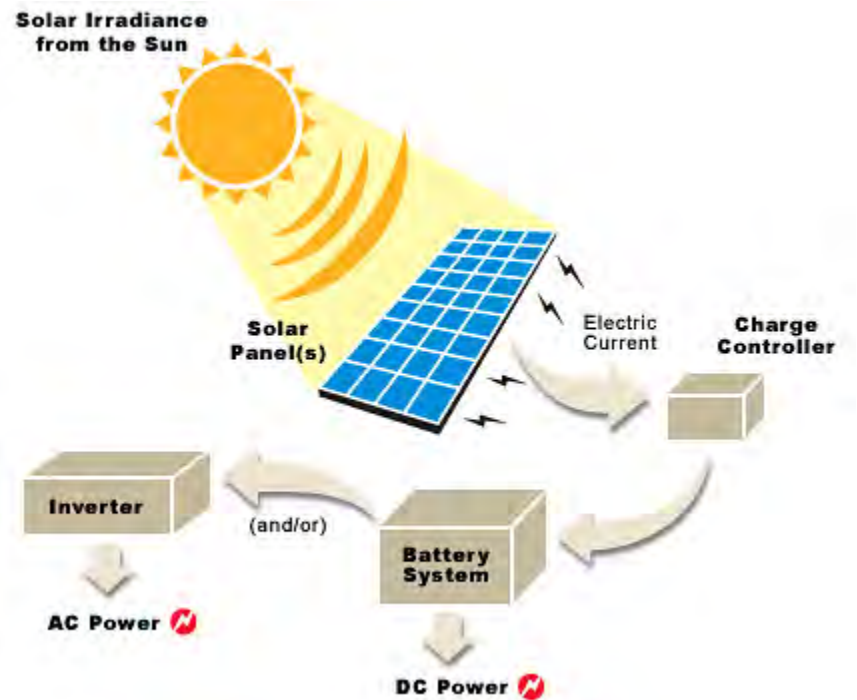


# Grafton Solar Forum

August 22, 2012



Umass Research Farm, South Deerfield  
70 panel, 16.45 kW project installed in 2010



# Solar Industry

- Solar installations at the end of 2010
  - Globally 18,200 MW
  - United States 2,593 MW
  - Massachusetts 38 MW
  
  - Massachusetts as of 5/1/12 105 MW
  - Massachusetts' goal 250 MW by 2017
  
  - MA Projects in the “queue” 353 MW as of 10/19/11

# Electricity Consumed at Tufts

Campus	Energy (kWh)	
Grafton	11,325,421	15%
Boston	25,259,643	34%
Medford	37,339,976	51%
Total	73,985,040	100%

**\$11-12 million annually**

# What is PowerOptions?

- Created when electricity and natural gas industries were deregulated in MA (1996)
- To help nonprofits consolidate their energy buying influence
  - “bring energy predictability, dependability and cost savings to nonprofits.”
- Tufts has been a member since the late ‘90s
- Over 550 members throughout Massachusetts
- Current programs include: electricity, natural gas, demand response and solar

# Why did PowerOptions pursue a solar program?

- MA institutional electricity customers inundated with solicitations by solar provider
- Tufts receives 2-5 inquiries each month
- How to find the right developer?
- How to develop a fair power purchase agreement (PPA)?
- Membership encouraged PowerOptions to run a competitive process for MA institutional customers

# Why now?

- Price of panels has fallen dramatically
- Federal and State incentives enable SunEdison to offer competitive PPA contracts
  - Accelerated depreciation + bonus depreciated (50% in 2012)
  - 30% Federal Investment Tax Credit
  - MA Solar Renewable Energy Certificates (SREC)
- ~~Supply of SRECs is tight now, so pricing is high~~
- Utilities in MA have a renewable portfolio standard (RPS) obligation
- Green Communities Act requires 15% of MA electricity to be supplied by new renewable power facilities by 2020. In 2010, RPS=5% with 1% increase annually.



Queue is filling with projects,  
so SREC prices are falling

# PowerOptions' Review Committee

- President and CEO, PowerOptions
- Program Manager
- Consultant to PowerOptions (and Tufts), 25+ years of utility company experience
- Renewable energy project finance expert
- Attorney specializing in Energy and Utilities
- Attorney specializing in emerging legal issues relating to green energy, and alternative energy
- Member representative: Municipality
- Member representative: University

# PowerOptions Process

- **RFQ development:** solar developers interviewed for background information
- **RFQ solicitation:** Advertised widely in MA, with solar development trade associations and journals.
- **RFQ Response Review:** 15 responses received
- **Committee review:** established evaluation criteria, conducted interviews, checked references, performed analysis and negotiated contract terms.
- **Review elements:** project development experience, financial qualifications, commercial competence, corporate and staff experience, range of additional services, terms.
- **Narrowed to 8 firms:** asked to price a case study for a specific university campus
- **In-person Interviews:** the committee met with 8 firms. Three finalists were selected.
- **Negotiation and selection:** Three finalists invited for 2<sup>nd</sup> interviews
- **Developer selected**
- **PowerOptions Solar Program Agreement:** PPAs executed between member institution and developer. PowerOptions enters into a separate agreement with developer allowing for on-going program monitoring.



# SunEdison Selected

- SunEdison selected based on best PPA pricing methodology, 10 year SREC fixed value, willingness to develop large and small projects, strength of company and team, financial backing
- SunEdison is a subsidiary of MEMC Electronics Materials, a global leader in polysilicon and silicon wafer manufacturing (the foundation of most solar cells and semiconductor devices)
- SunEdison has 500 MW of solar installed globally

# Power Purchase Agreement (PPA)

- Long-term (20 years) agreement between the solar provider and the host (Tufts)
- Host is obligated to buy all power generated from the solar installation
- Some PPAs start at a low rate and escalate
- PowerOptions PPA is a fixed rate for the entire contract period
- Fair Market Value buyout option starts in year 6 of contract
- Contractual financial guarantees for system removal and site restoration

# Solar PPA Benefits

- No capital outlay
- No on-going maintenance costs
- Locks in “all in” price of electricity
  - Transmission (cannot be hedged, expected to increase)
  - Distribution (cannot be hedged)
  - Supply (can hedge up to 5 years)
- Provides hedge against future price increases for 51% of campus needs. Cannot be done via standard commodity contract.
- Demonstrates leadership and commitment to climate change action.
- The coincidence of peak solar generation and peak campus demand likely to lower demand for remaining grid supplied electricity resulting in a lower unit price for balance of grid supplied electricity.

# Important to remember...

- The solar system cannot provide power during an emergency
  - Electric code requires that the photovoltaic arrays automatically disconnect with the loss of utility power to prevent back feeding the utility grid and possible electrocution of personnel
- The host does not keep the “green attributes” of the solar generation
  - To make finances work, the SRECs go to the developer

# Solar Options Discussed for Grafton

- Roof mounted
- Parking canopies
- Ground mounted

# Roof Mounted

Grafton roof space is not ideal

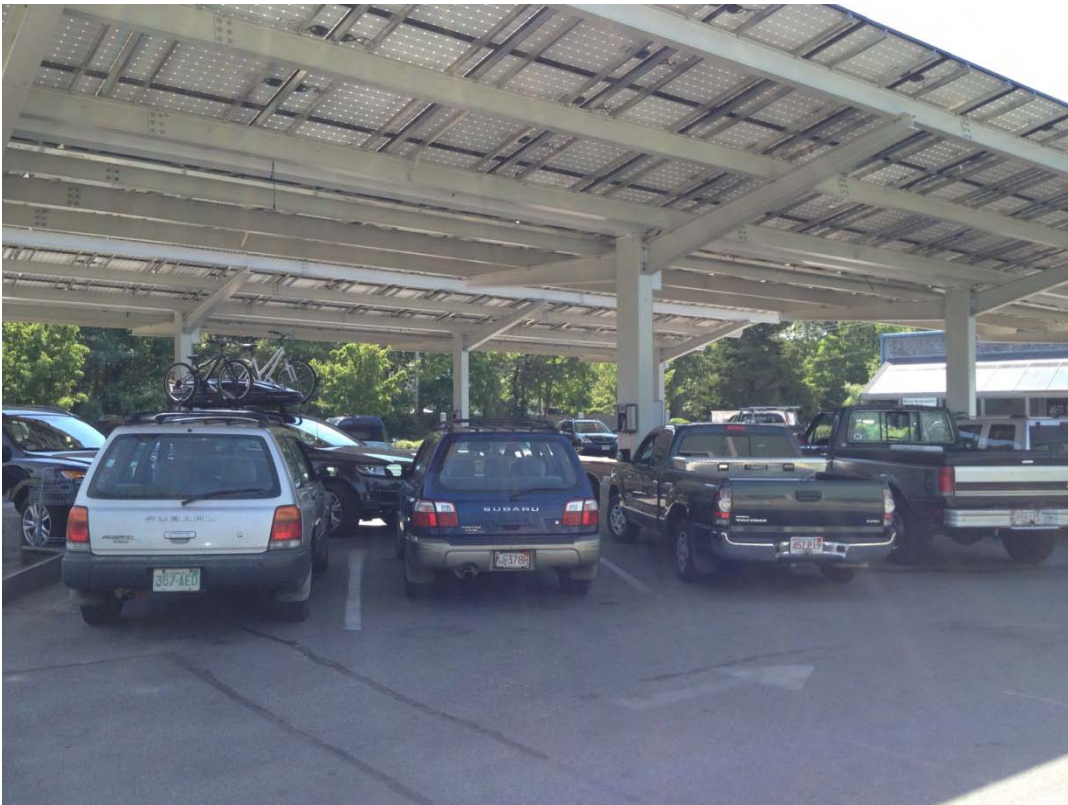
- Need large expanses of flat or south facing roof
- Cannot be shaded by trees or other buildings
- Recently replaced or in mint condition
- Minimal mechanical equipment or other obstructions





# Parking Canopies

- Systems will be smaller
- System costs are higher, so PPA rate is higher
- Parking lot snow removal may be an issue



# Ground Mounted

- Ability to build large scale systems
- Simpler, less expensive installation
- Easiest to maintain
- Lower installation costs reflected in cost of power for 20 years
- Mounting angle is optimized (usually 30 degrees)
- Direction is optimized (due south)



# What is the technology?

- The preliminary designs use:

- Modules:

- MEMC-M310AMC

- Manufacturing locations in the US and worldwide

- Inverters:

- AE Solaron 500

- AE Solaron 333

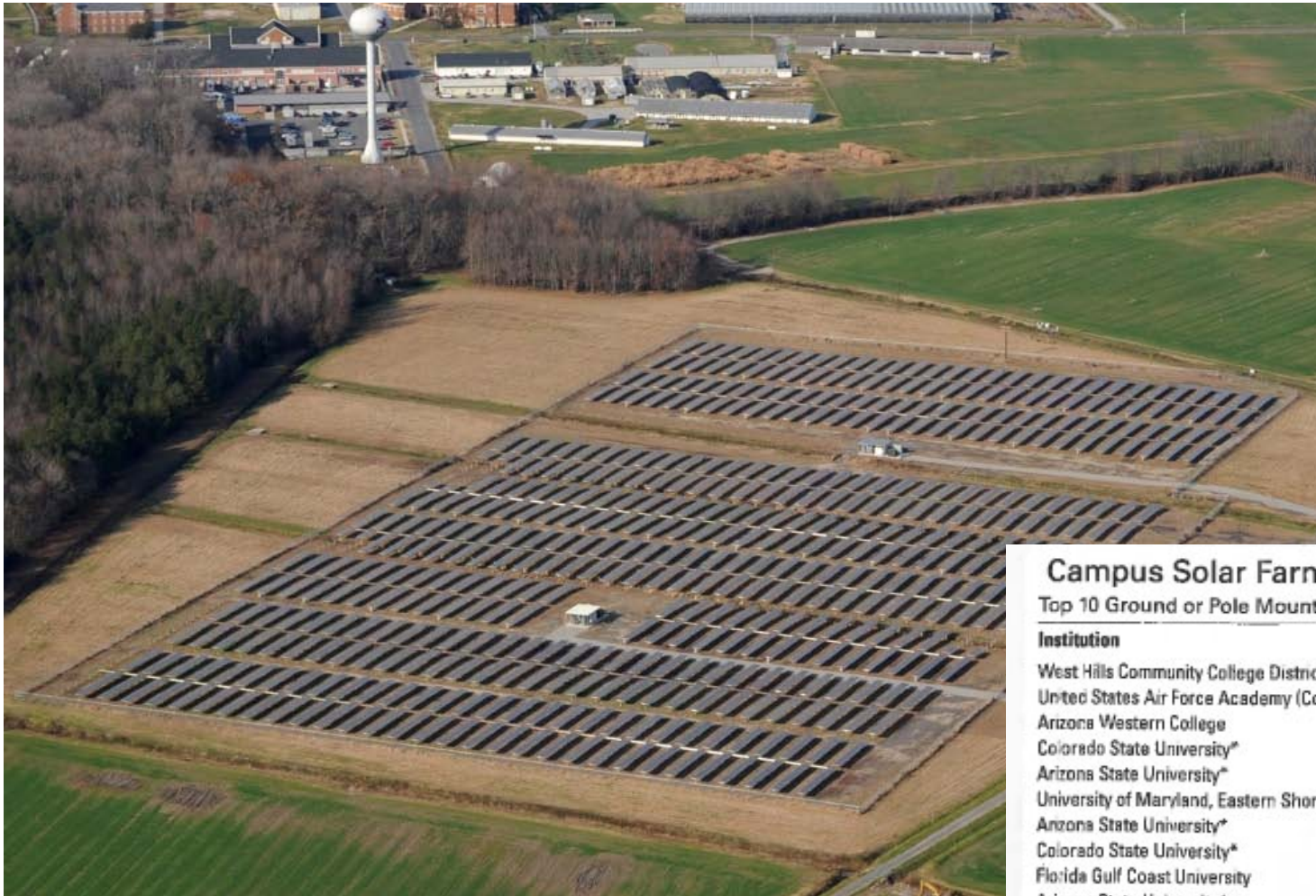
- Solaron products built in the US are fully compliant with the Buy American Act

- The final design could use a different manufacturer's panel



# University of Maryland, Eastern Shore “Solar Farm”

## 20 year PPA with SunEdison



Institution	Year Complete	Capacity (kW)
West Hills Community College District (Calif.)	2011	6,000
United States Air Force Academy (Colo.)	2011	6,000
Arizona Western College	2011	5,000
Colorado State University*	2010	3,300
Arizona State University*	2011	2,677
University of Maryland, Eastern Shore	2009	2,200
Arizona State University*	2011	2,124
Colorado State University*	2009	2,000
Florida Gulf Coast University	2008	2,000
Arizona State University*	2011	1,976

SOURCE: AASHE Campus Solar Photovoltaic Installations Database, as of April 2012, database includes information on 467 installations on 293 campuses, [www.aashe.org](http://www.aashe.org) \*Denotes separate installations on the same campus

7,800 panels, 17 acres on a former cornfield, 2.1 MW, 15% reduction in electricity purchase

# SunEdison System @ Simcoe, Ontario

## Winter Conditions



Inverters



9,111 kW DC

76 acres

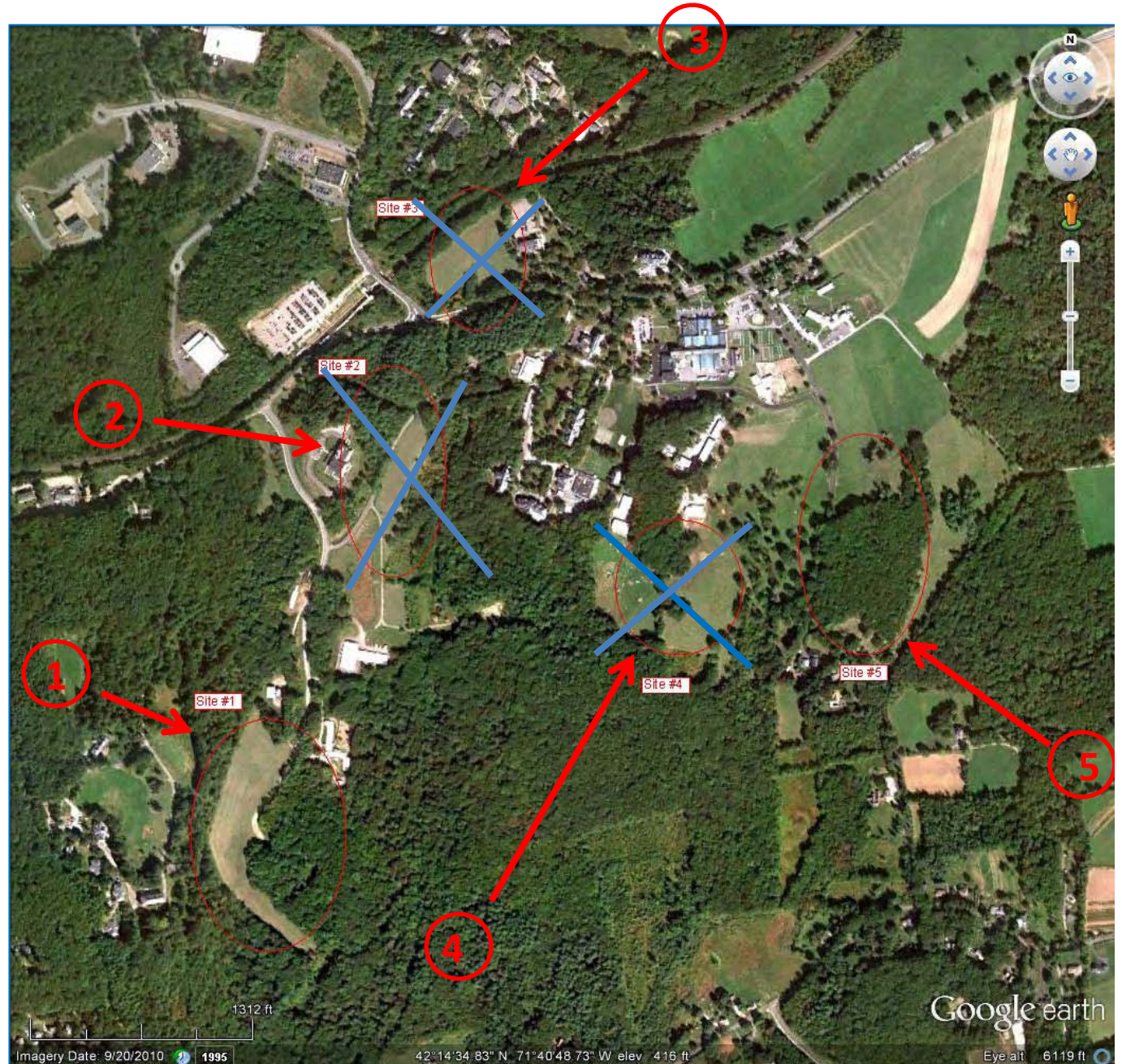
Contractual generation=9.8 million kWh/yr

1<sup>st</sup> year actual generation=10.4 million kWh



# Potential Sites

- 1) Science Park
  - Large
  - Flat
  - Near interconnection
- 2) Small, rocky, steep
- 3) Loew Center
  - Small
  - Free of rocks, trees
  - Utility easements
- 4) Small, far from interconnection
- 5) The Knoll
  - Large
  - Near interconnection
  - Rock removal
  - Tree removal





# Selected Sites



Science Park  
Phase II

The Knoll



# Science Park Phase II



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 Project: 8/21/2014 11:08:33 AM  
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12500 Baltimore Avenue,  
 Beltsville, MD 20705  
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PROJECT NAME  
**TUFTS UNIVERSITY - GRAFTON CAMPUS**

GRAFTON, MA

PROJECT NUMBER  
**MA-11-0159**

PROPOSAL SUBMITTAL

REVISION NO.	DATE	BY	JUSTIFICATION

SOLAR ELECTRIC SYSTEM CLIENT:  
**TUFTS UNIVERSITY**

DESIGNER:	DATE:	
MANAGER:	DATE:	
ENERGY CONSULTANT:	DATE:	

SHEET NO.  
**1 OF 1**

PRELIMINARY DESIGN  
 TUFTS UNIVERSITY - GRAFTON CAMPUS

PRELIMINARY DESIGN  
 NOT FOR CONSTRUCTION

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# Science Park

View from Access Road Looking West



Photo Location Map

# Science Park -- Existing View from Access Road Looking West

Tufts University—Grafton Campus I Solar Energy Project



Existing Condition

Photo Location Map

FIGURE 1a

Project Visualization

Science Center Site

View from Project Access Road Looking West



# Science Park – Simulated View from Access Road Looking West

Tufts University—Grafton Campus I Solar Energy Project



Simulated Condition

FIGURE 1b



Project Visualization  
Science Center Site  
View from Project Access Road Looking West



# Science Park

View from Access Road Looking North



Photo Location Map

# Science Park – Existing View from Access Road Looking North

Tufts University—Grafton Campus | Solar Energy Project



Existing Condition

FIGURE 2a



Project Visualization  
Science Center Site

View from Project Access Road Looking North



# Science Park – Simulation

## View from Project Access Road Looking North

Tufts University—Grafton Campus I Solar Energy Project



Simulated Condition

FIGURE 2b



Project Visualization  
Science Center Site

View from Project Access Road Looking North

# Science Park

- Pros
  - No plan for land use for 20 years
  - Less tree removal
  - Away from neighbors
- Cons
  - Must be developed as commercial real estate
  - Out of sight, therefore out of mind







# The Knoll

View from Access Road Looking West



Photo Location Map



# The Knoll – Existing View from Access Road Looking West

Tufts University—Grafton Campus | Solar Energy Project



Existing Condition

FIGURE 3a



Project Visualization  
The Knoll Site

View from Project Access Road Looking West



# The Knoll – Simulated View from Access Road Looking West

Tufts University—Grafton Campus I Solar Energy Project



Simulated Condition

FIGURE 3b

Project Visualization  
The Knoll Site

View from Project Access Road Looking West

# The Knoll

View from Access Road Looking South  
(near Wildlife Clinic)



Photo Location Map



# The Knoll – Existing View from Access Road Looking South

Tufts University—Grafton Campus I Solar Energy Project



Photo Location Map

Existing Condition

FIGURE 5a

Project Visualization

The Knoll Site

View from Project Access Road Looking South



# The Knoll – Simulated View from Access Road Looking South

Tufts University—Grafton Campus I Solar Energy Project



Simulated Condition



FIGURE 5b  
Project Visualization  
The Knoll Site

View from Project Access Road Looking South



# The Knoll

## View from Route 30 Looking South



Photo Location Map

# The Knoll – Existing View from Route 30 Looking South

Tufts University—Grafton Campus I Solar Energy Project



Existing Condition



FIGURE 6a  
Project Visualization  
The Knoll Site  
View from Grafton Road Looking South



# The Knoll – Simulated View from Route 30 Looking South

Tufts University—Grafton Campus I Solar Energy Project



Simulated Condition

FIGURE 6b

Project Visualization  
The Knoll Site

View from Grafton Road Looking South



# The Knoll

- Pros
  - Somewhat visible depending on vantage point
  - Closer to utility interconnection point
  - Attractive PPA rate
  - No plans for land use
- Cons
  - Somewhat visible depending on vantage point
  - Tree removal
  - Rocky terrain



# Solar Generation in Grafton

Site	System Size (kW DC)	System Size (kW AC)	Energy (kWh)	Area (Acres)
Grafton Campus		2,870	11,325,421	
Science Park	1,829	1,500	2,395,000	10.86
Knoll	<u>2,580</u>	<u>2,000</u>	<u>3,380,000</u>	<u>14.00</u>
Total	4,409	3,500	5,775,000	24.86
Grafton solar % Grafton Total			51%	
Grafton solar % University Total			8%	

Energy/Emissions Working Group to recommend a Tufts renewable portfolio standard .

MA RPS increases 1% per year.

# Savings assuming current tax rate

Summary				Solar/				
With Tax Payments		Acres	Gen from Solar	Tot Campus	20 yr Savings	NPV @ 4%:	NPV @ 5%:	NPV @ 7%:
Science Park Ph II (1,500 kW AC)	Maximized	10.86	2,395,000	21%	\$1,588,236	\$1,030,997	\$935,004	\$777,693
Knoll (2,000 kW AC)	Shifted	14.00	3,380,000	30%	\$2,383,233	\$1,575,013	\$1,435,547	\$1,206,738
Total		24.86	5,775,000	51%	\$3,971,468	\$2,606,009	\$2,370,550	\$1,984,431
Note:								
Assumes ongoing Cummings School costs for lost farm income and required Grafton Land Trust mitigation payment, and								
assumes real estate taxes paid at \$14 per \$1,000, increasing PPA costs to \$.095 cents per kWh on each site. Ground lease costs still at revenue neutral.								
Tax Assumptions:								
Tax rate:		0.01413						
Capital investment:		\$8,000,000						
Annual taxes:		\$113,040						
Increase in base PPA rate due to taxes:		\$0.02						

# Savings assuming reduced tax rate

Summary				Solar/				
With Tax Payments		Acres	Gen from Solar	Tot Campus	20 yr Savings	NPV @ 4%:	NPV @ 5%:	NPV @ 7%:
Science Park Ph II	Maximized	10.86	2,395,000	21%	\$2,067,236	\$1,343,966	\$1,219,261	\$1,014,820
Knoll	Shifted	14.00	3,380,000	30%	\$3,059,233	\$2,016,698	\$1,836,711	\$1,541,390
Total		24.86	5,775,000	51%	\$5,126,468	\$3,360,664	\$3,055,972	\$2,556,211
Note:								
Assumes ongoing Cummings School costs for lost farm income and required Grafton Land Trust mitigation payment, and assumes real estate taxes to be paid at \$7 per \$1,000, increasing PPA costs to \$.085 cents per kWh on each site. Ground lease costs still at revenue neutral.								
Tax Assumptions:								
Tax rate:		0.01413		0.007				
Capital investment:		\$8,000,000		\$8,000,000				
Annual taxes:		\$113,040		\$56,000				
Increase in base PPA rate due to taxes:		\$0.02		\$0.01				



# Emissions Reductions

## U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator

The systems will generate approximately							
<b>5,775,000</b> kWh of electricity annually to avoid	3,982	Metric Tons of Carbon Dioxide emissions					
This is equivalent to:							
Annual greenhouse gas emissions from		781	passenger vehicles				
CO <sub>2</sub> emissions from		446,433	gallons of gasoline consumed				
CO <sub>2</sub> emissions from		9,261	barrels of oil consumed				
CO <sub>2</sub> emissions from		53	tanker trucks' worth of gasoline				
CO <sub>2</sub> emissions from electricity use of		497	homes for one year				
CO <sub>2</sub> emissions from energy use of		345	homes for one year				
Carbon sequestered by		102,107	tree seedlings grown for 10 years				
Carbon sequestered annually by		849	acres of pine or fir forests				
Carbon sequestered annually by		40	acres of forest preserved				
CO <sub>2</sub> emissions from		165,924	propane cylinders used for home barbeques				
Greenhouse gas emissions avoided by recycling		1,388	tons of waste instead of sending it to landfill				

Estimated forest acreage to be removed: 15

# Next Steps

- Finalize sites
- Amend PPA language with “out clause” should property tax negotiations fail (expected this week)
- Sign PPA before August 31, 2012 to hold PPA pricing
- Interconnection permit with National Grid
- SunEdison engineering begins
- Local permitting process
- Construction likely by spring/summer of 2013

# More information:

- PowerOptions [www.poweroptions.org](http://www.poweroptions.org)
- SunEdison [www.sunedison.com](http://www.sunedison.com)
- US EPA Greenhouse Gas Equivalencies Calculator [www.epa.gov/cleanenergy/energy-resources/calculator.html](http://www.epa.gov/cleanenergy/energy-resources/calculator.html)