Product Development for Organic Photovoltaics

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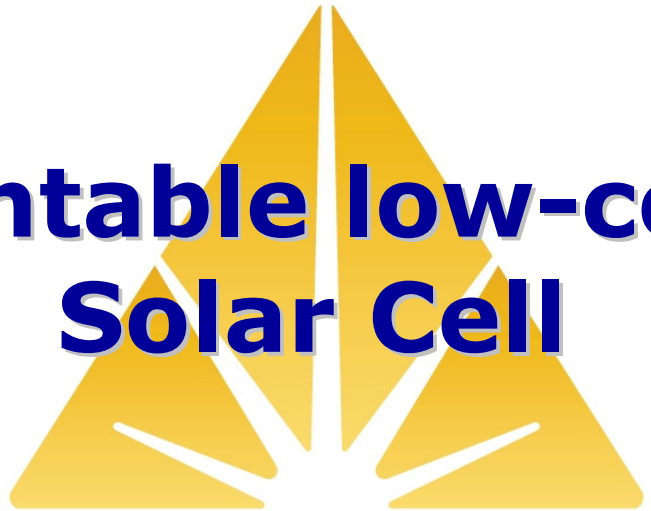
Creating Energy where there is light

Who is Konarka?

Renewable Energy



Printable low-cost Solar Cell

Organic Chemistry

Printed Electronics

Innovators at the Intersections

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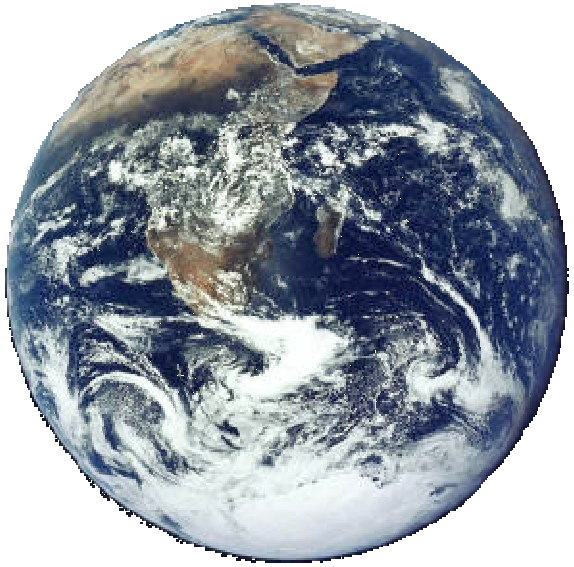
Renewable Energy Supply

Solar
1 x 10^5 TW at Earth surface
10,000 TW (technical value)

It´s about TWs

Wind
14 TW



Biomass
5-7 TW

Tide/Ocean Currents
0.7 TW

Hydroelectric
1.2 TW technically feasible
0.6 TW installed capacity

Geothermal
1.9 TW

Energy gap
~ 14 TW by 2050
~ 33 TW by 2100

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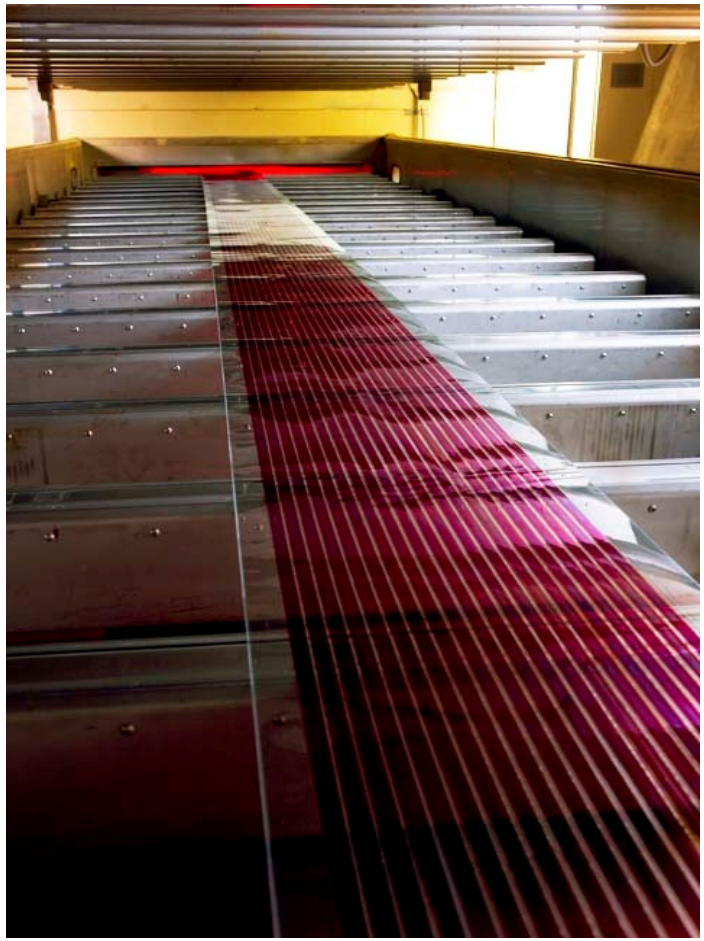
Source: Arthur Nozik

Manufacturing Paradigm



Developing Low Cost, Scalable PV Manufacturing Process

- **Low Cost:** low temperature, ambient conditions, no clean room, no silicon, lower energy footprint
- **Scalable**: coating or printing technology, utilization of existing capacity
- **Continuous:** roll-to-roll high-volume production

Consequence: Thin, lightweight, flexible PV Product.

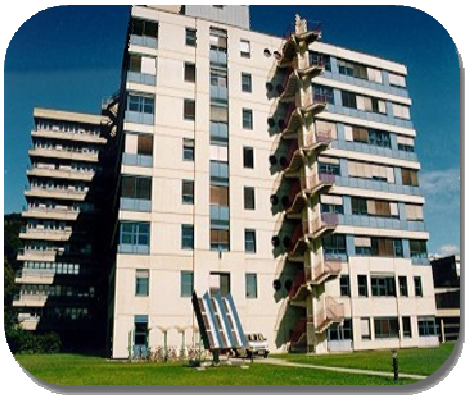
Company Overview

- Founded in 2001 as spin-out of UMass and University of CA
- Leading IP position with nearly 350 patents and global filings
- Strong 100+ person team with technical and industrial expertise
- $150+ private funding raised to-date, $20M government grants
- Global presence with staff in US, Germany, Austria, & China

Headquarters:
Lowell, MA

Production
New Bedford, MA

Nurnberg, Germany



Linz, Austria

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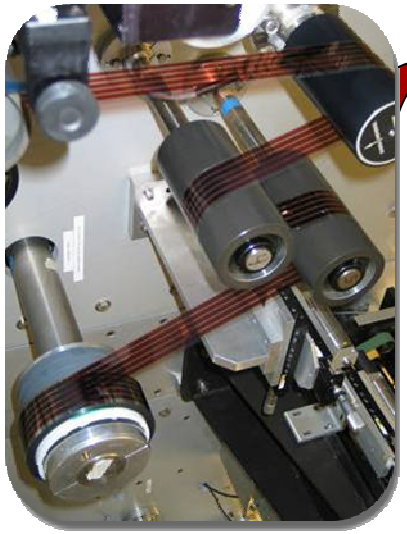
Capacity Upscaling

Lab



2006
5 cm
1kWatt

Pilot

2007
25 cm
1MWatt

Production

2008
150 cm
1GWatt

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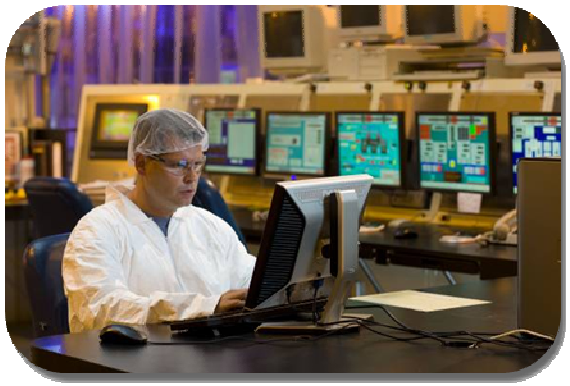
Production Plant



- 250 to 1500 mm width
- No facing roll
- 100 feet / minute: **1GW per year potential**

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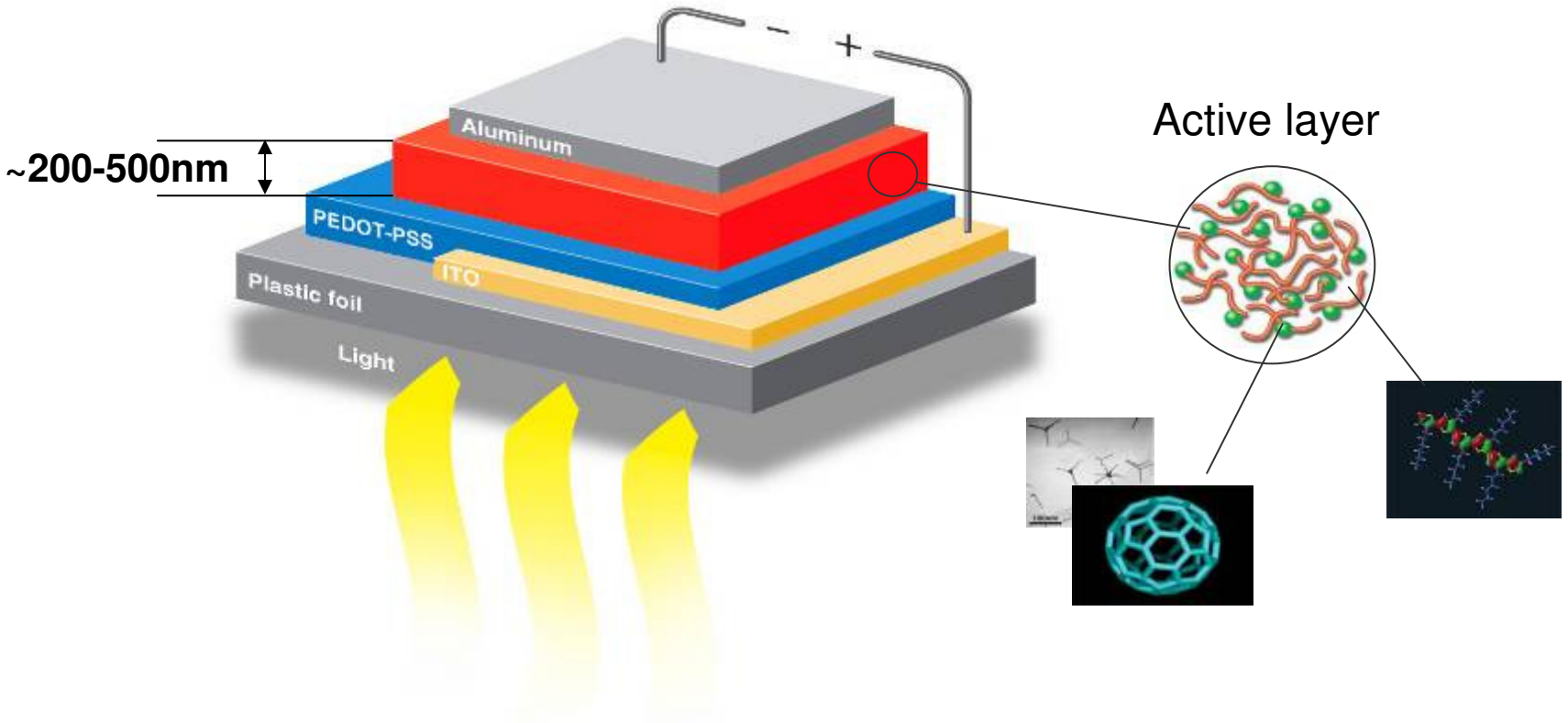
Bulk Heterojunction (OPV)



Main components of the active layer:
Semiconducting polymer and Fullerene

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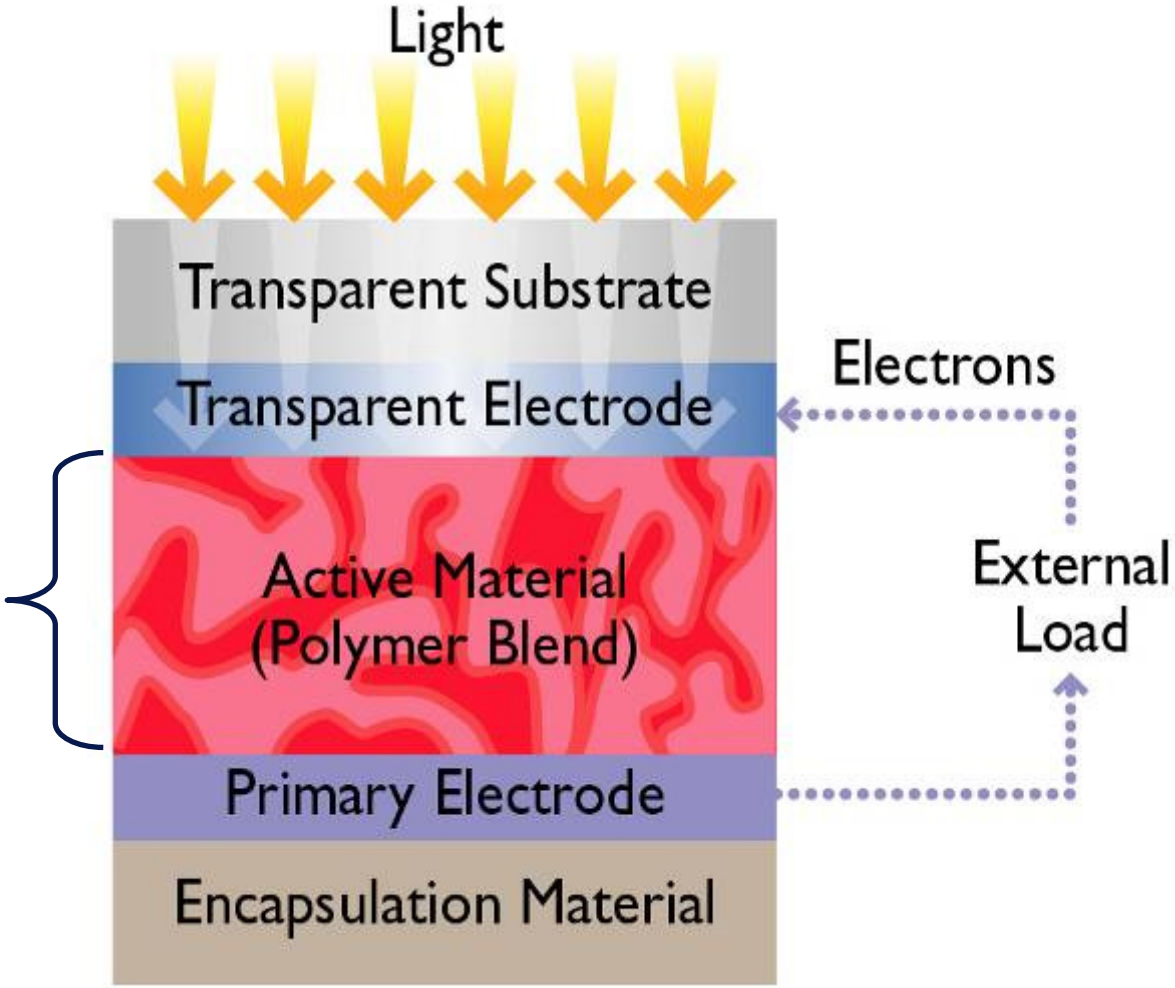
OPV Cell Schematic
Bulk Heterojunction Polymer/Fullerene

3 Key Functions

1. **Light Absorber**
2. **Hole Carrier**
3. **Electron Carrier**



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Shifting Solar: Rooftop to Anywhere

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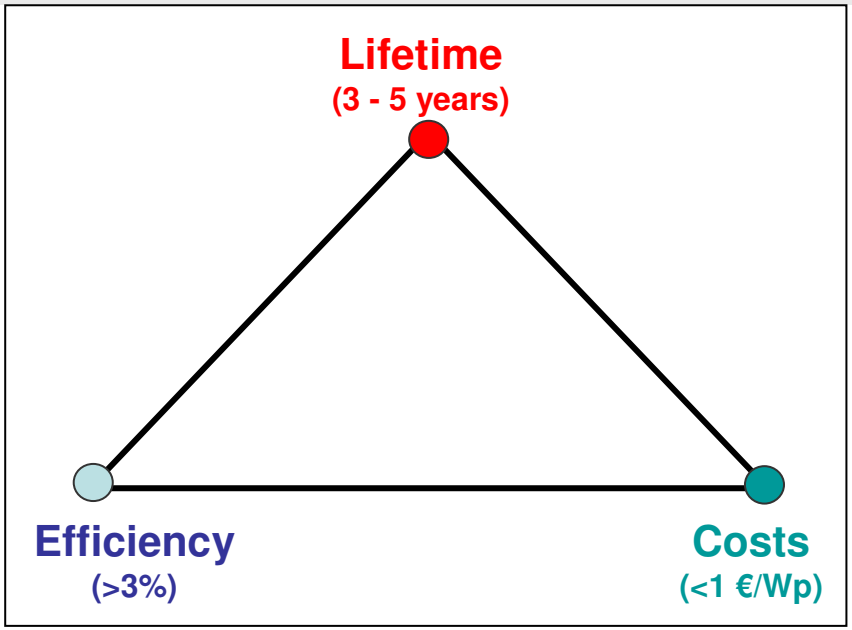
Minimum requirements for any PV technology

KONARKA®

Technical Requirements



- **Key Parameters are efficiency, lifetime and cost**
- **The application decides which is the most important parameter.**

A successful product must fulfill all 3 requirements:

➡ Efficiency, Lifetime and Cost

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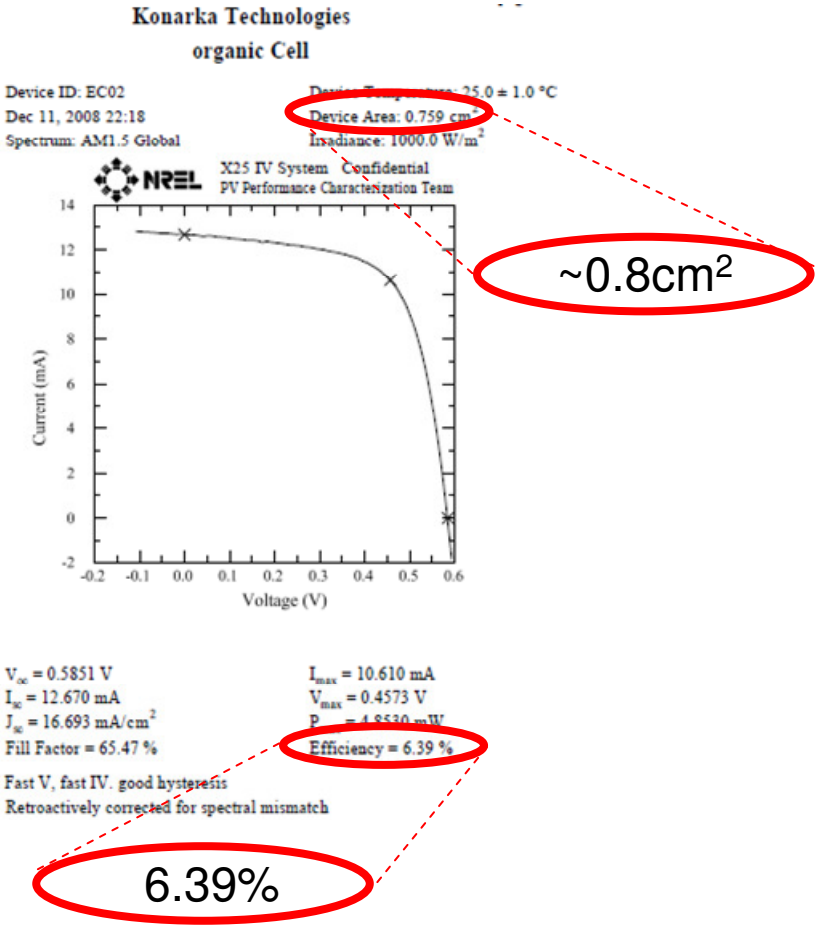
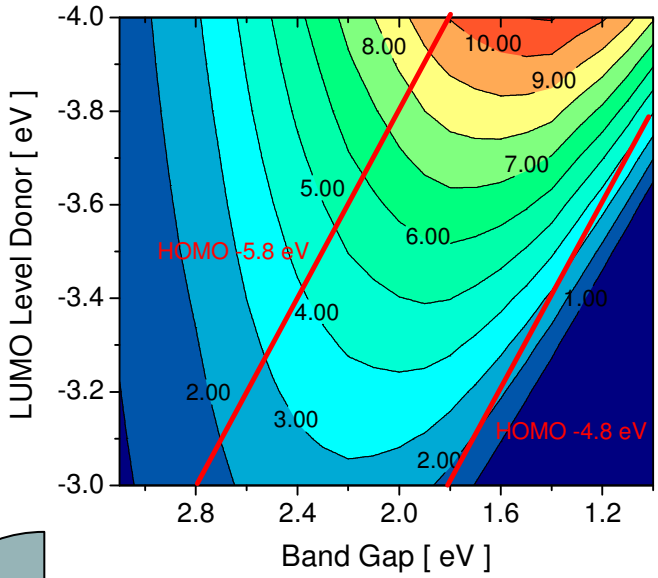
Efficiency – State of the Art

Device performance
Certified by NREL



requirements for new materials



Max. device efficiency

New materials drive efficiency

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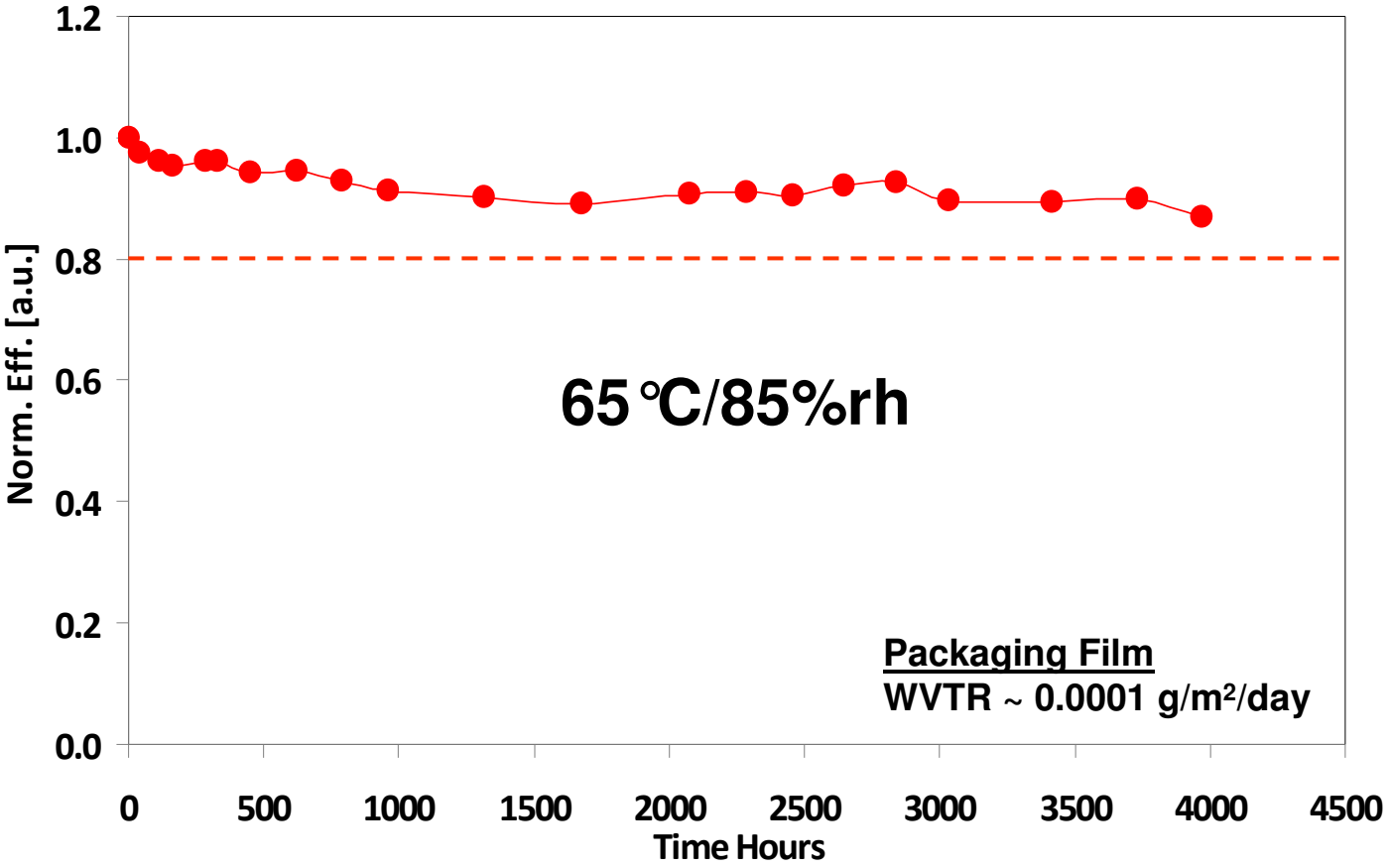
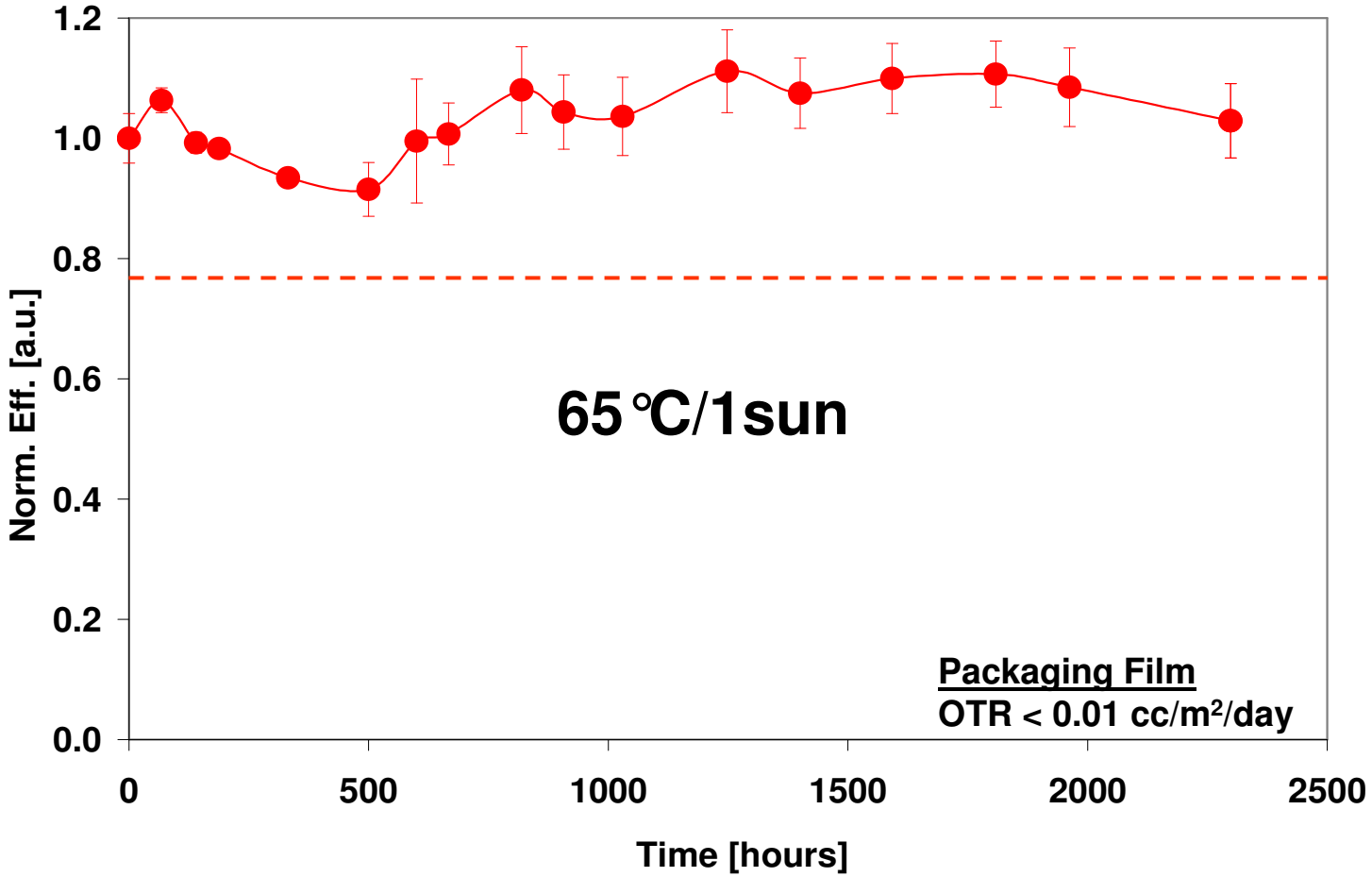
State of the art – ALT Production Modules



Extrapolated LT > 8000hrs

State of the art – ALT Production Modules



Expected Lifetime > 3yrs

Oxygen permeation does not appear to be limiting packaged device lifetime

Rooftop Testing

Location Lowell, MA.
Facing solar south at 42°≈1600 kWh / m^2

Two measurement modes

a) Outdoor jV in 4th quadrant with modulated load and wireless data read out

b) Periodic characterization under standard solar simulator

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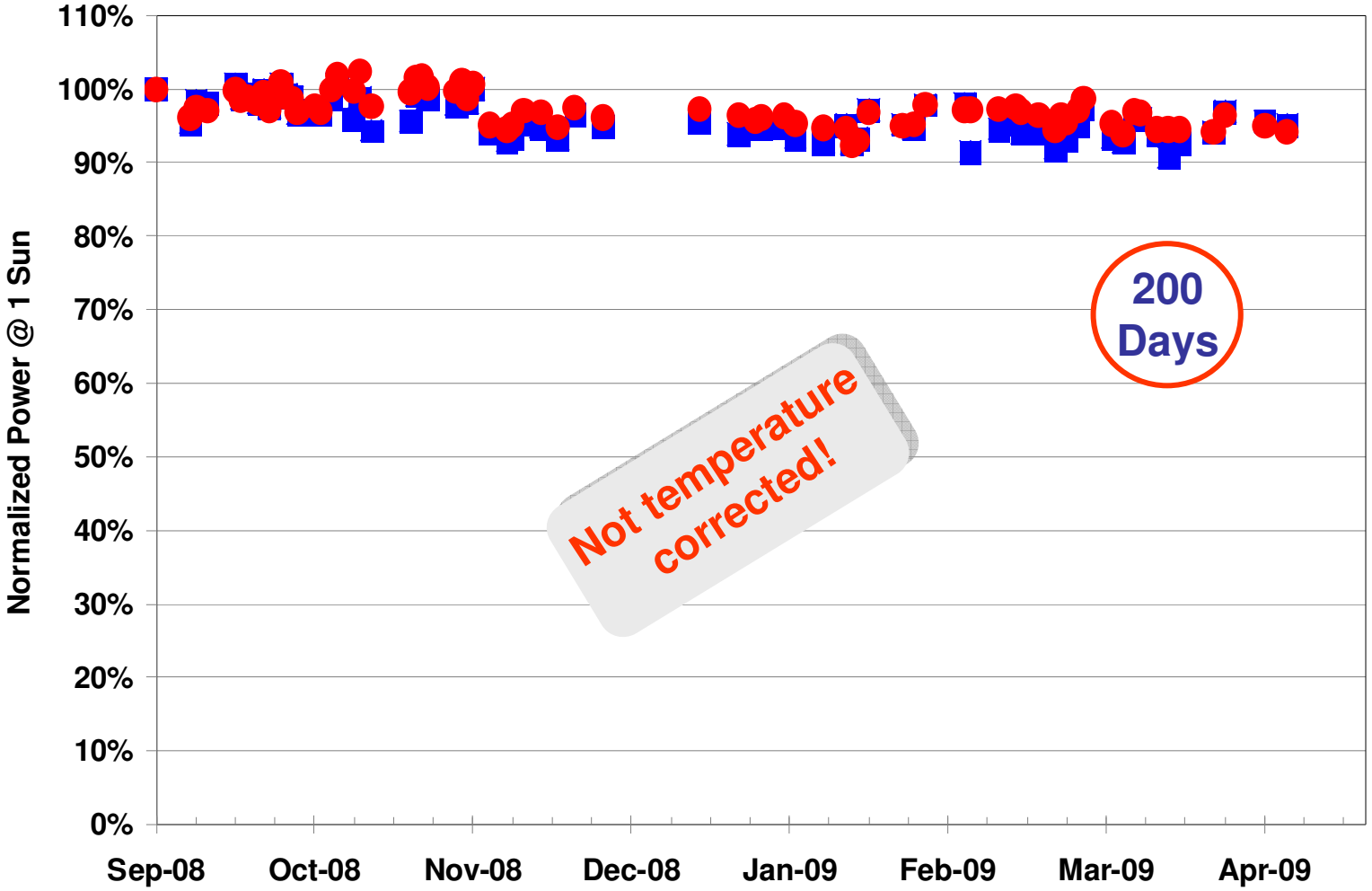
Outdoor Testing

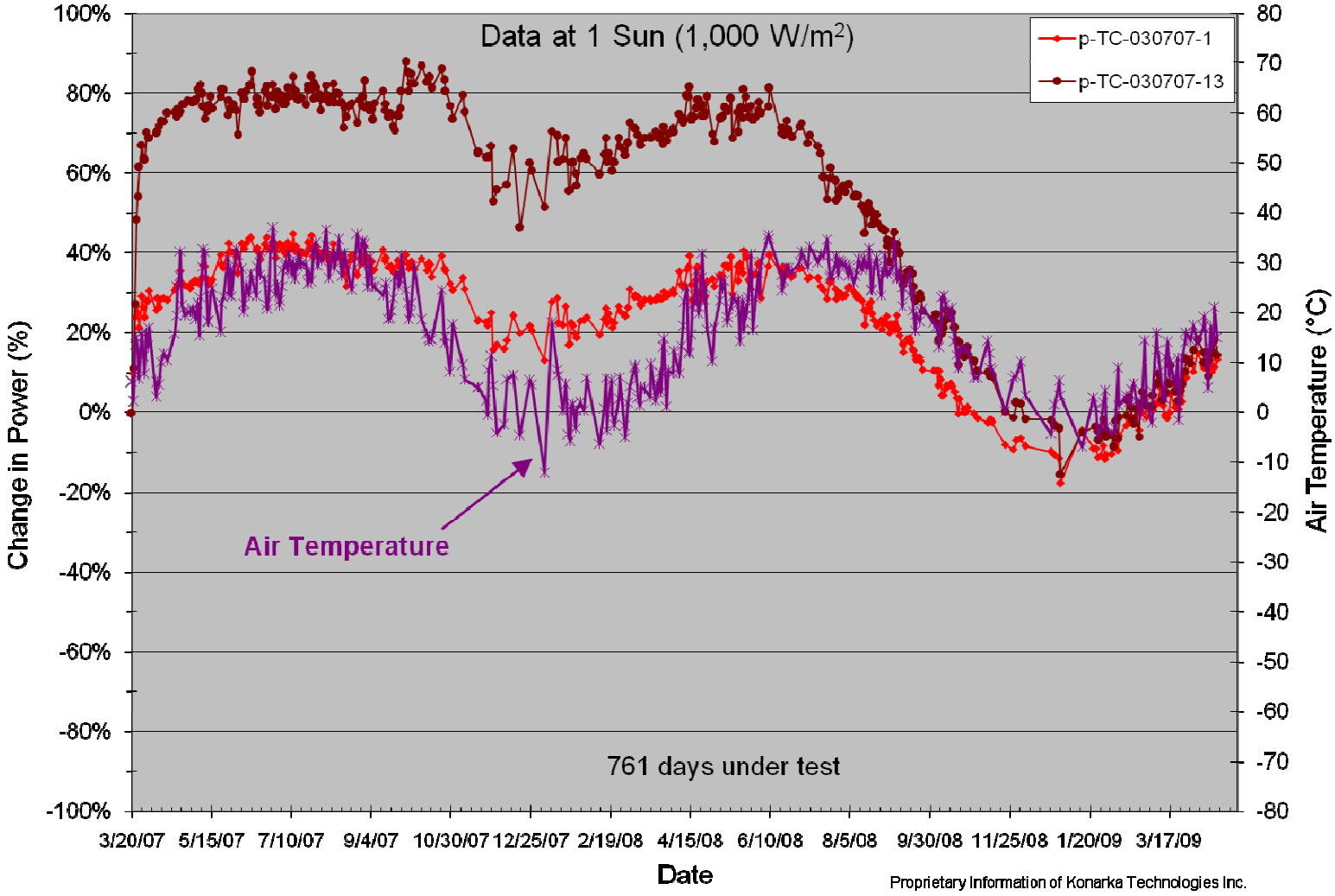


Outdoor Degradation of Production Modules

WVTR=.07g/m2/day - Estimated Lifetime > 3yrs

Outdoor Testing

Still measuring device intalled two years ago with poor components



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Power Plastic Standard Products

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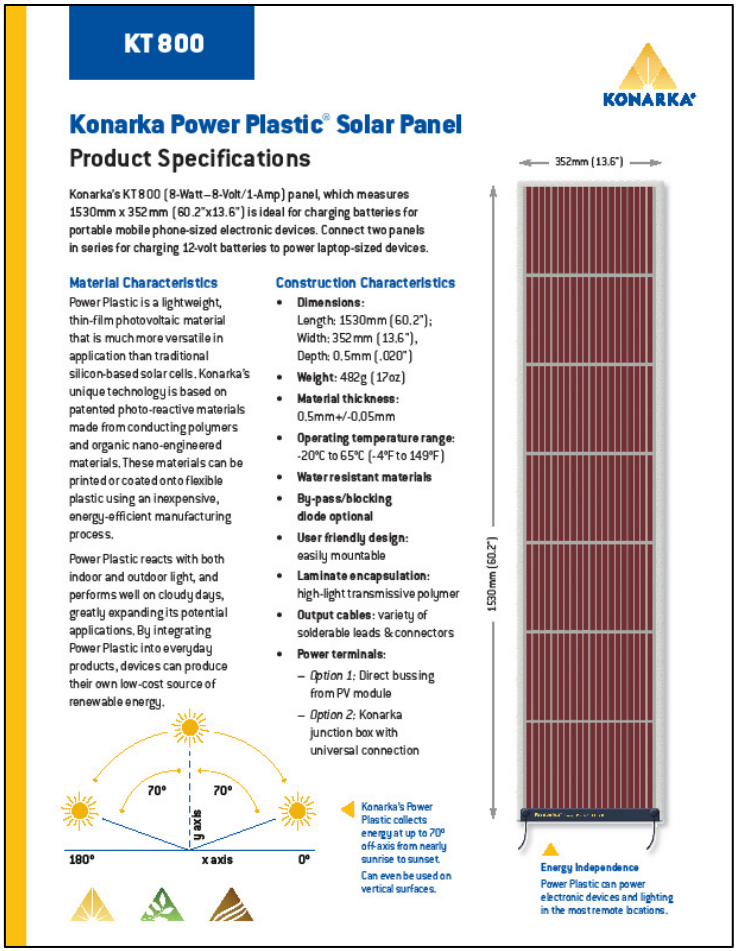
Power Plastic Standard Products

Standard Product Technical Spec. Sheets Available



KT 800

KONARKA

Konarka Power Plastic® Solar Panel

Product Specifications

Konarka's KT 800 (8-Watt–8-Volt/1-Amp) panel, which measures 1530mm x 352mm (60.2"x13.6") is ideal for charging batteries for portable mobile phone-sized electronic devices. Connect two panels in series for charging 12-volt batteries to power laptop-sized devices.

Material Characteristics

Power Plastic is a lightweight, thin-film photovoltaic material that is much more versatile in application than traditional silicon-based solar cells. Konarka's unique technology is based on patented photo-reactive materials made from conducting polymers and organic nano-engineered materials. These materials can be printed or coated onto flexible plastic using an inexpensive, energy-efficient manufacturing process.

Power Plastic reacts with both indoor and outdoor light, and performs well on cloudy days, greatly expanding its potential applications. By integrating Power Plastic into everyday products, devices can produce their own low-cost source of renewable energy.

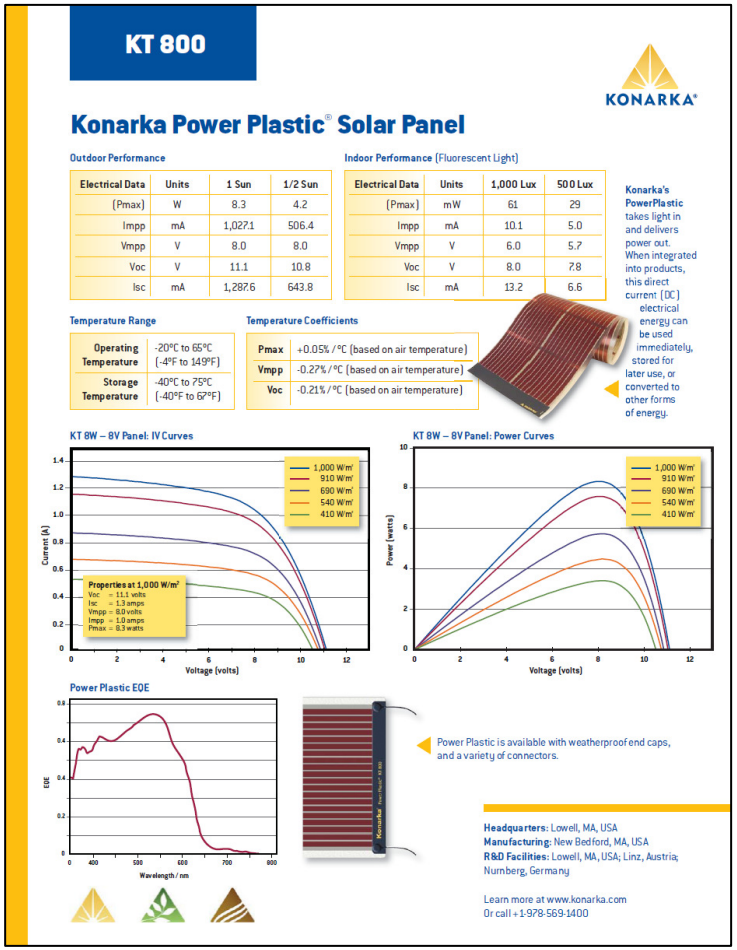
Construction Characteristics

- **Dimensions:** Length: 1530mm (60.2"); Width: 352mm (13.6"), Depth: 0.5mm (.020")
- **Weight:** 482g (17oz)
- **Material thickness:** 0.5mm+/-0.05mm
- **Operating temperature range:** -20°C to 65°C (-4°F to 149°F)
- **Water resistant materials**
- **By-pass/blocking diode optional**
- **User friendly design:** easily mountable
- **Laminate encapsulation:** high-light transmissive polymer
- **Output cables:** variety of solderable leads & connectors
- **Power terminals:**
  - *Option 1:* Direct bussing from PV module
  - *Option 2:* Konarka junction box with universal connection

Konarka's Power Plastic collects energy at up to 70° off-axis from nearly sunrise to sunset. Can even be used on vertical surfaces.

Energy Independence

Power Plastic can power electronic devices and lighting in the most remote locations.



KT 800

KONARKA

Konarka Power Plastic® Solar Panel

Outdoor Performance

Electrical Data	Units	1 Sun	1/2 Sun
(Pmax)	W	8.3	4.2
Impp	mA	1,027.1	506.4
Vmpp	V	8.0	8.0
Voc	V	11.1	10.8
Isc	mA	1,287.6	643.8

Indoor Performance (Fluorescent Light)

Electrical Data	Units	1,000 Lux	500 Lux
(Pmax)	mW	61	29
Impp	mA	10.1	5.0
Vmpp	V	6.0	5.7
Voc	V	8.0	7.8
Isc	mA	13.2	6.6

Konarka's PowerPlastic takes light in and delivers power out. When integrated into products, this direct current (DC) electrical energy can be used immediately, stored for later use, or converted to other forms of energy.

Temperature Range

Operating Temperature	-20°C to 65°C (-4°F to 149°F)
Storage Temperature	-40°C to 75°C (-40°F to 67°F)

Temperature Coefficients

Pmax	+0.05% / °C (based on air temperature)
Vmpp	-0.27% / °C (based on air temperature)
Voc	-0.21% / °C (based on air temperature)

KT 8W – 8V Panel: IV Curves

KT 8W – 8V Panel: Power Curves

Power Plastic EQE

Power Plastic is available with weatherproof end caps, and a variety of connectors.

Headquarters: Lowell, MA, USA
Manufacturing: New Bedford, MA, USA
R&D Facilities: Lowell, MA, USA; Linz, Austria; Nurnberg, Germany

Learn more at www.konarka.com
Or call +1-978-569-1400

¼ watt ½ watt 1 watt 2 watt 5 watt 8 watt 12 watt 26 watt

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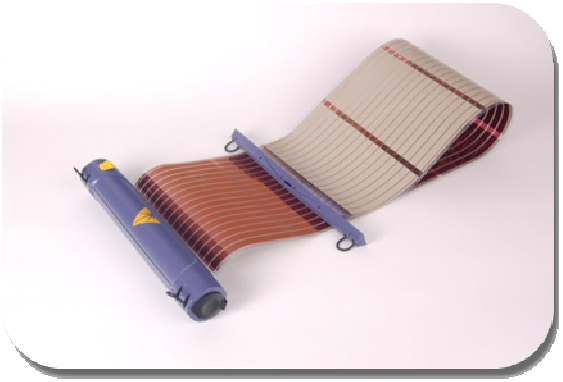
End User Products



Rollable power supply

Shading elements

Solar Bags: Standard 2W

KT-3000 :
30 Watts

Semi-Transparent
Module

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Acknowledgments

- **A J Heeger and the "*Center for Polymers and Organic Solids*", UCSB**

The Konarka Technologies R&D team

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

napolyde nanostructured polymer deposition

Flexonics

MOLYCELL

oe-a Organic Electronics Association

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