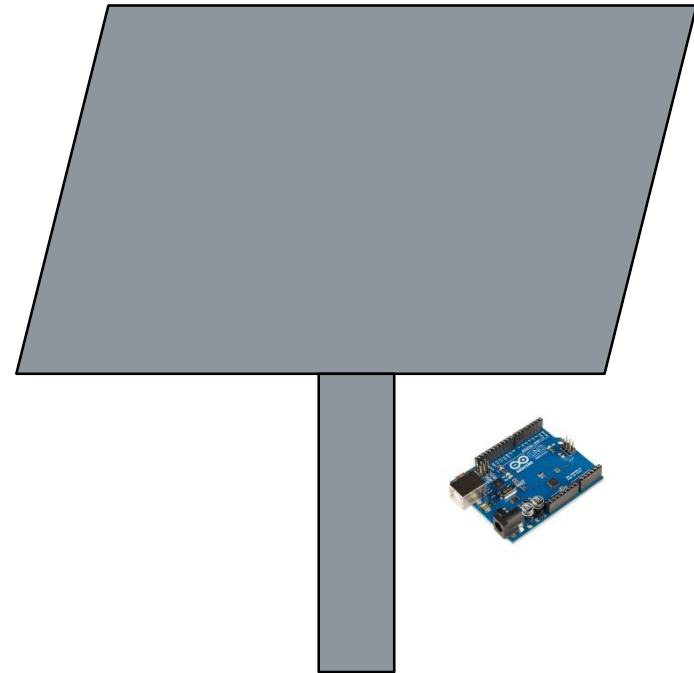


30.87 \$/m²

10.39 \$/m²



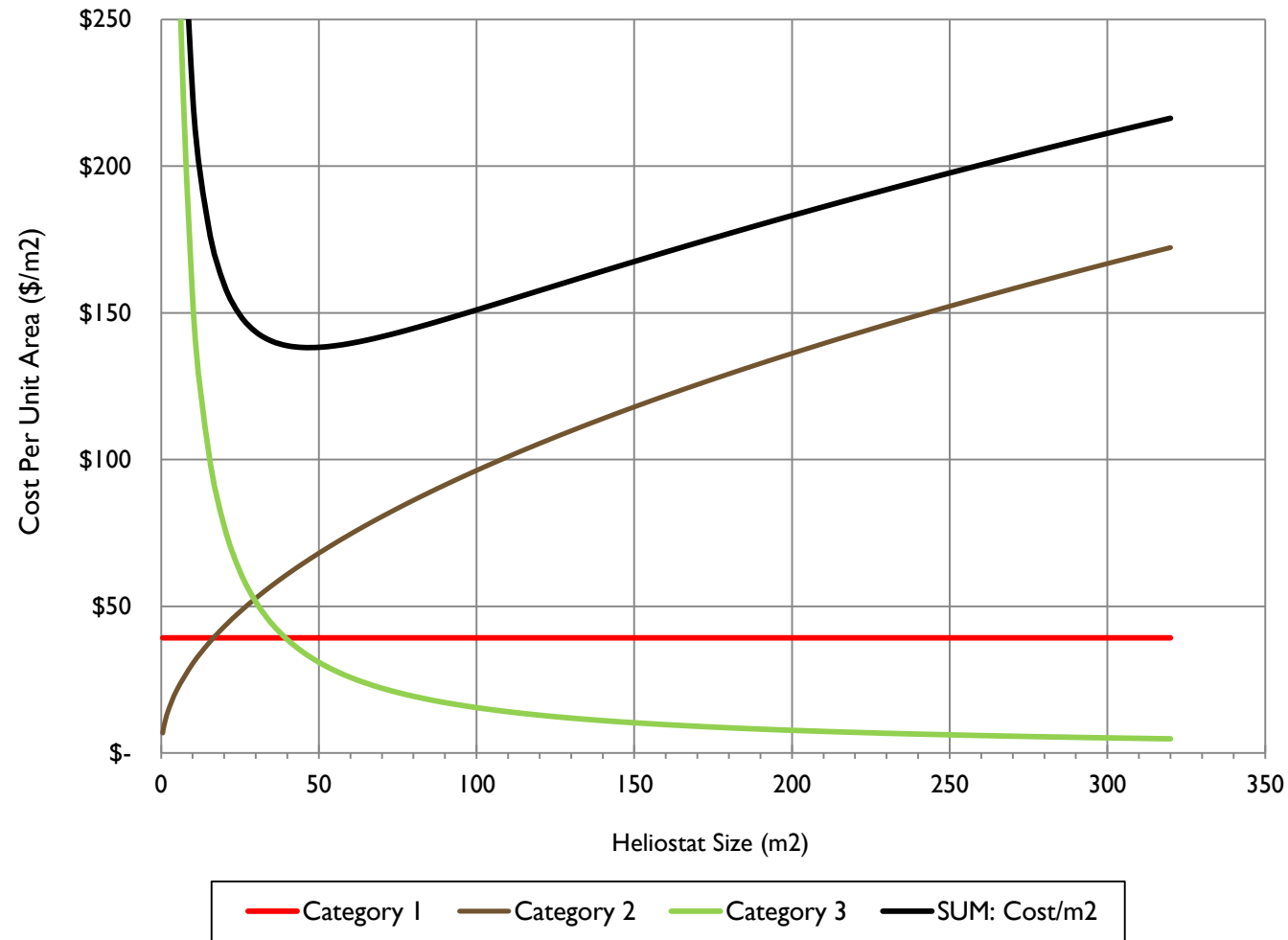
3X 50m²



150m²



Illustrative example: ATS 150 Heliostat





Illustrative example: ATS 150 Heliostat



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Source: Blackmon (2012), Kolb, (2007).



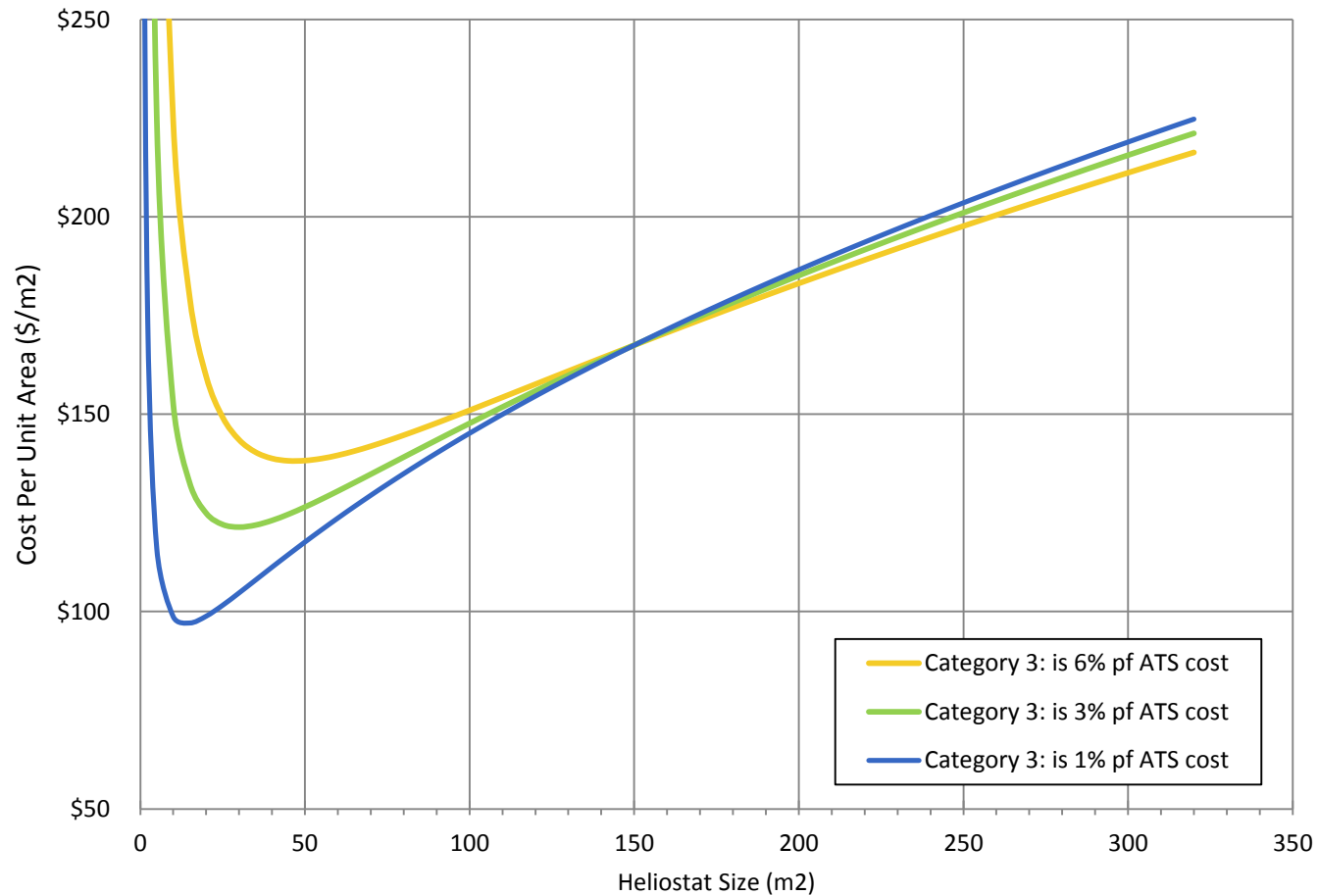
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Illustrative example: ATS 150 Heliostat



Case 1: $A_{\text{opt}} = 49.3 \text{ m}^2$





STERG HelioPOD

22



- First Revision Experimental Heliostat
- High Cost
- Not yet optimised
- 2.2m^2
- Fabrication cost of \$551.05/m²
- Low Volume at 20 units/year
- Excludes overheads and profit



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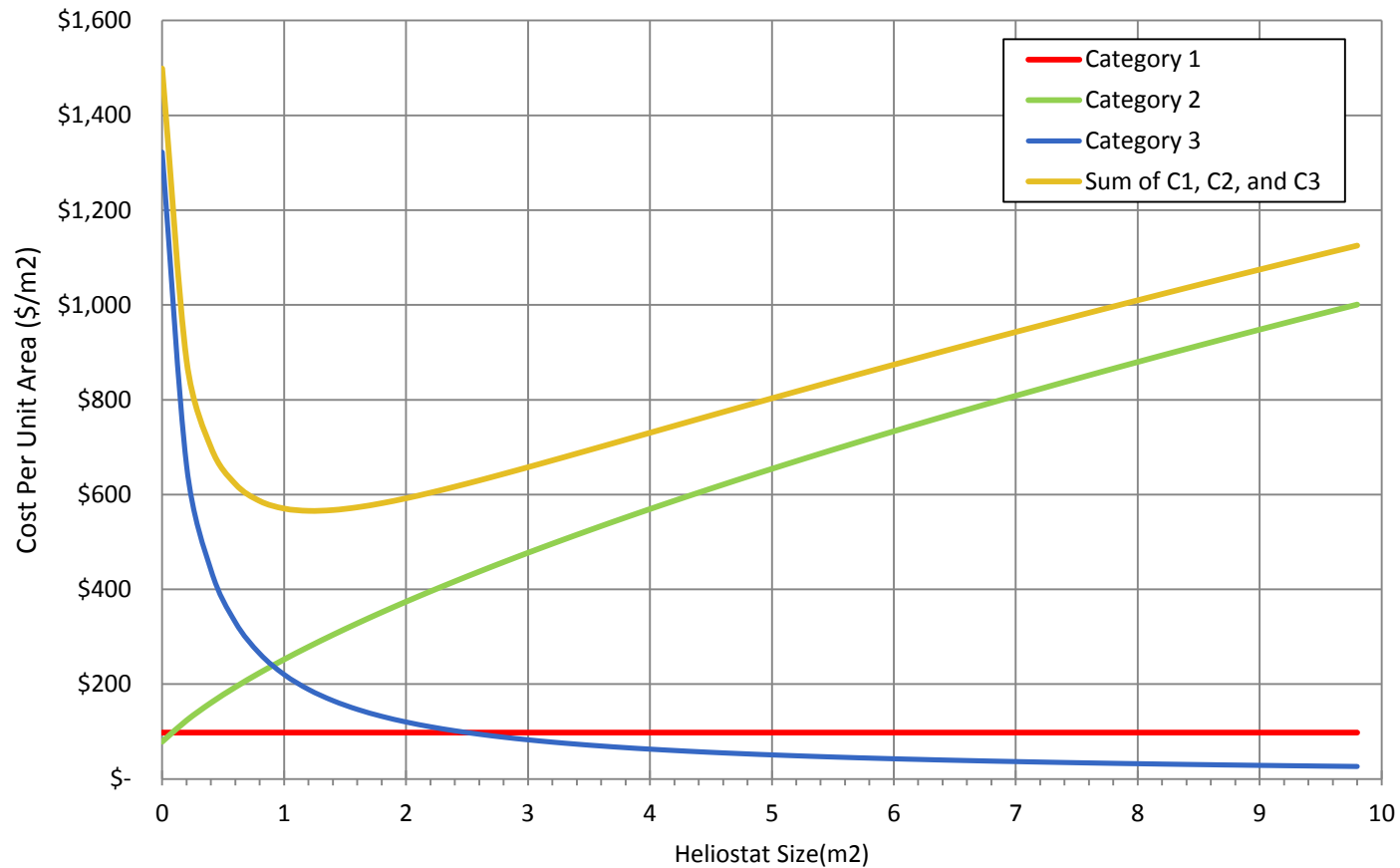


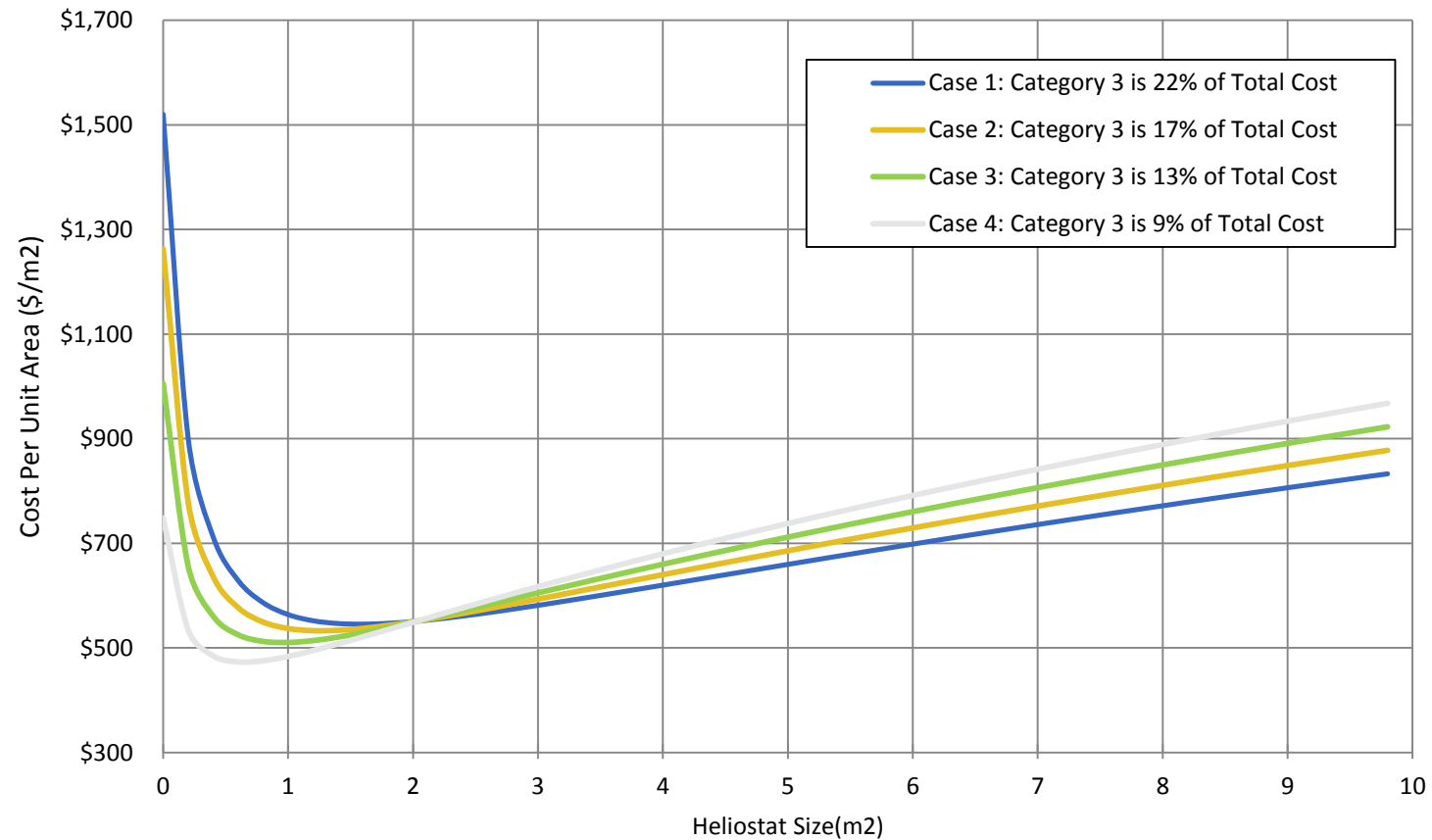
<u>All costs shown as \$/m²</u>		<u>HelioPOD Data</u>		
Item	Cost/m2	Category 1	Category 2	Category 3
Mirror Module	\$ 33.24	\$ 33.24		
Mirror Support Structure	\$ 109.71	\$ 43.88	\$ 65.83	
Elevation Assembly	\$ 54.78		\$ 54.78	
Drive 1 (Azimuth)	\$ 113.86		\$ 91.09	\$ 22.77
Drive 2 (Elevation)	\$ 69.32		\$ 55.46	\$ 13.86
Controls and Cabling	\$ 53.95		\$ 21.58	\$ 32.37
Pedestal	\$ 53.84		\$ 53.84	
Direct Heliostat Support (Lattice Work)	\$ 55.90	\$ 18.63	\$ 37.27	
Foundation	\$ -		\$ -	
Field Wiring - comms	\$ -		\$ -	
Alignment and Checkout	\$ 6.45	\$ 2.15	\$ 2.15	\$ 2.15
Total Installed cost/area	\$ 551.05	\$ 97.91	\$ 381.99	\$ 71.16
Total Installed price/area	\$ 551.05	\$ 97.91	\$ 381.99	\$ 71.16

Invoiced costs for H40 HelioPOD



STERG HelioPOD







- Fixed costs are low
- Drives and structure are oversized
- Investigate the use of
 - smaller drives
 - optimised structure





Conclusion

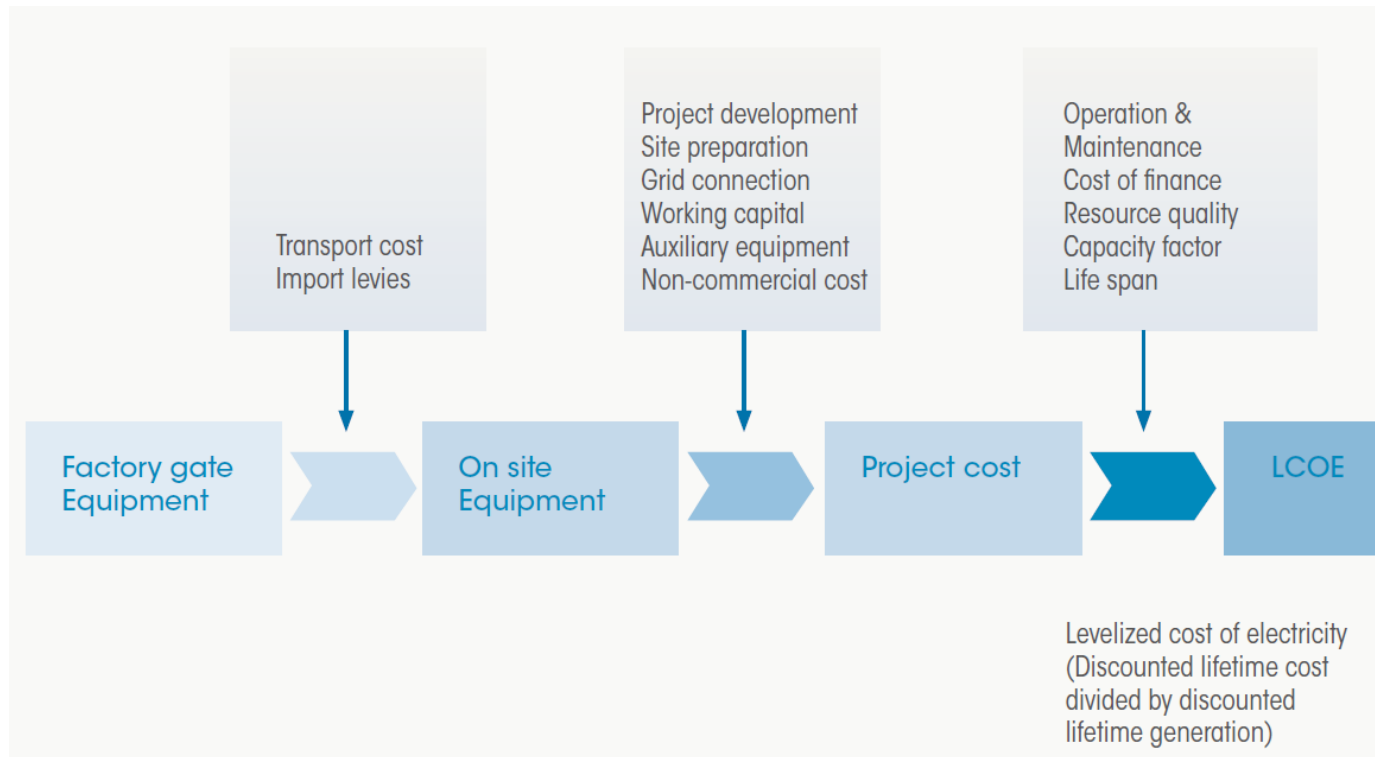


- Commercial trends do not show a clear heliostat area strategy
- The parametric method presented allows for the estimation of an optimum heliostat area
- Model shows partial assessment, not addressed:
 - Site preparation
 - Management and production overheads
 - Learning curves
 - O&M
 - Optical performance and Size
- Within this scope the model favours smaller heliostats





Limitations



(IRENA 2012)



Conclusion



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Acknowledgements:

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