

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AFFORDABLE WIRE MANAGEMENT, LLC,
Petitioner,

v.

CAMBRIA COUNTY ASSOCIATION FOR THE BLIND AND HANDICAPPED,
INC.,
Patent Owner.

IPR2024-00182
Patent 11,349,291

**DECLARATION OF EDWARD C. KERN, JR., PH. D.
IN SUPPORT OF PATENT OWNER'S PRELIMINARY RESPONSE**

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I, Edward C. Kern, Jr., declare as follows:

I. INTRODUCTION

1. I have been retained by counsel for Cambria County Association for the Blind and Handicapped, Inc. (“CAB”) as an expert witness in connection with IPR2024-00182, concerning U.S. Patent No. 11,349,291 (“the ‘291 Patent”), pending before the U.S. Patent and Trademark Office, Patent Trial and Appeal Board (“the Board”). I have been asked to provide my opinion about the grounds for unpatentability of the claims of the ‘291 Patent as asserted in the Petition. The following is my written declaration on these topics. I am personally knowledgeable about the matters stated herein and am competent to make this declaration.

2. I understand that Petitioner Affordable Wire Management, LLC (“Petitioner”) filed a petition for inter partes review (“the Petition”) regarding certain claims of the ‘291 Patent, which was supported by the Declaration of Omid Beik, Ph. D. (“the Beik declaration”, cited to herein as EX1002). The Petition challenges the patentability of the following claims:

- Ground 1 – Claims 1-13 as allegedly being unpatentable as obvious over *CAB Catalog* in view of the knowledge of a POSITA;
- Ground 2 – Claims 14-23 as allegedly being unpatentable as obvious over *CAB Catalog* and *Almy* in view of the knowledge of a POSITA.

3. This declaration provides my opinions, and the bases therefor, regarding the asserted grounds of unpatentability of the challenged claims, and includes my rebuttal of assertions made by Dr. Beik in his declaration.

4. The conclusions I present reflect my own judgment, based on my knowledge, background, education, training and experience in the field of energy technology, including specifically in the design, development of solar power systems. My opinions expressed herein are based on the issues and materials that I have reviewed to date, including the '291 patent, asserted prior art references and other materials submitted to the Board in support of the Petition. If additional issues, materials or information are provided to me for review, I may supplement, amend or modify my opinions expressed herein based upon that further review.

5. I am being compensated for my work as an expert with respect to this inter partes review proceeding at the rate of \$400 per hour. I have no financial interest in CAB or in the '291 Patent, and my compensation is not dependent on the outcome of this or any other proceeding, including the related district court proceedings involving the '291 Patent.

II. MY BACKGROUND AND QUALIFICATIONS

6. A summary of my relevant experience follows. More details of my background and experience, including my relevant projects, publications, and

speaking engagements, are included in my Curriculum Vitae, which is being submitted as Exhibit A herewith.

7. I earned an Artium Baccalaureus (Bachelor of Arts) with a major in Engineering Sciences from Dartmouth College in June 1967 and a Bachelor of Engineering from Dartmouth's Thayer School of Engineering in June 1968. In September 1968 I began graduate studies at the Massachusetts Institute of Technology (MIT) and in 1971 I received a Master of Science Degree in the field of Naval Architecture and Marine Engineering. I received my Ph.D. in the field of hydrodynamics from MIT in 1973.

8. My professional career has centered on developing energy sector technology to function in the natural, outdoor environment, exposed to the forces and varying conditions of nature. Early in my career my focus changed from design in the marine environment to design for exposed terrestrial locations, in both the built environment and in the natural environment. My work in the marine environment concluded with participation with the US Coast Guard in immediate recovery efforts following the Argo Merchant grounding in December 1976.¹ I began my work with photovoltaic (PV) power systems in January 1977 at MIT's

¹ <https://response.restoration.noaa.gov/oil-and-chemical-spills/significant-incidents/argo-merchant-oil-spill/argo-merchant-birth-modern-oil>

Lincoln Laboratory. My solar power development activities span 47 years and six continents.

9. I am currently retired from running my own company, Irradiance, Inc. (formerly named Ascension Technology) which I founded in 1987. I am now consulting part time as the sole member of KRNLPWR LLC applying my forty-seven-plus years' experience designing and developing photovoltaic power systems, beginning during the formative years of the photovoltaic industry in the mid-1970s.

10. I have been involved in the design for many of the first "large" scale PV systems deployed starting in 1977 at the DOE's Field Tests and Applications Project at MIT Lincoln Laboratory. My first project involved roof-mounting solar panels at the Museum of Science and Industry in Chicago. This and other systems at the time deployed some of the first terrestrial solar panels manufactured and involved collaboration between the MIT Lincoln Laboratory (MITLL) and the California Institute of Technology (Caltech) Jet Propulsion Laboratory (JPL). I worked closely with JPL staff in my role developing PV systems for terrestrial applications using the solar PV panels then being developed by JPL. Both MITLL and JPL were engaged in applying their experience with space applications for solar photovoltaics to terrestrial applications. In space applications as with my background in ocean engineering there are few if any jurisdictions applying codes

or standards and engineering design evolved from “first principles” of physics and mathematics. For novel terrestrial PV applications at that time there were no standards (e.g. the National Electrical Code or the National Electric Safety Code) specific to solar power and code enforcement officials (e.g. building wiring inspectors) had no code guidance dealing with the idiosyncrasies of solar electricity. At that time both my group at MITLL and JPL engaged in developing both UL standards and National Electrical Code provisions (e.g., Article 690) for terrestrial solar PV applications.

11. At MITLL I planned and implemented the US Department of Energy's Residential Rooftop PV Applications Program, which involved engineering development of prototype roof mounted PV arrays and testing them at research stations in Massachusetts, New Mexico and Florida starting in 1979.

12. Throughout my career I have authored reports and made presentations for DOE PV Program Management meetings starting in 1977; for the IEEE Photovoltaics Specialists Conferences starting in 1978; for Electric Power Research Institute (Palo Alto, CA); the World Bank and International Finance Corporation (Washington, DC); the Central Research Institute for the Electric Power Industry (Tokyo, Japan); the IEEE Power Systems Relay and Protection Standards Development; China Light and Power (Hong Kong), Tata Power Company (Mumbai, India), Solar PACES Meetings; (Perpignan, France and

Granada, Spain); and Saudi Electricity Company and King Abdullah City for Atomic and Renewable Energy (Riyadh, Saudi Arabia).

13. In 1987 I left MIT and founded Ascension Technology to continue my work researching, designing, engineering, and constructing solar power systems. Ascension Technology's first project was sponsored by the New England Electric System R&D department and Massachusetts Electric Company and involved installing PV systems on 30 homes at the end of a power distribution circuit in Gardner, Massachusetts to demonstrate the safety and performance of roof mounted PV on homes, and to demonstrate for the first time the ability of numerous distributed generation systems to operate collectively and properly when connected to utility power distribution lines and equipment. This project led to collaboration and subsequent developments of rooftop PV in Japan through ongoing exchanges with engineers from the Kansai Electric Company in Osaka and their first testing of rooftop PV at a test station at Rokko Island, near Kobe, Japan. Through Ascension I designed, developed, sought and received UL listings, and manufactured components for and installed pioneering grid tie PV systems with support and sponsorship from numerous electric power companies, the US Environmental Protection Agency, and the US Department of Energy and the National Renewable Energy Laboratory. My projects in the late 1980s and early 90s installed some of the first grid-interconnected solar PV systems in Hawaii,

California, Oregon, Arizona, Nevada, Idaho, Utah, Wyoming, Texas, Oklahoma, Colorado, Minnesota, Wisconsin, Michigan, North Carolina, Virginia, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. Ascension also designed and installed systems in Mexico and India during the mid-1990s.

14. Throughout my career after forming Ascension Technology I maintained a close working relationship with MIT, initially the MIT Energy Laboratory, then the MIT Laboratory for Energy and the Environment, and finally the MIT Energy Initiative. I both lectured on solar and wind energy at MIT and installed the first two grid-tie PV systems on buildings on the MIT Campus. I have lectured at my alma mater Dartmouth College's Thayer School of Engineering and installed Dartmouth's first grid-tie PV system in 1995 and have continued pro bono support to the present for Dartmouth's deployment of solar technology.

15. I am a Senior member (emeritus) of IEEE and a Fellow and Life Member of the American Solar Energy Association.

16. Based on my experience and education, I believe that I am qualified to opine as to the knowledge and level of skill of one of ordinary skill in the art at the time of the alleged invention underlying the '291 Patent, as well as the state of the art at that time.

III. LEGAL STANDARDS

17. As a technical expert, I am not offering any legal opinions. Rather I am offering technical assessments and opinions. In rendering my analysis, I have been informed by counsel regarding various legal standards for determining patentability. I have applied those standards informing my technical opinions expressed in this declaration.

A. CLAIM CONSTRUCTION

18. I understand that in this proceeding the '291 Patent claim terms are to be interpreted according to the so-called *Phillips* standard.

19. I further understand that under the Phillips standard, claims are to be given their ordinary and customary meaning, i.e., the meaning that the claim term would have to a person of ordinary skill in the art in question at the time of the invention, in light of the specification and prosecution history. It is further my understanding that the specification is the single best guide, and usually dispositive, as to the meaning of any disputed claim terms.

B. PERSON OF ORDINARY SKILL IN THE ART

20. I further understand that in this matter, Petitioner has asserted that a person of ordinary skill in the art ("POSITA") with respect to the technology described in the '291 Patent would be a person with a bachelor's degree in a pertinent discipline, such as electrical engineering, civil engineering, mechanical

engineering, or equivalent with 2-3 years of experience in electrical utility systems, planning, and design, with the understanding that the number of years of experience could be higher or lower given the level of education and vice versa. For purposes of my analysis, I have assumed this definition of a POSITA.

C. OBVIOUSNESS

21. I understand that a claim in a patent is unpatentable if the differences between the claim and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains.

22. I understand that an issued patent claim can be obvious in view of a single prior art reference or multiple prior art references. I have also been informed that when asserting obviousness under § 103, whether based on a single prior art reference or a combination of references, a petitioner must articulate a reason, with rational underpinnings, why a POSITA would have been motivated to modify that single prior art reference or combine multiple references to arrive at the claimed invention.

23. I understand that obviousness concerns not whether a skilled artisan *not could have made*, but *would have been motivated to make*, the modifications or combinations of prior art to arrive at the claimed invention.

24. I understand that the determination of obviousness requires the consideration of the following factors: 1) the scope and content of the prior art; 2) the differences between the prior art and the claims at issue; 3) the knowledge of a person of ordinary skill in the pertinent art; and 4) secondary considerations such as commercial success, long-felt need, failed attempts, copying, unexpected results, praise of the invention, expressions of skepticism in the industry, and the patent owner proceeding contrary to accepted wisdom of the prior art.

25. I understand that in making an obviousness analysis, the fact that individual elements of the claimed invention are disclosed in the prior art is not alone sufficient to reach a conclusion of obviousness.

26. I understand that in making an obviousness analysis, one may not use hindsight when comparing the prior art to the claimed invention, or consider what was learned from the teachings of the patent. In particular, I understand that it is improper to use the patent claims as a road map for selecting and combining items of prior art. In other words, one must avoid using the challenged patent as a guide through the prior art references, using hindsight to combine references solely for the purpose of achieving the result of the claims at issue. Instead, one must put oneself in the place of a person of ordinary skill at the time the invention was made and consider only what was known before the invention was made and not consider what is known today. Therefore, I understand that defining the problem

in terms of its solution reveals improper hindsight in the selection of the prior art relevant to obviousness.

D. REASONABLE EXPECTATION OF SUCCESS

27. I understand that where a party argues a skilled artisan would have been motivated to modify a single prior art reference or combine references, it must show the artisan would have had a reasonable expectation of success from doing so.

IV. OVERVIEW OF THE RELEVANT TECHNOLOGY

A. EARLY DEVELOPMENT OF SOLAR INSTALLATIONS

28. From the inception of federal R&D programs in the mid-1970s in response to the OPEC oil embargoes to the present, solar photovoltaic technology has evolved through collaborations between federal research laboratories such as JPL, MITLL, Sandia National Laboratories and the Solar Energy Research Institute (now the National Renewable Energy Laboratory, NREL), private organizations such as Underwriters Laboratories and the National Fire Protection Association which oversees the National Electrical Code (NEC), electric utilities and their jointly sponsored research arm the Electric Power Research Institute, and private sector companies ranging from major industrials to academic spin-off startups.

29. Fifty years later, in the first 10 months of 2023, solar power accounted for 42% (10,937 MW of a total 25,968 MW) of new electric power generation and

now accounts for 7% of power generation capacity in the United States.² Solar power has evolved from a vision into a booming industry.

30. A key attribute of solar photovoltaic (PV) energy is that, by its nature, it is a spatially distributed power generation resource. Before solar PV, the economies of scale favored the construction of large power plants. Consequently, electric power systems developed with a model of power flowing outward from large sources (e.g. coal and nuclear power stations) to many distributed consumers. This meant that the power carrying wires and cables in these systems could be protected by fuses and circuit breakers “upstream” of the many distributed consumers and power consuming devices. Typically, these circuit protection devices are “opened” when current levels exceed safe values, as can happen with a short circuit or short to ground.

31. PV’s spatially distributed nature is the exact opposite. Power is aggregated from smaller to larger currents, as with brooks, streams and creeks aggregating to form rivers. In solar PV wiring, lethal voltages that occur both directly as a shock hazard and indirectly through electrical arcs igniting a fire, exist throughout PV arrays and power aggregation cannot be protected in the same way as power distribution.

² <https://cms.ferc.gov/media/energy-infrastructure-update-october-2023>

32. PV system building and wiring inspectors, engaged in assuring public safety, are trained to verify that equipment meets certain standards and installed to meet certain codes including the National Fire Protection Association’s “National Electrical Code” (NEC).

33. PV system designers and installers, while seeking to lower both manufacturing and construction costs, are guided and constrained by these NEC safety codes as well as structural codes. Non-compliance can result in a costly failure to pass an electrical inspection and professional liability in the case of an injury, accident, or damage. Accordingly, persons engaged in designing and constructing PV systems are and have been advisably cautious in designing so-called “balance of systems” in PV systems, which include mounting structures, foundations, *wire and cable management and organization*, electrical panels, switching gear, battery storage and other structural features of a typical solar plant.

34. The unique nature of power collection and aggregation in solar PV facilities introduced novel constraints and challenges in wire and cable design, management, and organization not arising in other fields and industries. These unique challenges related to, for example, aggregating and collecting power in a PV array “string” of modules, transmitting power output to string combiners and on to inverters in PV output circuits, and proper management of ground faults that occurred in the system.

35. Aside from highly instrumented experimental technology R&D prototypes, PV systems initially had only DC wiring and fixed panels. Early “commercial” markets for battery charging in remote (“off-grid”) places were DC only. Most “demonstration” and R&D grid-tied systems from the 1970s through the 1990s also had DC only wiring in their PV arrays, and most were relatively small (in comparison to PV systems prevalent today) - in the range of 5 to 20 kW in rated power, though several “utility scale” demonstrations were built up to 1 MW scale.

36. Early prototype tracking collectors in the 1970s and 1980s used optical light concentration, which used mirrors or lenses to focus light on cells, and reduce the number of cells needed to capture sunlight. Trackers had the benefit of capturing about 40% more solar radiation by following the sun across the sky.

37. Commercial solar farm applications at ~1 MW capacity and larger, producing electricity for bulk power markets, began appearing in the early 2000s. The first large solar farms used fixed (non-tracking) arrays with DC power cables only, together with lower cost “thin film solar modules.” These modules were typically less efficient than standard silicon solar cell-based modules and therefore required greater land areas per unit of power produced and longer wire runs to gather the power to collection points.

38. During the 2000-2010 period, prices for higher efficiency silicon solar cell modules dropped precipitously and brought them into the solar farm market. Higher module efficiencies for these modules reduced land costs, structural support costs, and favored simple one axis tracking to improve electricity production by 20 to 25%. Notably, however, it also complicated array field wiring by introducing the requirement for control cabling.

39. With tracking came the need for both powering the mechanical tracking devices and for signals from panel orientation, irradiance, wind speed, fault conditions such as ground faults, and temperature sensors within the array field, and for signals to the mechanical tracking devices to control their position. The increased use of tracking devices, therefore, resulted in the increased use of AC cables to power the devices, as well as the increased use of signal wiring, or data wiring, to monitor and communicate data within the PV solar array.

B. EVOLUTION OF POWER CABLES IN SOLAR INSTALLATIONS

40. As solar PV arrays became commercially viable in the 2000-2010 time frame and transitioned to larger multi-megawatt installations, lower voltage solar wiring gave way to the need for higher voltage cables, enabling lower cost for comparable performance.

41. The power carried in DC electrical cables is the product of the circuit voltage and current. Electrical cables are rated at their current carrying and voltage

isolation capabilities. Increasing current capacity requires increased diameters and more copper or aluminum cross sectional area and therefore larger and heavier cables.

42. Over this period, NEC allowable voltages increased from 600 to 1500 V, increasing the power that could be transported on a given wire size by a factor of 2.5 (150% gain). The increase in system voltage also increased the number of modules that the wires could connect in series, in concert with the growing size of PV farms, and significantly increased the length of these power cables, and the need to manage them.

43. As noted above, large solar PV systems involve the aggregation of small amounts of electricity generated from sunlight falling over large areas toward a single point for interconnection to the power grid. Each square meter of solar panel area will produce about 200 Watts of DC electricity in full sunlight, on a clear day, tilted toward the sun at noon. To prevent tilted panels from shading one another they need to be spaced apart. Spacing the modules apart increases the land area needed, to about twice the total area of solar modules. Accordingly, it would be expected that there would be approximately 100 Watts of DC electricity generated for each square meter of land. Viewed another way, a 250 Megawatt solar power plant would occupy a square mile of land, and have hundreds of miles

of DC power cables aggregating electricity to a single point for interconnection to the power grid.

44. DC cabling begins with module-to-module series connection of panels to form a “series string”. About 30 such panels, each producing 10-15 Amps, and extending over an area of about 150 square meters, are connected in series forming 1500 V series strings producing 15-20 kW. A number of strings are then extended to a “string combiner” and wired in parallel to aggregate their current. For this stage, wire support systems such as cable trays or wire ties were used to support multiple DC cables. These DC cables are larger in diameter and heavier than 10 AWG in order to reduce power losses, are required for a range of wire length runs (up to 150 meters).

45. Output current from a typical string combiner could be 100 Amps (150 kW power at 1500 Vdc) and needs to be routed to an inverter. The output from multiple string combiners then needs to be combined again and converted to AC power. At 100 Amperes significantly larger wires are needed, typically 4/0 which is about $\frac{3}{4}$ ” diameter and weighs (aluminum conductor) about 1/3 pound per foot. Such output wires from multiple string combiners run to second aggregation points at inverters, typically capable of converting about a megawatt of DC power to three phase AC power. At this stage, the wire runs would likely be routed 90 degrees from the direction of the rows of PV panels, and would typically be placed

in trenches with risers to the string combiners. This cabling might also be protected by buried conduit.

46. Following this example, the DC power from eight string combiners would aggregate at an inverter and be converted to three phase AC power. Inverter output power would then be wired to a transformer and boosted to a distribution level voltage, such as 13,800 volts. At larger than 1 MW scale, multiple 1 MW building blocks would be replicated, and the output wiring from each building block would be three phase AC distribution voltage. A square mile would accommodate 250 of such building blocks forming a 250 MW solar farm.

47. As discussed above, the increased use of trackers in PV arrays also required AC cables to power the trackers. As the size of solar farms increased, the AC cables necessary to power these trackers were integral to, and extended from, the solar panels in the PV array, and ran along with the DC cables. The AC cables were typically bundled together with the DC cables.

C. THE NEED FOR IMPROVED SYSTEMS FOR CABLE MANAGEMENT

48. Wiring for increasingly large solar farm arrays evolved from well understood and proven methods for outdoor wiring. But as the size scale, number of solar projects, and competitive entrants in the industry grew exponentially in the 2000-2010 time period, the high costs of materials, supply chain logistics, installation, and maintenance of using older methods of cable management, such as

trenching and metal wire trays, provided an opportunity for innovation in developing improved and more efficient cable management systems.

49. To meet electrical code, cabling prior to 2014 was usually bundled and buried underground, with or without conduit, or placed in a metal wire tray. Trenching and direct burial of the cabling, however, present issues for increasing “capacity” as PV output circuits are added along the path to the inverter. The tradeoff between direct burial (without conduit) and laying conduit relates to site soil conditions, such as the likelihood of sharp rocks abrading the cable. Direct burial is cheaper, but more prone to failure and once in place cannot be easily replaced.

50. Yet another impact of trenching is the construction sequence of events. Access within the array field for mounting and wiring individual modules or panels is required and once the structure is in place the only means of access by construction vehicles is along pathways between the rows. While a trench is open it introduces a dead-end barrier along the pathway during construction.

51. Cable trays, on the other hand, are expensive and cumbersome to build. They need to be designed to match the array field structure’s length and repetition scales for aligning attachment points. These structural length scales are in turn dictated by PV module dimensions which are highly variable from one product to another. The required lengths, attachment points, and “capacity” (width

and depth) are in constant play complicating supply chain logistics and impacting costs.

52. A further consideration is that cable tray capacity requirements change along the row as additional cables are added as the tray collects additional “home run” wires along its path to the combiner box, further complicating design choices and cost considerations.

53. To complicate matters further, as the ‘291 patent explains, prior to 2014, AC and DC cables could be bundled together, and there was no requirement to separate AC from DC cables, including in solar installations. In fact, commingling the AC and DC cables in the cable trays used with fixed systems was the cheapest and most direct way of managing these cables. Changes to the 2014 NEC, however, for the first time required that AC and DC cables be separated from each other. *See* EX. 1001, 1:32-42.

54. In addition, as discussed above, there was increased need in solar installations for signal wiring and data cabling for monitoring and communicating data from the PV array. Because it was known that AC and DC power cables could interfere with such signal and data wires that are located adjacent to them, there was also a known need for separating AC and DC power cables from signal and data wiring. *Id.*, 1:37-56.

55. Separation of DC wiring from the AC and signal wiring necessitated by the increased use of tracking devices is imperative for a number of reasons: (1) physical reasons of weight, stiffness, environmental exposure protection requirements, potential for electrical failure of each wire type, (2) construction sequence of installation and the skills of personal and potential mechanized equipment associated with each wire type, (3) AHJ (Authority Having Jurisdiction) inspection requirements of each wire type, (4) potential for one type of wiring to interfere with the proper operation of another, (5) potential for catastrophic failure in one wiring system to impact another, (6) standardization for routine wire inspection and maintenance such that everywhere in the array field wire types are clearly and quickly identifiable by field personnel.

56. As further discussed below, the '291 patent addresses the need for an improved cable management system in the solar industry. At the time of the '291 invention, however, there were significant challenges unique to the solar industry to developing such improved systems.

57. Prior to 2000, there were significant industry investments in solar module and power electronics manufacturing, but little if any in solar structures and wiring. The period from 2000 leading up to the time of the '291 patent saw some PV module industry investment in structures to support PV modules. But there was still the expectation within the industry that wire management for solar

installations would simply involve selection and application of existing methods and equipment.

58. Some of these unique challenges are discussed in an article from an early 2013 article in a leading trade industry publication, SolarPro Magazine, entitled “PV Array Wire Management,” which is an exhibit introduced by Petitioner in these proceedings. EX. 1011.

59. This article begins by stating that “designers and installers face persistent challenges to managing free-air conductors within the PV array,” and that “[i]mplementing a safe, reliable and *Code*-compliant wire management system for exposed PV conductors is not an easy task.” *Id.*, at 1-2.

60. The author further states that “[w]hile securing array wiring seems like it should be a straightforward exercise, the reality is that integrators continue to face numerous challenges.” *Id.*, at 2.

61. One of the most significant challenges is the extreme environments in which PV arrays are installed. In fact, as aptly stated by the author, “[c]oupled with the harsh environmental conditions that PV array conductors are exposed to – UV radiation, high winds and extreme ambient temperatures, and ice, snow and other debris – wire management continues to be the *Achilles heel* of the majority of PV installations.” *Id.*

62. The 2014 NEC new requirements for separating DC and AC power cables only further complicated the unique challenges of cable management in the solar industry. The SolarPro article, Petitioner’s EX. 1011, further expresses concerns with the need for solar wire management techniques to comply with NEC requirements. For example, one industry expert complains that “[b]esides squirrels, the biggest issue we face is a “recreate the wheel” approach at every site as we strive to meet *NEC* requirements while installing systems that will last 25 years.” EX. 1011, at 4. The author also discusses concerns from a senior research engineer at the Institute for Energy and the Environment that even literal compliance with NEC requirements for spacing of supports such as hangers to support PV cables could be insufficient to protect against damage to PV conductors in certain weather conditions. *Id.*, at 7 (expressing concern that in windy conditions, the specified spacing “would be inadequate to prevent conductor motions that would abrade the insulations over time”). The author of the article concludes that while compliance with the NEC “provides a good baseline for wire management,” additional steps must be considered “to provide a safe and reliable installation.” *Id.*, at 8.

63. All of these challenges and concerns discussed by the SolarPro article only increased the need for innovative solutions for cable management in solar installations.

V. OVERVIEW OF THE ‘291 PATENT

64. The ‘291 patent, entitled “Locking cable hanger and method of using,” was filed on June 16, 2021, and issued to Patent Owner CAB, as the assignee, on May 31, 2022, and naming Allen Garrett Smith, Frank Edward Hodge, David James Prasko, and Timothy Joseph Wedding as the inventors. EX1001.

65. Set forth below are exemplary independent claims 1 and 14 at issue in this IPR:

1. A system for organizing a plurality of electrical cables extending from a plurality of solar panels, the system comprising:
 - a messenger wire structured to be supported a distance above the ground; and
 - a plurality of cable hangers structured to be disposed along, and suspended from, the messenger wire, each cable hanger having a plurality of cable carrying surfaces, each cable carrying surface being structured to support at least one electrical cable of the plurality of electrical cables, wherein adjacent cable carrying surfaces of the plurality of cable carrying surfaces are separated by a cable carrier divider.

* * * *

14. A solar plant comprising:
 - a plurality of solar panels;
 - a plurality of electrical cables extending from the plurality of solar panels; and

a system for organizing the plurality of electrical cables, the system comprising:

a messenger wire supported a distance above the ground adjacent the solar panels; and

a plurality of cable hangers disposed along, and suspended from the messenger wire, each cable hanger having a plurality of cable carrying surfaces, each cable carrying surface being structured to support at least one electrical cable of the plurality of electrical cables,

wherein adjacent cable carrying surfaces of the plurality of cable carrying surfaces are separated by a cable carrier divider.

EX1001, 10:24-37; 11:29-45.

66. The ‘291 patent is one of several patents that claim priority from U.S. Patent Application No. 14/556,117, filed on November 29, 2014. While the specification of the ‘291 patent discusses cable hangers, methods of using hangers, and systems utilizing cable hangers in organizing electrical cables extending from solar panels, the claims of the ‘291 patent are directed only to systems and methods of *organizing electrical cables extending from solar panels*. EX1001, 10:24-13:8 (emphasis added).³

³ In addition to reciting systems for organizing electrical cables extending from solar panels, independent claims 14 and 19 also recite solar plants with a

67. With respect to the solar industry, the Background of the Invention Section of the ‘291 patent specification discusses the “need for electrical cables to extend from a **power** or signal source to a location of application.” *Id.*, 1:20-22 (emphasis added). In describing the types of electrical cables and other wires utilized in solar plant installations, the ‘291 patent states that “[i]n solar plants, **direct current** wires attach first to the solar panels and then run to combiner boxes before extending further to power inverters. In addition, **alternating current power cables** are used to power the motors that control the trackers, devices that rotate the solar panels to follow the sun in order to obtain maximum power during daylight hours.” *Id.*, 1:25-31 (emphases added).

68. The ‘291 patent states that in solar power plants “there are various sized wires and bundles of wires with an almost unlimited variety of wire bundle sizes.” *Id.*, 1:57-59.

69. The ‘291 patent specification further states that “[i]n a solar plant there is a recent move to tracker systems which utilize more wiring than previously fixed in place systems.” *Id.*, 2:1-3. The patent also notes the harsh environmental

plurality of solar panels and a plurality of electrical cables extending from the plurality of solar panels.

conditions, including the “stifling heat of the desert where solar power plants are usually located [which can reach 120 degrees F].” *Id.*, 2:37, 49-50.

70. As discussed above in my overview of the relevant technology (Section IV), prior to the priority date of the ‘291 patent, cable management of electrical cables in solar installations extending from the solar panels to the combiner boxes and power inverters utilized direct burial cables, cables in conduit, or metal wire trays, without any separation of AC cables from DC cables.

71. Notably, as discussed in the ‘291 patent:

Prior to 2014, AC and DC cables could be bundled immediately adjacent to, and touching, one another in a wire management system for the solar panels. In the new National Electric Code of 2014, the AC and DC cables must not be immediately adjacent to one another, but must have a degree of separation from one another. Power carrying cables have a tendency to induce errors or interfere with the signal wires that are located in close proximity to them. This new requirement also applies to other applications outside the solar power industry, such as the mining and electrical industries.

Id., 1:32-42.

72. The ‘291 patent further explains:

Because of the increased use of trackers in solar power plants, there is increased use of category five cables and other data wiring. This type of control wiring is used to give power plant

operators feedback from the solar power plant array on what angles the panels are stationed, and what the proper angle should be to maximize power output from the sun. This data and information is constantly monitored to obtain maximum power output from the thousands of solar panels in the solar power plant. The type of wiring used in collecting data is sensitive to cables used for AC and DC power and because of that sensitivity, data wiring cannot be bundled with power cables and must be supported by a separate carrier that is at least one inch away from all power cables.

Id., 1:43-56.

73. The ‘291 patent states that “[b]ecause of [the] changes [to the NEC], the wire management systems are much more complex, especially given the vast number of wires involved in a utility scale solar power plant.” *Id.*, 2:6-9.

74. In view of the recognized deficiencies of existing solutions for managing and organizing electrical cables in solar installations at the time, as well as the new requirements of the 2014 NEC Code, the ‘291 patent is directed to several improvements over the prior art, including:

- providing a new multiple electrical cable hanger system for the solar industry that is safe, more efficient and that reduces installation labor time;

- providing a more “organized system to support cables” in the solar industry;
- providing an electrical cable support system that offers safe, secure, strong, and “effective separation of cables and wires so as to protect the electrical performance of cables” in solar applications;
- providing a safer cable management system for control and electrical cables in the solar industry

See id., 4:52-5:11.

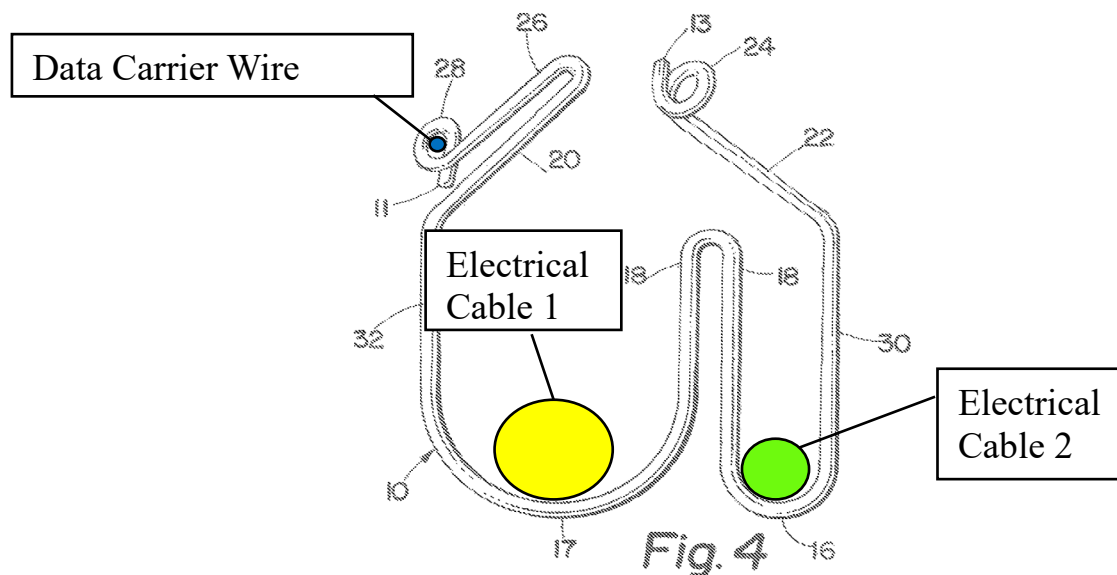
75. The ‘291 patent claims a system for organizing electrical cables and data wires in a solar plant as shown in an exemplary embodiment depicted in Fig. 2 of the ‘291 patent (an annotated version of which is reproduced below identifying a plurality of electrical cables extending from a plurality of solar panels as claimed in claim 1). The system shown in Fig. 2 includes a messenger wire 12 and a plurality (e.g., two) of cable hangers 10 suspended from the messenger wire 12.

Id., 6:50-54.

Id., FIG. 2 (annotated)

76. While independent claim 1 recites that each of a plurality of cable hangers has a plurality of cable carrying surfaces, with each cable carrying surface structured to support at least one electrical cable, and while Figure 2 above shows only one cable in each of two cable carrying surfaces, the ‘291 patent also claims cable hangers with at least three, four and five cable carrying surfaces, each structured to support at least one electrical cable. *See id.*, 10:38-46; *see also*, e.g., FIG. 23.

77. As shown in Figure 4 (an annotated version of which is reproduced below), the hanger 10 includes electrical cable carrier formations 16 and 17 with a cable carrier divider 18 separating cable carrier formations 16 and 17. *Id.*, 6:27-32. Figure 4 further shows the hanger 10 further includes a data carrier loop 28 for carrying a data information wire along the same path as the messenger wire 10. *Id.*, 6:38-41.



Id., FIG. 4 (annotated)

78. The ‘291 patent states that “[w]hat is important is that the hanger 10 provides a sufficient separation between both cable carrier formations 16, 17 and a further sufficient separation between the two carriers formations 16, 17, and the data carrier loop 28” *Id.*, 7:14-17.

79. The systems and methods of the ‘291 patent, therefore, provide for DC cables extending from solar panels to be separated from AC cables, and for DC and AC cables to be separated from data carrying wires.

VI. DESCRIPTION OF ASSERTED PRIOR ART

A. CAB CATALOG

80. The “CAB Hooks, Hangers & Mine Safety Products” catalog (“CAB Catalog”), as the title suggests, describes purported product offerings related to

hooks, hangers and safety products, predominantly for use in underground mines.
EX1006, 2-23.

81. The CAB catalog contains no disclosure or suggestion that any of the offerings are intended or suitable for use in solar applications. Moreover, the hangers disclosed in the CAB Catalog are not disclosed as being used for separating DC power cables from AC power cables, or for separating power cables from data carrier cabling.

B. ALMY

82. U.S. Pub. No. 2010/0139731 (“Almy”) published on June 10, 2010, and is titled “Wire-Based Hanging Wire-Way for Photovoltaic Modules or Module Groups.” EX1004.

83. Almy describes a “[w]ire-based hanging wire-way for photovoltaic modules or module groups.” *Id.*, at 1, Abstract.

84. In its Background Section, Almy states that “[g]round based power distribution networks require significant cabling between photovoltaic modules or discrete groups of modules” *Id.*, at 8, [0004]. Almy further states that “[t]o meet electrical code, the cabling is usually placed in a metal wire tray or conduit,” but that “metal wire trays or conduits can be both expensive and cumbersome to build.” *Id.* Thus, “additional improvements are needed in the evolution of

photovoltaic systems which include arrays of photovoltaic modules and ground based power distribution networks.” *Id.*

85. Almy’s wire-based hanging wire-way only supports bundles of DC power cables. As explained in Almy’s specification and shown in Figure 6 (reproduced below), bundles of electrical cables extending from each of photovoltaic module groups 602, 604 and 606 (e.g., bundle of electrical cables 612 extending from photovoltaic module group 602) are all connected to combiner box 620, which is coupled to inverter 624. *Id.*, at 11, [0034]. Inverter 624 “combines lines from several combiner boxes and converts DC current to AC current.” *Id.* In other words, all the cables extending from the solar panels in Almy and bundled in Almy’s wire-loops are exclusively DC power cables.

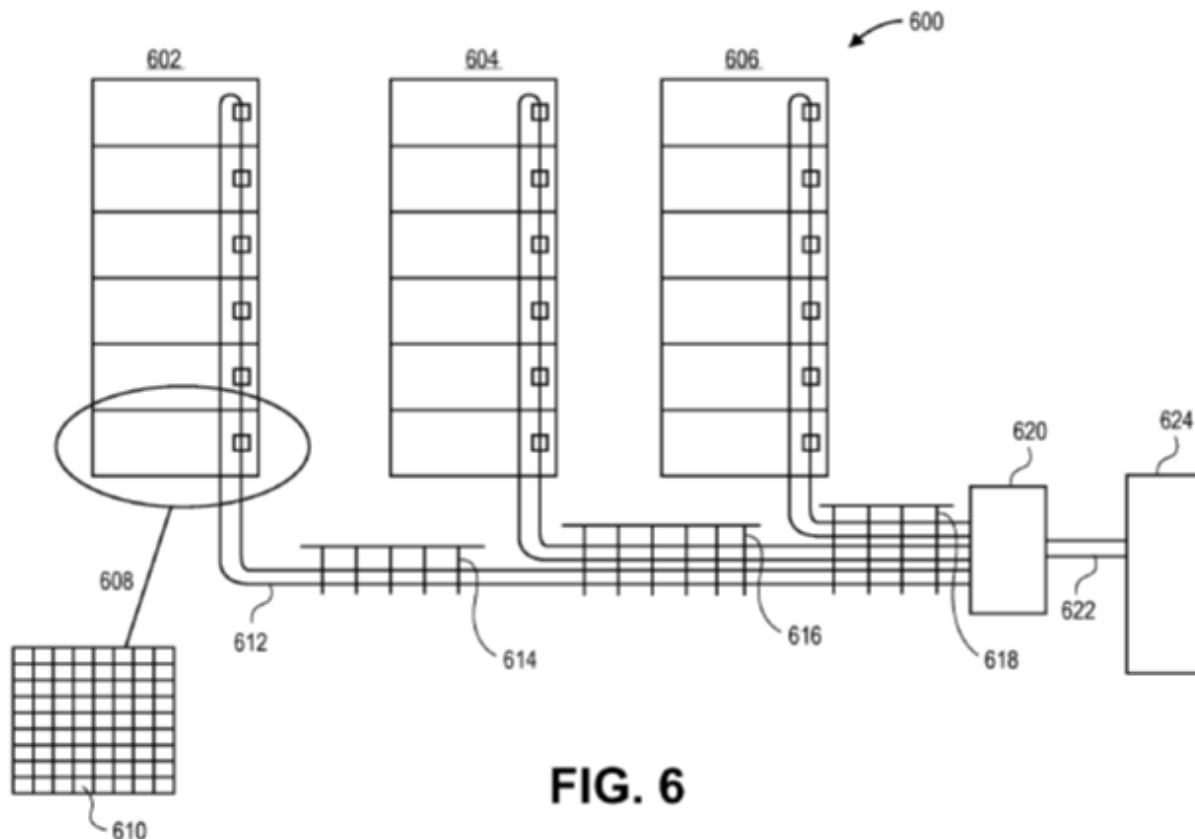


FIG. 6

EX. 1004, at 7, FIG. 6.

86. Further with respect to Figure 6, Almy states that “the size of each wire-based hanging wire-way expands with each successively larger bundle of electrical cables.” EX. 1004, at 11, [0034].

**VII. OPINIONS REGARDING PETITIONER’S ASSERTED GROUNDS
BASED ON 35 U.S.C. § 103**

87. For convenience, I again set forth below exemplary independent claims 1 and 14 at issue in this IPR:

1. A system for organizing a plurality of electrical cables extending from a plurality of solar panels, the system comprising:

a messenger wire structured to be supported a distance above the ground; and
a plurality of cable hangers structured to be disposed along, and suspended from, the messenger wire, each cable hanger having a plurality of cable carrying surfaces, each cable carrying surface being structured to support at least one electrical cable of the plurality of electrical cables, wherein adjacent cable carrying surfaces of the plurality of cable carrying surfaces are separated by a cable carrier divider.

* * * *

14. A solar plant comprising:

a plurality of solar panels;

a plurality of electrical cables extending from the plurality of solar panels; and

a system for organizing the plurality of electrical cables, the system comprising:

a messenger wire supported a distance above the ground adjacent the solar panels; and

a plurality of cable hangers disposed along, and suspended from the messenger wire, each cable hanger having a plurality of cable carrying surfaces, each cable carrying surface being structured to support at least one electrical cable of the plurality of electrical cables,

wherein adjacent cable carrying surfaces of the plurality of cable carrying surfaces are separated by a cable carrier divider.

EX1001, 10:24-37; 11:29-45.

A. GROUND 1 - CLAIMS 1-13 OF THE ‘291 PATENT WOULD NOT HAVE BEEN OBVIOUS OVER CAB CATALOG VIEW OF THE KNOWLEDGE OF A POSITA

88. In my opinion, the CAB Catalog in view of the knowledge of a POSITA does not render claims 1-13 of the ‘291 patent obvious.

89. Claims 1 and 6 are independent claims. Dependent claims 2-5, 8, 9, 11 and 13 all depend from independent claim 1, claim 10 depends from claim 9, and claim 12 depends from claim 11. Dependent claim 7 depends from independent claim 6.

1. CAB Catalog As Prior Art Under 35 U.S.C. § 102

90. Initially, Dr. Beik states his understanding that the CAB Catalog was publicly available on CAB’s website by August 11, 2011, and that the CAB Catalog is prior art to the ‘291 patent.

91. Dr. Beik does not provide any information other than EX. 1006 itself, and the fact that it bears a 2010 copyright date and a reference to “ver2010,” to support his proposition that EX. 1006 is prior art. In its Petition, however, Petitioner references EX. 1024, which purports to be an Internet Archive web page from March 14, 2011, that purportedly shows availability of “2010 CAB Catalogs.” Petition, at 8. I note that EX. 1024 was not accompanied by any affidavit from the Internet Archive.

92. I also note that EX. 1024 does not attach EX. 1006 or any other document, and that while there appear to have been links to certain CAB catalogs contained in the archived website page, the links are not active, so there is no way to access the referenced documents through these links.

2. CAB Catalog Does Not Disclose or Render Obvious the Claimed “A System for Organizing a Plurality of Electrical Cables Extending from a Plurality of Solar Panels” of Independent Claims 1 and 6 (and Dependent Claims 2-5, 7-13)

93. Dr. Beik states that “a cable hanger for suspending multiple conductors was well-known in the prior art.” EX. 1002, ¶49. He further states that the prior art “discloses *precisely* the systems and methods claimed in the independent claims of the ‘291 Patent.” *Id.* (emphasis added).

94. I disagree with Dr. Beik. The claimed system of the ‘291 patent is not directed simply to a cable hanger that supports “conductors” from a messenger wire. The system of the ‘291 patent is specifically directed to “*organizing*” a plurality of *electrical cables extending from a plurality of solar panels*. There is no dispute that in the context of the ‘291 patent, this means separating DC power cables from AC power cables and separating DC and AC power cables from data carrier cables.

95. In the context of the ‘291 patent, a POSITA would understand that “electrical cables” are current-carrying cables that provide power, i.e., “power

cables.” Specifically, the ‘291 specification describes how the 2014 NEC introduced a new requirement that DC and AC cables “must have a degree of *separation* from one another.” EX. 1001, 1:35-37 (emphasis added). The specification further explains that “[p]ower carrying cables have a tendency to induce errors or interfere with the signal wires that are located in close proximity to them.” *Id.*, 1:37-39 (emphasis added). The ‘291 specification makes clear that the “signal wires,” or “control wiring,” refers to category 5 cabling or other wiring necessitated by “the increased use of trackers in solar power plants,” so as to “give power plant operators feedback from the solar power plant array on what angles the panels are stationed, and what the proper angle should be to maximize power output from the sun.” *Id.*, 1:43-51. The specification continues on to explain that this “type of wiring used in collecting data is sensitive to cables used for *AC and DC power* and because of that sensitivity, data wiring cannot be bundled with *power cables* and must be supported by a separate carrier that is at least one inch away from all *power cables*.” *Id.*, 1:51-56 (emphases added).

96. Dr. Beik has acknowledged that the ‘291 patent describes its system for organizing electrical cables extending from solar panels as separating AC and DC power cables, in accordance with the 2014 NEC requirements. *See* EX. 1002, ¶¶32, 41-42. In the same way, a POSITA would understand the ‘291 patent’s system for organizing electrical cables extending from solar panels to be a system

for separating DC and AC power cables in order to comply with the NEC, and further for separating power cables from data carriers.

97. As I discuss further below, the CAB products shown in the CAB Catalog are not disclosed for organizing electrical power cables in an outdoor solar installation, but are predominantly for bundling various kinds of cables in underground mines. *See, e.g.*, EX. 1006, at 3, 5. *See also*, EX. 1002, ¶51 (Dr. Beik quoting from the CAB Catalog that “CAB Bosserman Clips are widely respected for their superior ability to safely suspend electrical cables and wiring in a variety of *underground* applications. . . .”) (emphasis added). To the extent the CAB Catalog depicts the use of any of its hangers for above-ground outdoor applications, for example the “plant” that Dr. Beik identifies on p. 14 of the CAB Catalog, they are hangers with a single carrying surface that appear at most to be supporting a single cable or bundle of cables from one point to another, but certainly not extending from a plurality of solar panels. EX. 1002, ¶53; EX. 1006, at 14.

98. Furthermore, the cables that are depicted in the image that Dr. Beik includes in his declaration are simply referred to as “aerial cables,” without specifying what type of aerial cables they are. It is a bit of leap for Dr. Beik to conclude that a POSITA, relying on the grainy image that Dr. Beik relies upon in ¶53 of his declaration, would have understood that the hangers shown in the CAB

Catalog could be used to organize a plurality of electrical cables extending from a plurality of solar panels in a solar installation.

99. In fact, Dr. Beik relies on pp. 9-11 of the CAB Catalog to specifically disclose hangers used for “electrical cables.” EX. 1002, ¶54, citing to EX. 1006, at 9. The J-Hooks disclosed on pp. 9-11, however, are disclosed for use in underground mines, not in outdoor above-ground solar applications. EX. 1006, at 9 (referring to the various types of J-Hooks as being for “sidewall applications,” “supporting pipe and cables from roof, side or structure,” “hanging multiple cables from roof,” “hanging from roof or other structure”).

100. Neither Dr. Beik nor Petitioner have disclosed any such system for organizing current-carrying power cables extending from solar panels in an outdoor solar installation prior to the invention of the ‘291 patent.

101. Dr. Beik points to standards and practices for cable installation in substations, generating stations and industrial facilities to support his proposition that cable management issues existed long before solar power systems. EX. 1002, ¶52. Dr. Beik specifically references the “proper installation of wire and cable systems in commercial, governmental and public facilities when the *same or similar wire or cable types and raceways are used.*” *Id.* According to Dr. Beik, a POSITA looking to manage cables in the solar industry would look to cable management in other electrical industries. *Id.* None of the references to which Dr.

Beik cites, however, discuss separation of *different* types of cables, such as DC from AC power cables, or separation of DC and AC power cables from data carriers, which is “precisely” the “system for organizing a plurality of electrical cables extending from a plurality of solar panels” that the ‘291 patent claims. Solutions for cable management in substations, generating stations and industrial facilities, just like cable management solutions used in underground mines, do not translate into solutions suitable for organizing electrical cables extending from solar panels in outdoor solar installations. Dr. Beik offers no support for his conclusory opinions to the contrary.

102. Dr. Beik’s analysis makes no mention of the unique challenges to cable management in outdoor solar installations. As discussed above in Section IV.C., Petitioner’s own Ex. 1011, the SolarPro article from early 2013, explains clearly those unique challenges. As set forth in more detail in my Overview of the Relevant Technology in Section IV.C. above, the numerous challenges addressed in EX. 1011 relate to the extreme and harsh environmental conditions, including high winds, extreme temperatures, ice, snow and other debris, in which PV arrays are installed, as well as concerns with NEC compliance. EX. 1011, at 2, 3, 4, 7, 8.

103. Dr. Beik and Petitioner both rely on the disclosure in the ‘291 specification that the locking cable hanger system is “for use in the solar, mining and electrical industries.” *See, e.g.*, EX. 1002, ¶52, Petition at 22, citing EX. 1001,

1:18-22. But just because the system claimed by the ‘291 patent for organizing electrical cables in the solar industry can also be used in mining and electrical industries, it does not follow, for the reasons stated above unique to the solar industry, that prior art solutions from the mining and electrical industries could be used in the solar industry, or that a POSITA would have a reasonable expectation of success in trying to do so.

104. Dr. Beik also states that using hangers shown in the CAB Catalog to organize cables extending from solar panels “would have yielded predictable results and reasonable expectation of success.” EX. 1002, ¶¶55. Petitioner goes beyond what Dr. Beik states, stating that the use of the hangers disclosed in the CAB Catalog “would have involved routine implementation, would have posed no technical risk, and would have achieved predicable [*sic*] benefits of improving wire runs in solar installations.” Petition at 21.

105. To support his assertion that a POSITA would have had a reasonable expectation of success in using the hangers disclosed in the CAB Catalog to organize cables extending from solar panels, Dr. Beik merely states that “(i) the CAB Catalog offers a hanger and support system that is spaced apart . . . , (ii) it would have been obvious to a POSITA to modify the *CAB Catalog* hangers where there was a need for multiple sets of cables when paralleling solar panels, and (iii)

solar power systems use cables that are common in the electrical power distribution industry.” EX. 1002, ¶55.

106. The reasons stated by Dr. Beik, however, are totally disconnected from, and ignore, the known challenges unique to cable management in solar installations, as discussed by the SolarPro article. EX. 1011, at 2, 3, 4, 7, 8. These factors are critical to Dr. Beik’s analysis. Merely stating that using CAB Catalog hangers in above-ground outdoor solar installations would have yielded predictable results, would have involved routine implementation, and would have posed no significant risk, are nothing than conclusory assertions, if they are silent as to the known challenges to cable management in solar.

107. I note that Petitioner cites to EX. 1007, a 1984 report prepared by Underwriters Laboratory (UL) for Jet Propulsion Laboratory (JPL), EX. 1007, to support an “express motivation” to use the hangers disclosed in the CAB Catalog in the solar industry. Petition, at 22. Petitioner mischaracterizes the UL report as explaining that “a messenger with rings and saddles for conductor support” *is* a ‘practical PV application . . . for terrestrial arrays located away from the building.’ *Id.* (emphasis added). Dr. Beik mischaracterizes the UL report in the same way. EX. 1002, ¶31.

108. In fact, the UL report states that “[a] practical PV application of messenger supported wiring *may* be for terrestrial arrays located away from the

building.” EX. 1007, at 39. In other words, the report is entirely speculative back in 1984 as to the potential use of messenger supported wiring in a PV application.

109. It is my opinion that, in view of the growth in PV arrays and installations over the 30 years between the time of the UL report and the ‘291 invention, and the techniques for cable management that had been developed and utilized over that time, the UL report would have in no way provided an “express motivation” to use the hangers disclosed in the CAB Catalog to organize a plurality of electrical cables in a solar installation 30 years after the report. Moreover, the UL report would not have even informed the knowledge of a POSITA (as defined by Petitioner and Dr. Beik) as of the time of the ‘291 invention. Rather, it is my opinion that a POSITA at the time of the ‘291 invention would have viewed this report as an outdated catalog of equally outdated wiring methods, not motivation for product development in solar installations as they had developed leading the ‘291 patent.

110. Finally, I note that Dr. Beik and Petitioner also mischaracterize the SnakeTray cable tray system disclosed in EX. 1008 as comprising a plurality of “spaced apart hangers’ designed to be suspended from a messenger wire for use in solar installations.” EX. 1002, citing EX. 1008; *see also* Petition, at 22-23. A POSITA would understand that a cable tray is an entirely different structure than a cable hanger.

3. CAB Catalog Does Not Disclose the Claimed Messenger Wire of Independent Claims 1 and 6 (and Dependent Claims 2-5, 7-13)

111. Citing to various pages from the CAB Catalog, Dr. Beik states that the CAB Catalog “explicitly discloses the use of a messenger wire to support cable hangers, rings, saddles and clips suspended from a messenger wire.” EX. 1002, ¶57. Dr. Beik relies upon various images from the CAB Catalog that he includes in his declaration. *Id.* Based on these cited pages and images, Dr. Beik concludes that the “*CAB Catalog* discloses ‘a messenger wire structured to be supported a distance above the ground.’” *Id.*, ¶58. I disagree with Dr. Beik.

112. First, none of the citations or images from the CAB Catalog that Dr. Beik relies upon disclose a messenger wire “structured to be supported *a distance above the ground.*” Dr. Beik cites to the bottom portion of p. 5 of the CAB Catalog that refers to “messenger wire,” but ignores the disclosure at the very top of p. 5 that expressly discloses (as shown in the photos on p. 5) that the CAB Bosserman Clips are for “*underground applications.*” EX. 1006, at 5. As such, the messenger wire referenced at p. 5 is expressly not a messenger wire suspended a distance above the ground.

113. Dr. Beik further cites to the reference to “messenger wire” at p. 8 of the CAB Catalog, but that reference does not indicate that the messenger is suspended a distance above the ground. In fact, the hanger designed to be

suspended from the messenger wire referenced on p. 5 is a plastic CAB Telewire Hook. A POSITA would understand in the context of the overall disclosures of the CAB Catalog that “telewire” is run underground in the mine.

114. Similarly, none of the references to “messenger wire” on p. 14 of the CAB Catalog disclose whether the specifically referenced messenger wire, or the hangers suspended the messenger wire, are for above-ground or underground application. Contrary to Dr. Beik’s assertion, therefore, the cited references and images in the CAB Catalog do not disclose a messenger wire structured to be supported a distance above the ground.

115. The claims of the ‘291 patent make clear that the claimed messenger wire must not only be supported a distance above the ground, but also must support a plurality of hangers having a plurality of cable-carrying surfaces, each cable-carrying surface structured to support a plurality of electrical cables extending from a plurality of solar panels.

116. With one exception, all the hangers disclosed in the CAB Catalog pages cited by Dr. Beik for the “messenger wire” limitation of the claims are hangers with a single cable carrying surface. *See* EX. 1006, at 5, 14. Only one of the cited to “messenger wire” references is a messenger wire for a hanger with multiple cable carrying surfaces, and that is the CAB 905 Plastic Telewire Hook shown on p. 8. *Id.*, at 8. By its very name, however, that hanger is made of plastic

and is for supporting lighter weight telewires. It is not one of a plurality of cable hangers having a plurality of cable carrying surfaces structured to support a plurality of much heavier electrical power cables extending from a plurality of solar panels. As Dr. Beik has acknowledged, referring to “electrical cables,” “[a] POSITA would have recognized that higher voltage and heavier load applications exist in the solar power context.” EX. 1002, ¶54; *see also id.*, ¶29 (acknowledging that current-carrying cables are heavier, and that large bundles of current-carrying cables, if not supported, will deflect under load).

4. CAB Catalog Does Not Disclose the Claimed or Render Obvious the Claimed Plurality of Cable Hangers of Independent Claims 1 and 6 (and Dependent Claims 2-5, 7-13)

117. Dr. Beik relies on various images of hangers and certain text references in the CAB Catalog to disclose the claimed “a plurality of cable hangers structured to be disposed along, and suspended from, the messenger wire, each cable hanger having a plurality of cable carrying surfaces, each cable carrying surface being structured to support at least one electrical cable of the plurality of electrical cables.” I disagree with Dr. Beik. With one exception, a POSITA would understand that the cited images and text portions of the CAB Catalog either show hangers with single cable carrying surfaces suspended from a messenger wire, or hangers with a plurality of cable carrying surfaces that are not structured to be disposed along, and suspended from, a messenger wire as required by the claims.

118. Specifically, the images from the CAB Catalog of hangers suspended from a messenger wire shown by Dr. Beik in ¶59 of his declaration are all hangers that do not have a plurality of cable carrying surfaces. EX. 1002, ¶59.

119. The images of hangers from pp. 8-11 from the CAB Catalog that have a plurality of cable carrying surfaces, as shown by Dr. Beik in ¶60 of his declaration, with one exception, are not structured to be disposed along and suspended from a messenger wire. The Double J-Hook shown on p. 9 is described in the CAB Catalog as hanging from a roof. EX. 1006, at 9. The CAB Longwall Hanger shown on p. 10 is described as having an extension hook for “higher roof areas,” and is nowhere described as being suspended from a messenger wire. *Id.*, at 10. With respect to the 4 Carrier Bullhorn Hangers shown on p. 11, the CAB Catalog again states that custom sizes of these hangers are available for “high roof areas.” *Id.*, at 11.

120. Again, as discussed above in connection with the “messenger wire” limitation, the only hanger disclosed in the CAB Catalog, and shown in Dr. Beik’s declaration, with a plurality of cable carrying surfaces and that is suspended from a messenger wire is the CAB 905 Plastic Telewire Hook shown on p. 8, and again, that hanger is disclosed as being made of plastic and, by its name, is for suspending telewires. *Id.*, at 8. Dr. Beik fails to explain how this disclosure is sufficient to meet the claim requirement that the claimed cable hanger have a plurality of cable

carrying surfaces structured to support heavier electrical power cables extending from solar panels in a solar installation.

121. The CAB hangers described in various portions of the CAB Catalog and cited to in ¶61 of Dr. Beik’s declaration also fail to meet this claim limitation. The CAB Bosserman Clip disclosed and depicted on p. 5 of the CAB Catalog is, again, a hanger with a single cable carrying surface. *Id.*, at 5. The CAB J-Hooks disclosed and depicted on p. 9 are described as being used for sidewall and roof applications. And the CAB Cable Rings and Saddles are hangers with single cable carrying surfaces. *Id.*, at 14.

122. Dr. Beik states in ¶62 of his declaration that “a POSITA would have found it obvious to modify CAB’s cable clips, rings, and saddles to have a plurality of cable carrying surfaces.” EX. 1002, ¶62. Dr. Beik reasons that the “simple design” of CAB’s cable clips, rings, and saddles “would *allow* a POSITA to modify their design to include additional cable carrying surfaces.” *Id.* (emphasis added). Dr. Beik offers no details of the specific design of these cable clips, rings and saddles, or how they are made, and apparently bases his assertion that their design is “simple” based on their appearance alone. Dr. Beik further opines that, based on the “possible variety” of the hangers’ size and configuration options, it would have been obvious to a POSITA to modify the hangers “to allow for larger, smaller, or a plurality of cables to fit into the disclosed hangers.” *Id.* In apparent recognition

that even with such modification the hangers would still only have a single cable carrying surface, Dr. Beik then asserts that “a POSITA would know that this same hanger *can be* modified . . . to include extra bends in the hanger to provide separate and divided areas for each of the cables to occupy.” *Id.* (emphasis added).

123. In other words, Dr. Beik simply states, without any real support and not professing any knowledge as to how these hangers are designed and manufactured, that these hangers *could* be modified to have multiple cable carrying surfaces by simply bending them. But he offers no explanation as to why a POSITA *would* modify the hangers in this way. This appears to be hindsight reconstruction.

124. Petitioner relies solely on Dr. Beik’s opinions for how it would be obvious to modify CAB’s cable clips, rings and saddles to have a plurality of cable carrying surfaces. Petition, at 26.

125. In sum, it is my opinion that Dr. Beik and Petitioner have offered not offered any motivation to modify the alleged disclosure of the CAB Catalog, other than hindsight reconstruction for the sole purpose of rendering the claims of the ‘291 patent obvious.

126. For these reasons, it is my opinion that Dr. Beik and Petitioner have not shown how the CAB Catalog renders independent claims 1 and 6 obvious. Because dependent claims 2-5 and 8-13 depend directly or indirectly from claim 1,

and dependent claim 7 depends from claim 6, it is also my opinion that Dr. Beik and Petitioner have not shown how the CAB Catalog renders these claims obvious.

B. GROUND 2 - CLAIMS 14-23 OF THE ‘291 PATENT WOULD NOT HAVE BEEN OBVIOUS OVER CAB CATALOG AND ALMY IN VIEW OF THE KNOWLEDGE OF A POSITA

127. Claims 14 and 19 are independent claims, dependent claims 15-18, 20-21 and 23 depend directly from claim 14, and dependent claim 22 depends from claim 21.

128. In my opinion, Petitioner and Dr. Beik have not offered any support for how combining the CAB Catalog and Almy would have achieved the claimed inventions recited in the claims of the ‘291 patent.

129. At the outset of his analysis in Ground 2, Dr. Beik offers his opinion as to why a POSITA would have been motivated to combine the CAB Catalog with Almy’s wire-based hanging wire way for supporting a bundle of electrical cables between photovoltaic modules or module groups. EX. 1002, ¶¶100-103; *see also* Petition, at 46-48. But Dr. Beik’s analysis is not based on any combination of CAB Catalog and Almy with respect to any single claim limitation.

130. Dr. Beik only relies on Almy to disclose the limitations “a solar plant,” “a plurality of solar panels” and “a plurality of electrical cables extending from the plurality of solar panels” recited in claim 14. EX. 1002, ¶¶104-109. For the limitations in claim 14 that recite “a system for organizing the plurality of

electrical cables [extending from the plurality of solar panels,” Dr. Beik purports to rely on the CAB Catalog and Almy, together or individually, to meet these claim limitations. *Id.*, ¶¶110. For his analysis, however, Dr. Beik relies only on his analysis for claim limitation 1[a], which is based solely on the CAB Catalog. *Id.*, citing Section XI.A.1.a., ¶¶51-56. For all other limitations of claim 14, Dr. Beik also relies solely on the CAB Catalog. *Id.*, ¶¶111-113.

131. For independent claim 19, Dr. Beik only relies on Almy to disclose the limitations “a solar plant,” “a plurality of solar panels” and “a plurality of electrical cables extending from the plurality of solar panels” recited in claim 19. *Id.*, ¶¶114-116. For all other limitations of claim 19, Dr. Beik relies only on the CAB Catalog. *Id.*, ¶¶117-121.

1. CAB Catalog Does Not Disclose or Render Obvious the Claimed “A System for Organizing a Plurality of Electrical Cables Extending from a Plurality of Solar Panels” of Independent Claims 14 and 19 (and Dependent Claims 15-18, 20-23)

132. For the same reasons stated above in Section VII.A.2. in response to Ground 1, Dr. Beik and Petitioner have not shown how the CAB Catalog discloses the limitation of independent claims 14 and 19 “A System for Organizing a Plurality of Electrical Cables Extending from a Plurality of Solar Panels.”

2. CAB Catalog Does Not Disclose the Claimed Messenger Wire of Independent Claims 14 and 19 (and Dependent Claims 15-18, 20-23)

133. For the same reasons stated above in Section VII.A.3. in response to Ground 1, Dr. Beik and Petitioner have not shown how the CAB Catalog discloses the limitation of independent claims 14 and 19 “a messenger wire supported a distance above the ground adjacent the solar panels.”

3. CAB Catalog Does Not Disclose the Claimed or Render Obvious the Claimed Plurality of Cable Hangers of Independent Claims 14 and 19 (and Dependent Claims 15-18, 20-23)

134. For the same reasons stated above in Section VII.A.4. in response to Ground 1, Dr. Beik and Petitioner have not shown how the CAB Catalog discloses the limitation of independent claims 14 and 19 “a plurality of cable hangers disposed along, and suspended from the messenger wire, each cable hanger having a plurality of cable carrying surfaces, each cable carrying surface being structured to support at least one electrical cable of the plurality of electrical cables.”

135. For these reasons, it is my opinion that Dr. Beik and Petitioner have not shown how the CAB Catalog discloses or renders independent claims 14 and 19 obvious. Because dependent claims 15-18, 20-23 depend directly from independent claim 14, it is also my opinion that Dr. Beik and Petitioner have not shown how the CAB Catalog discloses or renders these dependent claims obvious.

VIII. SECONDARY CONSIDERATIONS OF NON-OBVIOUSNESS

136. Dr. Beik states that he is not aware of any secondary considerations that would weigh against the alleged obviousness of the ‘291 patent claims. EX. 1002, ¶¶128-130. I believe several secondary considerations are already disclosed in the record.

137. Dr. Beik has failed even to mention, let alone address, the industry’s long felt need for improved cable management systems, the “challenges to managing free-air conductors with the PV array,” the challenges presented by the extreme environmental conditions in which PV arrays are installed, and the overall challenges of challenges of “implementing a safe, reliable and *Code*-compliant wire management system for exposed PV conductors” that I discuss in more detail in my Overview of the Relevant Technology, Section IV., above. All of these factors of secondary considerations are specifically identified in the SolarPro article that Petitioner has introduced in support of its Petition. EX. 1011, at 1-2.

138. In addition, Dr. Beik fails to acknowledge or address evidence of secondary considerations included within the ‘291 prosecution history. Specifically, during prosecution, in response to the Examiner’s rejection under 35 U.S.C. § 103, one of the inventors, Allen Smith, submitted a declaration that explicitly identified additional evidence of secondary considerations. Specifically, Mr. Smith explained that a great amount of work and financial investment that

CAB devoted to developing “products that met the particular needs of the industry both from service and safety standpoints as well as *to gain acceptance and trust in the industry for such new approach*,” including preparation of white papers by an expert and installation of mockups and “actual installations on solar sites to prove the product would perform in actual applications.” EX. 1015, at 201-202.

139. Mr. Smith also identified evidence of commercial success, stating that CAB had no sales in the solar industry prior to 2014, but by fiscal year 2020/2021, had sold over \$37 million in product to the solar industry, with even more sales projections for fiscal year 2021/2022. *Id.*, at 203-204.

140. It is my opinion that Dr. Beik has not supported his opinion that there are no secondary considerations that outweigh any asserted obviousness of the claims when he has not addressed evidence of secondary considerations that were put into the record by Petitioner and available for Dr. Beik to review.

IX. CONCLUSION

141. For all the reasons set forth above, it is my opinion that Dr. Beik has not provided sufficient support to show that claims 1-10, 14-22, and 24-25 of the '291 Patent are unpatentable over the references cited by Petitioner.

X. CERTIFICATION

142. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are

believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine, imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Respectfully submitted,

A handwritten signature in blue ink, appearing to read "Edward C. Kern, Jr.", is written on a light yellow rectangular background.

February 15, 2024

Edward C. Kern, Jr., Ph. D.

EXHIBIT A

Edward C. Kern, Jr., Ph.D.

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Dr. Kern has over four decades experience designing and building solar photovoltaic power systems. He is a director of Irradiance, Inc. a firm designing and manufacturing instruments for solar resource measurement. Dr. Kern consults on renewable energy technology development, infrastructure, and utility power system integration through KRNL PWR LLC and consults and serves as an expert witness in areas pertaining to photovoltaic panel and array structural products and system design concepts.

He is a founder, past president and director of the Solar Energy Business Association of New England. From 2002 through 2004, Dr. Kern lectured in wind and solar energy technology as part of MIT's subject 10.319j "Sustainable Energy". He was Director of Engineering for Schott Applied Power Corporation until 2002 when he formed Irradiance, Inc. and focused his activities on technology consulting and instrumentation design and manufacturing. Since 2015 he has devoted pro bono efforts within his community of Lincoln, Massachusetts and his alma mater Dartmouth College advocating for and providing design guidance toward their initial investments in solar power generation.

Dr. Kern has participated in solar power system research, development, and engineering projects across the United States and internationally since the mid-1970s. After leaving Schott, he worked with an electric utility in the Philippines and the International Finance Corporation to design and build the first megawatt-scale solar photovoltaic system to support clean electric power development in developing countries. He has worked with the United Nations Environment Program and electric utilities in Mexico, El Salvador, Costa Rica, Peru, India, Thailand and the Philippines on planning megawatt-scale PV installations. He worked with the Tata Power Company in Mumbai developing a megawatt-scale PV installation in collaboration with the U.S. Department of State's Asian-Pacific Partnership on Clean Development and Climate. He has served as a consultant to the International Finance Corporation, World Bank Group, in the area of renewable energy and infrastructure.

Dr. Kern has been active in the field of solar energy resources assessment, solar power system design, and power system performance modeling throughout his renewable energy career which started in 1977. Irradiance manufactures a rotating shadowband radiometer (RSR), a field survey instrument for measuring and recording global, direct and diffuse solar irradiance that Dr. Kern invented in the early 1990s. Since 2005 over one thousand RSR instruments have been installed in the United States, Australia, Bahrain, Brazil, Canada, China, Chile, Costa Rica, Ethiopia, Ghana, Greece, India, Indonesia, Israel, Italy, Jordan, Libya, Mexico, Morocco, Pakistan, Peru, the Philippines, Qatar, Russia, Saudi Arabia, South Africa, Spain, Switzerland, Tunisia, Turkey, and

DECLARATION OF EDWARD C. KERN, JR., PH.D.

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Uruguay. Irradiance and the National Renewable Energy Laboratory's Solar Radiation Research Laboratory worked collaboratively for many years to characterize and improve rotating shadowband radiometers. A third generation of RSR instruments has been developed by [Irradiance, Inc.](#) under his son Chris Kern's leadership.

As founder and president of Ascension Technology (1987-1999) Dr. Kern oversaw the design and installation of over 200 grid-connected photovoltaic systems, in over 20 U.S. states from Hawaii to Massachusetts and internationally, totaling over two megawatts. These seminal grid-tie projects ranged in size from a 300-watt "AC-Module" to 100-kW systems installed within a wind farm in Tamil Nadu State, India and at the Pentagon in Washington, DC. The earliest of these projects were co-funded by the EPA, EPRI and electric utilities across the United States to demonstrate the feasibility of grid-connected solar photovoltaic systems and to determine the air emission offsets derived from clean PV power displacing fossil fuel fired generation. In these and many subsequent projects, system performance-monitoring and solar energy resource measurement equipment was developed under the supervision of Dr. Kern and used in these projects.

Before founding Ascension Technology in 1987, Dr. Kern was a member of the Massachusetts Institute of Technology faculty and research staff. He joined the MIT Lincoln Laboratory Photovoltaic Field-Test and Applications Project in 1977 and was promoted to Assistant Group Leader in 1980. In 1979 he planned and then managed the U.S. Department of Energy's Residential Rooftop Photovoltaic Systems Project. From 1982 until 1987 he continued this photovoltaic systems development activity at the MIT Energy Laboratory.

Before entering the solar photovoltaic power field in 1977, Dr. Kern's professional activities were in the field of hydrodynamics, particularly studying the dynamics of floating ocean structures for the control of oil spills. During the mid-1970s he was an Assistant Professor at MIT's Department of Ocean Engineering.

A Senior Member of the IEEE, Dr. Kern served as a member of the IEEE Standards Coordinating Committee on Dispersed Storage and Generation. During the early 1980s this committee developed the *IEEE Guide for Interfacing Dispersed Storage and Generation with Utility Systems*. He has consulted to the Electric Power Research Institute on photovoltaic applications, has served on the Science and Technology Review Committee for the National Renewable Energy Laboratory's Solar Radiation Resource Assessment Project and has served as a Peer Reviewer for the U.S. Department of Energy's Solar Program for Evaluation, Validation and Analysis.

Dr. Kern earned an A.B. in Engineering Sciences from Dartmouth College, a B.Eng. from Dartmouth's Thayer School of Engineering and a Ph.D. in the field of hydrodynamics from the Massachusetts Institute of Technology. He is a Fellow of the American Solar Energy Society.

A handwritten signature in blue ink, appearing to read "Edward C. Kern, Jr.", is displayed on a light blue background.

Projects, Reports, Teaching and Presentations	Year Start	Year End	Type of Activity	Client	Sponsors	Country
DOE Field Tests and Applications Program	1977	1982	PV System R&D		US DOE	USA
DOE PV Program Project Integration Meetings	1977	1982	PV System Field Test and Evaluation		US DOE	USA
IEEE PVSC	1977	2000	PV System R&D		US DOE	USA
DOE Residential PV Roof Top PV Program	1979	1986	PV System R&D		US DOE	USA
IEEE PES Relay and Protection Committee	1983	1986	Codes and Standards Development		US DOE	USA
EPRI Appliance Signature (NIALMS)	1984	1986	Power monitoring instrumentation		EPRI	USA
Gardner MA Model PV Community Project	1984	1990	PV System Field Test and Evaluation	New England Electric System	EPRI	USA

Massachusetts PV Utilization Program	1987	1988	PV System Field Test and Evaluation	Massachusetts Dept of Energy Resources		USA
Florida Power and Light Substation	1987	1988	Power monitoring instrumentation	Florida Power and Light		USA
EPRI Early PV Applications for Electric Power Industry	1987	1990	Training (Utility)		EPRI	USA
Early PV Applications Seminars	1988	1990	Training (Utility)		EPRI	USA
Nantucket Electric PV School	1988	1999	PV System Demonstration	Massachusetts Dept of Energy Resources		USA
EPRI CRIEPI Planning Meetings	1990	1994	Consulting		EPRI	USA
NREL Pakistan	1992	1992	Solar radiometry instrumentation		SERI	Pakistan
NYPA RSR	1992	1995	Solar radiometry instrumentation	New York Power Authority		USA

New England Power RSR	1992	1998	Solar Resource Monitoring	New England Electric System		USA
Northeast Utilities RSR	1992	1998	Solar Resource Monitoring	Northeast Utilities		USA
EPA PV Utility Air Emission Offset Studies 1	1993	1995	PV System Field Test and Evaluation		US EPA	USA
NREL AC Module Development	1993	1999	Power Electronics Development			USA
EPRI RSR	1994	1997	Solar radiometry instrumentation		EPRI	USA
Isla Mona PV	1995	1996	PV System Field Test and Evaluation	Amoco Enron Solar		USA
NEPC Micon Wind/PV integration	1995	1996	PV System Field Test and Evaluation			India
NREL Flat Roof Mounting Design	1995	1996	PV System R&D		NREL	USA
NREL White House	1995	1998	PV System Demonstration		NREL	USA

ISES World Conferences	1995	2000	PV System Field Test and Evaluation		US EPA	Multiple
Bayer Mexico City	1996	1996	PV System Demonstration	Bayer Pharma		Mexico
EPA PV Utility Air Emission Offset Studies 2	1996	1999	PV System Field Test and Evaluation		US EPA	USA
Utility Photovoltaic Group Projects	1996	2000	PV System Field Test and Evaluation		UPVG	USA
NREL Pentagon 1	1997	1997	PV System Field Test and Evaluation	NREL	NREL	USA
NREL Pentagon 2	1998	1998	PV System Field Test and Evaluation	NREL	NREL	USA
Brazil Remote Village Power	1998	1999	Power monitoring instrumentation		NREL	
Applied Power Corporation Management	1998	2000	Consulting			USA
Massachusetts Deregulation	1998	2000	Consulting		US DOE	

Solar Energy Business Association of New England	1999	2002	Consulting			USA
Schott Glass Management	2000	2001	Consulting			USA
MIT Sustainable Energy Subject	2001	2004	Teaching (University)			USA
NYCT Stillwell	2001	2005	PV System Procurement Consulting	New York City Transit Authority		USA
IFC Cagayan de Oro	2002	2005	PV System Procurement Consulting	Cagayan Electric Power and Light Company	WB/IFC	Philippines
NREL Proposal Review Committees	2003	2006	Consulting		NREL	USA
IFC World Outreach	2004	2008	Training (Utility)		WB/IFC	USA
US DOS India	2005	2008	PV System Procurement Consulting		US DOS	India
NREL SRRL Utility Solar Resource Collaboration	2005	2010	Solar radiometry instrumentation		NREL	USA

Tata Power Mulsi 2 MW	2008	2008	PV System Procurement Consulting	Tata Power Company	US DOS	India
Saudi RSR Network	2008	2013	Solar radiometry instrumentation	King Abdullah Center for Renewable & Atomic Energy		Saudi Arabia
Chile - Atacama Resource	2009	2014	Solar radiometry instrumentation			Chile
Egypt Nile Delta PV Irrigation	2010	2010	Consulting		WB/IFC	Egypt
World Bank/Int Fin Corp PV Technology Seminar	2010	2010	Training (Utility)		WB/IFC	USA
Solar PACES Annual Meeting	2010	2010	Solar radiometry instrumentation			France
China Light and Power	2010	2012	Solar Resource Monitoring	China Light and Power		Australia
World Bank South India 5 MW	2010	2012	PV System Procurement Consulting		WB/IFC	India
CH2M Hill Rajasthan/West Bengal	2010	2012	Solar Resource Monitoring	CH2M Hill Consultants	US DOS	India

Tata PowerSolar Resource Studies	2010	2014	Solar radiometry instrumentation	Tata Power Company		India
World Bank/Int Fin Corp PV Technology Seminar	2011	2011	Training (Utility)		WB/IFC	India
Solar PACES Annual Meeting	2011	2011	Solar radiometry instrumentation			Spain
Qutar Energy Agency	2012	2012	Solar radiometry instrumentation			Qatar
Solar PACES Annual Meeting	2012	2012	Solar radiometry instrumentation			USA
Saudi Electric Company	2012	2013	Solar Resource Monitoring	Saudi Electric Company		Saudi Arabia
Swiss Sensor Trials	2012	2013	Solar radiometry instrumentation			Switzerland