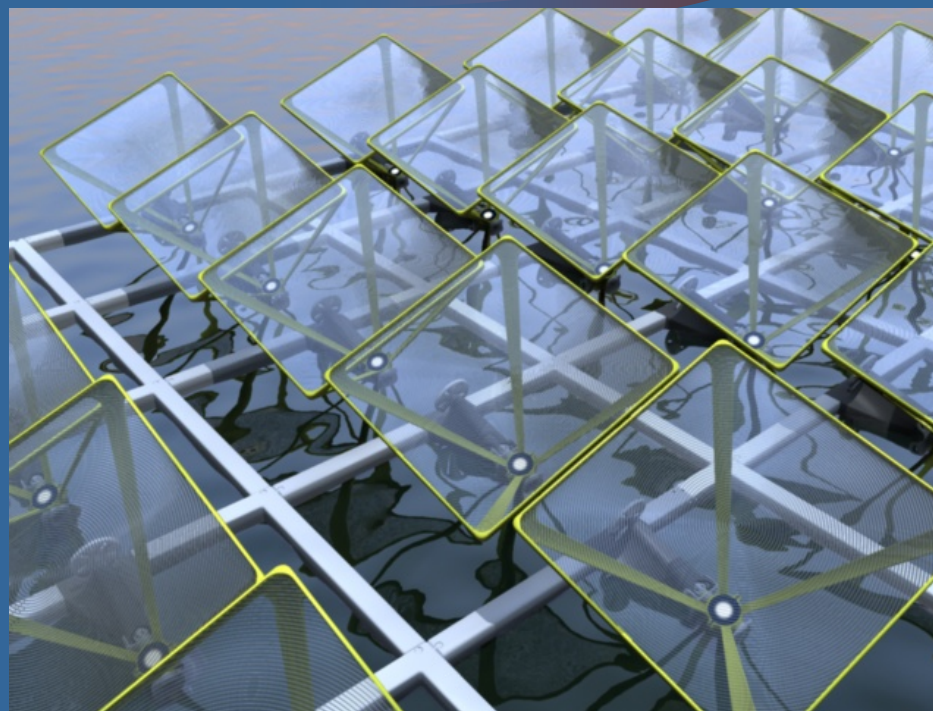




## *-Liquid Solar Array-*

- A method to remove the main economic limitations of solar electricity generators.
- Virtual storage on Hydro dams.
- Potential to reach \$1 per watt in 2 yrs of production, 70 cents longer term.



**Sunengy**

Pty Ltd, ABN 87 116 625 560

-Phil Connor-

# *Solar the Primary Resource*

- **Solar Energy is the primary source.**
- 120,000Tw in, 12Tw used by man.
- Essentially **unlimited** in size & scope. Available +/-40 deg latitude.
  - e.g.: A fifth of W. Australia could supply all mankind's power needs.
- Present flat plate silicon photovoltaics are **not nearly good enough**: \$4/W after 40 years development (now **24c per kWh**).



# *Solar Basics*



- The fundamental issue in the economics of solar energy is the efficiency in relation to the area cost of each system.
- Thus, if the efficiency is low the cost per square metre must be **very** low
- On the other hand, it is no use making a very high efficiency system if the costs are too high (solar input is fixed).

# Solar Possibilities



- There are at least three solar technologies that might reach under 4 cents per kWhr & all are Photovoltaic:
  - **Thin Film** Photovoltaics ( from Interphases, Nanosolar, CSG):
    - Lower efficiency, lower area cost. Rare materials used.
  - High Efficiency **PV concentrators** ( from Spectrolab, Emcore, Solar Systems etc):
    - High efficiency, high area cost (must be precise, robust- weather resist.)
  - **Light weight PV concentrators** (LSA from Sunengy):
    - Medium to high efficiency AND low area cost.

# *PV Concentrators*




*Solar Systems 35kW PV reflective concentrator*




*Green&Gold Solar Cube 300W PV Fresnel concentrator*

*[www.greenandgoldenergy.com.au](http://www.greenandgoldenergy.com.au)*

# *The Promise of Concentrators*

- 
- Greatly reduced area of silicon (semiconductor), compared to flat plate collectors – to 1% !
  - Replaces expensive material (silicon) with cheaper plastic or glass as the collector of light.
  - Potential of one tenth PV cost? ( $\ll \$1/w$ )
  - But there is an Achilles Heel (or two).

# *The Problems of Concentrators*

- 
- Tracking is essential
  - Concentrated heat must be removed from the focal area
  - They must withstand extreme weather forces while allowing pivoted movement for tracking, resulting in relatively massive structures.

## *An Immediate Solution*

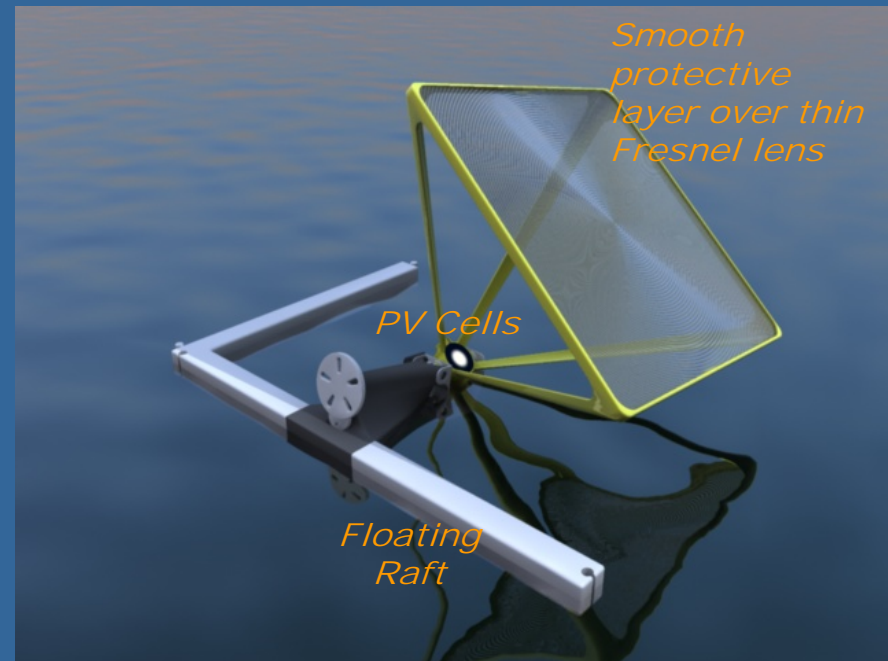


- The Liquid Solar Array resolves each of these limitations and, in particular, avoids the problem of weather in a way that reduces both complexity and mass.

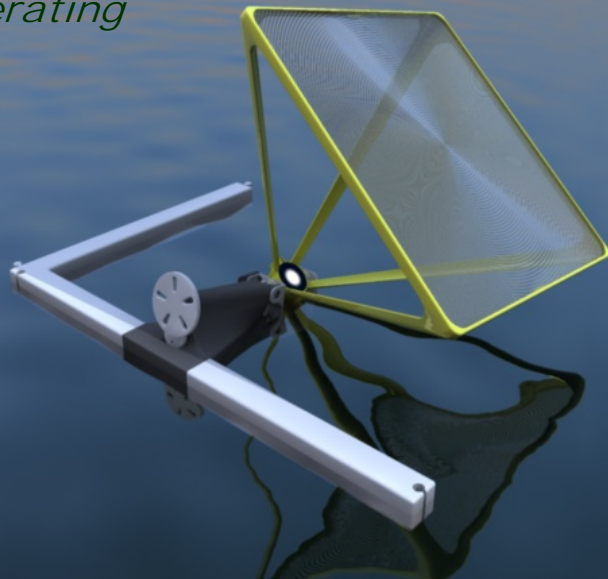
# *The LSA method*

*Liquid Solar Array*

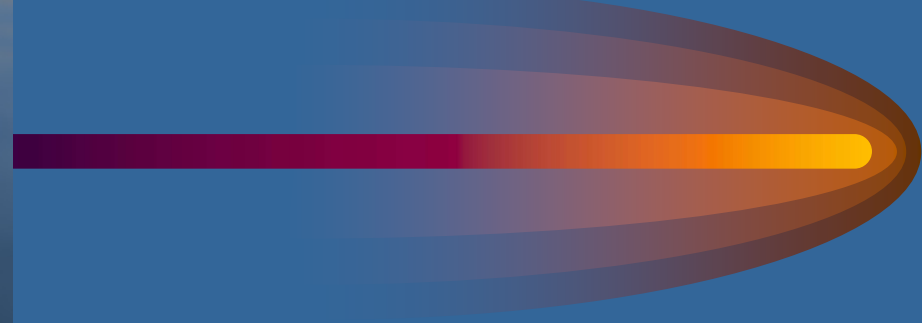
- LSA is a set of plastic solar collectors floating in water.
- Sunlight is focused by a thin lens into a sealed well containing photovoltaic cells, that are cooled by the surrounding water.
- But what about **wind & hail?**



*Operating*

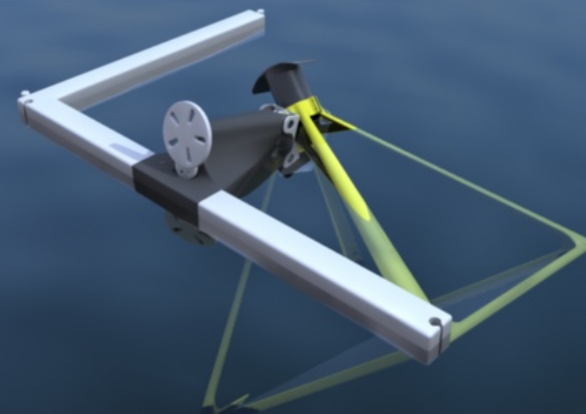


## *Wind Protection*



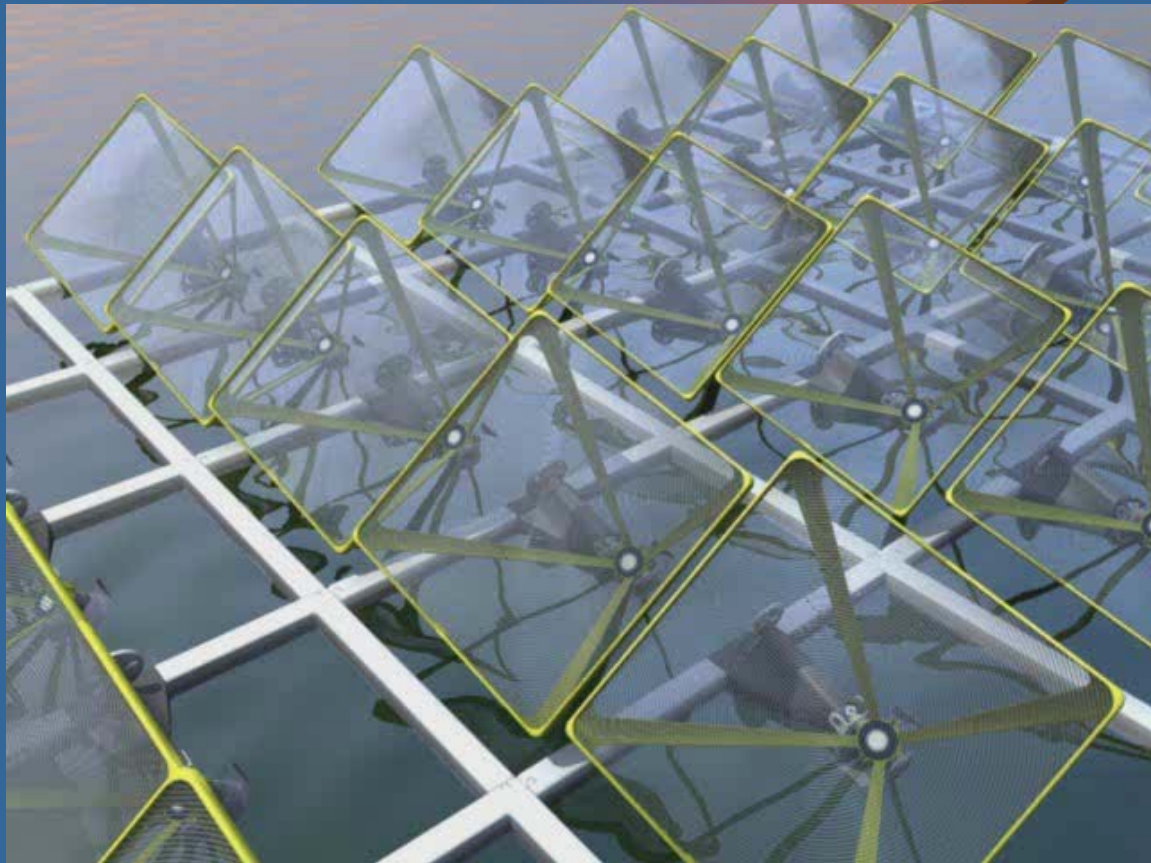
- Large area concentrator lens can rotate into the water to protect it against bad weather conditions.
- Lens is covered by an envelope of easily cleaned, super durable & water repellent plastic.
- Comes out dry and clean – even in salt or muddy water.

*Protected*



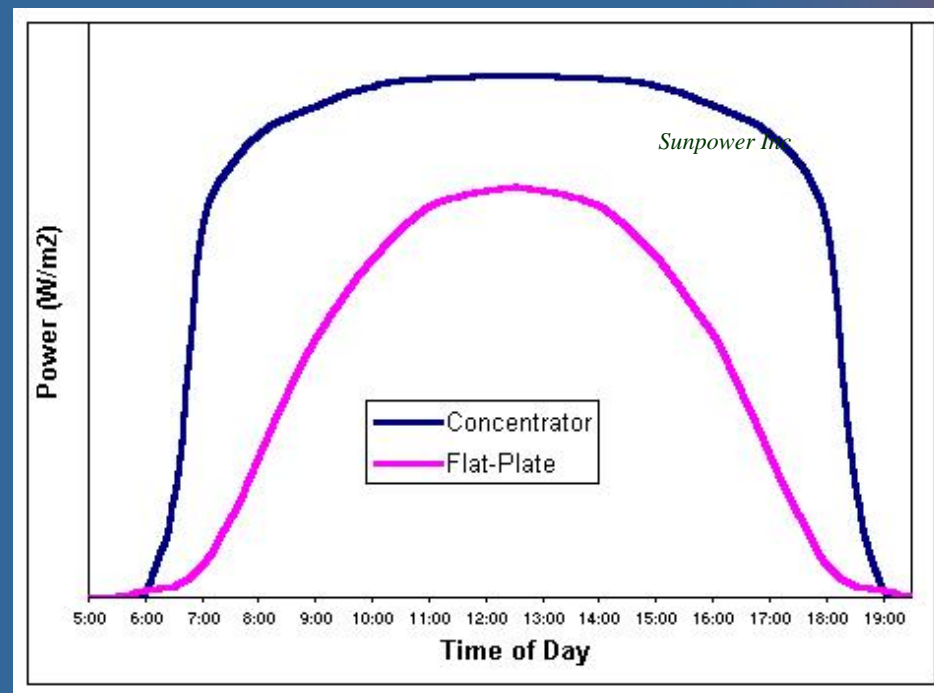
# *Economic Solar Solution*

- LSA resolves the problems of concentrators to allow simpler structure and very low capital costs – ultimately ~70c per watt.
- Water cooled, lightweight structure of cheap materials and a little silicon- all readily available.
- Like Hydroelectricity, but more available & conserves rather than consumes water.



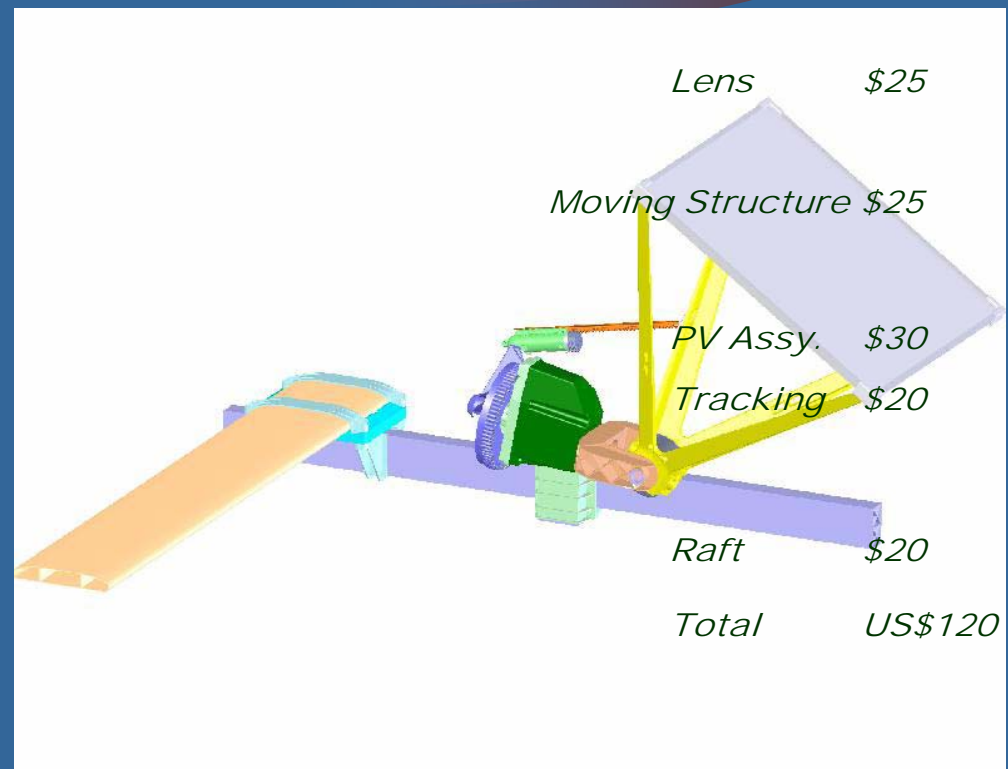
Hydrophobic lens cover keeps it dry & clean, raft stops waves, operation to 60km/hr, survive 300km/hr

# CPV Daily Output



# Production Costs

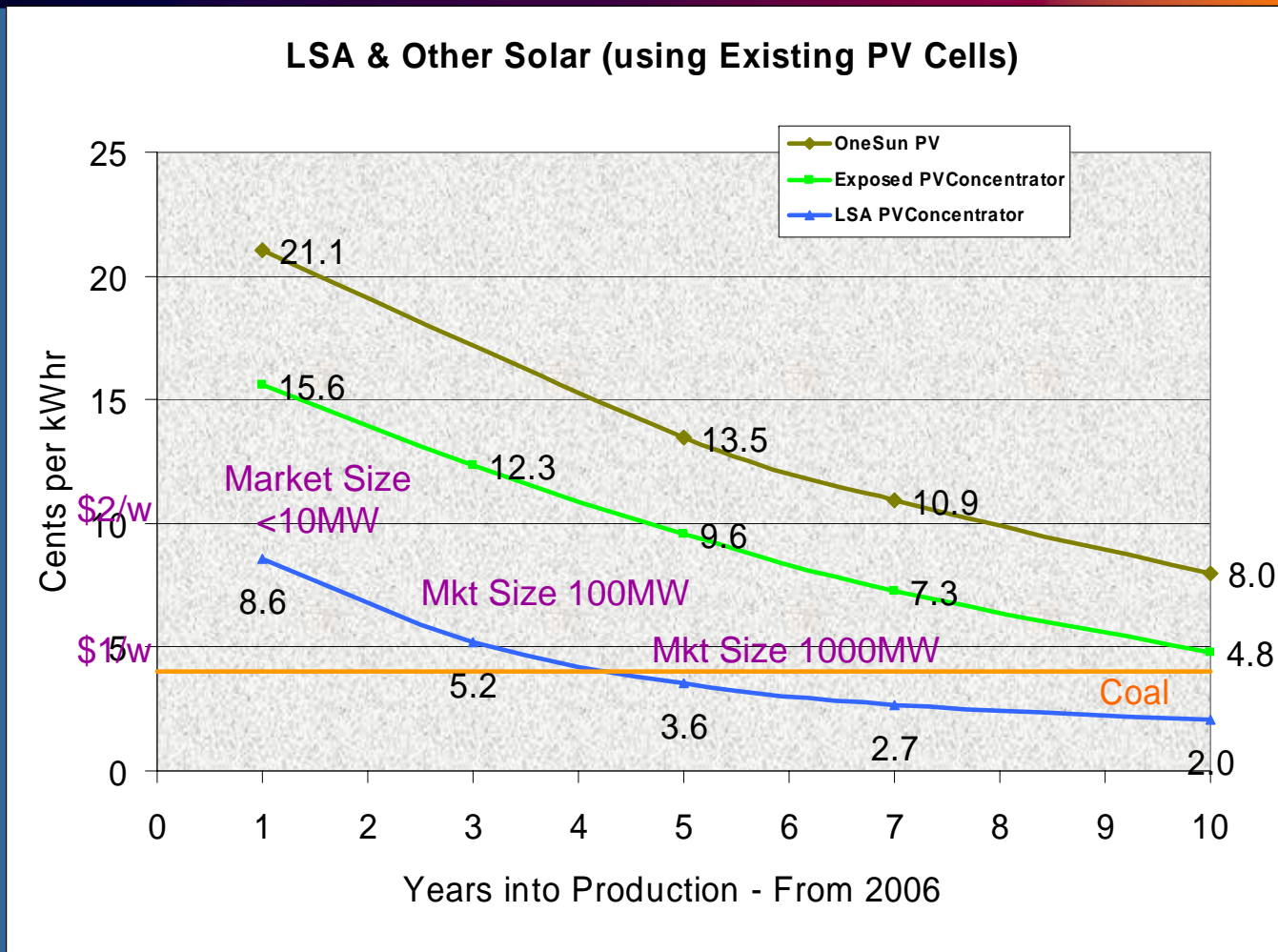
- **What might it cost?**
- Estimated early mass-production cost for a one square meter unit is approx. **\$130** with labor.
- Each M<sup>2</sup> produces about 130W, so the capital cost is **US\$1 per Watt**. (at 1 mill/yr scale prod'n)
- This is approx **5c per kWhr**.



Early stage costs from CAD model masses (\$2/kg resin)

# Likely cost evolution

At 2400 hrs per year sunlight - ideal.



# *Advantages 1*



- Photovoltaic cells used are naturally cooled by convection of the water to give top efficiency and life.
- Structure & Concentrator lens can be made from very lightweight, low cost plastics as they are protected from extreme weather forces.
- Technologies used are all ‘off the shelf’.
- Minimal BOS & setup cost. No land cost.

## *Advantages 2*



- Leverages any improvements in PV cells (triple jn) .
- Small quantity of silicon means rapid deployment of large capacity possible (to 40 GW p.a. with current Silicon refining capacity).
- No rare materials used.
- Minimal mass ~ 14 kg per sq. m of collector.
- Long life (20 yrs should be achievable).
- Gives near constant output all day.



## *Water area required*

*25 kW Dam Installation*

- 1 megawatt output requires about five acres (23,000m<sup>2</sup>) of water area (1/3 filled).
- A small sized city water reservoir of 2.3 sq miles (6 km<sup>2</sup>) gives up to 250MW.
- A larger lake/ reservoir with 7 sq miles (23 km<sup>2</sup>) available could provide 1000MW (1GW).
- The water is unaffected by the system.
- As an example a 500MW hydro dam could typically generate another 500MW if 5% of surface utilised.

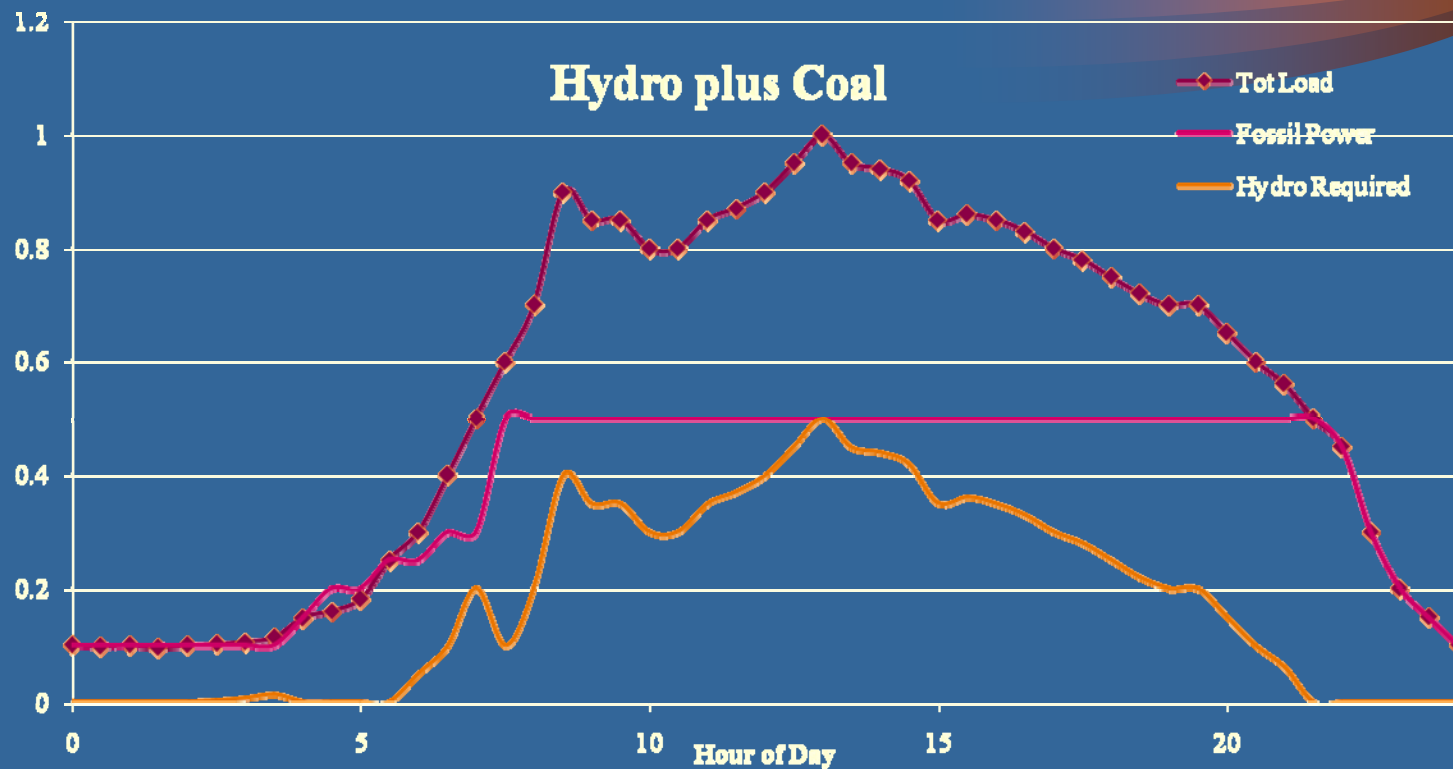
# *LSA on hydroelectric dam*



- Virtual power storage with location on Hydroelectric systems – by offsetting water usage.

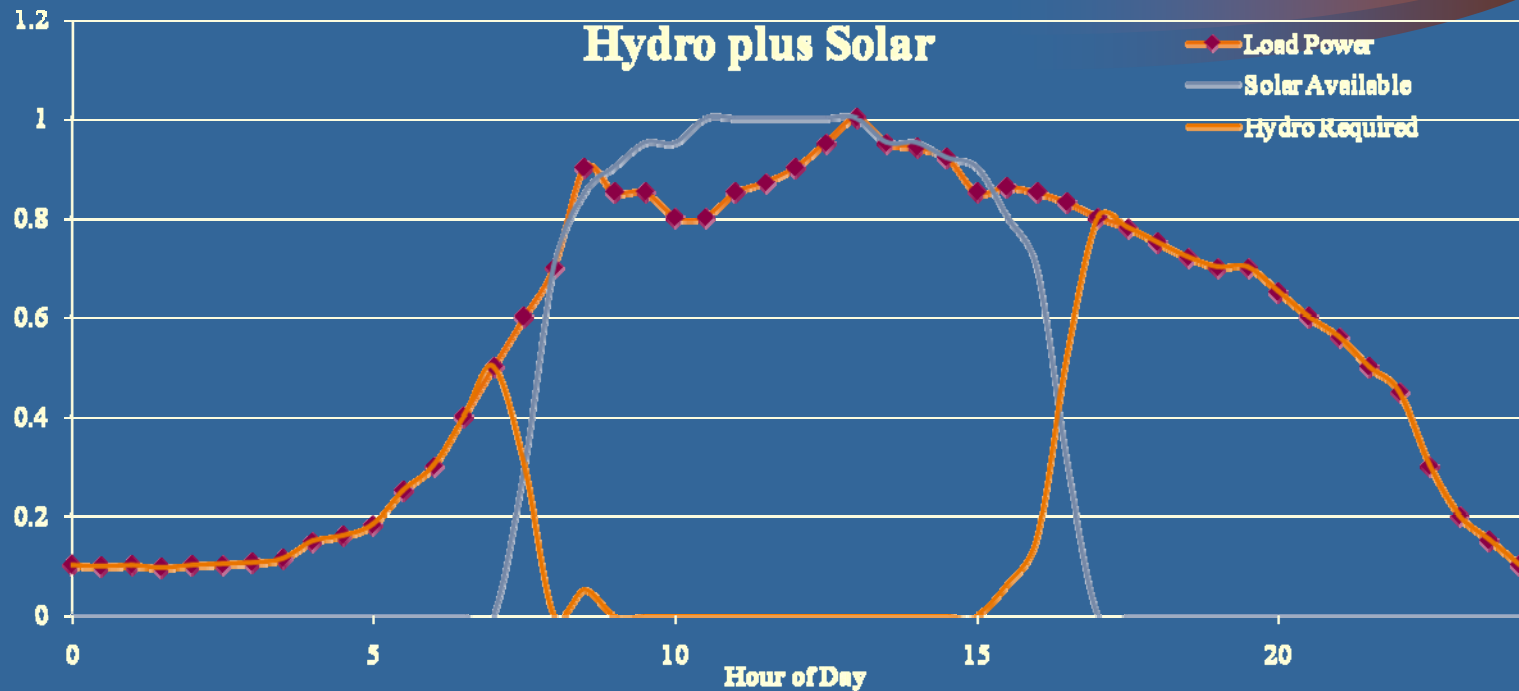
- Around 50MW LSA in view

# Hydro with Fossil Power



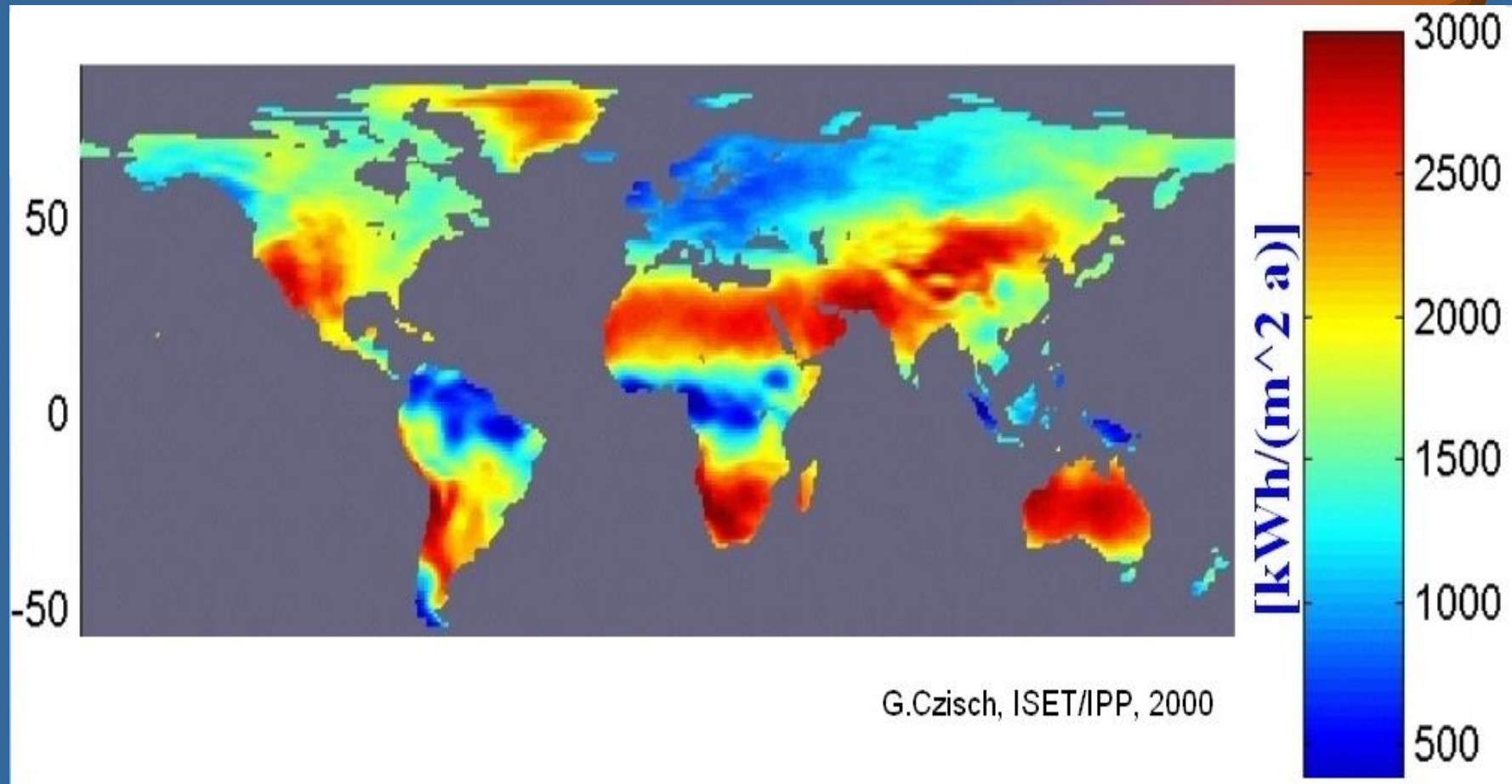
- Hydro installations have typically 0.3 capacity factor, limited by water availability, so the transmission line is 30% used.

# Hydro with LSA Solar



- With a substantial solar plant on the dam, the transmission line can be much more fully used. The hydro dam can deliver double the power on the same transmission line, offsetting water usage to no-sun hours, effectively storing the solar power generated.

# Markets



*Average Yearly Direct Sunshine*



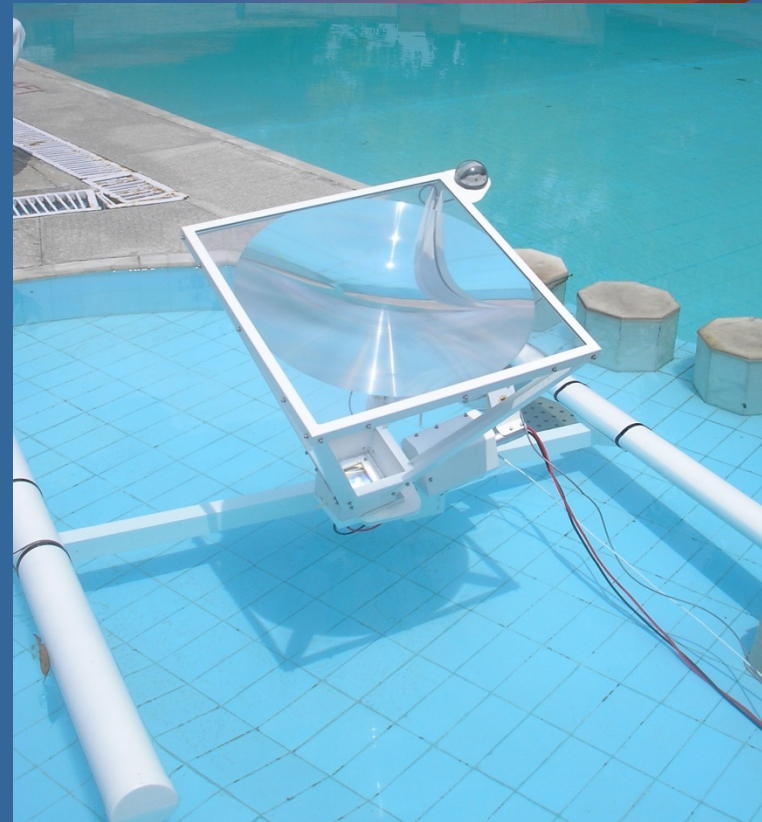
# *LSA Potential*

- Economical 3-4c/kWhr
- Achievable 'now'
- Global Impact
- Modest capital requ'd:  
us\$5mill to market
- Patented Australian  
innovation

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