Business Plan

2/07

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1. Introduction - executive summary

Orionsolar has set its sights on providing the lowest cost solar power technology in the market. We can achieve this ambition because we will be the first company to successfully commercialize dye cell photovoltaics for low cost applications. Via a range of patents and innovations we are close to producing at less than $1.20 per peak watt.

Some background

Solar energy technology is effective and reliable. More than 1 Gigawatt of solar modules are sold each year in a market worth $7 billion per annum. And the market is growing fast. Solar energy has many advantages – electricity production can be close to the consumer (dispersed), it is quickly installed, uses local labour for manufacture, and above all, it is environmentally clean.

Despite its fast growth, solar energy still only constitutes a small part of the whole energy industry. Yet it is clear, as solar energy technology improves, it will be progressively provide a larger part of the world’s energy needs. The major factor holding back growth is cost and this is where Orionsolar and dye technology have tremendous advantages.

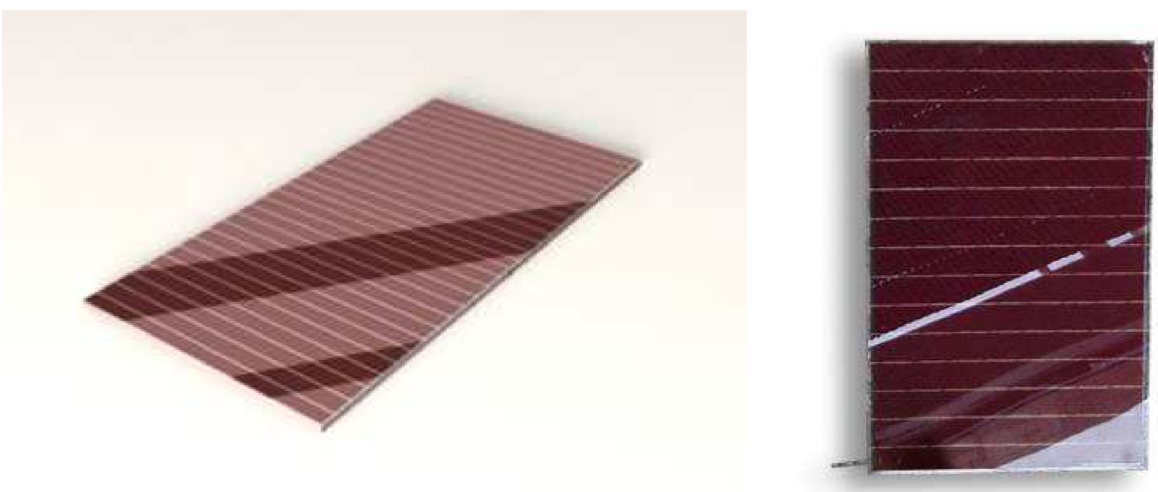

Figure 1. Our monolithic module design

The race is on

The manufacturers of solar modules based on current multi-crystalline and poly-crystalline silicon wafer technology have tried to cut manufacturing costs for some time; Kyocera, Sharp, Suntech, and others have made strides and have reached close to $2.3 per peak watt (module) by improving efficiency and fabrication techniques. However silicon wafer manufacture requires expensive production lines, that are also capital and energy intensive. It is generally

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accepted in the industry that it will be difficult to lower the cost of silicon cells significantly in the near future.

So what alternatives are there to silicon? Thin films show promise but when it comes to cutting costs dye cells have a strong advantage – and Orionsolar is the leader in this field.

Photovoltaic dye cells

Professor Graetzel of Lausanne Polytechnique invented the concept of the electrochemical dye solar cell in 1991. The “Graetzel” dye cell is based on a layer of nano sized titanium dioxide particles impregnated with dye. Over the years, more than 50 university research teams around the world have worked to increase the lifetime, size, and efficiency of dye cells. This technology is now ready for commercialization.

Dye cells have the following major advantages.

- They are based on inexpensive raw materials and production inputs.
- The production line costs 40% less than the cost of a silicon line.
- Dye cells are the most environmentally friendly of technologies requiring the least amount of energy to manufacture, and has no need for problematic input materials.

The disadvantages of dye cells are that the first generation products will have lifetimes no longer than 7 years and so we will be emphasizing applications where shorter lifetimes are acceptable

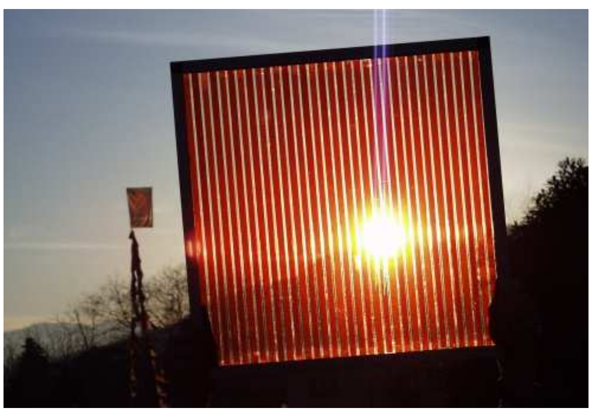

Fig. 2. Large dye module.

A note on metrics

Solar panels or photovoltaics are rated according to their peak watts, i.e. how many watts they produce on a cloudless day at midday at a certain geographical location.

The manufacturing costs we quote are the factory gate for a complete module, including amortization, and not including installation costs.

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2. Orionsolar's advantages

- We have developed new intellectual property which will substantially reduce the cost of existing dye cells.
- We have developed a design that will reduce losses in electric current allowing larger cells to be built.
- Our developments allow an increase in active area increasing efficiency substantially
- Our designs will cut out the most expensive raw materials reducing costs to below $1.20 less than half the cost of existing silicon modules.(see figure 2)

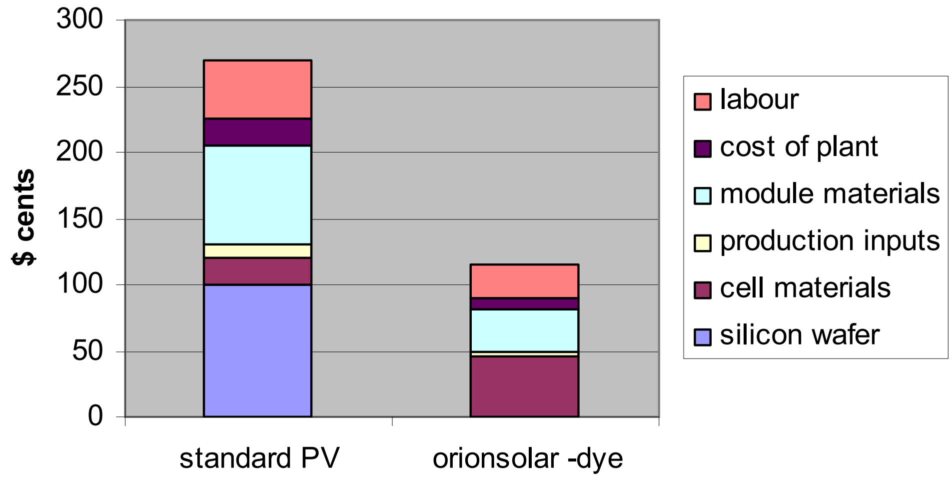

Fig. 3. Manufacturing Costs.

Orionsolar modules will cost only 120 cents per Wp to produce.

We have attempted to look at the whole picture from the cost of raw materials right through saving costs on production labor and module build.

This is how we are saving on costs

a) Our technology does not require expensive silicon wafers. Instead we have a much cheaper bill of materials which is explained in more detail in Appendix 3.

b) Production lines. Generally for every megawatt of production line, one needs $1million. So for a complete 20MW cell and module factory one needs $20million in capital equipment. Historically for thin film technologies the costs are even higher. By contrast a complete cell and module Orionsolar line will cost in the order of $12 million for 20MW.

c) Sandwich materials. Compared to other dye cells, our design has only one layer of conductive glass which is one of the most expensive components.

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d) Titanium dioxide. Our new production technique allows cheaper titanium dioxide with less wastage.
e) Large cell design. Traditionally dye cells have had a problem of scaling up in size. We have succeeded in building large cells allowing easy current take-off and large module design.

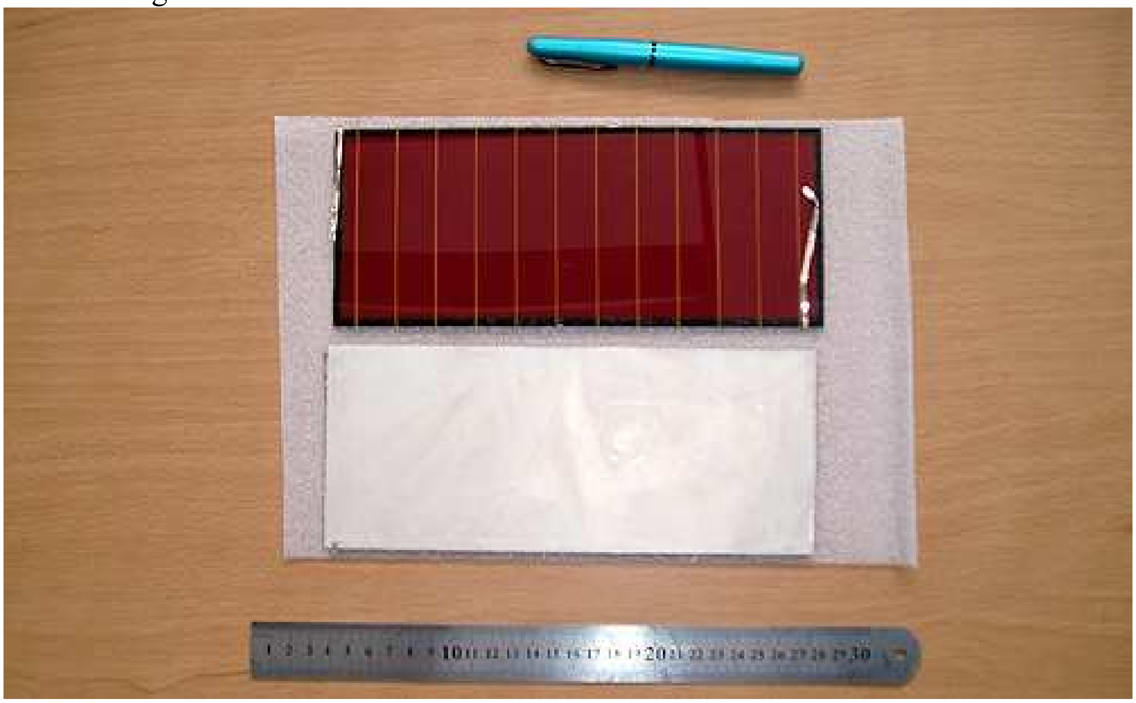

Figure 4 – Our glass-foil design.

Module Specification (Standard)

Module Configuration

Cell:	DSSC (Dye Sensitized Solar Cell)
Configuration:	framed module
Suggested Warranty:	7 years

Electrical Characteristics

Rated Power (Pmax):	80 watts
Power tolerance:	± 5%
Solar Cell Efficiency (ηc):	7.4%
Module Efficiency (ηm):	7.0%
Voltage at Pmax (Vmp):	6.0 V
Current at Pmax (Imp):	13.3 A
Short-circuit current (lsc):	16.0 A
Open-circuit voltage (Voc):	8.4 V

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Mechanical Characteristics

Length	123.0 cm
Width	92.0 cm
Thickness	4 mm
Weight	8.5 kg

Module Configuration

Cell:	DSSC (Dye Sensitized Solar Cell)
Configuration:	framed module, thin and lightweight
Suggested Warranty:	7 years

Electrical Characteristics

Rated Power (Pmax):	80 watts
Power tolerance:	± 5%
Solar Cell Efficiency (ηc):	7.4%
Module Efficiency (ηm):	7.0%
Voltage at Pmax (Vmp):	6.0 V
Current at Pmax (Imp):	13.3 A
Short-circuit current (Isc):	16.0 A
Open-circuit voltage (Voc):	8.4 V

Mechanical Characteristics

Length	123.0 cm
Width	92.0 cm
Thickness	2 mm
Weight	3.5 kg

Note on cell size

We can make our cells any size from 15 x 15 cms to 160 x 100 cms which is the size of a full module. We would prefer the latter since this would cut costs further. There are some manufacturing tests that need to be done before the final design can be settled on.

To complete this section we have prepared 3 appendices.
Appendix 1. How dye cells work.
Appendix 2. Our manufacturing line
Appendix 3. Our bill of materials.

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3. Marketing

In this introductory section, we would like to explain four issues relevant to the solar industry.

1) **Size and growth.**
Electricity from solar energy is a large and growing industry with good future prospects. The table below is taken from a document written by Michael Rogol who has undertaken an extensive survey of the solar photovoltaic industry. Rogol believes that $16billion of modules will be sold in 2010 representing on year growth of greater than 30%. The upper black line includes BOS (balance of systems) and installation costs.

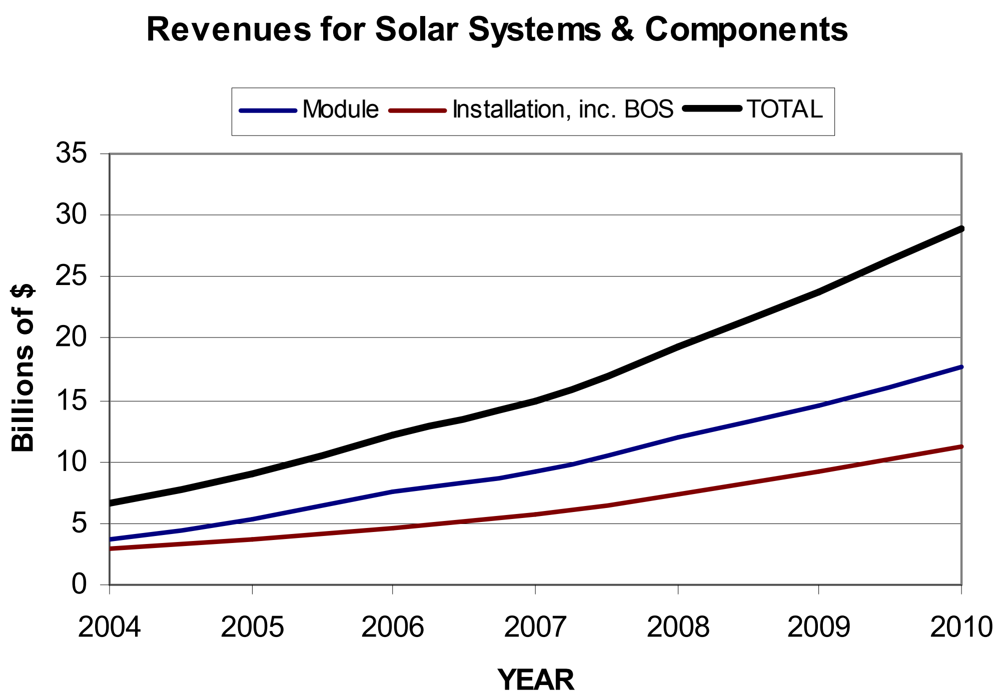

Figure 5. Table showing growth in solar energy photvoltaics revenues. Source –Rogol.

2) **Variety.**
There is a range of applications with varying market requirements. Most solar market sectors have strong potential.

The Solar energy market is growing fast and can be divided as follows:

a) Water heating products: This market segment is growing fast and is dominated by companies like Chromagen and Solarhaart with solar-radiation technologies.

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b) Power stations- wholesale: The wholesale market is basically the non-distributed power station market. The dominant technology in this market segment is the LUZ-Solel technology though there are some large PV silicon installations of more than 10MW.

c) Space - communications: Space products require high power density and not low cost. For terrestrial communications product, cost is paramount.

d) BIPV – Building integrated PV: This growing market segment requires long lifetime products with strong esthetics. Some thin film products have promise besides future dye products.

e) Grid connected solar energy rooftop systems. PV can be net-metered and its product or excess can be sold back to the grid. This can be done in Israel and at very advantageous prices in countries like Germany. This is the largest section of the market where cost is the most important issue. Dye technology will be of great significance.

solar applications


Solar Water

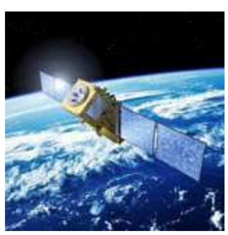

Power stations- wholesale


Remote sites


Solar parks


BIPV


DIY & Rooftop


Satellite space


Residential grid connect


Consumer


SHS

f) Remote sites. This market is now relatively small market and highly reliable non-grid connected systems are the chosen solution.

g) Solar parks. There is a new developing of solar parks where installations of 1 to 10MW are common often located on brownfield sites. These parks are popular in Spain and Germany where the feed-in tariffs are high. The chosen technological solution is either silicon or thin-film and both tracking and non-tracking systems are being installed.

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h) Consumer. There are many interesting portable power applications forh back-packs, cellular phones, or soldiers equipment. The most important application presently is garden lighting which requires no cabling.

i) Solar Home Systems (SHS)- or world off grid rural. These systems are installed where grid connection is expensive.

The graph below gives one some idea the market and growth of some of these applications.

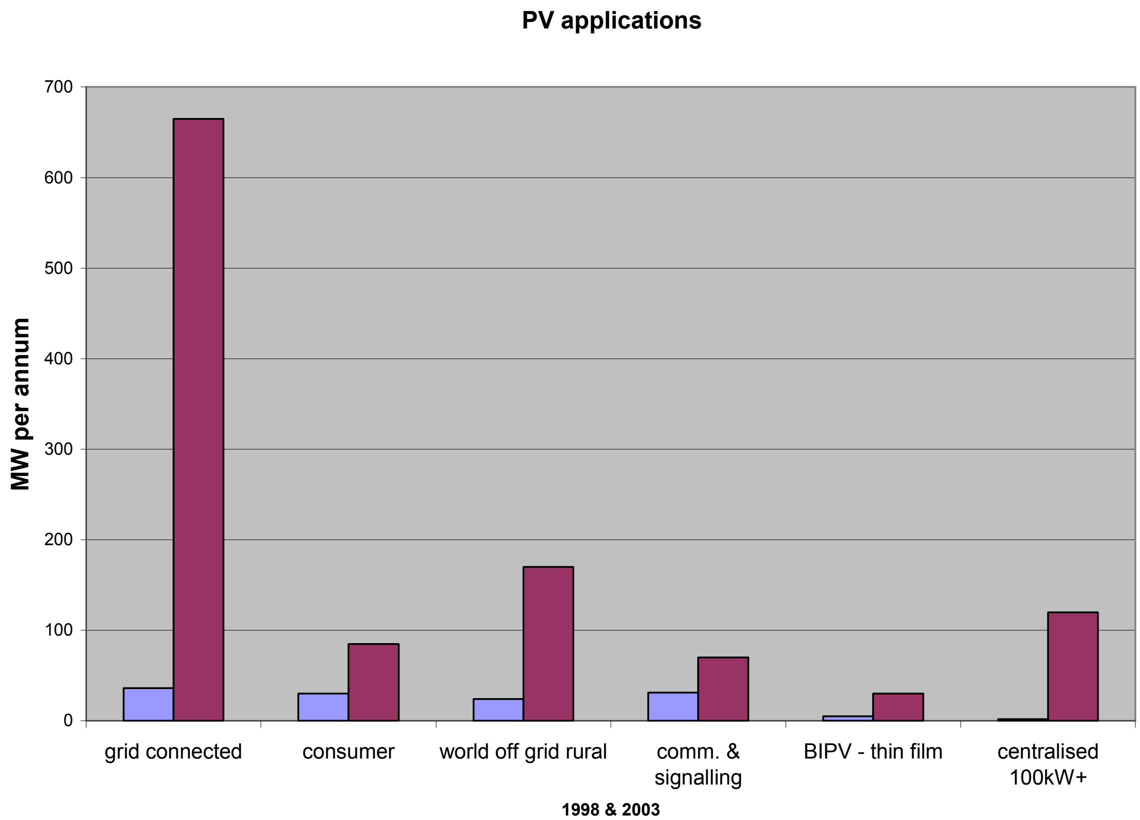

Figure 6. Table showing growth in revenues for different types of applications.

3. Trends in technology

There are far reaching changes taking place in the energy industry as markets are opening up to independent suppliers, new sustainable technologies, and distributed power. In addition there are a range of new solar technologies and applications, each one with its own characteristics. In this section we will emphasize the applications where the Orion technology is significant and has a substantial advantage.

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There are many new trends in the target market and the solar industry's extraordinary growth has attracted much attention:

a) Low cost per peak watt. To lower the cost of solar for the mass industrial and residential markets, there are three trends. A) The turn to dye technology, which is relatively new with excellent low cost characteristics. B) improving existing silicon technology by cutting down the amount of silicon used and improving efficiency and c) thin film technologies and in particular CIGS which are trying to simplify manufacturing processes.
b) High efficiency photovoltaics. Led by Spectralab and Frauenhofer, researchers are succeeding in boosting the efficiency of standard silicon technology. This is relevant for space, military and concentrator PV applications.
c) Cutting the cost of concentrator designs. Based on old Luz concepts and opto-mechanical designs, engineers are developing large solar thermal power stations and other concentrator systems for the larger power applications.

4. The cost of solar energy.

The impressive growth in solar energy has been achieved despite the fact that in most cases it is subsidized. Solar energy enthusiasts point out that if the true costs of fossil and nuclear fuels were calculated, solar is already competitive. Without going into this issue, it should be sufficient to conclude that solar energy is here to stay, that the market can only grow, and that future drop in costs will only help future sales.

The table below has been taken from an intensive study by Micahel Rogol of Credit Lyonnais for silicon technology.

Table 7. Costs $per watt

	2004	2005	2006	2007	2008	2009	2010
silicon	0.42	0.48	0.55	0.50	0.40	0.32	0.28
wafer	1.00	1.15	1.23	1.18	1.09	1.00	0.96
cell	2.00	2.30	2.42	2.29	2.18	2.03	1.89
module	3.25	3.58	3.75	3.57	3.39	3.15	2.93

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Orionsolar Applications

At Orionsolar we are focusing on two initial markets.

1) Solar sheets for the DIY market.

We undertook a survey of solar market experts and one of the conclusions was that Do-It – Yourself outlets such as Home Depot would be ideal for the sale of solar panels since distribution and installation costs would be minimized. Indeed Home Depot already sell a limited range of panels in a few branches. We have redesigned our modules with this market in mind.

In our case, the pay back is breathtakingly fast. The table takes the example of a 1kW installation on a flat roof in California. The first column describes the present situation with traditional photovoltaics, the second column is with our low cost plus DIY distribution. All figures in dollars for a 1kW system.

		Traditional PV , 2006		Orionsolar DIY 2007
PV module cost		2,800		1000
Manufacturer's mark up	30%	840	50%	500
Transport & handling		100		100
Distributor mark up	20%	750		
Inverter & cables		750		750
Mechanical support		260		150
Installer costs		1500		
DIY retailer			30%	750
Electrician hook-up				200
Total		7000		3450

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The new subsidy package from the Californian state is worth understanding. Along with the Federal grants of 70 cents a peak watt, California is offering $2.6 a peak watt for every installation between 1 kW and 1 MW in 2007. We expect that this type pf incentive will become increasingly popular around the USA and other countries. Since the package only costs $3450 and the subsidy is $3300, the payback is immediate!

2) Non-grid applications- Solar Home Systems

There are more than a billion people who do not have ready access to electricity or use expensive, polluting, and noisy generators. In this market, where price is the overall determinant for market penetration, Orionsolar's home systems will be the cheapest solution.

In developing country markets there is a need for a certain type of energy package for developing countries which is a) relatively low cost- less than $2 per installed peak watt, b) easily maintained requiring only unskilled personnel, c) has potential for low cost local assembly, d) distributed power, i.e. located close to the user without additional expensive transformers and connections to the grid, e) simple and quick to install, and f) non-polluting. The Orionsolar dye cell is the only potential technology which could fulfill these criteria and is therefore ideal for 'village power' applications.
In particular there are four countries, Brazil, China, India, and Indonesia that have substantial and growing power needs, have ample sun and technical expertise, and import fossil fuels. These countries have a total population of around 3 billion and are all confronted with severe energy problems.

China for example has made it a priority to switch away from its highly polluting coal power stations. Indonesia, being an island nation, would find the distributed nature of photovoltaics especially attractive.

Orionsolar dye cells have an additional advantage in that they are particularly suited to warmer climates. Dye cells work well in a wide range of lighting conditions and orientation, and they are less sensitive to low level illumination.

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A note on diesel generation

Comparison of diesel generator and SHS systems for Orionsolar

Let us take a system which provides 400Wh per day. This will power 3 hours of four 18W compact fluorescents, a 100W TV for 2 hours and some other small appliances like radios.

Assumptions.

Both the diesel generator and the Orionsolar modules with charge controller are expected to last 7 years. The lead acid battery is expected to last 3.5 years and will be replaced half way through.

The peak daily sunshine will average at 6 hours and the fall off in power – 15% on the 7 years.

Over 7 years 400x365x7 = 1022kWh will be consumed

.

The cost of the Solar system will be as follows.

The system will be oversized at 120 watts and not 70 to over come battery and storage losses.

Price of modules 120 x 2.5 = $ 300 (assuming 100% till consumer)

Price of two lead acid batteries systems - $ 150

Charge controller, cables, and transformer - $100.

Maintenance -0

Total $550

Costs of diesel generator

Small genset diesel generator – 2kW - $550-750

Diesel engine efficiency: ~25%. Energy content of diesel fuel: ~38.6 MJ/L

Therefore, actual work produced by a liter of diesel fuel (motion, electricity) is ~8.7 MJ/L = 2.4 kW-hr."

To produce 1022kWh, one needs 424 litres of diesel . Each litre diesel costs $1 so there is an additional $424.

Total costs $974

Solar comes out 44% per cent cheaper.

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4. Business model

Orionsolar does not intend to build and own manufacturing plant around the world. Our plan is to license out the technology, supply some of the production plant, the most important chemical inputs, and market some of finished products in certain territories. The principal business model will be to sell the production line and then later the chief inputs - critical and proprietary cell components such as titania, electrolyte and dyes etc. The production line sale will include a contract covering future maintenance and product updates. At the back of our minds is the HP model. The production line will be supplied turnkey from a specialist engineering company who will buy, transport, and commission the process line. We are presently negotiating with turnkey engineering companies who are excited about entering a fast growing industry.

Our revenue flow will come from 4 different sources

1) Production lines.
   In conversations with potential manufacturers, many have been attracted by the low up-front costs of our dye module lines. In addition, for Orionsolar to own production lines in locations outside Israel and Europe, will be expensive to set up and manage. Since solar energy manufacturers are used to buying lines at more than double the price, we can supply our technology are margins which are attractive.
2) Chemical inputs.
   We intend to sell dye, titania, and counter electrode pastes for the following reasons – we intend to continually improve these inputs, reverse engineering will be made more difficult, and high margin sales are possible.
3) Own brand distribution.
   Selling low cost modules is not a difficult marketing exercise as there is a general shortage of product in the market. We have purchase offers from more than 15 different countries. It is clear that with minimal marketing efforts, Orionsolar can build a presence in certain territories. The UK will be used as a sales centre and markets where we have no production lines will be our first choice – Africa, Caribbean, South-eastern Europe, and the Middle East all have large pent-up demand for low cost solar. Product will be bought and supplied from production lines we have set up round the world. We also maintain that close contact with the market will enable us to develop improved products and new designs in the future.
4) Custom made product.
   Dye cells can be configured in a variety of ways and we expect to receive revenues arising from the adaptation of our technology for special applications. Our intention is to make prototypes and short run production in house. The special features of our product suggest many potential applications for instance
   a) solar roofs for air-conditioning of electric buses
   b) Translucent panels for architectural BIPV applications.
   c) Cells for garden lighting.

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The net profit margin per revenue stream is expected to be

Production lines	40%
Chemical inputs	40%
Own brand distribution	25%
Custom Product	40%

A note on plastic dye cells
We have flirted with making a plastic dye cell. Unfortunately plastic panels have lower life and efficiency to the degree. The advantages of plastic are their potential low cost roll-to-roll manufacture and the their flexibility.

Why the Asians Love our technology

If you are an Asian manufacturer and you want to enter the field of manufacturing new generation photovoltaics, you presently have only one choice and that is to buy silicon cell and module plants. Thee plants are expensive and produce an expensive product.
The thin film plants are proprietary and are not for sale. They are also large and expensive.

In this way a dye cell plant answers all their needs

1. It is relatively small. A dye cell plant can be efficient at 8MW whereas a thin film plant minimum is now 25MW.
2. It will be physically relatively compact.
3. IT can be bought at a relatively cheaper price per MW. Whereas a thin film plant costs an average of $1.5million per MW , dye is less than $1million.
4. The product output is highly price competitive. Whereas silicon PV costs $2.4 at its cheapest, with dye you will be manufacturing at $1.2 per peak watt. This allows you greater margins and allows you to compete with the large silicon PV people.

The only competition is from amorphous silicon plants. There is a technological issue here. You can buy a 1990s technology amorphous plant but a new 2006 silicon plant is not available since the technology has moved on from then and the likes of Kaneka and Schott do not want to release their improved 'third generation' technology.

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Comparison

	2nd generation Asi	3^{rd} generation Asi	Dye
Cost of 10MW plant ($m)	10	15	8
Production cost per peak watt	2.2	2.2	1.4
Product efficiency %	5	7	7
Lifetime	10	20	5-7

Payback.

Assuming the following.
If one purchases an Orionsolar 8MW plant for $7 million, the output will cost 8 x 1.4= 11.2 million and can be sold easily with a 35% margin, giving annual revenues of 11.2 x 1.35 = 15.1 million, with gross profits of 3.9 million. The manufacturer can expect local government subsidies of at least 25% on capital machinery purchases, so his payback is 16 months.

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5. Competitive environment

This section surveys other dye enterprises and other PV enterprises of relevance.

Dye.

In the dye community, there are more than 50 academic teams many researching into improving various components of the cell. Of the commercial companies, the list is as follows.

1) Solaronix, Switzerland sells chemicals to the dye community and has now signed a cooperative agreement with us. They are, therefore, not a competitor.
2) Solarcell, Denmark is a small research team concentrating on BIPV and consumer applications and not on low cost .
3) Dyesol, Australia sells materials to the dye community and has concentrated on the BIPV market. Their chief scientist and engineer left the company and is now our consultant. His experience will help us build our pilot lines quicker.
4) Konarka, Massachussets, USA has tried to develop plastic dye cells and have succeeded in raising large amounts of money from the VC community. For reasons mentioned before, we are of the opinion that they have set themselves an over-ambitious and to some degree pointless target. The dye cell community is critical of their efforts. They have recently licensed their technology to a UK company called G24i which has bought a production line from Solarcoating Gmbh and will start making low efficiency 3.5% , short lifetime flexible PV, for battery charging. We will be watching their progress with interest. If their product is successful, we can enter the market with a cheaper and more efficient version and following G24i marketing footsteps.
5) Piccell, Japan has developed an interesting but low efficiency plastic cell for consumer applications. Again they have targeted a different and smaller market section.
6) Solaris Nanosciences, Rhode Island, USA has developed a refillable system which allows dye modules to be 'recharged'and so last 20 years. We see this technology, if commercial, to be complimentary to ours.
7) Sharp, Japan has researched into dye cells and has achieved some high efficiencies. We understand that at this stage they have no plans to manufacture commercial product.
8) Aisen Seki, Japan has developed a monolithic module but have no commercialisation plans.

Conclusion. At this moment in time, outside 2-3 Japanese enterprises, Orionsolar has the field to itself as no other substantial enterprise is seriously developing low cost dye modules.

Traditional PV

Traditional silicon photovoltaics lasts for more than 25 years but its cost per peak watt will be more than $2.50 for another 7 years – see table 3. The question whether there are other technologies that hold out the promise of $1 per peak watt and when.

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Thin film

There are three principal thin film technologies.
Amorphous silicon. This technology has been on the market for many years and has the advantages of being manufactured with little silicon on flexible substrates. Commercial single junction amorphous is stuck at 6.5% efficiency for many years and the high temperature vacuum processes determine that this technology will struggle to ever go below $2.0 at the module level. ECD-Ovonics produce a complicated triple junction amorphous with 10% efficiency. The manufacturing process is extremely expensive and complicated and pundits believe that this technology has limited growth possibilities.

CIGS/CIS and CdTe technologies.

None of these technologies use silicon and so therefore these technologies have attracted much attention recently. We see that in the future thin film will provide low cost competition to dye though there are questions as to when. Thin film technologies have suffered from expensive and unreliable production problems with low and unreliable yields and low production capacity. BP Solar has closed down two of its thin film lines and Antec went bankrupt. However Miasole, Nanosolar, and Heliowatt CIGS developers have all attracted VC monies and claim that they will produce low cost solar. Till now sputtering lines have always proven to be more wasteful of materials and energy that originally expected and none of them have presented a detailed case as to how they will so radically cut costs from existing high cost of thin film.

Concentrator PV

There are many start-ups which use optics and tracking to focus sunlight onto a miniature high efficiency PV cell and concentrate photons on the cell with tracking reflectors. The designs save on expensive PV but have other disadvantages particularly in the cooling needed for the photovoltaic and the requirement for non-diffuse sunlight. It is likely that in areas where there is little cloud or haze, as well as demand for CHP electricity and water heating, these designs may have display cost advantages. This technology has still to establish itself in the market.

Organic cells

Organic cells have the potential of being very cheap. There are two commercial enterprises running already, but the prospects of a commercial product within 5 years are very unlikely.

Analysis of alternative technologies:					
	Orion-Dye	Poly-silicon	Thin film CIGS/CdTe	Amorphous	Concentrator PV
Cost of a panel	+++	+	++	++	++
Cost of production line	+++	-	-	+	++
Lifetime	+	+++	++	++	++

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Ease of installation	++	+	++	++	-
Efficiency/ size	+	+++	++	+	+++

We have chosen applications where our low initial cost is of particular importance.

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6. Development plan

So far we have succeeded in proving that our basic intellectual property works. We have built working cells with good low cost characteristics and part of a pilot line.

	Q2 2007	Q3	Q4	Q1- 2008	Q2	Q3	Q4
Advanced prototypes							
Increasing efficiency							
Module design							
Testing stability, environmental							
Standards testing							
Build pilot line							
Build large plant							

Table 8. Development schedule

Summary of Development Program **Development timetable**

2007 will be devoted to continued development work – in particular perfecting the non-corrosivity of the strips, developing the cathode, and of course stability testing.

The development philosophy is to design a stable cheap anode technology, then the cathode technology, stick them together in a way that they work effectively, and seal.

In parallel, there are two other inter-related tracks.

One is materials . We need to cut the cost of the materials going into the module which will require testing of cheaper components. The other track is production. In this case we have to ensure that any new designs can be produced simply and cheaply. Some processes will be scaled up already in 2007, and others will be rejected because they cannot be done cost effectively.

Critical Tasks

1. Cathode Development.
2. Sealing and Electrolyte Filling
3. Anode Alloy Scale Up
4. Developing a fast Dye Staining production process

Secondary Tasks

1. Stable, low vapor pressure Electrolyte

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2. Automated lifetime and performance testing
3. Optimization of Titania process, preliminary

2008 . During the first 9 months we will be building the pilot line.

The Orionsolar R&D program will fix a manufacturing process for dye solar cells of 15 cm X 15 cm size. The next stage is to assemble the dye cell and to produce large quantities of these modules for reliability testing and for sampling to potential partners and customers.

The Prototype Production Facility is based upon use of a single custom built large area screen printer (up to 150 cm X 75 cm substrates) for all screen printing based processes. The screen printer and related drying and firing belt ovens will be reset for each of the sequential dye cell manufacturing processes. This approach is very limiting on product throughput, but it allows manufacturing product samples at a fraction of the cost of a full production line.

The primary equipment set for the Prototype Production Facility is as follows:

Prototype Facility Equipment	**Cost, $**
Semi-automatedscreen printer with camera alignment	100K
Fast staining centre	300K
EPD titania centre	300K
Belt oven for drying	50K
Belt oven for firing	100K
Fume hood for cleaning	50K
Fume hood for dye impregnation	100K
YAG laser for scribing	100K
Bonding and assembly equipment	100K
QA & QC equipment	200K
Other + tooling & cassettes	150K
Utilities and air-conditioning infrastructure	150K
TOTAL	**1,700K**

An extra 700k will be needed for three engineers, sub-contractors, and materials.

Assuming one shift operation of this Prototype Production Facility, it will be possible to produce up to 80 cells per day. Taking into account maintenance and other down time, up to 25000 cells can be produced annually.

By Q2, 2008 we will have advanced prototypes sealed, 6-7% efficient, with good cost characteristics. Q2-3 will concentrate on long term testing. If the testing progresses well by Q3, we will finish the pilot line.

Once we have built the pilot we will ask a company like Zander, to help us design a package for a full production facility. We expect them to charge $350K, and their reputation and experience will help us win future orders.

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2009 Q2. Finish first 8MW production line.

The strip dye cell production line is best scaled to multiples of 8MW and so we have done the calculations accordingly.

Here are the financial and sales assumptions for the 8MW line.

1. Price $7million
2. Manufacturing cost $3.9m for the cell and $0.9m for the module plant. Commission, transport, calibration will cost an extra $0.7m.

Net profit $1.5m.

3. There is an extra cost of 2 months materials amounting to $2.5million. This has to be in stock and supplied immediately once the line is running.
4. Generally, payments will be 25% on purchase order, 50% line built before delivery – 3 months later, 25% payment line installed and working, 6 weeks after that. Materials payments will be on letter of credit.
5. In initial discussions with finance houses, they will be willing to finance orders to strong customers once the technology is working. Thus I do not expect we will need working capital for production lines sales.

Summary of financial needs for the next 3 years in $ millions

	2007	2008	2009
Research and development	0.9	1.1	1.1
Pilot line costs	0.2	2.75	
Working capital for production lines			3.0
Present situation	0.36		
Chief Scientist	0.1	0.15	
FP7 Euro monies		0.25	
Net profits			6.0
Total capital needs	0.64	3.45	3.1*

* Profits will only partly off- lay capital needs.

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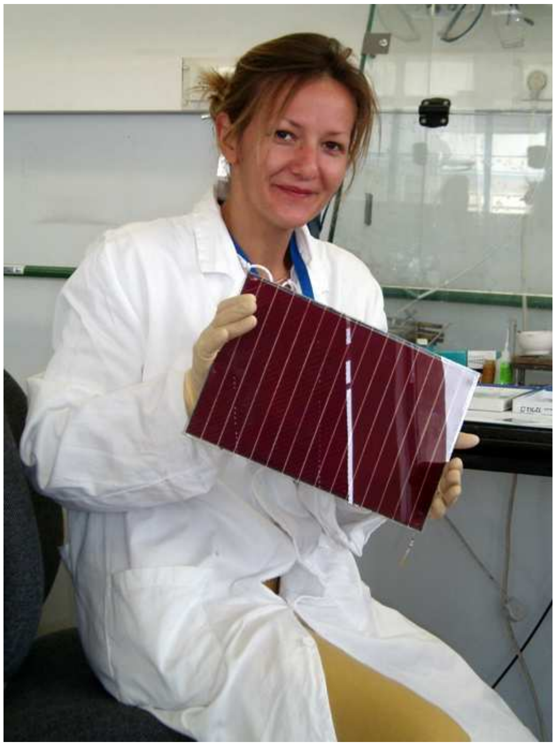
Innovative solution: Conductive wires/strips



The company is optimizing the design and specifications of a conductive grid with continually improving results. We are working to choose the right materials and then to select the best way to put them on the substrate (commercially available FTO glass). Orionsolar has designed various new substrates. Loss of active area from shading can be below 5% via this approach and lower conductivity higher transmittance FTO glass used.

The use of parallel conductors on the FTO glass face allows a) effective current takeoff at low optical shading and with lower grade FTO glass and b) the creation of a bigger cell (typically 200 sq cm and above). By creating a bigger cell, the loss in active area from conductors and seals can be reduced to around 6%, whereas state of the art active area loss is typically 30% in competitor cells.

Further improvements

The company will have an on-going program to improve efficiency and lifetime and we expect that lifetimes in 2012 will be greater than 15 years and efficiencies beyond 10%.

There are 3 reasons for further optimism.

1) Being a younger technology we have much greater potential to improve than other more established technologies who have already matured. Silicon also started with 7% efficiencies and improved over time.
2) Being virtually the only commercial company selling low cost dye cells, we will have an open field to pick and license from amongst the multitude of academic teams, the most promising ideas. We expect cheaper dyes and more stable electrolytes to be two developments which we are likely to license in the next 3 years.
3) There are development teams which are developing nano-layers which will improve the efficiency of dye and thin film photovoltaics by harvesting unused spectrum particularly in the infra-red. These layers can potentially raise our efficiencies beyond 12%.

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7. Intellectual property

Our first Orionsolar IP item is US Application 20050072458 (April 2005) of Jonathan Goldstein, entitled “Solar Cell Device”. This describes a current collector design for photovoltaic dye cells.

In addition, Orionsolar has acquired from Bar Ilan University the rights to US Provisional No. 60/705,188 (August 2005), entitled “Method for Production of Nanoporous Electrodes for Photoelectric Applications” This has been filed as a PCT application and describes a method for the electrophoretic deposition of titania. Orionsolar has also acquired the rights to US Provisional No. 60/705,190 (August 2005) “Method for Preparation of Stable Metal Oxide Nanoparticle Suspensions” which has also been filed as a PCT application and discloses suspensions to be used in the titania electrophoretic deposition method.
Orionsolar is presently preparing two additional in-house patent applications. The first disclosure describes a screen-printable, porous, highly conductive carbon cathode paste applicable for dye cell assemblies of monolithic construction. The second disclosure describes a screen-printable, low porosity conducting graphite cathode paste in which current collecting wires have been embedded, applicable to large area dye cell assemblies. We expect during the next 6 months that further IP will result from our in-house cell sealing approaches especially in the domain of monolithic cells.
Once we enter pilot line and production line phases we expect to accumulate a whole range of new IP concentrating on novel production techniques.

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8. Personnel and partnerships

Four teams working together on development.

Orionsolar's philosophy is to take the best and the most experienced personnel without compromise. Effectively the development efforts are spread over more than one site.

1) **Orionsolar**.

The main team is built around Dr Jonathan Goldstein, the company President. Dr. Goldstein has worked for many years in battery technology and has 37 patents to his name. His experience includes work at Luz which developed solar thermal power plants, and Electric Fuel, where he was Chief Scientist.
Included in our main team we have succeeding in attrtacting Barry Breen, Dr Ilya Yacupov, and Eli Rosh-Hodesh.

Ilya and Eli worked successfully together to build Electro Chemical Research (ECR) which had a successful exit two years ago.

2) **Solaronix**

Orionsolar is fortunate in having reached a joint-cooperative agreement with Solaronix of Switzerland. Solaronix has joined us wholeheartedly in our ambition to build low cost dye cells. Solaronix is managed by the Meyer brothers who have possibly more experience than any other team building dye modules. The Meyer brothers have worked closely with Professor Graetzel, the originator of the dye cell concept, and Solaronix supply chemicals to most of the leading academic research teams in the market. Their experience will be vital in bringing our new designs to the market quickly.

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3) Weizmann Institute

We are also fortunate to be working closely with two faculty members of the Weizmann Institute, Israel's premier research establishments. Professor Joost Manassen helped pioneer the first photo-electrochemical cells and set up the new Department of Materials and Interfaces at Weizmann. He leads our IP research team.

Professor David Cahen holds the Rowland and Sylvia Schaefer Chair in Energy Research. He serves as the chairman of our scientific advisory board. Professors Manassen and Cahen both take an active role in Orionsolar's development program.

4) The Nanotechnology Centre – Bar Ilan University.

Professor Arie Zaban heads the Nanotechnology Center at Bar Ilan University. We consider Professor Zaban to be the leading researcher of dye cell technology in Israel. Bar Ilan University has taken a share of Orionsolar company. In return we have both at our disposal the services of Dr. Zaban and his team, and have the relevant Intellecutal Property developed at the Nanotechnology Centre.

The following people are also supporting the project.

Dr Igor Skryabin

STI, now Dyesol of Australia invested more than $8million in developing dye cell technology during the last 10 years. . The Chief Scientist and CTO was Dr Igor Skryabin who pioneered many of the designs and features which are common to present dye cell technology. He recently left Dyesol after 10 years of service and we are fortunate to have his exclusive services and he is now out of contract. Igor will help us substantially in building a pilot line as he previously built one at the STI- Dyesol facilities as well as building the first dye module

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façade in Queensland, Australia. He has much experience in sourcing and specifying many of the chemicals and other materials which will cut down our development time.

The structure of the management and development program is as follows

Senior Management	**Role**
Dr Jonathan Goldstein	Chief scientist and President
Dr Ilya Yacupov	Chief technical Officer
Barry Breen	CEO

Short CVs of these personnel are available in appendix 4

Senior Consultants	**Specialty**
Professor David Cahen	General development issues
Professor Arye Zaban	Innovative dye cell designs
Dr Igor Skryabin	Development and pilot line issues
Dr Toby Meyer	Dye cell technology

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9. Financials

Cash Flow projection 2008-2012 in $ millions

	2009	2010	2011	2012	2013
Sales					
Manufacturing lines	21	42	70	105	140
Chemicals	4	9	16	28	41
Marketing of product	10	15	23	34	64
Specialty sales	0	3	6	10	21
Total revenues	35	69	115	177	266
Cost of Goods	25	48	86	132	195
Gross Profit	10	21	29	45	71
Research and Development	4	4	6	6	6
Capital machinery	4	4	3	3	3
Gross Operating Profit	2	13	20	36	62

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	Budget for 2007 $000													
		jan	feb	mar	april	may	june	july	aug	sep.	oct.	nov.	dec.	
Salaries	5 Senior	40	40	40	40	40	40	40	40	50	50	50	50	
	5 Lab. tech.	11	11	11	11	11	11	13	13	13	13	13	13	
Experts		5.4	5.4	5.4	5.4	5.4	5.4	5.4	4.6	8	8	8	6	
Subcontract	development					5	5	5		5	5		5	
	mechanical	4	4	4	4	4	4	4	4		4	4		
	other	3	3	3	3	3	3	3	3	3	3	3	3	
Equipment		3		3		3		10		10		50	80	
Materials		5	10	10	10	10	10	10	10	10	20	20	25	
Bus. dev.	Travel	2		2		2		2		2		2	2	
	Marketing									5	5	5	5	
Patents	IP registration						20				20			
Overhead	rental	3	3	3	3	3	3	3	3	3	3	3	3	
	legal/accounts	0.5	0.5	0.5	0.5	0.5	0.5	0.5	3	0.5	0.5	2	2	
	transport	2	2	2	2	2	2	2	2	2	2	2	2	
	other	1	1	1	1	1	1	1	1	1	1	1	1	
Total		**79.9**	**80**	**85**	**80**	**89.9**	**105**	**99**	**84**	**113**	**135**	**163**	**197**	**1309**

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Development Costs 1	**Monthly figures in $000s**				
	2006	2007	2008	2008	2008
Period	**Jan -Dec.**	**Jan.-dec**	**Jan- Sep**	**Oct-Dec.**	**Jan-April**
Programme	**Efficiency**	**Stability/effic.**	**Build pilot line**	**Automation**	**Prod. line**
Costs					
Salaries	38	44	44	44	
Constants	5	5	5	5	
Subcontraction 1	4	4	4	4	
Materials 1	7	7	7	7	
Equipment 1	5	5	5	5	
Overhead	24	24	29	29	
Subcontract 2		4	6	256	
Materials 2		7	10	10	
Equipment 2		10	20	20	
Capital Equipment			225		
Monthly burn rate	**83**	**110**	**355**	**380**	

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Appendix 1:

HOW DYE-SENSITIZED SOLAR CELLS WORK
(portions courtesy of the Swiss Federal Institute)

Conventional solar cells convert light into electricity by exploiting the photovoltaic effect that exists at semiconductor junctions. They are thus closely related to transistors and integrated circuits. The semiconductor performs two processes simultaneously: absorption of light, and the separation of the electric charges ("electrons" and "holes") which are formed as a consequence of that absorption. However, to avoid the premature recombination of electrons and holes, the semiconductors employed must be highly pure and defect-free.

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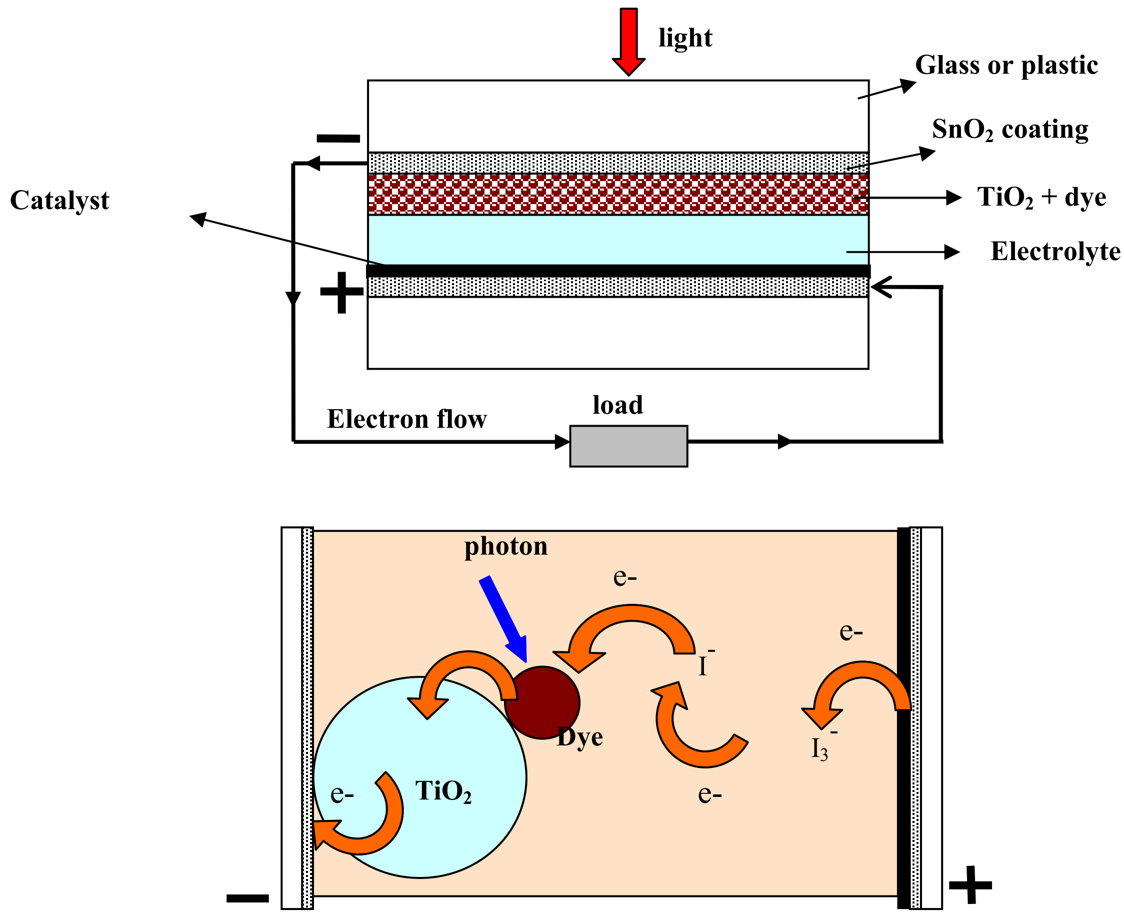
In contrast, dye solar cells work on a different principle whereby the processes of light absorption and charge separation are differentiated. Due to their simple construction, the cells offer hope of a significant reduction in the cost of solar electricity



PV dye cell schematics

The solar cell consists of two conducting electrodes in a sandwich configuration, with a redox electrolyte separating the two. On one of these electrodes, a few micron-thick layer of TiO2 is deposited using a colloidal preparation of monodispersed particles of TiO2. The compact layer is porous with a high surface area, allowing monomolecular distribution of dye molecules. After appropriate heat treatment to reduce the resistivity of the film, the electrode with the oxide layer is immersed in the dye solution of interest (typically 2x10-4M in alcohol) for several hours. The porous oxide layer acts like a sponge and there is very efficient uptake of the dye, leading to intense coloration of the film. Molar absorbances of 3 and above are readily obtained within the micron-thick layer with a number of Ru-polypyridyl complexes. The dye-coated electrode is then put together with another conducting glass electrode and the

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intervening space is filled with an organic electrolyte (generally a nitrile) containing a redox electrolyte. A small amount of Pt (5-10 µg/cm2) is deposited to the counter-electrode to catalyze the cathodic reduction of triiodide to iodide. After making provisions for electrical contact with the two electrodes, the assembly is sealed.

Respectable Efficiency, thanks to Nanostructure

The absorption of light by a monolayer of dye is always destined to be weak. A respectable photovoltaic efficiency cannot therefore be obtained by the use of a flat semiconductor surface but rather by use of a porous, nanostructured film of very high surface roughness. When light penetrates the photosensitized, semiconductor "sponge", it crosses hundreds of adsorbed dye monolayers. The nanocrystalline structure equally allows a certain spreading of the radiation. The end result is a greater absorption of light and its efficient conversion into electricity.

Despite the heterogeneous nature of the semiconducting material, the diffusion of electrons in the bulk matter towards the supporting conductor occurs with almost no energy loss. The recombination between the electron which is injected into the conduction band of the semiconductor, and the hole that remains on the oxidized dye is effectively very slow, compared to the reduction of the latter by the mediator in solution. Furthermore, electron-hole recombination in the semiconductor which seriously affects the efficiency of classic photovoltaic cells does not occur in this case, due to the fact that there is no corresponding hole in the valence band for the electron in the conduction band. As a result, the efficiency of the cell is not impaired by weak illumination, e.g. under a cloudy sky, in contrast to what happens with classical systems.

Cell output under peak sunlight conditions of 650 mV at current densities up to 15mA per sq cm have been achieved, which is equivalent to 10% solar to electric conversion. Cells of this type (referred to as dye sensitized solar cells, DSSC) offer a new route to low cost solar cells, because the basic cell material, titania, is cheap (used in huge quantities for paint and toothpaste) and cell processing methods are low cost. This should be compared with costly silicon, requiring complex semiconductor production equipment such as vapor deposition and laser cutting rigs and the need for high purity raw materials and clean room protocols.

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Appendix 2:

MANUFACTURING LINE – OVERVIEW

A summary of important aspects of the Orionsolar manufacturing line is presented below.

1) The manufacturing line is designed to produce 8 MWp with a net annual operation of 6000 hours (24/7 operation).
2) Note that the stated manufacturing hours are net of obligatory holiday shutdowns, maintenance shutdowns and other equipment downtime.

3) Several of the dye cell manufacturing steps are based upon screen printing processes (8 screen print process steps in the typical manufacturing setup). These processes utilize fully automatic screen printers with automatic loading, substrate alignment and unloading. Two automatic machines are required for each of these process steps.

4) While automatic screen printers are standard and readily available, other equipment is custom designed by Orionsolar and its partners.

5) Module build is an integral part of the Dye Cell production.
6) Equipment and infrastructure costs for cell and module manufacture are approximately $4.7 million.

7) Manufacturing facilities will be provided under our supervision by an experienced turnkey engineer such as M+W Zander. Zander have supplied other lines to many other solar cell manufacturers.

8) The Dye module is fully sealed against the environment.

Manufacturing Line for Orionsolar Cells – Process Sequence

1) Incoming inspection

2) Cut, scribe, clean FTO glass

3) Titania special process, dry and sinter

4) Print, dry and sinter titania, spacer, catalyst and carbon cathode layers

5) Dip in dye bath and dry

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6) Print electrolyte and plastic encapsulant and dry/cure

7) Cut and clean aluminum sheet

8) Doctor blade adhesive, robotic assembly of cells on aluminum & cure

9) Solder electrical connections between cells

10) Apply liquid encapsulant between cells on electrical wiring and cure

11) Bond bus wires and diode to cell

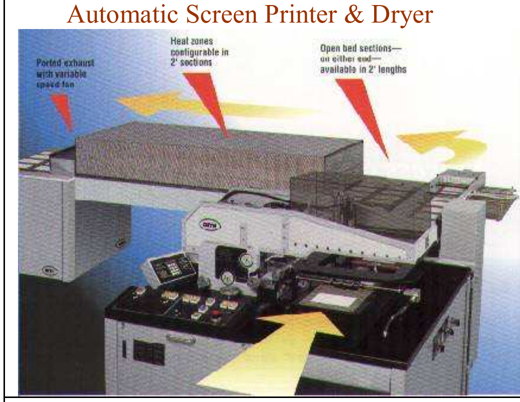
12) Hermetic edge seal process

13) Final product test

14) QC testing

Production Line Equipment for Orionsolar Cells and Modules

Automatic Screen Printer & Dryer



Hi-Temp Belt Oven

Chemical Process Unit

Robotic Assembler

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Summary Table – Orionsolar Dye Manufacturing Line – Equipment Cost

100 x 60 cms in size

Cell Manufacturing Equipment			
Type	**Cost per unit**	**No. of units**	**Total**
Automated screen printers & dryers	$250K	6	$1,500K
Hi-Temp, Hi-throughput belt ovens	$150K	4	$600K
Chemical process units & batch ovens	$100K	3	$300K
Robotic stations for scribing, cutting, bonding, sealing	$100K	11	$10500K
Inline measurement & QC stations			$550K
Infrastructure			$750K
TOTAL:			**$4.800K**

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Appendix 3:

COST OF MANUFACTURING AN ORIONSOLAR DYE MODULE

All costs are in USA $.
For illustrative purposes we have assumed that we are making a 1m2 module.

Cell materials	Conductive glass	9
	Titania	2.5
	Dye	8
	Electrolyte	1
	Carbon layer	2
	Polymer layer	0.5
	Foil layer	4
	Sealing etc	5
Framing materials	Aluminum frame	6
	Diode	0.3
	Wiring	1.5
	EPV + environmental	8
	Box and packing	3
	Labour	15
	Plant amortisation	0.5
		$66

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Appendix 4 CVs of senior personnel

Dr Jonathan Goldstein

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Curriculum Vita of David R. Waimann

Date of birth:	15.7.58
Family status:	Married with 3 children.
Nationalities:	Israeli, British, and Swiss.
Languages:	English (mother tongue), Hebrew, and some French, German, and Spanish.

Education

B.A.& M.A.	**Economics** - Cambridge University, U.K (1977-80)
B.S.	**Engineering Science** - University of Rochester, U.S.A (1985-6)

Work Experience

03- present **CEO of Orionsolar Photovoltaics**.

00 –02 **Founder Partner** and **CEO** at **Myriad Partners** This investment house focuses on early seed telecom and internet infrastructure situations. My responsibilities focused on marketing and technical due-diligence, building partnerships with other VCs, as well negotiating term sheets.

95 – 00 **Chairman and Managing Director** of **Barorianne Plasma**,
This company developed and manufactured the first hand portable metal cutting machines based on plasma technology.
I started this manufacturing company from scratch and succeeded in developing and marketing portable plasma cutting systems for the industrial market. Distributors were set up in over 11 countries and successful OEM contracts completed with two large multi-nationals, one based in the USA and the other in Germany.
Exit – bought out by two of my largest distributors (4X money in).

89 – 95 **Chairman** of **Solcon Industries**
I joined this start-up in its initial phase when it was still a sub-division of a large conglomerate. During my five-year stay, this manufacturer of electronic soft-starts grew into a successful and highly profitable enterprise employing 70 people with more than $1million in EBIT.
Exit- bought out by an investment company (5X money in).

86 – 88 **Founded Captain Wildberry** which developed two product ranges – a kitchen appliance which was bought out by Black and Decker and cosmeceuticals for the sunscreen industry.
Exit – 10 times money in.

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Development Economist

81 – 84 I was awarded the honor of being the British representative on a United Stations program in New York. During this stage I was attached to the UN Centre for Transnational Corporations.

I was also appointed to a post at the European Parliament in Luxembourg attached to the development committee. For two years I was a volunteer evaluation (VSO) economist in Ngabu Malawi, in charge of 25 people as part of a large World bank financed agricultural expansion project.

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