# *Konarka Technologies, Inc.*

## *From Light to Power*

### *Enabled by Nanotechnology*

***Innovator of polymer photovoltaic products in a variety of form factors for commercial, industrial and consumer applications***

**Flexible ✹ Lightweight ✹ Indoor/Outdoor**
**✹ Mission-Designed ✹ Low cost**

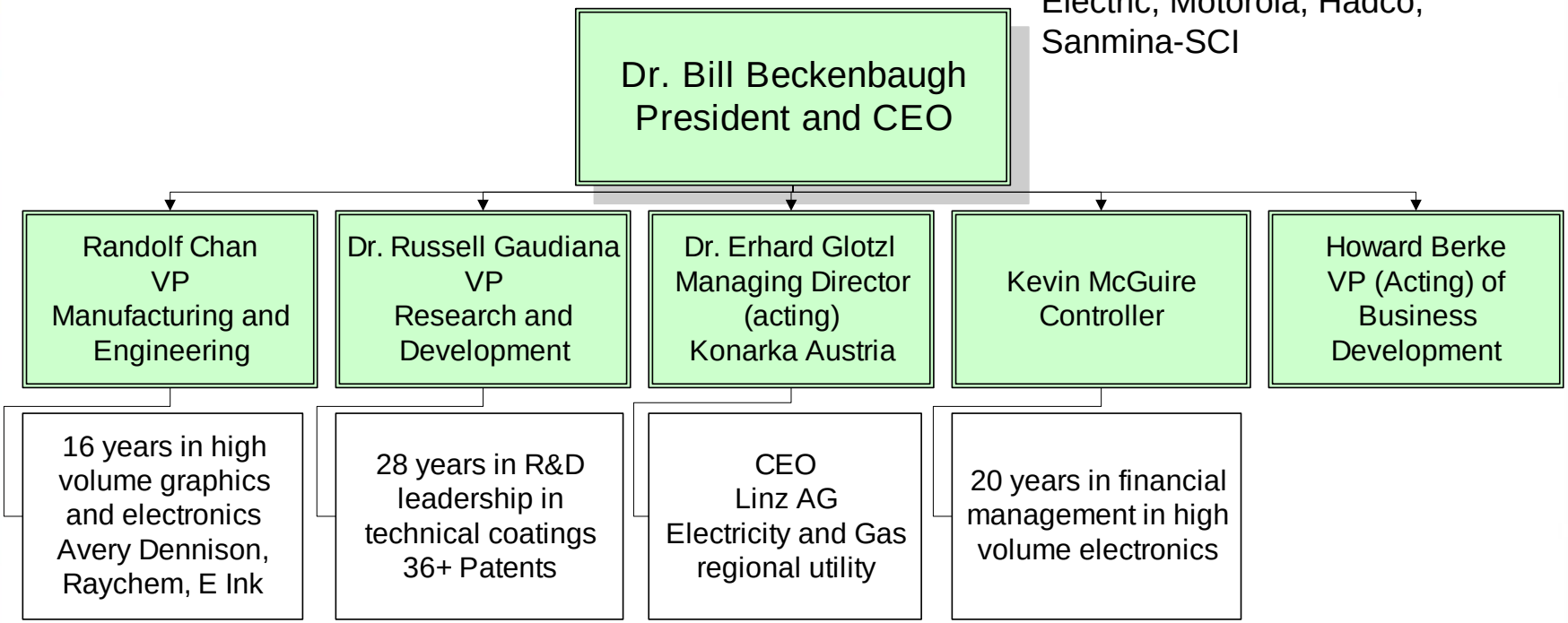
September, 2003

# Financing

- Completed $13.5 Million B round, Fall ‘02
  - Lead:  Draper Fisher Jurvetson
  - ~ $18 million in total financing to date
- Late 2004 C Round
  - Mid-stage institutional equity investors

# Experienced Leadership and Technical Excellence

30 years as executive with extensive marketing and technology leadership; Western Electric, Motorola, Hadco, Sanmina-SCI



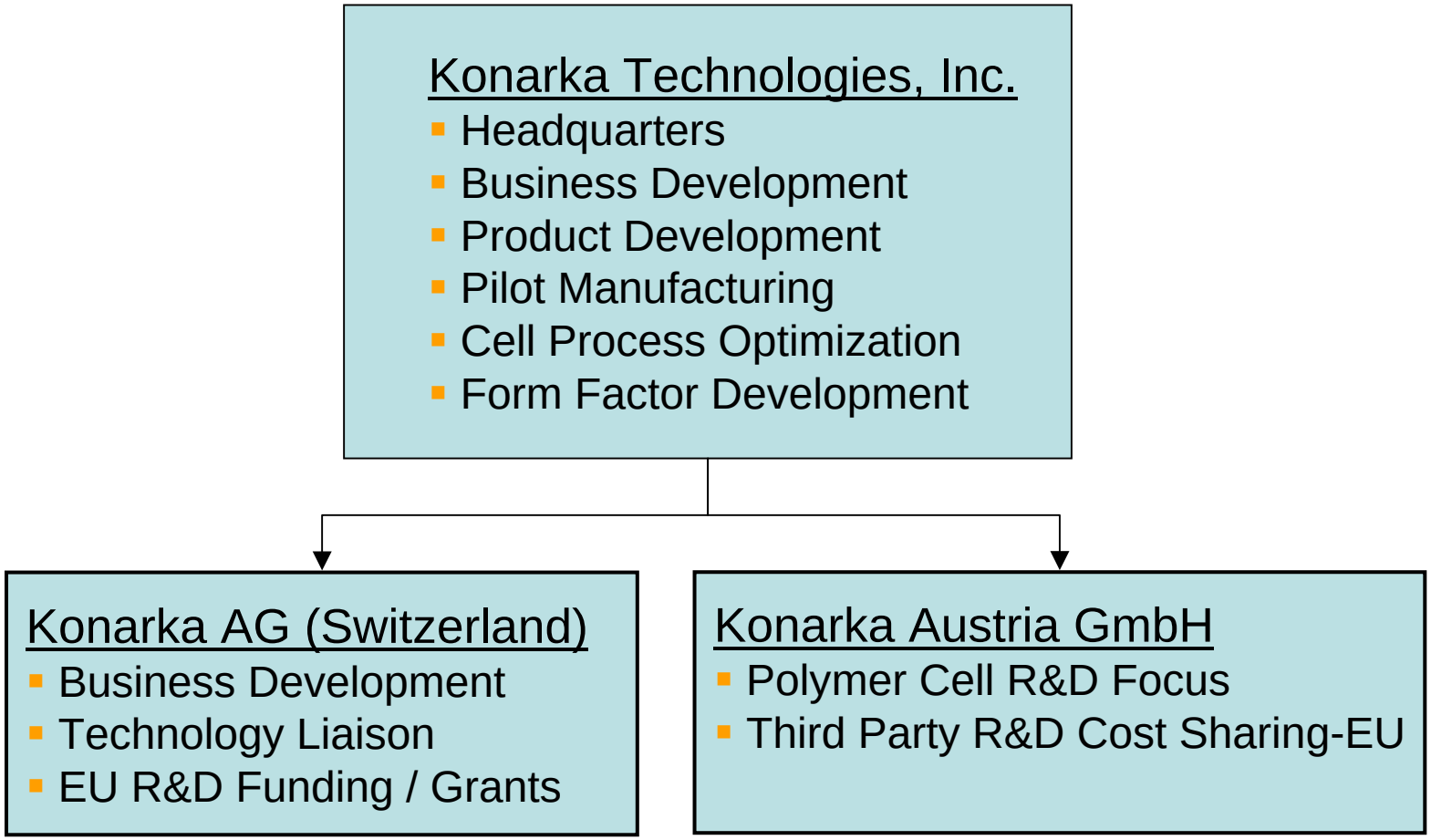
# Expert Advisors

- 15 world-class technical advisors, including:
  - Dr. Alan Heeger, Nobel Laureate, all-polymer PV
  - Dr. Michael Graetzel, EPFL, dye-based cells
  - Dr. Alan Bard, University of Texas
  - Dr. Serdar Sariciftci, Linz Inst. for Organic Solar Cells
  - Dr. Jack Hanoka, CTO-Evergreen Solar
  - Dr. Elliot Berman, founder SPC, CTO-Arco Solar
  - Dr. Merrill Cohen, GE (retired)
  - Dr. Jayant Kumar, University of Massachusetts
  - Dr. Joan Vrtis, Rose Street Labs, Intel
  - Dr. Frank Shemansky, Consultant, Orchid BioSciences, Motorola,
  - Bruce Anderson, IGNITE! Startups
  - Paul Wormser, Consultant, PV Products Market

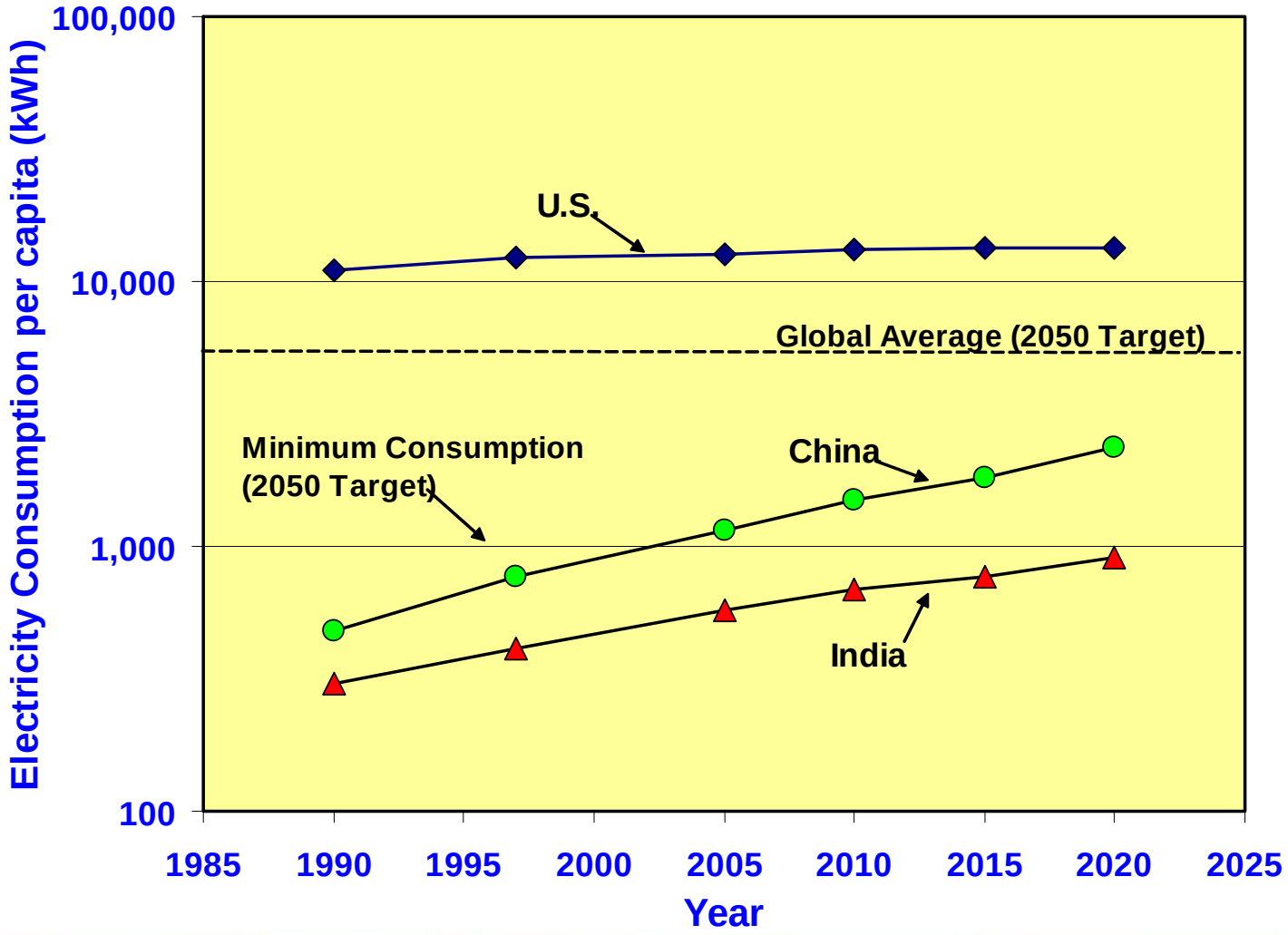
# Board of Directors

| | |
|---|---|
| **Raj Atluru**<br>Director / Comp | Partner, Draper Fisher Jurvetson, Redwood City, CA |
| **Dr. Bill Beckenbaugh**<br>Director / Audit | President, CEO, Konarka Technologies |
| **Howard Berke**<br>Chairman / Audit / Comp | 25+ year Executive & Founder of 12 technology companies |
| **Dr. Alan Heeger**<br>Director | Nobel Laureate in Chemistry for conducting polymers in OLEDs and photovoltaics (2000), Uniax founder, University of California |
| **Bic Stevens**<br>Director / Audit / Comp | Managing Director, Zero Stage Capital, Cambridge, MA |

# Operating Structure



# Global Demand for Energy

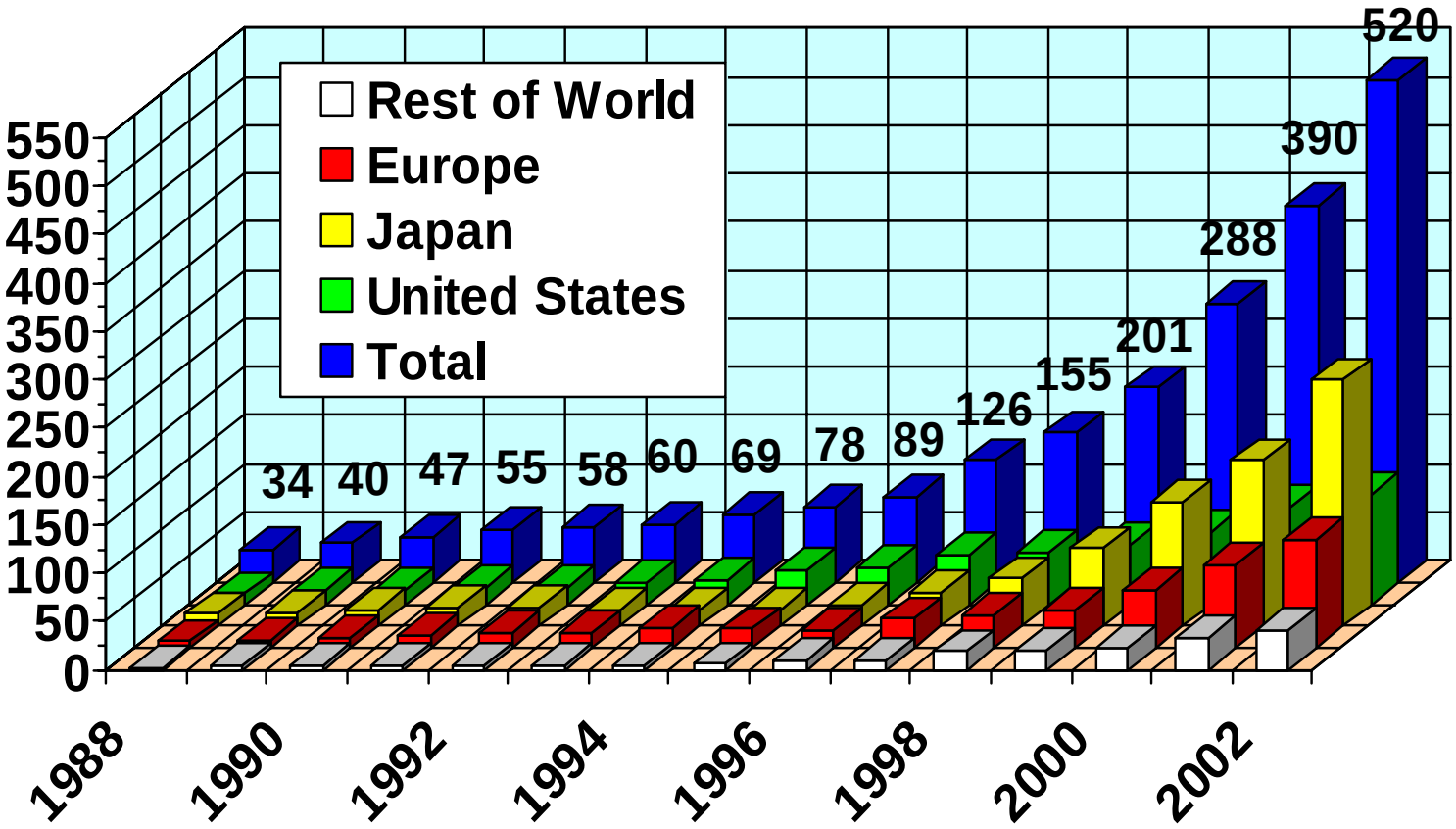



Source: EPRI, US DOE 2000

# Photovoltaics (“PV”)

- The conversion of light into electricity
- Silent, no maintenance, no fuel, no emissions
- The lowest cost option for remote applications
- Recognized as part of the solution to the global need for electricity and clean energy
- Generator of Choice for >2 billion people
- Option for all of us

# PV Production in Megawatts
# Representing a global market of $7 Billion




**35% growth – 2001 to 2002**

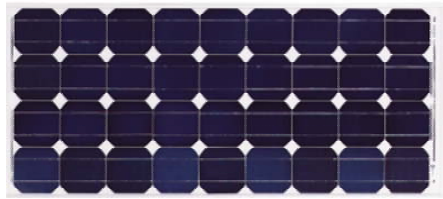

Source: PV News, Paul Maycock, editor

# Konarka's Story

- What: Energy conversion of light → electricity
  - Based on nanomaterials and conductive polymers
  - High-speed roll-to-roll manufacturing on plastic & metal foils
  - Unique product benefits for new applications
- Why: Growing existing market / enable new markets
  - World market solar industry CAGR > 35%
- Who: Superior team
  - 31 staff, 15 advisors, experienced Board
- How: Blocking and enhancing IP
  - 20+ patents issued and pending
  - Supporting IP from UMass (exclusive), EPFL (sole US licensee), JKU-Linz (exclusive)
  - Strategic investors & partners - Chevron Texaco and Eastman Chemical

# PV Technologies

- **Crystalline Silicon on Glass**
  - **1st generation** (developed in the 70s) semiconductor wafer in glass, complex manufacturing process

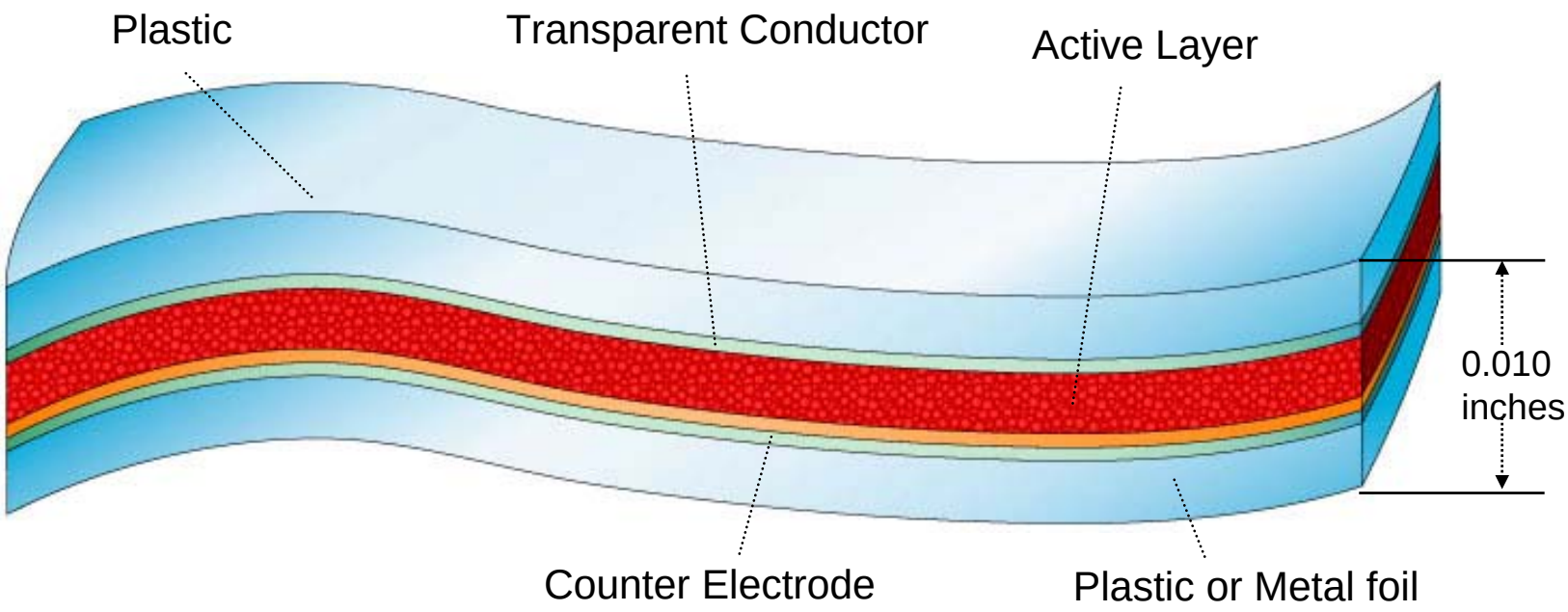


- **Thin Film (majority on glass)**
  - **2nd generation** (developed in the 80s) requires low-pressure, high-temperature film deposition, expensive packaging, complex manufacturing process

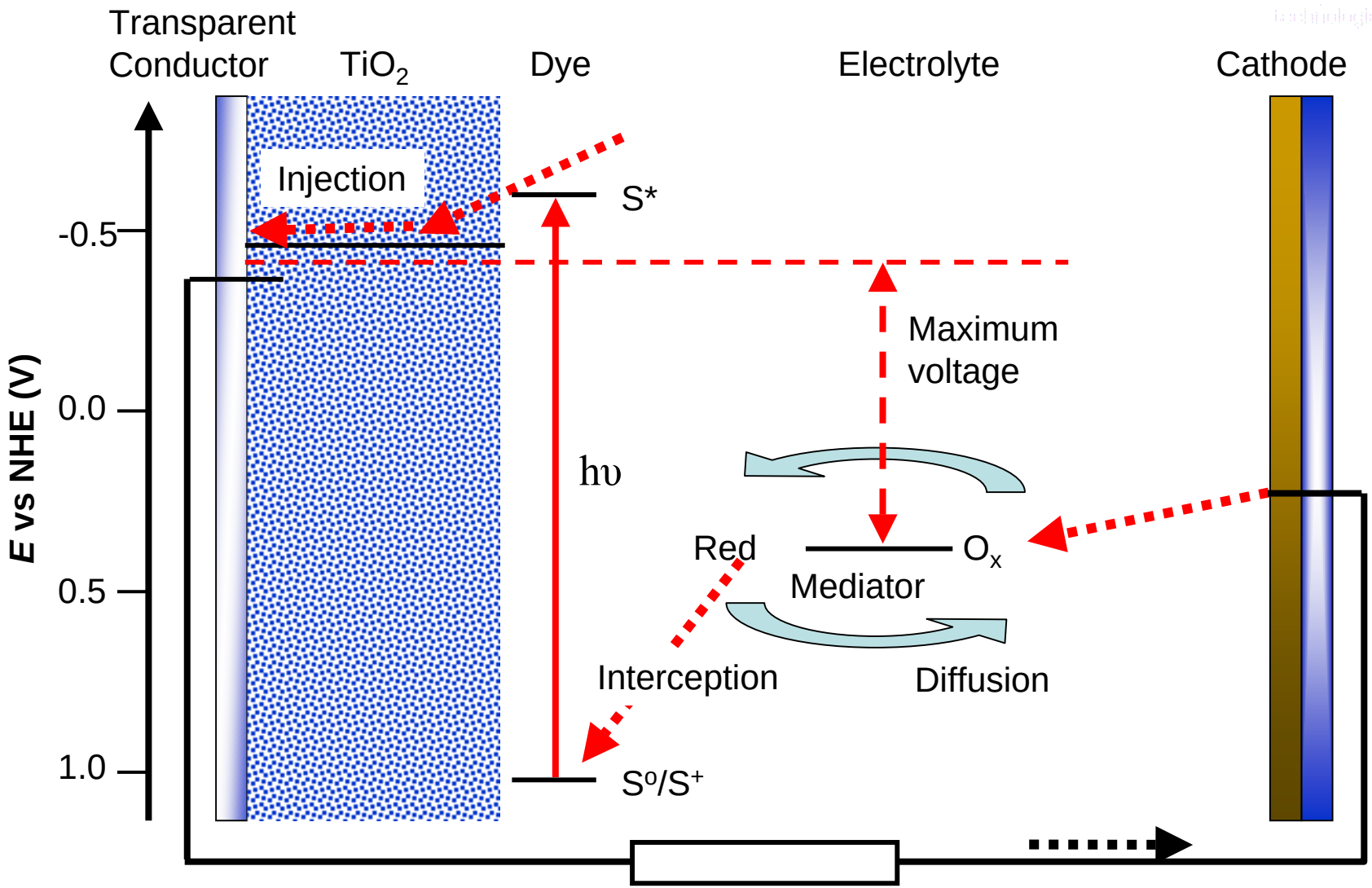
# Photovoltaic Nanotech Companies

- Nanosolar – nanoparticles (20 - 40nm)
  - Titania - dye sensitized
- Hitachi-Maxell
  - Titania – dye sensitized
- Nanosys – quantum dots (<10nm)
  - CdSe, PbS
- Evident Technologies – quantum dots (<10nm)
  - CdSe, PbS

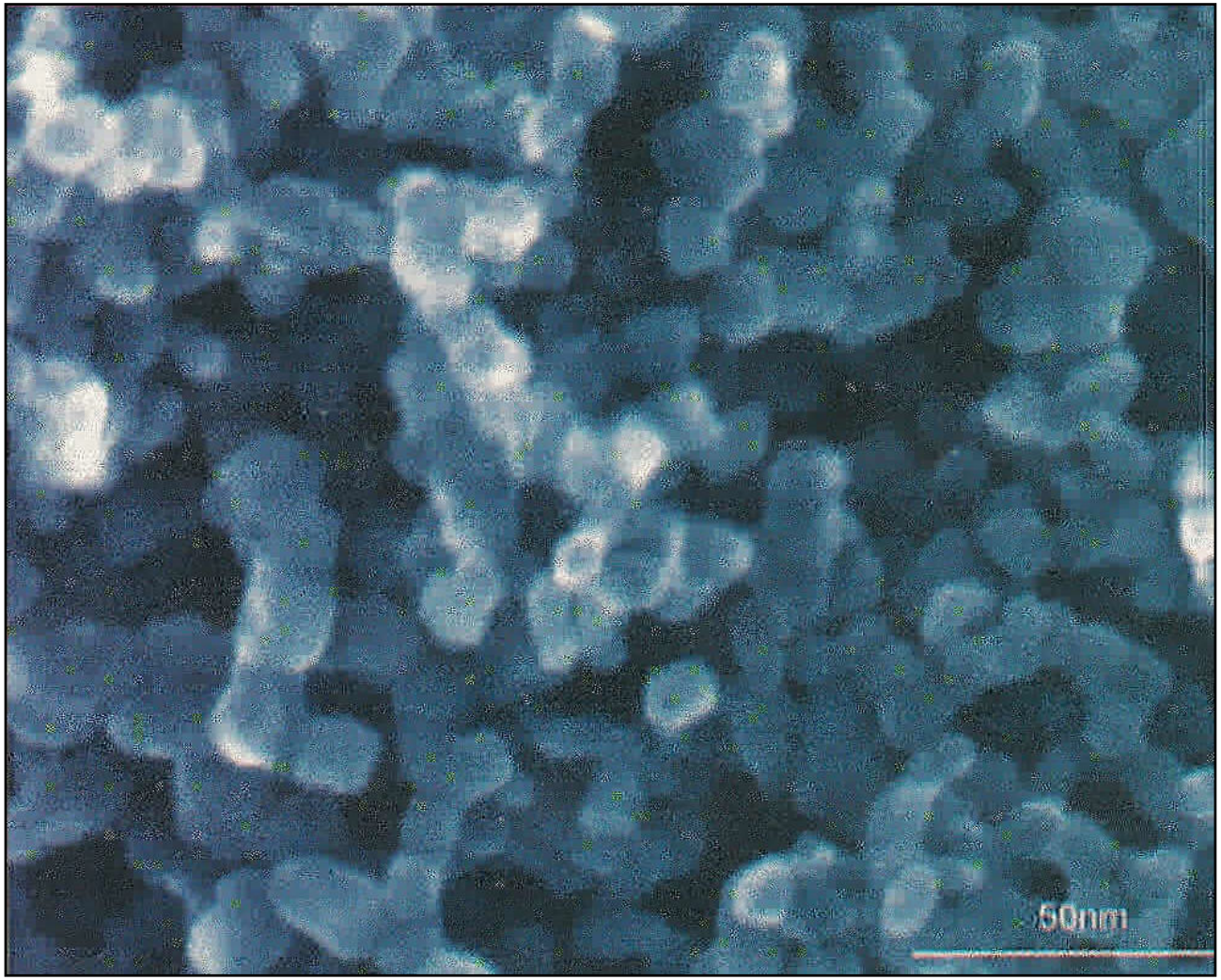
# KTI's Vision: Light-weight, Flexible Photovoltaics



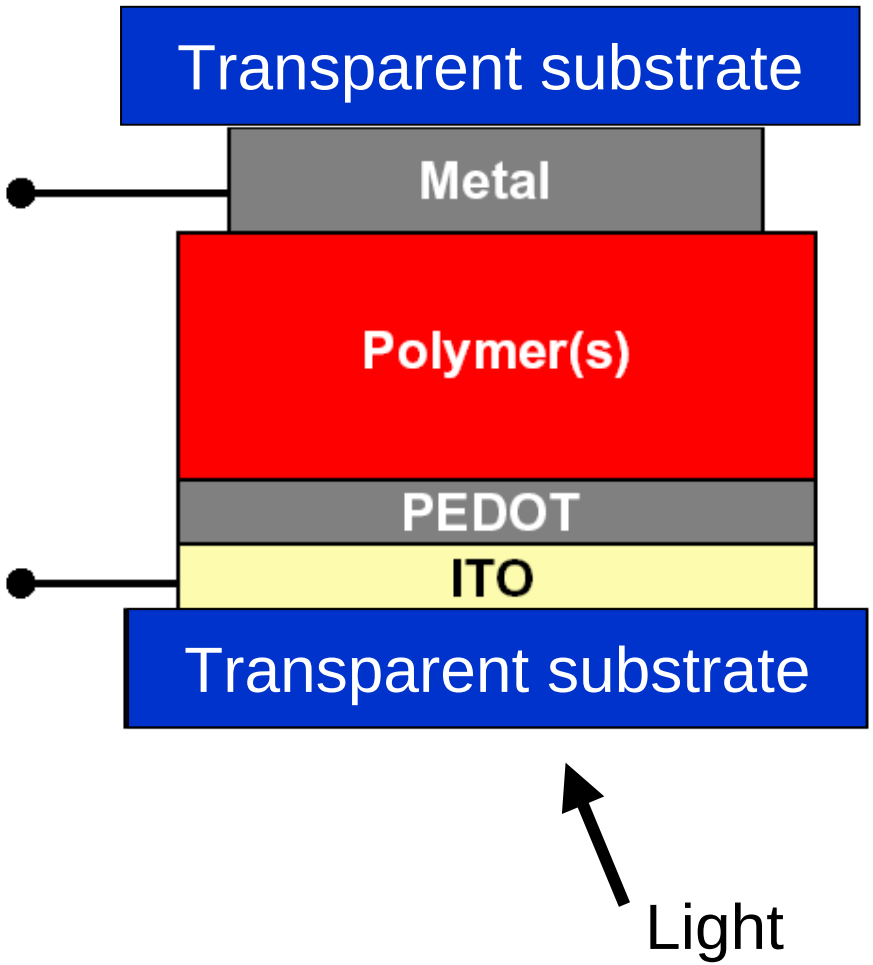
# Dye Cell Principle of Operation



# SEM of Nanostructured Titania

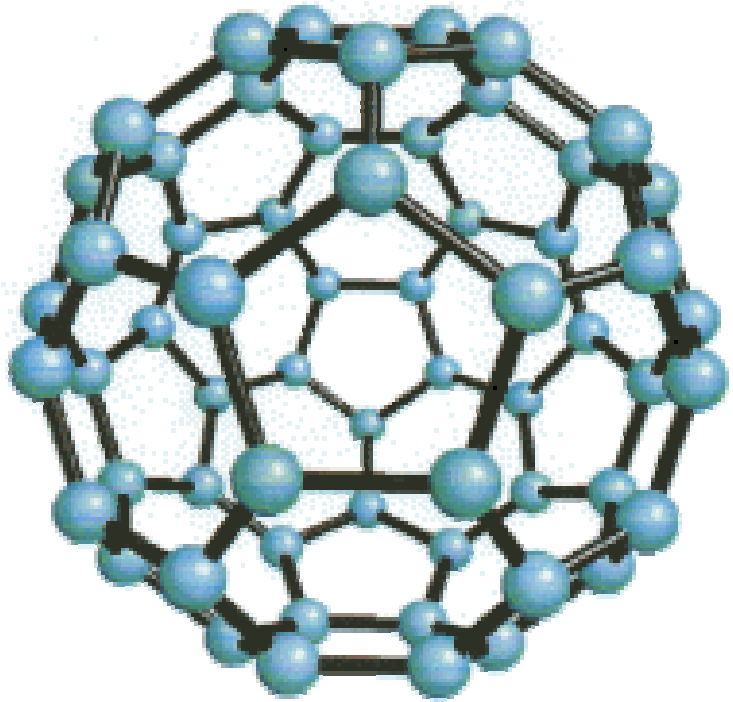


# Polymer Cell Schematic



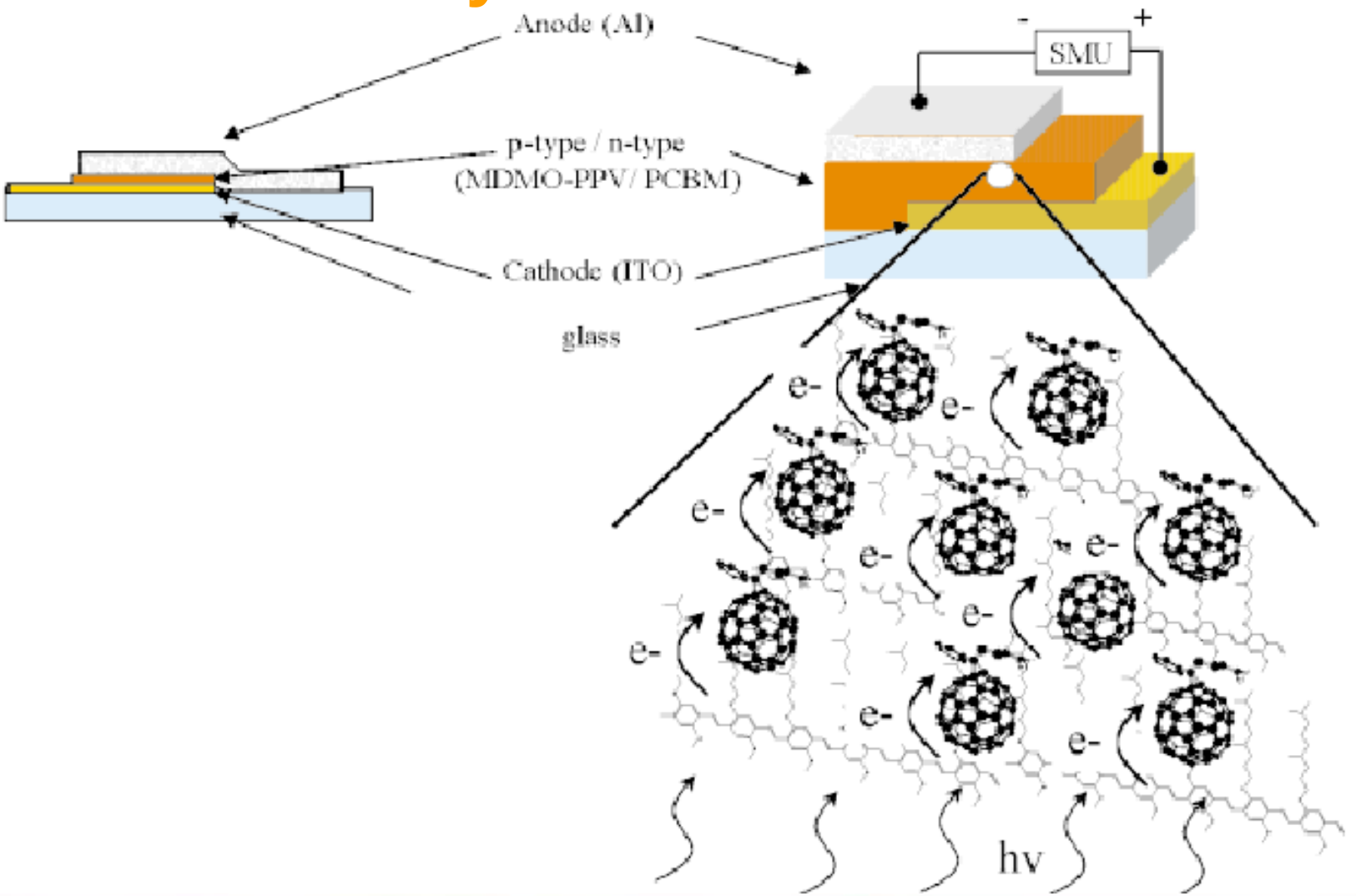
# Fullerenes Carry Electrons

- Fullerenes are carbon molecules
- Electrons can freely move around the molecule and “hop” to adjacent fullerene

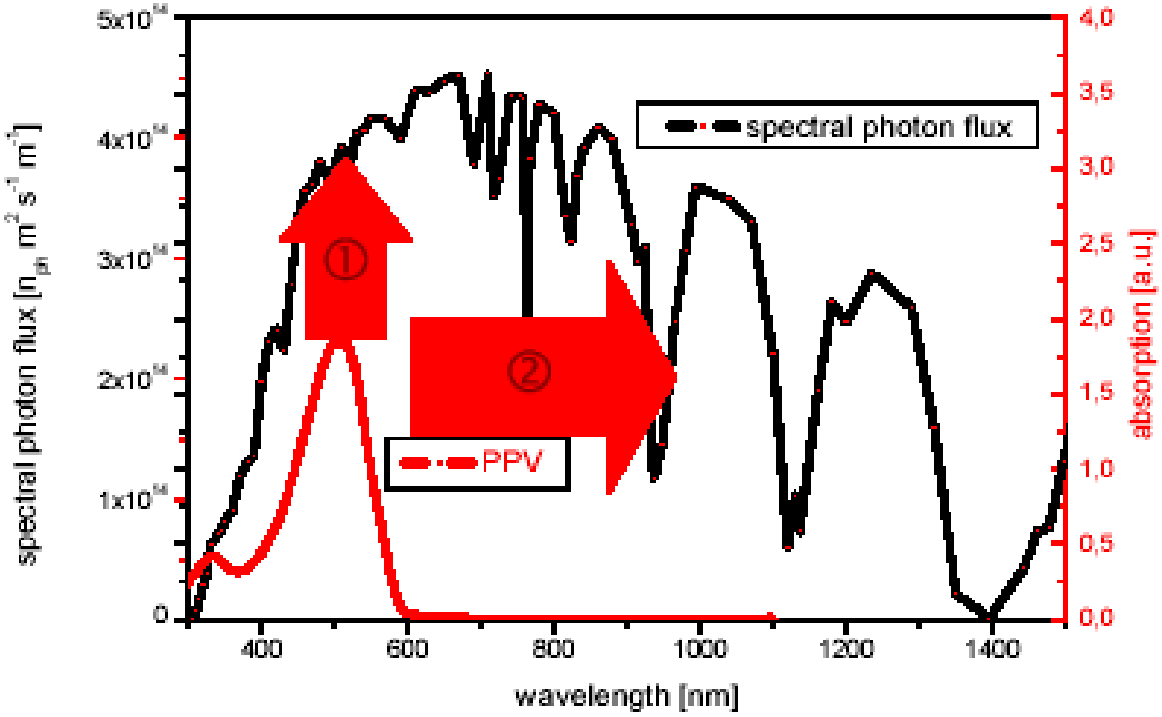


Fullerene (60 atoms of carbon)

# Fullerene / Polymer Function

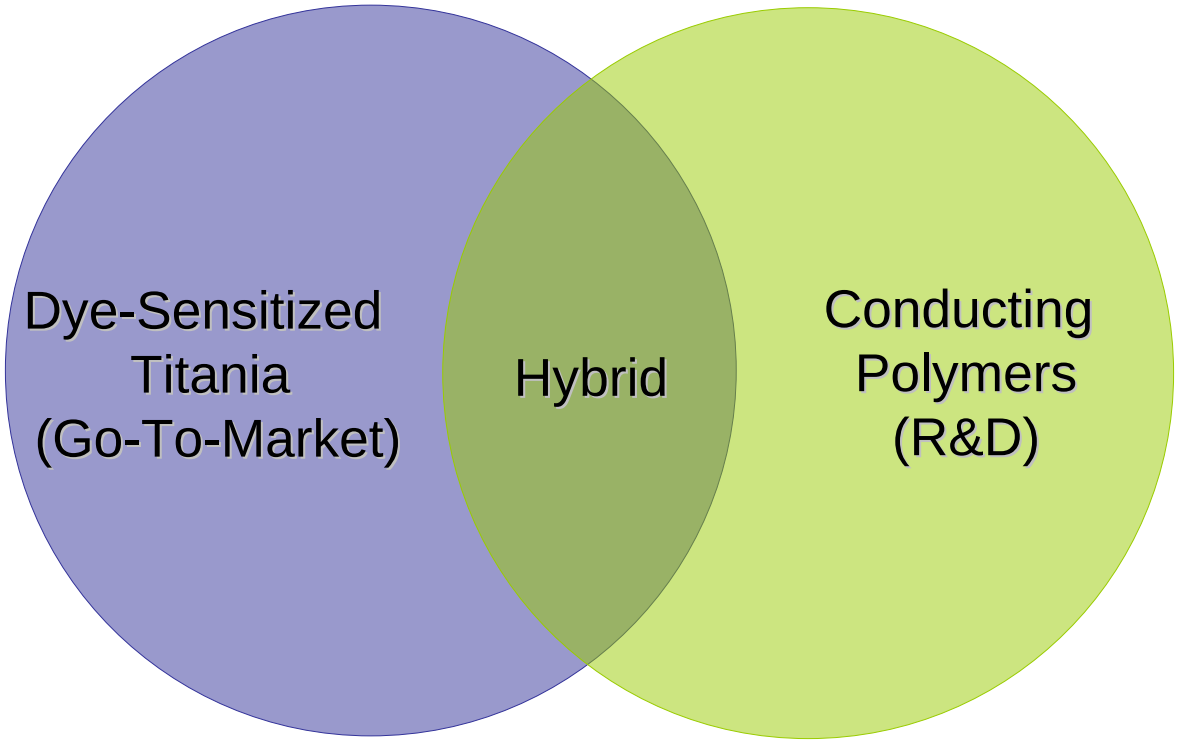


# Increasing Performance: Matching the Solar Emission




1. **Increase absorption**
   - Higher absorption coefficient; Higher charge carrier mobility
2. **Shift of the absorption to red**
   - Low Band Gap Polymers

# Complementary Materials Platforms



# Dye vs. Polymer

| Attributes | Dye | Polymer |
|---|---|---|
| Efficiency | + Absorbs broad spectrum<br>+ Thin (but absorbs more light)<br>+ High electron mobility | - Low efficiency (today)<br>- Too thin to absorb all light<br>+ Potential for multi-layer junctions |
| Lifetime | > 10 years | Undetermined |
| Cost | - Multiple coating steps<br>- Catalyst cost | + Single layer (no catalyst or electrolyte)<br>+ Single coating step |
| Features | + Thin<br>+ Light weight<br>+ Flexible<br>+ Colors (sacrifice efficiency) | + Thin<br>+ Light weight<br>+ Increased Flexibility<br>+ Unique form factors |

# Choice of Materials & Process

| Material | Purpose | Advantage | Disadvantage |
|---|---|---|---|
| $TiO_2$ | Absorb light, convey electron | Semiconductor, abundant, low cost | Only works with UV |
| Dye | Absorb light, inject electron into $TiO_2$ | Bonds to $TiO_2$, absorbs broad spectrum of light | Too thin to absorb all available light |
| Nanoscale $TiO_2$ | Increase surface area 100x | Commodity (low cost) | Requires sintering |

# Product Attributes

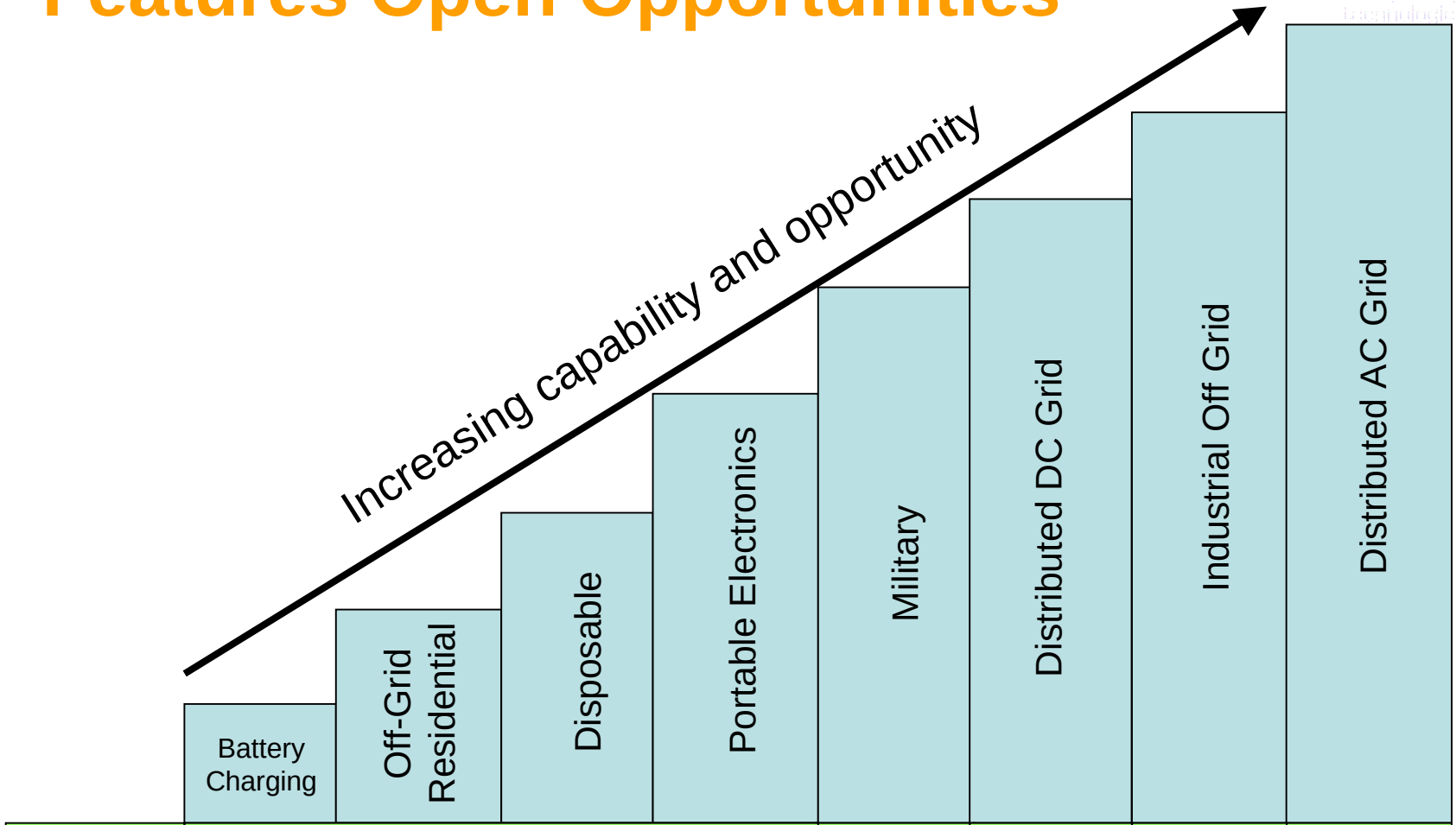
| | Cost | Flex | Form Factor | Trans-mission | Color | Weight | Indoor, Outdoor Use | Eff |
|---|---|---|---|---|---|---|---|---|
| Konarka 3rd generation | ● | ● | ● | ● | ● | ● | ● | ◐ |
| Thin Films 2nd generation | ◐ | ◐ | | ◐ | ● | ◐ | ◐ | ◐ |
| Crystalline 1st generation | | ● | ● | | ◐ | ● | ● | ● |

● Signifies significant competitive advantage

◐ Signifies moderate competitive advantage

● Signifies distinct disadvantage

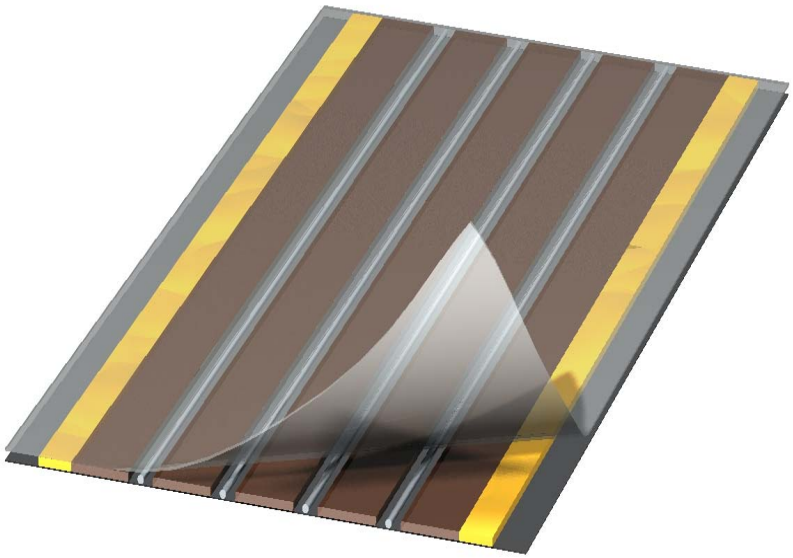
# Features Open Opportunities

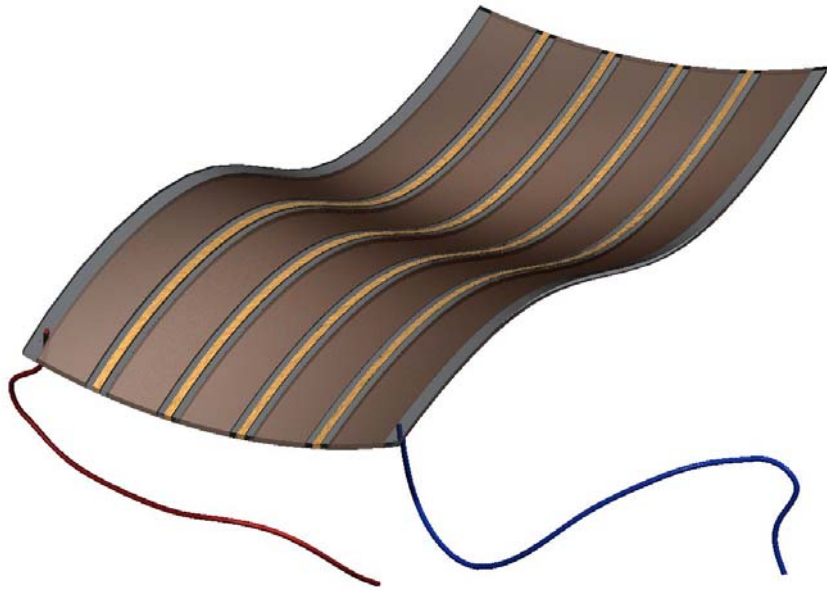



| | | | | | |
|---|---|---|---|---|---|
| 2001 TAM | 40 MW | 10 MW | 50 MW | 100 MW | 300 MW |
| 2010 TIM | 200 | 25 | 400 | 700 | 1200 |

TAM per PV News; TIM per EPIA Forecast (Mil. By KTI)

# First Products



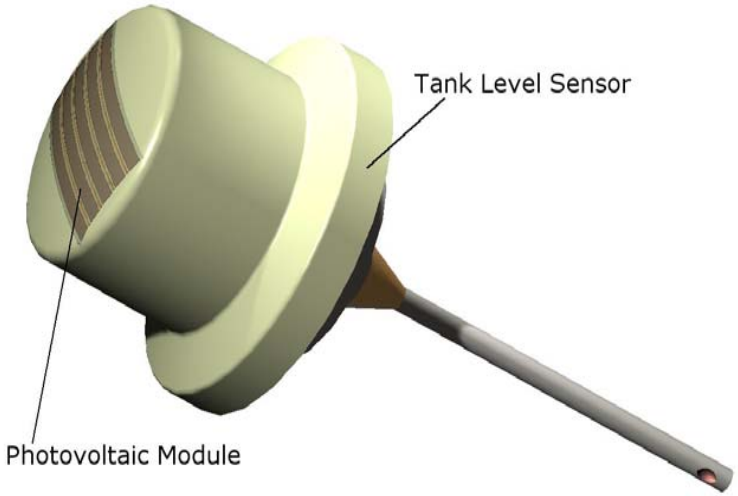


# Portable Applications

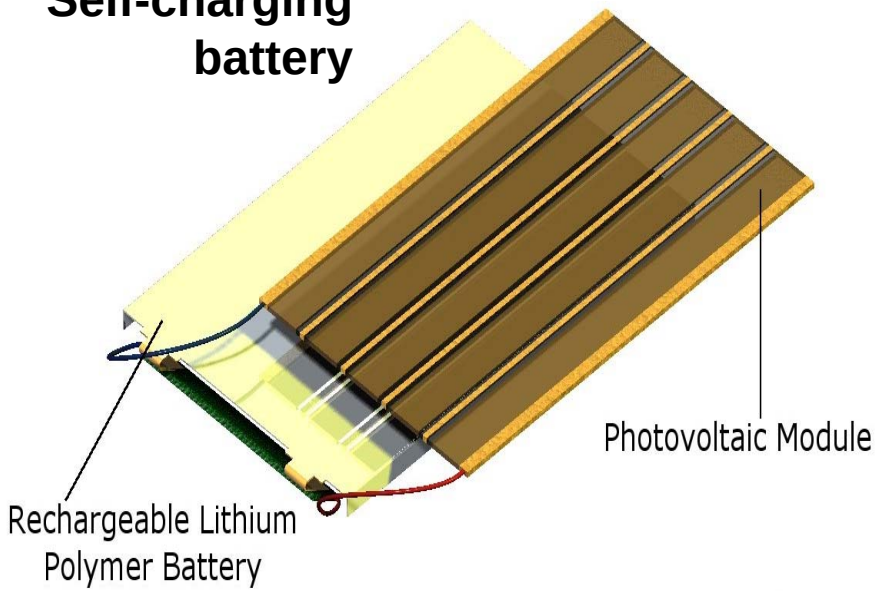
Bluetooth™

**Personal LAN Appliances**

**Wireless instrumentation**



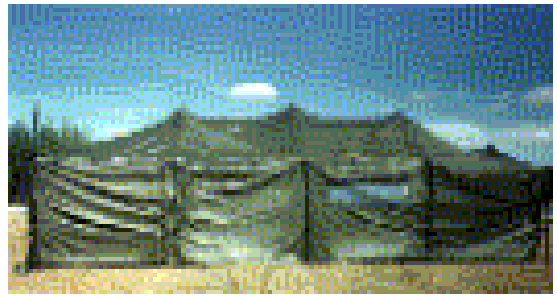

**Self-charging battery**



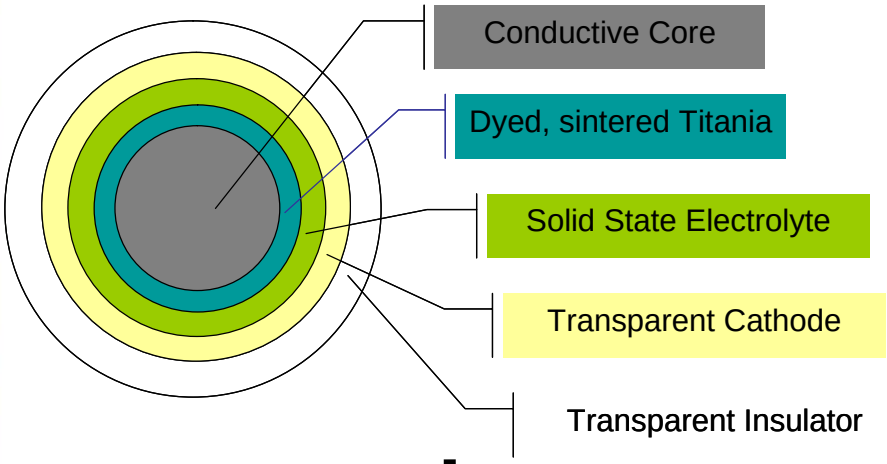
# Military / Civil / Emergency

Flexible Light-weight Charger

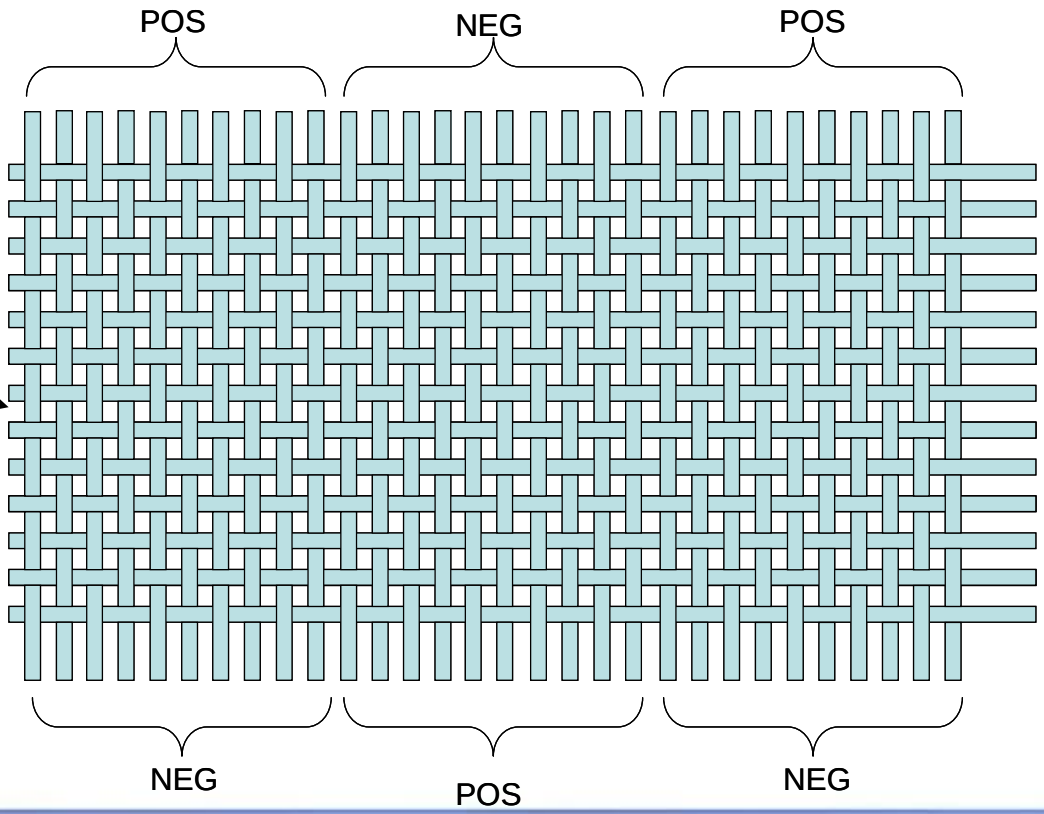
Wearable Power



PowerCloth™



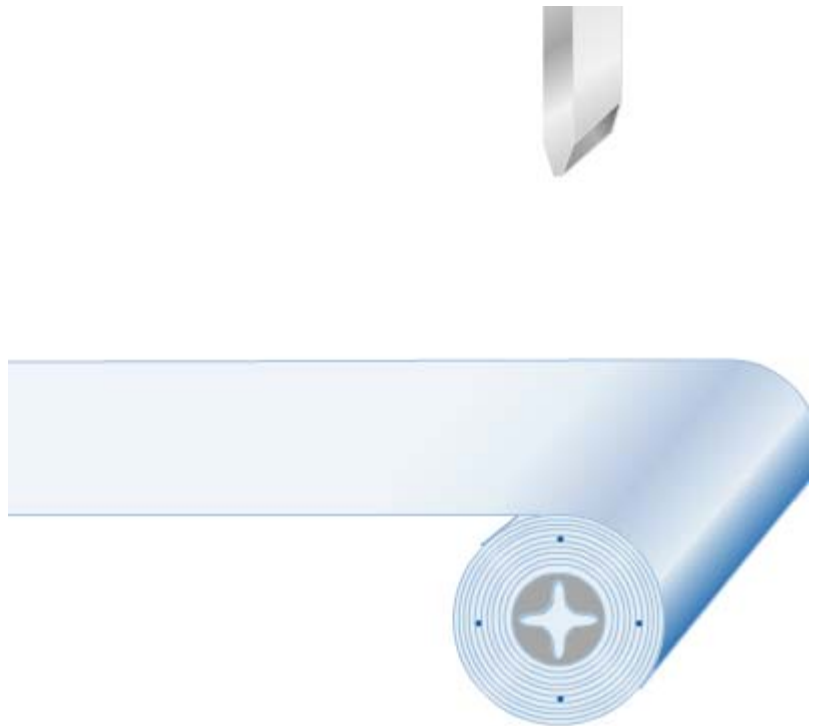

# Product Vision- Photovoltaic Fibers*



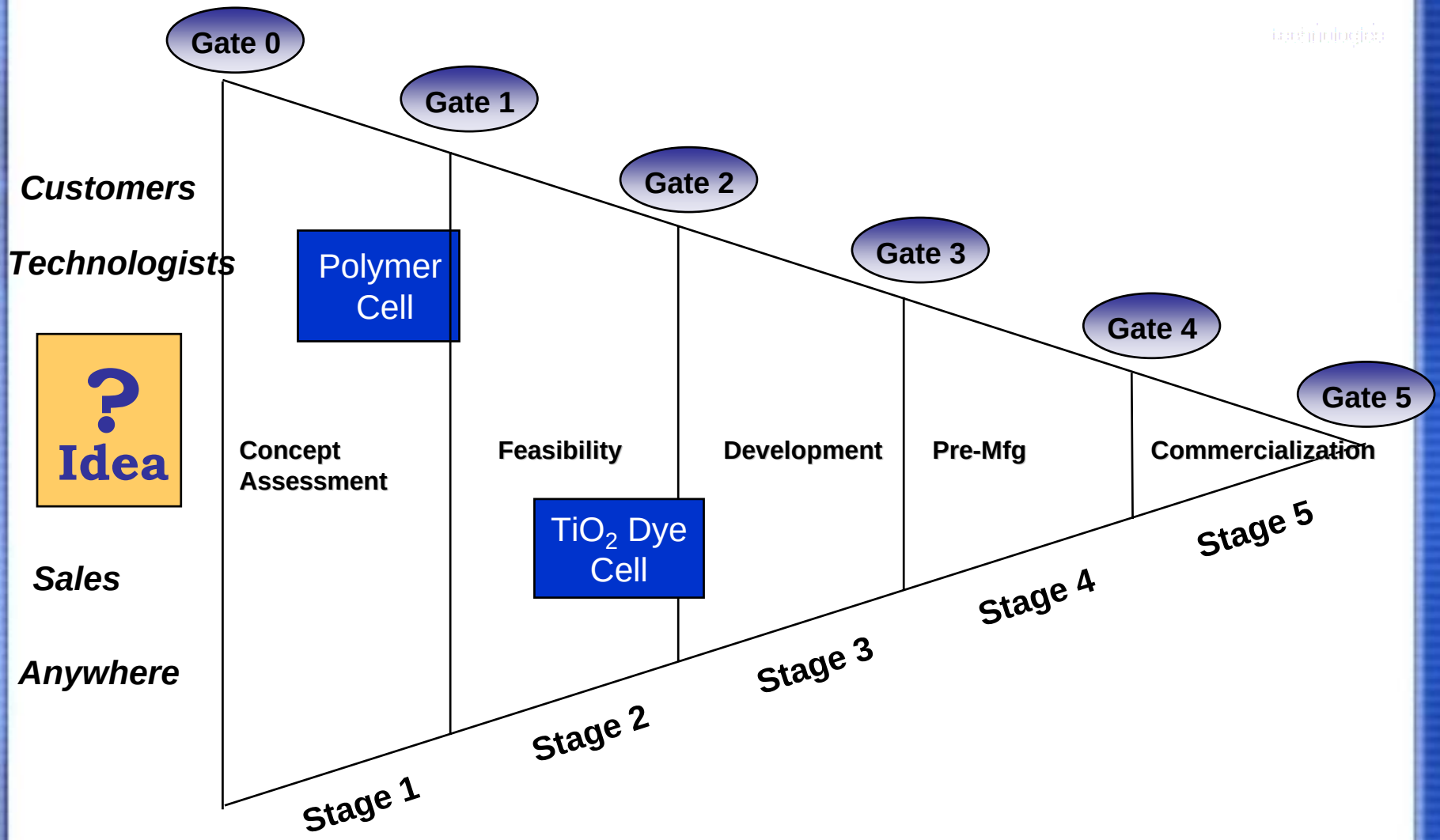

*Patents applied for in 2002

# Coating Production Process Applicable to all Materials Platforms

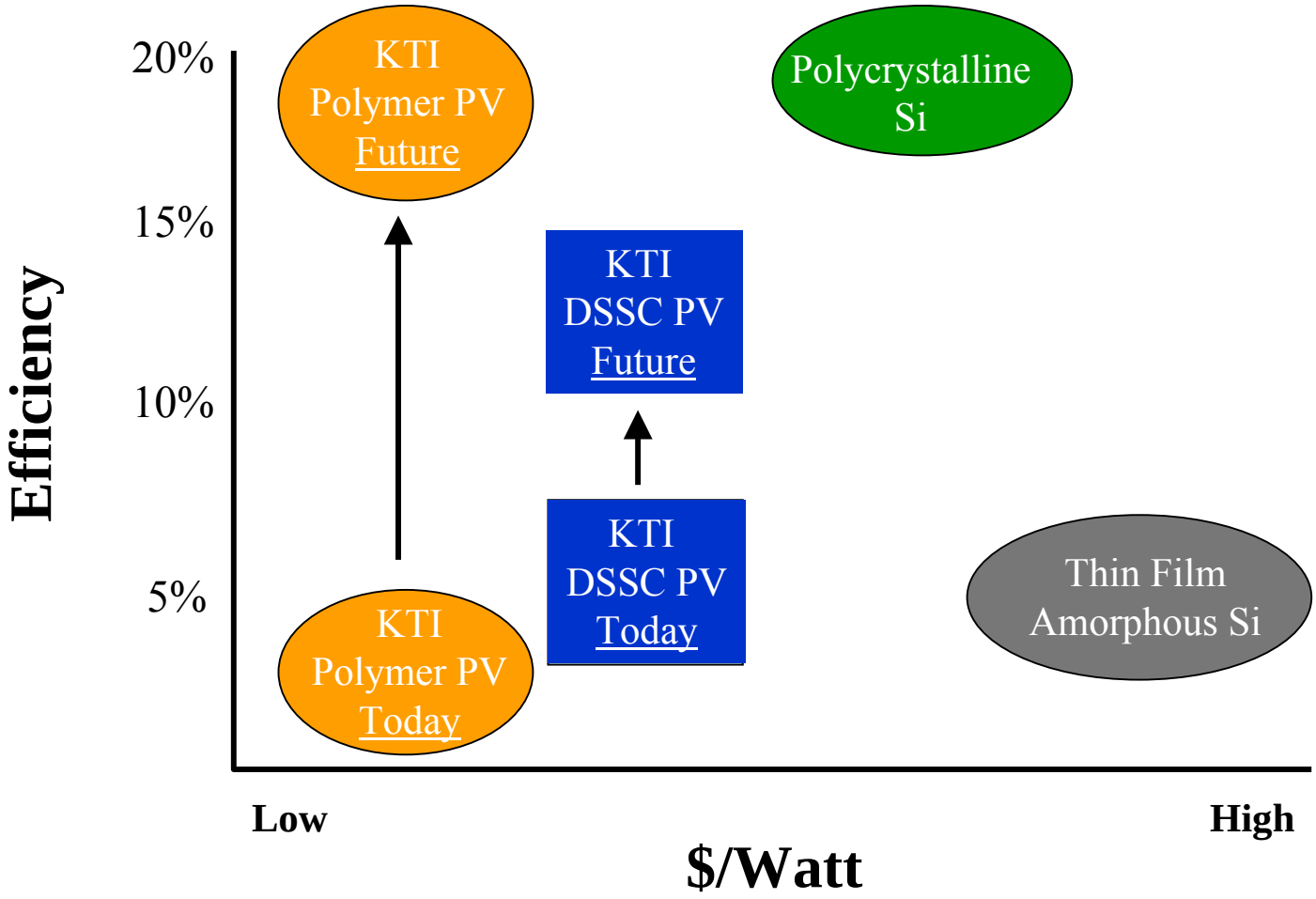
- “Roll-to-roll” on plastic
- Continuous coating
- Utilize existing plants (corporate partners)
- Conventional methods
- No capacity constraints



# KTI Commercialization Process



# Technology Benchmark and Goals

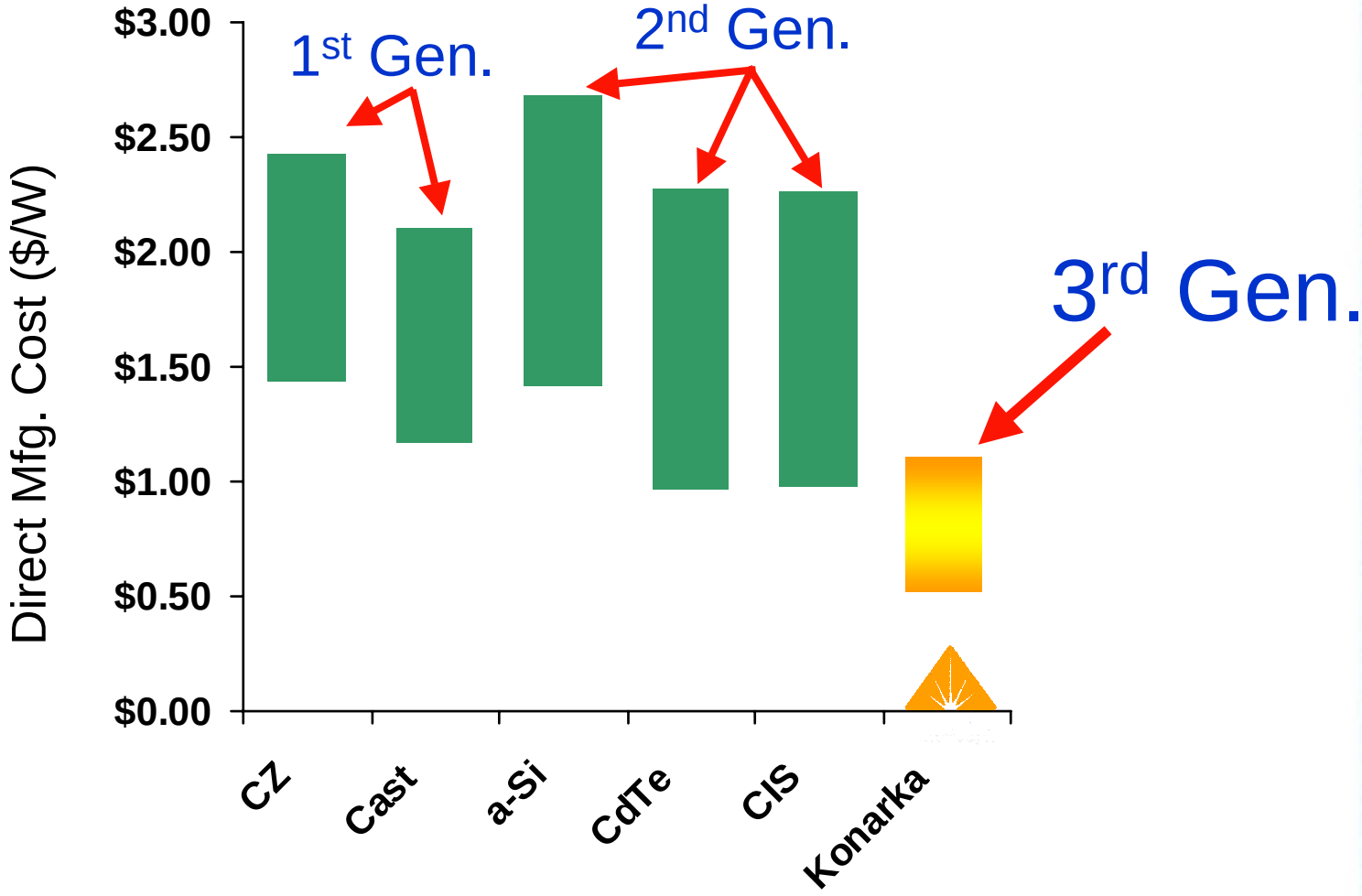


# Preliminary Production Ramp Schedule and Module Efficiency Goals for KTI-Lowell Pilot Production

| 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| Technology Development DSSC | Product and Process Development and Scale-up | Product Launch:<br><br>5% Module<br><br>1 MW* | Production:<br><br>6% Module<br><br>3 MW* | Production:<br><br>7% Module<br><br>4 MW* |

* Production Capacity – 3 shifts / 6 days per week.

# We have a Commercial Cost Advantage




33 Range of Possible Gen 1 and 2 Direct Manufacturing Costs Achievable by 2010 - Source: A.D. Little