Ohio | Department of Development

Final Proposal Evaluation

2011

Third Frontier Photovoltaic Program

January 2011

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This Report written by:

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PROPOSAL REVIEW TEAM

❖ TARATEC CORPORATION

- Edward Ungar, President (Quality Control)
- Paula Dunnigan, Project Leader
- Chuck Meadows
- Bill Munk
- Reed Slevin

❖ SIX (6) EXTERNAL REVIEWERS

- **Mr. Thomas J. Gross** is an energy consultant who retired from DOE after 30 years where he served as a Senior Executive and Member of the Board of Directors of Energy Efficiency and Renewable Energy (EERE) and Deputy Assistant Secretary for the Office of Transportation Technologies (annual budget of $300M). Mr. Gross held major roles in the following DOE programs: Partnership for a New Generation of Vehicles, FreedomCar Partnership, International Partnership for the Hydrogen Economy, and California Fuel Cell Partnership. His specific areas of expertise include hydrogen/fuel cells, vehicle batteries including nickel metal hydride, lithium-ion, and other types, biodiesel, and other alternative fuels.
- **Dr. Joseph M. Morabito** is a Director at Alcatel-Lucent. He was named a Bell Laboratories Fellow in 2004 for outstanding lifetime contributions to thin film surface and interface analysis and the development of new thin film systems that provide high density interconnections, thin film resistors, capacitors and cross-overs of high reliability and performance for the silicon integrated circuits (SICs) and hybrid integrated circuits (HICs) used in advanced telecommunications systems. Dr. Morabito is an expert in photovoltaic technologies and was a valuable advisor to the EPRI Solar Program for over 20 years. He has broad expertise in other distributed energy technologies and has published extensively on systems analyses linking various types of distributed energy generation with the smart grid. Dr. Morabito serves on the Board of Directors of the R&D Council of New Jersey.
- **Dr. Evan E. Hughes** is a specialist in biomass and waste as fuels for power generation via combustion, thermochemical gasification, biological gasification (e.g. anaerobic digestion, landfill gas, algae, etc.) and energy crops. He has managed technical projects involving fuel derived from municipal solid waste as well as biomass and alternate fuels (tires, plastics, paper, sawdust, other wood wastes, and energy crop fuels-both woody and herbaceous crops and crop residues). As the Manager, Biomass Energy at EPRI, he has worked with electric utilities, U.S. DOE, and the California Energy Commission. Dr. Hughes currently does project reviews and evaluations for one of the California utilities.
- **Mr. George A. Hay III** brings more than 30 years of experience with EPRI, DOE, and GRI in the areas of renewable energy and distributed generation for the electrical industry. He is a DOE proposal reviewer in the areas of biorefineries, advanced biofuels, and renewable manufacturing. Mr. Hay is currently working with the University of California and NREL on municipal/county/university applications of sustainable energy projects including solar, wind, biomass, landfill gas, energy storage, and fuel cells. He is an advisor to various committees of the New Jersey Clean Energy Program.
- **Mr. Norman D. Malcosky** has over 40 years of experience in the energy industry performing and managing research activities in fossil fuel exploration, alternative fuel vehicles, biofuels, and fuel cells. He has specialized in Liquefied Natural Gas, Compressed Natural Gas, and propane-fueled vehicles. Using his strong background in mechanical engineering, he has patented various types of industrial equipment for the natural gas industry. Mr. Malcosky retired from Battelle Memorial Institute in 2002 where he served as a Senior Research Scientist in Battelle's Transportation Group and Equipment Design and Mechanical Systems Group.
- **Dr. C. Fred Clark, Jr.** was a co-founder and co-owner of CeramPhysics (Westerville, OH) for 29 years where he combined the perspectives of a research scientist with those of a small-business entrepreneur. He was involved in all phases of contract research including proposal writing, contract administration, project management, patents, and licensing. Dr. Clark was involved in the development of a number of patented inventions involving unusual properties of ceramic materials including oxygen and NO_x sensors, SOFC electrodes, energy storage capacitors, oxygen removal technology, and improved dielectric insulation for high-temperature superconductors.

OVERVIEW OF PROPOSAL EVALUATION PROCESS

- Two-stage evaluation process
- The evaluation process is objective and robust. Its consistency has been evaluated through rescoring. Results were found to be independent of the composition of the individual review panels and consistent year-to-year.
- The objective of the **First Stage Evaluation** is to rank the proposals on the basis of which best meet the RFP requirements and then to select the highest-ranking proposals for more in-depth evaluation.
  - The cut-point is based on significant score differences and best use of evalution resources. Taratec recommends a cut-point and ODOD selects the cut-point.
- The objective of the **Second Stage Evaluation** is to rank the highest-scoring proposals from the First Stage on the basis of the quality of investment for the State of Ohio.
  - Ohio job and revenue creation/retention that is likely to occur within 3–5 years
  - Company viability and business functions that are planned in Ohio
  - Potential of the project to contribute to a cluster of related companies in an industry that Ohio is trying to build

PROPOSAL EVALUATION PROCESS

❖ FIRST STAGE EVALUATION

- Conflict of Interest evaluation for each reviewer
- Each proposal is read by 3 reviewers (internal and external)
- Proposal is scored by each reviewer using a scoring instrument (34 questions) based on the RFP criteria
- All scores from each reviewer are entered into a database
- Reviewers provide written comments on areas of concern or those requiring clarification
- A list of proposals ranked on the basis of their average scores is produced
- Taratec meets with ODOD to establish the competitive range (cut-point) for each competition
- Proposals scoring above the cut-point advance to the Second Stage Evaluation

❖ SECOND STAGE EVALUATION

- Reviewer comments are integrated into the construction of a customized set of written questions for each applicant
- Applicants have one week to submit written responses
- Face-to-face meeting (90 minutes) for reviewers and applicants to discuss issues
- Final trade secret identification by applicants
- Preparation of 2-page project write-up
- Risk-benefit scoring by the entire review team
- Scores entered into the database
- Final recommendations developed
- Preparation of materials for consideration by the Third Frontier Commission

SCORING METHODOLOGY

SUMMARY OF FIRST STAGE EVALUATIONS

	TFFCP	**TFPVP**	TFAEP	Total
LOIs Submitted	25	**33**	93	151
Proposals Received by ODOD	12	**18**	47	77
Proposals Evaluated by Taratec	12	**15**	43	70
Recommended for 2nd Stage	7	**9**	19	35
TFRDF Available	$7M	**$7M**	$7M	$21M
TFWCF Available	$1M	**$1M**	$1M	$3M
Cumulative TFRDF Requested	$6.9M	**$7.5M**	$16.9M	$31.3M
Cumulative TFWCF Requested	$57K	**$163K**	$3.2M	$3.4M

SCORING METHODOLOGY *(continued)*

SECOND STAGE EVALUATION FACTORS

❖ TECHNICAL RISK

- Technical Reach— (40%)
  Does the project require technology development beyond prior practice and is it practical to attain?
- Resource Limitations— (40%)
  Does the project team have sufficient resources in terms of people, facilities and funds to attain the project goals?
- Technology Protection— (20%)
  Have provisions been made to protect the technology by patent and trade secret?

❖ COMMERCIAL RISK

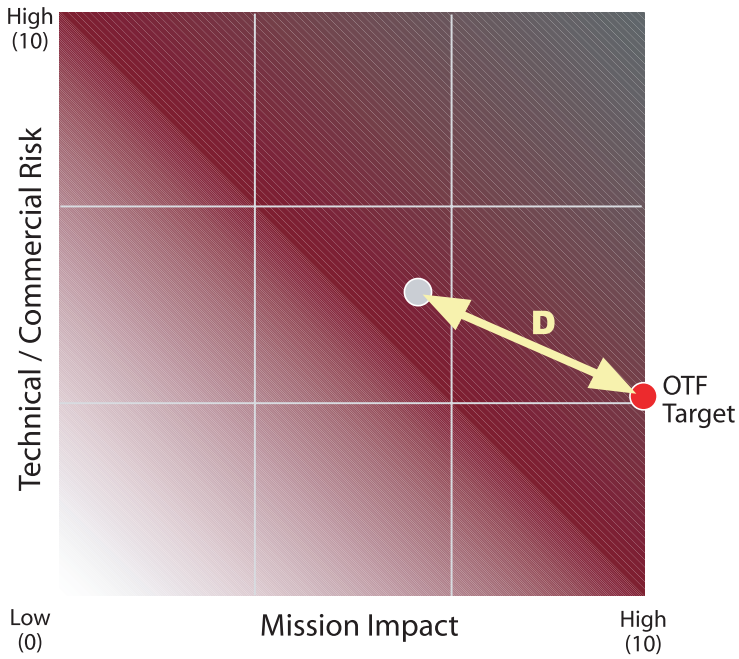
- Path to Market— (40%)
  Does the project team have a credible path to market, customer knowledge, pricing strategy, sales force, etc.?
- Corporate Stability— (40%)
  Does the project team have the financial resources available or committed to bring this product to market?
- Commercial Infrastructure— (20%)
  Does the project team have access to established distribution channels?

❖ MISSION IMPACT

- Cluster Formation— (25%)
  Does the applicant buy from, sell to, or otherwise contribute to the formation of a technology or industry cluster in Ohio?
- Ohio Economics— (50%)
  Does this project show a credible path to substantial job and revenue creation in Ohio in 3–5 years?
- Business Model— (25%)
  Is the proposed business model viable and will it lead to new business growth in Ohio?

SCORING METHODOLOGY *(continued)*

- Two 2-dimensional scoring matrices
  - One for Technical Risk
  - One for Commercialization Risk
  - Both risks are plotted against Mission Impact
- Target for Technical Risk is (10, 3.5)
- Target for Commercial Risk is (10, lowest value)
- Project's final score is based upon sum of D1 and D2



2011 TARGETS

	Technical Risk	Commercial Risk	Mission Impact
Fuel Cell	3.50	2.07	10.00
Photovoltaic	**3.50**	**2.40**	**10.00**
Advanced Energy	3.50	2.13	10.00

TARGET DEFINITION FOR OHIO'S THIRD FRONTIER CLUSTER PROGRAMS

The targets for Technical Risk, Commercial Risk, and Mission Impact have been set based on the profile of projects that are most likely to meet the intent of the Third Frontier Cluster Programs to develop new technology businesses that will produce economic development in Ohio in the 3- to 5-year timeframe. These targets were set after consultation with ODOD and the Third Frontier Commission.

Mission Impact

Ohio is seeking to fund the projects that will result in the highest economic development impacts for the dollars invested. Therefore, the target for mission impact has been set at the maximum of 10.

Technical Risk

Since economic development results are desired in a relatively short timeframe, projects selected for funding should be relatively mature, i.e., in the late Incubating or Demonstrating Stage with a functional prototype.

Projects that contain relatively little technical challenge, represent product line extensions, or are close to market are likely to score low on technical risk, i.e. 1 or 2. These types of projects would be candidates for internal funding by the applicant company, could attract investment, or would be bankable. They would not have the level of risk intended for this program.

At the other end of the spectrum, there will be projects that are still in early stages of development and have a number of significant technical and cost issues remaining to be resolved. These projects are frequently classified as Imagining or early Incubating Stage. They are likely to have technical risk scores in the range of 7–10. These projects would be candidates for federal R&D funding in the form of SBIRs or NIH grants. Only after they reach greater technical maturity would they be attractive candidates for the Third Frontier Cluster Programs.

The ideal level of technical risk for these three cluster programs has been set at 3.5. It is believed that this level of technical risk presents the optimum probability of achieving the intended economic development outcomes within the targeted timeframe.

Commercial Risk

The cluster programs are intended to serve the needs of both start-up companies and companies that have on-going business.

Existing companies frequently have well-developed distribution channels and some degree of financial stability resulting in low commercial risk scores. However, they may require assistance in new product development to reach a level of product maturity that will allow them to compete for scarce internal resources. Proposals from these companies will typically have commercial risks that score in the range of 1.5–2.5.

It was decided that these companies should not be penalized for having "too low of a commercialization risk." Therefore, for each competition, the target for commercial risk is set as the floor or at the lowest value of all proposals in the competitive range. This ensures that no proposal is penalized for having the ability to bring its product into the marketplace.

2011 TFPVP
Third Frontier Photovoltaic Program
Summaries of Proposals in Competitive Range

RECOMMENDATIONS FOR FUNDING
2011 Third Frontier Photovoltaic Program (TFPVP)

RECOMMENDED FOR FULL FUNDING

	OTF NO.	APPLICANT	OTF $ REQUESTED	OTF $ CUMULATIVE	WRIGHT $ REQUESTED	WRIGHT $ CUMULATIVE
1.	TFPVP 11-215	GreenField Solar Corporation	$1,000,000	$1,000,000	$0	$0
2.	TFPVP 11-209	Energy Focus, Inc.	$1,000,000	$2,000,000	$0	$0
3.	TFPVP 11-213	DyeTec Solar, Inc.	$ 950,000	$2,950,000	$0	$0
4.	TFPVP 11-231	Case Western Reserve University	$ 736,579	$3,686,579	$163,239	$163,239
5.	TFPVP 11-206	Process Technology	$ 357,713	$4,044,292	$0	$163,239
TOTAL FUNDS REQUESTED				**$4,044,292**		**$163,239**

2011 Third Frontier Funding Cycle Photovoltaic Program Final Round Scores

SCORE		City	County	OTFRD $ Requested	OTFRD $ Cumulative	WRIGHT $ Requested	WRIGHT $ Cumulative
Targets - Mission Impact: 10 Commercial Risk: 2.4 Technical Risk: 3.5							
78.1	**TFPVP 11-215** GreenField Solar Corporation Low Cost Concentrated PV Design	Oberlin	Lorain	$1,000,000	**$1,000,000**	$0	**$0**
	Technical Risk: **4.47** (R: 4.00 L: 5.00 P: 4.33) Commercial Risk: **4** (P: 3.00 S: 4.33 I: 5.33) Mission Impact: **7.67** (E: 8.33 M: 7.33 C: 6.67)						
74.8	**TFPVP 11-209** Energy Focus, Inc. High Efficiency Photovoltaic Enabled Off-Grid System	Solon	Cuyahoga	$1,000,000	**$2,000,000**	$0	**$0**
	Technical Risk: **4** (R: 5.00 L: 3.00 P: 4.00) Commercial Risk: **3.27** (P: 4.33 S: 3.00 I: 1.67) Mission Impact: **7** (E: 6.00 M: 9.00 C: 7.00)						
69.7	**TFPVP 11-213** DyeTec Solar, Inc. Dye-Sensitized PV Architectural Glass	Toledo	Lucas	$950,000	**$2,950,000**	$0	**$0**
	Technical Risk: **2.94** (R: 3.67 L: 2.67 P: 2.00) Commercial Risk: **4.93** (P: 5.00 S: 5.00 I: 4.67) Mission Impact: **6.75** (E: 6.00 M: 7.67 C: 7.33)						
69.0	**TFPVP 11-231** Case Western Reserve University Mirror-Augmented Solar Photovoltaic Systems: Durability and Lifetime Validation	Cleveland	Cuyahoga	$736,579	**$3,686,579**	$163,239	**$163,239**
	Technical Risk: **6.53** (R: 8.00 L: 4.67 P: 7.33) Commercial Risk: **2.93** (P: 4.33 S: 2.00 I: 2.00) Mission Impact: **6.84** (E: 5.67 M: 9.00 C: 7.00)						
67.2	**TFPVP 11-206** Process Technology Commercialization of Inline Heater for use in Photovoltaic Solar Cell Manufacturing	Mentor	Lake	$357,713	**$4,044,292**	$0	**$163,239**
	Technical Risk: **5.2** (R: 5.00 L: 5.33 P: 5.33) Commercial Risk: **3.53** (P: 5.00 S: 2.67 I: 2.33) Mission Impact: **6.25** (E: 5.00 M: 9.00 C: 6.00)						
63.3	**TFPVP 11-214** eQED, LLC Commercialization of Next Generation Solar Microinverters for Photovoltaic Power Systems	Mayfield Village	Cuyahoga	$1,000,000	**$5,044,292**	$0	**$163,239**
	Technical Risk: **6.13** (R: 7.00 L: 5.33 P: 6.00) Commercial Risk: **5.4** (P: 4.00 S: 6.00 I: 7.00) Mission Impact: **6.5** (E: 5.00 M: 9.00 C: 7.00)						
62.6	**TFPVP 11-207** Iosil Energy Corporation Optimizing Low Cost, High Purity, Manufacturing of Solar Grade Polysilicon for the Photovoltaics Industry	Albuquerque	NA	$988,800	**$6,033,092**	$0	**$163,239**
	Technical Risk: **3.47** (R: 4.33 L: 3.00 P: 2.67) Commercial Risk: **3.6** (P: 3.00 S: 4.00 I: 4.00) Mission Impact: **5.5** (E: 6.33 M: 4.00 C: 5.33)						
61.2	**TFPVP 11-224** Edison Materials Technology Center Integration of PV into Critical Power Sites	Dayton	Montgomery	$998,027	**$7,031,119**	$0	**$163,239**
	Technical Risk: **3.60** (R: 2.67 L: 3.00 P: 6.67) Commercial Risk: **2.4** (P: 4.33 S: 1.00 I: 1.33) Mission Impact: **5.25** (E: 5.00 M: 7.00 C: 4.00)						

2011 Third Frontier Funding Cycle Photovoltaic Program Final Round Scores

SCORE		City	County	OTFRD $ Requested	OTFRD $ Cumulative	WRIGHT $ Requested	WRIGHT $ Cumulative
Targets - Mission Impact: 10 Commercial Risk: 2.4 Technical Risk: 3.5							
50.8	**TFPVP 11-204** Calyxo USA, Inc.	Perrysburg	Wood	$465,000	**$7,496,119**	$0	**$163,239**

Optimization and Standardization of Atmospheric Pressure Physical Vapor Deposition Components for Improved CdTe Thin-Film PV Module Manufacturing

Technical Risk:	**3.80**	Commercial Risk:	**3.13**	Mission Impact:	**4**
R: 4.00 L: 3.67 P: 3.67		P: 2.33 S: 3.00 I: 5.00		E: 4.33 M: 4.00 C: 3.33	

Ohio Department of Development

2011 TFPVP Evaluation Summary

Third Frontier Photovoltaics Program

GreenField Solar Corporation (GFS)

Low Cost Concentrated PV Design

TFPVP 11-215	Final Score: 78.1	Rank: 1

Previous Ohio Investment

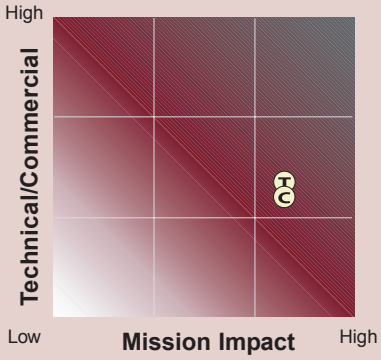
Greenfield Solar Corporation (GFS) has not received a prior OTF award.

Project Description

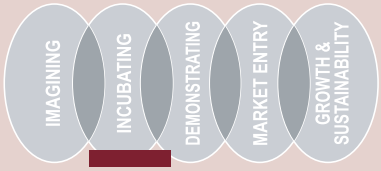
GFS has developed a concentrated photovoltaic (CPV) solar energy technology that decreases solar power cost by concentrating sunlight on a proprietary solar cell (PhotoVolt™), thereby reducing the amount of PV semiconductor materials required. The system, StarGen™, produces both electricity and thermal energy. While a first-generation system has been built and field demonstrated, its cost must be further reduced to meet mass-market pricing requirements. In the 2-year project proposed, GFS will conduct a complete cost reduction redesign to reduce total system installed cost to $1.76 per peak watt, a cost that would establish global price leadership for PV electricity. Redesign efforts with specific cost reduction targets involve the system electronics, mechanicals, primary optics, wiring and thermal management. Edison Materials Technology Center (EMTEC) will assist GFS in some of these redesign areas and in preparing certification packages. The Ohio State University Wright Center for Photovoltaic Innovation & Commercialization (OSU PVIC) will assist in improving the semiconductor processing methods.

Key Issues

- GFS has correctly identified the cost per watt of electricity delivered as the key to market success for solar powered generation. However, the system's long-term performance and reliability will also need to be demonstrated to customers, and it is not clear the Generation 1 units have provided sufficient validation. The length of the evaluation process required may delay volume sales of the system, delaying the economic impacts projected.
- The GFS business model proposed requires formalizing arrangements that are only in the discussion stage at this point. The benefits to Ohio may change, depending on how these arrangements are configured. While the business plan appears well thought out, this will be GFS' first experience with such a business.
- The economics of the system are most favorable when the thermal energy potential of the system is utilized. It is not clear if any of the scheduled demonstrations involve thermal energy use.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$1,000,000
WCF Request:	$ 0
TOTAL Request:	$1,000,000
Cost Share:	$1,000,000

Collaborators

- Edison Materials Technology Center (EMTEC)
- The Ohio State University Wright Center for Photovoltaic Innovation & Commercialization (OSU PVIC), Nanotech West Laboratory

Technical Risk

Overall Score = 4.47

Technical Reach

The PhotoVolt™ , multi-junction PV cell was developed over 20 years ago for applications related to space missions. It is been incorporated into the StarGen™ CPV system, and 35 units are being or have been deployed as single units or multiple (up to 20) arrays at various Ohio sites. The remaining technical challenges deal directly with manufacturing improvements that will increase power output and/or reduce production costs. Both lead to a reduced levelized cost of electricity generation.

Resource Limitations

GFS is not yet revenue-producing but has sufficient cash from its original angel investors and a Series A offering to cover its cost share requirement. The project funds appear sufficient to complete the project activities proposed. In 2011, a Series B offering is planned, and these funds are expected to carry the product to the market entry phase of commercialization. Current investors plan to fully subscribe to this offering.

Technology Protection

GFS has 11 patents filed covering the system design and the solar cells of the StarGen™. These were filed in 2008 and there has been no office action to date, but GFS indicates there are no known infringement issues. GFS also possesses trade secrets related to cell processing and the trademarks noted. Agreements are in place with OSU PVIC and EMTEC for any new IP developed.

Commercialization Risk

Overall Score = 4.00

Path to Market

GFS plans to continue demonstrations to introduce its system to the marketplace. MH Solar/Cleanway (Taiwan), a potential investor already has two Generation 1units under test and may purchase up to 300 in 2011. Other demonstration system purchases include: Falcon Green Energy (TX)–5, Ogihera America (MI)–4, Duke Energy–2 and Oberlin Municipal Power (OH)–2. Preformed Line Products, a Cleveland company providing PV racks and enclosures, is interested in adding GFS systems to its product line.

Corporate Stability

GFS's history dates back to 1994 when it began development of the PhotoVolt™ cell. In 2007 it expanded its product scope to a complete CPV system, and in 2008 GFS was formed. GFS is supported by its investor funding, and it has strong indications from investors that such support will continue as GFS meets its objectives in system performance and cost.

Commercial Infrastructure

GFS will continue its current direct sales approach in the U.S. and will concentrate on the demonstration participants in the near-term. GFS has already identified an Asian-based distributor and will pursue U.S. distributors during the latter stages of the proposed project. In 2015, GFS expects the majority of sales to be in the U.S. utilizing a direct approach. Local installation contractors will be used to construct systems and manage service agreements.

Mission Impact

Overall Score = 7.67

Cluster Formation

GFS is using the technical resources of EMTEC and OSU PVIC to assist in reducing system component costs. It currently uses Ohio suppliers for the majority of its balance-of-system (BOS) components. GFS will be headquartered in Ohio and produce the proprietary subsystems ("A" Kit) of the StarGen™. These currently represent nearly 50% of the system's value but will be reduced to 20% in the long-term when full production is reached.

Ohio Economics

GFS currently employs 25 staff and projects that it will grow to over 50 FTEs by 2013 and over 100 FTEs by 2015. GFS revenues from direct sales and distributor licenses are projected at about $9M in 2013 and over $30M by 2015.

Business Model

GFS will produce the proprietary components of the StarGen™ system and sell these to a "Master Distributor". GFS will also sell BOS components directly to the "Master Distributor" or the distributor will buy BOS components from licensed GFS production collaborators. A potential BOS collaborator is Ogihera America, although discussions with others, including Ohio entities, are underway. The "Master Distributor" will provide product to installers providing system assembly, sales, installation and service.

Prior Ohio Investments

- *None*

Ohio Department of Development

2011 TFPVP Evaluation Summary

Third Frontier Photovoltaics Program

Energy Focus, Inc. (EFOI)

High Efficiency Photovoltaic Enabled Off-grid System

TFPVP 11-209 Final Score: 74.8 Rank: 2

Previous Ohio Investment

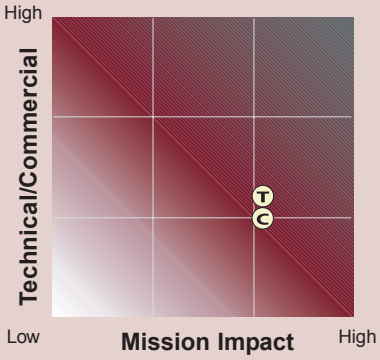
Energy Focus, Inc. (EFOI) has not received a prior OTF award.

Project Description

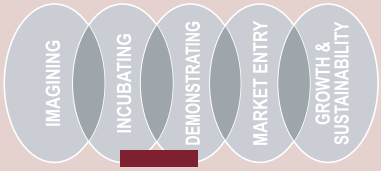
In this 2-year project EFOI will create an exterior light fixture. Called a "wall pack", the light fixture is mounted to the walls of buildings, parking lot lights, and driveway lights. The device requires no external wiring and no connection to the electric grid. The light fixture contains a solar panel to convert sunlight to electricity during the day, stores that electricity in an on-board battery, and discharges the battery at night providing power to the LED light. The system is planned to be cost competitive compared to existing, grid-powered wall pack lighting fixtures. The project will use concentrated photovoltaic chips (CPV's) developed by The Ohio State University (OSU), will use reflective concentration mirrors from Replex Plastics, and will be field tested by Lighting Services, Inc. (LSI).

Key Issues

- EFOI appears to have reversed a declining business trend and has made positive progress in the development of the proposed wall pack over the last year.
- EFOI is relying on The Ohio State University Wright Center for Photovoltaic Innovation & Commercialization (OSU PVIC) for the development and manufacturing of the PV cells for the fixture. While OSU PVIC can provide pilot-level production of PV cells for initial product introduction, a cell manufacturer will have to be located to supply quantities needed for full commercialization of the wall pack fixture.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$1,000,000
WCF Request:	$ 0
TOTAL Request:	$1,000,000
Cost Share:	$1,153,931

Collaborators

- The Ohio State University (OSU), Dept. of Electrical Engineering and Computer Engineering
- Replex Plastics
- Lighting Services Inc. (LSI)

Technical Risk

Overall Score = 4.00

Technical Reach

Over the last year, EFOI has selected the LED source, optics, reflector, and battery type to be used in the wall pack fixture. The LED electronics and thermal design have been completed, and several early prototypes have been made. OSU's MOCVD unit (for CPV chip processing) is now on line and has been processing chips. During this project OSU will refine the process and make the CPV chips, Replex Plastics will develop and provide mirrors, and EFOI will finish the system design and integrate the components into a final system for field evaluations. Fifteen complete systems will be produced, and LSI will arrange for field-testing.

Resource Limitations

The team has excellent technical capabilities and resources including OSU's chip processing equipment, OSU's CPV chip technology, Replex's experience with high quality plastic mirrors, and EFOI's LED and BOP production experience with lighting products. EFOI also has management experience with new product development, manufacturing lighting products, sales of lighting products, and raising funds from government grants and investors. EFOI will need another $12M for scale-up and commercialization, and will seek DOE and DoD funds, in addition to seeking funds from its current credit line and investors.

Technology Protection

EFOI has a patent portfolio of over 70 issued patents and 20 patents pending. EFOI expects to create additional IP related to the OSU PV developments, the optics and controls that will be used in the new lighting fixtures. A license arrangement with OSU will be negotiated. EFOI is confident it has freedom to operate in this space.

Commercialization Risk

Overall Score = 3.27

Path to Market

The primary business for EFOI is designing, manufacturing, and selling lighting products to commercial, industrial, and military applications. The proposed product is a next generation version of its existing product line and will be sold to end-users through its existing sales and distribution network. Existing customer LSI will be arranging for end-user field trials. Other existing lighting and general building construction customers, energy service companies, and resellers are enlisted for the proposed product rollout. EFOI also has established relationships with the military for specialized LED lighting systems.

Corporate Stability

EFOI is a publically traded company that has been in business for over 20 years. In 2007, sales were approximately $27M with 125 employees. Recent sales had dropped to less than $10M and employee count to 40. In response, EFOI sold an unprofitable business unit and acquired a new business unit selling products to the related target market. As a result, sales have significantly rebounded, and the company has returned to profitability.

Commercial Infrastructure

EFOI's Solon facility houses the headquarters, sales, engineering, and production departments. EFOI recently signed its building lease through 2014. The CPV cells will be initially made at Nanotech West, and then outsourced when production quantities dictate. Production and final assembly will occur in the existing operations in Solon. The existing group, through its network of resellers and others, will conduct the sales and marketing.

Mission Impact

Overall Score = 7.00

Cluster Formation

EFOI plans to use Ohio suppliers for over 75% of the value of the PV-powered lighting systems proposed. The LED components are supplied by out-of-state sources. OSU is providing the PV technology, and Replex Plastics is providing the concentrating mirror technology. If successful, EFOI will create a new PV-based product that will be manufactured in Ohio.

Ohio Economics

During the 2-year project, Energy Focus will generate 4 new jobs, and will secure additional funds for the market entry phase. Within 1 year of the end of the project (2013) Energy Focus will begin production with approximately 20 new employees and projects generating $790K in sales. By 2015, Energy Focus forecasts full-scale production employing at least 95 employees and generating $ 14M in annual sales. Within 10 years Energy Focus forecasts production of over 200K units annually, and plans to employ over 800 Ohioans.

Business Model

The proposed product is an extension of the existing specialty light business model. EFOI plans to outsource CPV chip production, to purchase the LED and mirror components, to purchase the balance of the fixture components, and to assemble the unit at its Ohio facilities. Sales operations will continue to be directed from EFOI's Ohio offices and will use existing sales contacts and OEM customers to sell to national accounts, municipalities, and military markets.

Prior Ohio Investments

- *None*

Ohio Department of Development

2011 TFPVP Evaluation Summary

Third Frontier Photovoltaics Program

DyeTec Solar, Inc.

Dye-sensitized PV Architectural Glass

TFPVP 11-213	Final Score: 69.7	Rank: 3

Previous Ohio Investment

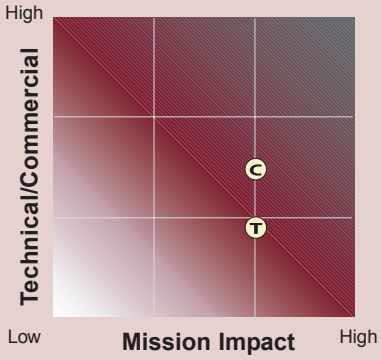
DyeTec Solar, Inc. has not received a prior OTF award.

Project Description

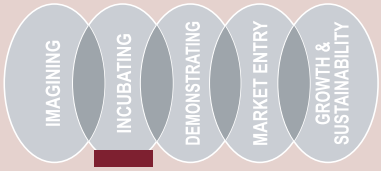
DyeTec Solar proposes developing a new Building Integrated Photovoltaic (BIPV) product, dye-sensitized PV architectural glass to be used in commercial and residential window applications. In the 6-month TFPVP project, DyeTec will establish prototype production and analysis, fabricate and test 12" x 12" prototypes, optimize the prototype efficiency and refine the cost model based on the prototype test results. Toledo-based Pilkington North America is collaborating on the project providing technical support for PV coating (transparent conductive oxide–TCO), glass manufacturing, and production engineering and market channel access. Overall, the development and commercialization effort covers a four-year period with market entry planned for 2015.

Key Issues

- A BIPV window product represents a PV approach that is new to the building and architectural community and therefore will likely face barriers related to codes and a resistance to change from current practices. DyeTec is aware of this situation, has included code activity in its plans, and is targeting applications that place value on "green" technology and will be willing, early-adopters of the BIPV windows/systems.
- In the near-term (through 2013), the revenue generation from DyeTec will be mainly from the investments that will be sought to support the commercialization of the BIPV products. Sales of demonstration units from the pilot facility proposed will generate sales in 2014 and 2015 with DyeTec reaching profitability in 2015.
- DyeTec's plans are to build the R&D and pilot plant facility in Northwest Ohio. The initial full-scale plant is also planned for Ohio, but the final decision will be based on the business development proceeding as expected.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$	950,000
WCF Request:	$	0
TOTAL Request:	$	950,000
Cost Share:	$	950,000

Collaborators

- Pilkington North America

Technical Risk

Overall Score = 2.94

Technical Reach

DyeTec's dye sensitive solar cell (DSSC) technology comes from its parent company, Dyesol, which has constructed the largest known DSSC prototype modules to date (1 meter x 1.2 meters). These modules are constructed from 4" x 7" active PV tiles. DyeTec will construct 12" x 12" tiles, a size that reduces manufacturing complexity and costs. The 12" x 12" tiles will be the basis for multiple square meter window sizes. The current DSSC cells have demonstrated efficiencies that, on an annual electric generation basis, are competitive with crystalline Si modules of the same rated power.

Resource Limitations

The technical team of Pilkington and Dyesol provide world-class expertise in DSSC materials and glass manufacturing. Project funding appears sufficient to accomplish the project goals and objectives. The estimate of the resources required to complete the commercialization activity is reasonable, but the efforts to raise this capital will not addressed until after the prototype evaluation is completed. The collaborators have access to internal and investment resources and experience in raising investment capital.

Technology Protection

DyeTec has licenses to registered Dyesol (9 patents) and Pilkington (25 patents) IP and access to other trade secret information related to DSSC materials. Dyesol indicates that nearly all DSSC-related developments employing glass substrates have utilized Dyesol materials and Pilkington glass.

Commercialization Risk

Overall Score = 4.93

Path to Market

The project collaborators currently provide products for the solar industry and have established routes to the market on a global basis. However, as no current BIPV window product currently exists, the product introduction will target commercial buildings willing to accept longer-term paybacks for "green" technology advantages/incentives. The objective is for DyeTec to be a "first-mover" in offering a BIPV window product.

Corporate Stability

DyeTec is a 2010 start-up joint venture by Dyesol and Pilkington. It anticipates revenue generation in 2013 from demonstration system sales with commercial offerings in 2014/2015. Through this period it will be dependent upon support from its owners and investors. Capital raise for the first manufacturing facility is planned for the 2014/2015 timeframe.

Commercial Infrastructure

Initially DyeTec will leverage the Pilkington and Dyesol existing market channels to introduce the BIPV glass modules to window manufacturers and building architects. In the future, DyeTec will build its own marketing sales and support organization.

Mission Impact

Overall Score = 6.75

Cluster Formation

The project leverages Pilkington's world leading solar research team housed at its R&D center in Northwest Ohio. Dyetec will establish engineering and R&D operations in Ohio, construct its pilot plant, and ultimately intends to build a full-scale manufacturing plant in Ohio. Balance-of-plant components for constructing modules will be obtained from local suppliers.

Ohio Economics

DyeTec will be pre-revenue through 2014, but will create from 10 to 20 jobs as part of the development program proposed, and investments of about $8M are anticipated. In 2015, sales of $20M and an additional $5M from licensing fees are projected. DyeTec employment will grow to 80 FTEs.

Business Model

Dyetec will manufacture BIPV glass modules in Ohio and license other fabricators that it will service. Dyesol and Pilkington will supply the glass and DSSC materials to DyeTec. Glass for the DyeTec manufacturing in Ohio will come from Pilkington's Ohio glass-making facility.

Prior Ohio Investments

- *None*

Ohio Department of Development

2011 TFPVP Evaluation Summary

Third Frontier Photovoltaics Program

Case Western Reserve University

Mirror-augmented Solar Photovoltaic Systems: Durability and Lifetime Validation

TFPVP 11-231 Final Score: 69.0 Rank: 4

Previous Ohio Investment

Since 2003, Case has been the lead applicant on 12 OTF awards and a collaborator on 8 awards. Many of these awards have focused on alternative energy, but this project is not a direct extension of any previous award. The previous project that will have the most impact on this project is a 2009 Wright Project entitled "Case Center for Surface Engineering". As part of that project, Case acquired three state-of-the-art instruments: a focused ion beam system, an energy-filtering transmission microscope, and a time-of-flight secondary-ion mass spectrometer. These instruments are being used by 15 Ohio companies in projects that have already created 8 new jobs and 10 pending patents. These three instruments will play a key role in this project and will provide additional opportunities for leverage.

Replex has been the recipient of 2 previous OTF awards. In 2008, Replex received $250K in TFAEP funds and $100K in Wright Capital funds to perform three-dimensional modeling and accelerated weatherization studies, acquire specialized testing equipment, and investigate means to filter out harmful portions of the solar spectrum. These activities were intended to allow Replex to develop its first solar concentrating mirror, and the company has made $80K in sales even though the recession caused three of its largest solar customers to cease operations. In 2010, the company received a TFAEP award of $1.26M to develop a low-cost compound parabolic concentrator that will concentrate solar energy by 10X to improve the performance of PV cells in northern latitudes. Field testing has shown that a concentrator array was able to generate 140W using one-tenth the silicon content of a comparable standard PV module that generated 220W under identical solar exposure. This performance was expected to be attractive to PV system developers who are under strong pressure to reduce the installed cost of PV systems.

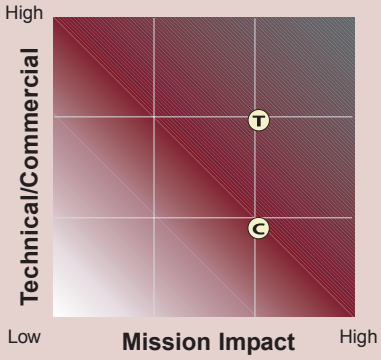
Project Description

When Replex attempted to market the solar mirrors it developed in earlier TF projects, it found that PV module manufacturers were unwilling to warranty their products for 20 to 25 years if they were subject to mirror enhancement. This behavior stemmed from industry experience in the 1980's at a site known as Carissa Plains where PV modules using solar mirrors exhibited power degradation rates of 40% within 4 years. After extensive analysis, NREL has concluded that the degradation observed at Carissa Plains was due to materials issues within the PV modules and not to mirror augmentation. However, PV module manufacturers have still not altered their position and seek proof of long-term performance of mirror-enhanced systems.

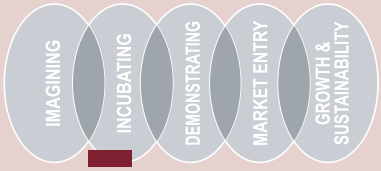
Some PV manufacturers, such as Canadian Solar, Abengoa Solar, Skyline Solar, and MegaWatt Solar, are beginning to consider mirror augmentation because of the need to lower PV costs and have long-term outdoor tests underway. Mirror augmentation offers the ability to boost the output of PV modules by 100%, but mirrors cost only 5–10% of silicon PV per square meter. These manufacturers would like to see data on accelerated aging that would speed-up the evaluation process.

The primary research thrust of this project is to study and understand the degradation processes of both mirrors and PV modules so that they can be minimized allowing better designs to be invented and sensible warranties to be written. Replex is seeking to prove that its UV-absorbing mirror can safely augment existing PV modules with no appreciable deterioration of performance. Replex has achieved a technical breakthrough with a mirror that cuts off UV reflectance at 400 nm and is trying to introduce this mirror to the PV market.

The technical work for this project will be led by Dr. Roger French, who became the F. Alex Nason Professor in the Department of Materials Science and Engineering at Case in August 2010. Dr. French will use the specialized equipment located in the Case Center for Surface Engineering to study the behavior of materials and PV components upon exposure to sunlight, heat, and humidity in both outdoor and laboratory conditions in an attempt to understand the operative degradation mechanisms. Funding from this proposal would be used to purchase the following capital equipment ($163K): PV trackers, 1.6 kW solar simulator, 15X concentrator, and sensors. Grant funds will support one FT senior research associate, one FT graduate student, and staff from Replex. This team will develop durability and lifetime data on solar mirrors using accelerated radiation and environmental exposures. This data will be used to evaluate alternative metallization, durability of the UV cutoff, and front coat and edge seal



Stage of Development



County Location

Funds Requested

TFRDF Request:	$	736,579
WCF Request:	$	163,239
TOTAL Request:	$	899,818
Cost Share:	$	899,818

Collaborators

- Replex Plastics

stability of the solar mirrors. After the mirrors have been optimized, the performance of PV modules will be evaluated with and without mirror augmentation.

Key Issues

- Understanding the degradation mechanisms in the various polymer layers of the mirrors and also of the PV modules is likely to be a challenging task within the time and budget constraints of this project.
- It is unclear whether accelerated aging data from Case will be sufficient to cause PV module manufacturers to change their warranties relative to mirror augmentation. It may take additional time and effort to overcome their perceptions of Carissa Plains and to provide long-term data from the field. Replex acknowledges that there is no substitute for years of field success to achieve bankability and expects that 2–3 years of field experience will be needed for large utility ground mount projects.
- The upside potential from creating this research capability to understand solar degradation mechanisms on polymers may be far greater outside of the photovoltaic industry. Many other Ohio companies that produce polymer products for exterior use could benefit from this capability.

Technical Risk

Overall Score = 6.53

Technical Reach

Dr. Roger French, a former Senior Fellow with 25 years at DuPont, is recognized as an expert in the area UV light on materials. The work scope of this project involves how to develop optimized exposures and evaluations to accelerate product development efforts. It will involve both real time and accelerated solar irradiations of materials, components, and systems under outdoor and laboratory conditions. Understanding the reliability, degradation, and failure mechanisms will present significant technical challenges.

Resource Limitations

Both Dr. French's arrival at Case and the analytical equipment at his disposal create strengths for research in this area. While the TFPVP funding would be adequate to launch an initial effort focused on Replex's mirrors, additional resources would be needed to sustain the research endeavor. DOE has indicated that PV module lifetime and degradation science is a prioritized research direction. It is possible that federal funding of $5-20M may become available to support additional research in this area.

Technology Protection

Replex intends to conduct a thorough patent search as part of this project and plans to develop a portfolio strategy related to mirror-augmented PV systems. It believes that the combination of the UV-absorbing mirror product that it has already developed coupled with an understanding of the degradation mechanisms will create a competitive advantage.

Commercialization Risk

Overall Score = 2.93

Path to Market

Replex plans to enter the market with fixed mirrors and will focus on smaller initial deployments in Ohio. This product is designed for ballasted roof mount installation. The company is already working with Dovetail. There have been signs of interest from BtB, Borrego, and Tipping Point. A major PV module maker has shown interest in collaboration on this project. Longer-term, Replex intends to launch a utility-scale ground mount deployment with trackers and is exploring options with AEP and Dayton Power & Light.

Corporate Stability

Replex is a long-established supplier of high impact, high performance optical domes, mirrors, and customer thermoformed plastic parts. The company has been consistently profitable, and it has annual sales of approximately $15M . Replex has a 100,000 sq. ft. manufacturing facility in Mt. Vernon, Ohio that employs 33. It operates at 100% of capacity and has expansion capacity for 2X. It has been actively working in the PV area for the past 3 years. Replex has indicated that it intends to seek private capital if growth from PV mirrors warrants it.

Commercial Infrastructure

Replex has an existing infrastructure to support its current business. The company makes 25% of its revenues outside the U.S. Its export business includes Europe, Asia, Canada, and South America. Replex anticipates that it will continue to use these same sales and marketing channels to sell the mirrors developed in this project. It is currently working with 15 companies in the PV area and plans to augment its sales and marketing capabilities as the product gets closer to commercialization.

Mission Impact

Overall Score = 6.84

Cluster Formation

Building capability in lifetime and degradation science at Case will provide a competitive advantage for many Ohio companies that produce a wide variety of polymer-based products for exterior applications. These products include roofing materials, siding, windows, and other types of architectural trim. Evaluating the long-term performance of new formulations based upon accelerated short-term test results will shorten the new product development process for these companies and make it more efficient.

Ohio Economics

Market entry for the fixed mirrors is likely to occur in 2013. Replex projects that this business will create 11 new jobs in 2013 with annual revenue of $1.5M . By 2015, the business will create 16 new jobs and grow to an annual revenue of $22M based upon the recent involvement of new PV OEMs. These projections are in addition to the economic development impacts projected for Replex's earlier awards.

Business Model

Replex hopes to retain 100% ownership in its PV mirror business and intends to scale-up production in Mount Vernon, Ohio using its existing bank relationship for financing. It projects that $100K will be required by 2013 for marketing, sales, inventory, distribution, and accounts receivable, and that this will increase to $1M by 2015. No large capital investments will be required because Replex intends to use its existing mirror manufacturing facility.

Prior Ohio Investments

- Case Center for Surface Engineering, 2008, $3,000,000
- Low-Cost PV Concentration Systems for Mid-Northern Latitudes, 2010, $1,000,000 (Replex, TFRDF) and $257,500 (OSU, WCF)
- Concentrated Solar Power, 2008, $250,000 (Replex, TFRDF) and $100,000 (OSU, WCF)

Ohio Department of Development

2011 TFPVP Evaluation Summary

Third Frontier Photovoltaics Program

Process Technology (PT)

Commercialization of Inline Heater for Use in Photovoltaic Solar Cell Manufacturing

TFPVP 11-206	Final Score: 67.2	Rank: 5

Previous Ohio Investment

Process Technology (PT) has not received a prior OTF award.

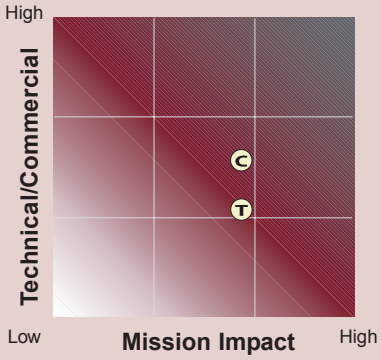
Project Description

PT, an established Cleveland manufacturer providing specialized heaters for various industrial processes, recognizes the need to diversify its customer base. The company plans to develop a heater for the photovoltaic (PV) industry that is 40% less expensive than current equipment and provides the safety, ease of installation, and cleanliness needed by PV manufacturers. The company has built and operated a positive temperature coefficient (PTC) inline prototype heater in the R&D laboratory for 11 months to prove the concept. The PTC heating elements, in which PT appears to have a preferred position, lend themselves to safe, compact, and simple construction that can produce cost effective performance. They could be used to heat the acids, bases, solvents, and developers in order to meet all the cleaning, etching, and stripping applications of the PV industry.

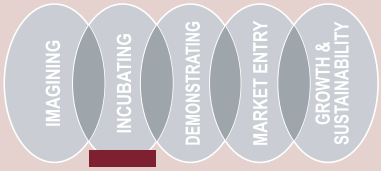
Cleveland State University (CSU) will perform Computational Fluid Dynamics (CFD) modeling on the PTC heating elements to ensure the most uniform and efficient heat transfer throughout the heater assembly. CSU will also model the fluoropolymer tubing to optimize the material, size, shape, and wall thickness for fluid flow, heat transfer, and permeation rates of chemistry. The best CFD options will be converted into prototype heaters for laboratory evaluation by PT. Control software development will also be initiated at this stage. At the end of prototype evaluations, the final design will be selected, patents will be filed, and third-party certifications will be obtained including UL 499, UL 823, CE, Semi S2/S3, and CSA. Prior to market introduction, PT will have the final device tested in photovoltaic processing steps at The Ohio State University's (OSU) Nanotech West Laboratory and will compare its performance with existing inline process heaters. At the end of the project, the new heater will be ready for customer evaluations.

Key Issues

- Although PT has had past success in new heater development, its business has contracted in recent years, and it lacks the resources to develop this new product to satisfy current demand. OTF funding would assist the company in hitting the window of opportunity. PT believes that it is important for this new product to reach the market within 2 years.
- Recent worldwide fluoropolymer supply shortages have resulted in higher resin prices for 2011 and will force PT to raise its prices on current products just as customers are demanding lower prices. The redesign of this product will reduce the amount of fluoropolymer.
- PT does not yet have commitments from customers for beta test sites since product development is at an early stage, but it plans to rely on its distributor Plaspro to secure commitments for six beta sites.



Stage of Development



County Location

Funds Requested

TFRDF Request:	$	357,713
WCF Request:	$	0
TOTAL Request:	$	357,713
Cost Share:	$	361,513

Collaborators

- The Ohio State University (OSU), Nanotech West Laboratory
- Cleveland State University (CSU)

Technical Risk

Overall Score = 5.20

Technical Reach

PT appears to understand the needs of the PV customer and has developed both cost and performance goals for this heater. Accessing the CFD modeling capabilities at CSU should enable PT to reduce the number of design and prototype iterations in its development process. The performance of a working prototype provides confidence that PT has a strong grasp of the technology and can complete the remaining development work.

Resource Limitations

PT is not in a position to adequately take on this project with its current level of staffing and available R&D resources. OTF funding would allow the company to hire 2 additional engineers. The company plans to provide its cost share from current operations. However, if this proves to be a problem, the company has secondary sources in the form of a $5M line of credit with its lending institution. PT has demonstrated competence in developing and commercializing new heaters.

Technology Protection

Three years ago, PT approached Epcos (currently TDK) about producing a custom PTC thermistor. Three thermistors were developed which were suitable for use in high voltage applications (like this heater). PT owns the rights to the UL listing of this product family and has an agreement with Epcos for the exclusive production of these unique devices.

Commercialization Risk

Overall Score = 3.53

Path to Market

Polycrystalline solar cells comprise 46% of the worldwide PV market, and the front end of their production involves heated wet chemistry. Many of these polycrystalline solar cell manufacturers are already using PT process heaters. However, these manufacturers are experiencing strong downward cost pressures, and at least five current PV customers have expressed a need for lower cost, higher performing process equipment. PT shows a good understanding of price and performance needs of these customers.

Corporate Stability

PT, a 32-year-old manufacturing company with annual sales in the range of $20–25M , has experienced declining sales since 2006. Its sales were particularly depressed in 2009 and the company was forced to layoff nearly 1/3 of its workforce. PT's business has rebounded somewhat in 2010. Today PT has 125 employees. The company clearly recognizes the need to diversify.

Commercial Infrastructure

Heaters are incorporated into process tools, and the most effective way to reach the market is through the OEM equipment manufacturers who specify the heaters in their tools. PT already has relationships with three OEM equipment manufacturers who represent 85% of the potential PV market. It has worldwide sales channels in place and appears to enjoy the trust and respect of its customers.

Mission Impact

Overall Score = 6.25

Cluster Formation

Leverage of the Ohio supply chain will be particularly strong in this project. All of the components of this heater are projected to come from Ohio suppliers with the exception of the PTC thermistors. Specific Ohio suppliers of aluminum plates, PTFE insulating components, heat exchanger manifolds, and ceramic insulation are identified and have been used by PT on other PTC projects. PT forecasts that these suppliers will generate $1.8M in revenues from this product in 2013.

Ohio Economics

PT expects this product to enter the market in 2012. By 2013, PT anticipates that it will be selling 1000 units to the PV industry which will create $4M in new annual revenues and 10–15 jobs. By 2015, the product will be introduced to the semiconductor industry which will result in new annual sales of $12M and the creation of 20–30 new jobs at PT.

Business Model

PT plans to manufacture these heaters at its plant in Mentor which is also its headquarters. While initial product introduction will occur in the PV industry, this will be followed by adapting the product for use in the semiconductor industry. There are also a number of additional industries which PT has targeted but wishes to keep proprietary at this time. These industries are likely to value the inherently safe operating characteristics (no fire hazard; no possibility of overheating) of the PTC technology and may allow PT to significantly grow this business.

Prior Ohio Investments

- *None*