

CURRICULUM VITAE

Vasilis M. Fthenakis, Ph.D., AIChE Fellow; IEF Fellow

Center for Life Cycle Analysis
Columbia University
New York, NY 10027
(212) 854-8885
email : vmf5@columbia.edu
www.clca.columbia.edu

Seminal Contribution:

Vasilis Fthenakis is internationally recognized as a most credible, prolific and impactful researcher of environmental sustainability of photovoltaic (PV) energy technologies. Fthenakis' multi-disciplinary work is a crucial part of the scholarly landscape for comparing renewable energy technologies with conventional energy options and assisted the current large scale penetration of PV into the European and U.S. electricity grids. Helping to put several energy technologies on a comparable basis with solar has been a crucial contribution to today's key debates about energy and climate change.

EDUCATION

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|-------------------------------|---|
| New York University, New York | Ph.D. in Fluid Dynamics and Atmospheric Science, 1991. <i>Thesis topic: Modeling of water spraying of toxic gas releases; with Dr. Victor Zakkay</i> |
| Columbia University, New York | M.S. in Chemical Engineering, 1978. <i>Thesis topic: Modeling on the methanation of carbon monoxide; with Dr. John Happel.</i> |
| University of Athens, Greece | Diploma in Chemistry, 1975. |

RESEARCH EXPERIENCE

Columbia University: Senior Research Scientist and Adjunct Professor, Founder and Director of the Center for Life Cycle Analysis (CLCA) (2006-present)

Adj. Professor Earth and Environmental Engineering (2000-2006), **Adj. Associate Professor** (1995-2000). The CLCA is supported with research grants from the PV industry, NSF, EPA, NYSERDA, and NREL. It involves three faculty members, several MS/PhD students, postgraduate research associates and international collaborations. He developed and led several led multi-disciplinary multi-million dollar research proposals involving the departments of earth and environmental engineering, mechanical engineering, chemical engineering, material science and electrical engineering. Current research focuses on renewable systems integration, energy environmental impact analysis, energy-water nexus, and renewable energy powered water desalination. Recently he co-founded the Global Clean Water Desalination Alliance (GCWDA) and was elected in its Board of Directors. The GCWDA was launched during the COP21 Paris and was also represented in COP22 Marakesh. Fthenakis is leading GCWDA efforts to integrate PV with desalination making it both clean and affordable.

His group also recently developed a new Unit Commitment and Economic Dispatch (UCED) model with detail on modeling solar and wind dispatch in electricity grids and thermodynamic models of storage that do not exist in commercial models.

Brookhaven National Laboratory: Senior Scientist Emeritus (2017-) **Tenured Senior Scientist** (2011-2016); **Senior Chemical Engineer** (2008-2010); **Chemical Engineer** (2003-2007); **Senior Research Engineer** (1995-2002); **Research Engineer I** (1987-1994); **Research Engineer II** (1980-1986)
Departments of Sustainable Energy Technologies, Energy Science & Technology and Environmental Sciences.

Co-authored in 2007-2008 a "Grand Plan for Solar Energy" a leading study published in Scientific American in 11 languages and in Energy Policy, showing the technical, economic and geographical feasibility of solar with other renewables to satisfy 69% of the electricity needs of the U.S. by 2050. The more detailed SunShot Solar Vision studies verified the first stage of this Solar Grand Plan. Current research focuses on renewable energy grid integration, energy-environmental impact analysis, and the energy-water nexus. He has been the Head of the National Photovoltaic Environmental Research Center,

since 2002. He has been leading international collaborations on life cycle assessment (LCA) under the auspices of the U.S.-DOE, and the International Energy Agency (IEA).

Major Contributions/Recognitions:

Fthenakis specializes in the areas of grid systems integration and on topics at the interface of energy and the environment. He has led the U.S. and to a certain degree the European PV industries onto a pathway of sustainable development. He identified potential barriers in PV commercialization and proactively conducted research that resolved concerns associated with rapid growth of the PV market. He built collaborations on silane safety and lead-free solder technologies among PV industry members, and he conceptualized and conducted original research on the life cycle of thin-film photovoltaics that opened the door to Europe and Asia for the U.S. thin film PV industry. Fthenakis foresaw the European trends towards banning products containing lead and cadmium and guided the crystalline silicon and the cadmium telluride industries in overcoming these barriers. In 1999, he organized and chaired a workshop in Vail, CO, to promote the use of lead-free solder technology in the PV industry. Eight years later, a large fraction of the crystalline-Si PV industry has converted to lead-free solder alloys. Currently, PV products are compliant with the Waste Electronic and Electrical Equipment (WEEE) and are exempt of the RoHS regulations, largely because of Fthenakis' pioneering research on the life-cycle of photovoltaics.

He entered the area of life cycle analysis (LCA) in 2004, intrigued by what he considered an unbalanced presentation of the environmental impacts of photovoltaics. Given the broad scope of this research that covered several major PV technologies, he concentrated on 2nd generation thin-film photovoltaics for which there were not previous studies, while engaging European researchers in updating LCA studies of crystalline silicon PV technologies. Thus, he formed an ad-hoc committee and held scoping meetings with researchers from the University of Utrecht, the Energy Research Center of the Netherlands, Chalmers University, University of Stuttgart, Siena University and Ambient Italia, assessing the LCA needs of the PV industry. Subsequently, he co-authored several papers with his collaborators compiling a well-balanced picture of PV in comparison with other energy technologies.

To safeguard the environmental friendliness of photovoltaics, he has been defining and promoting a proactive, long-term environmental strategy including recycling of photovoltaics at the end of their useful life. In 2002-2005 he established a laboratory for studies on recycling of spent photovoltaic modules and manufacturing scrap, using hydrometallurgical separation technologies; his work produced a patented technology for Cu, Cd and Te separations which has great potential in both the CdTe and CIGS technologies. He also conducted joint-studies and published on optimizing the collection of end-of-life photovoltaics, thus, minimizing the overall cost of recycling.

He foresaw concerns regarding the growth of CdTe and CIGS PV markets, and designed experiments for simulating the effect of fire on photovoltaics using a variety of techniques, included NSLS-x ray diffraction analysis of molten glass, and lead a multi-disciplinary team from BNL and the U. of Chicago in conducting the studies. In 2005, he led a workshop organized by the European Union's Joint-Research Center and the German Ministry of the Environment that enabled a U.S. company to open a manufacturing facility in Germany. This workshop was largely based on research conducted by the Fthenakis group at BNL. In 2007, he conceptualized and organized a 5-yr International Energy Agency (IEA) PV-EH&S Task (Task 12). He led the Task as the U.S. Operating Agent from 2007 to 2012.

His research on photovoltaics and the environment has produced ~200 journal and conference papers (in a total of more than 400 publications on energy and environmental topics). Three of his papers were ranked #11, 12 and 18 in the list of the top 40 cited articles in 2005-2008 of Progress in Photovoltaics: Research and Applications. He has been active at the IEEE PVSC and the EU PVSEC every year and has given many invited presentations in universities on LCA and environmental health and safety. In 2008, he published leading articles in Scientific American (ScAm) and Environmental Science and Technology (ES&T). The first showed how solar energy can satisfy all the energy needs of the US; it was featured in the cover of ScAm and translated in 11 languages. The later titled "Emissions from Photovoltaic Life Cycles, ES&T, 42(6), 2168-2174, 2008, featured in the cover of ES&T, was "A most accessed article in the ACS web-site" being accessed 2,973 times in February and March 2008. This article has been cited 320 times in Google Scholar as of August 1, 2015. As of January 2018, Fthenakis articles have been cited more than 8,000 times by Google Scholar, and his h-index is 44 (37 since 2013). His research was also

highlighted in the New York Times, Science News, ES&T, IEEE Spectrum, Scientific American, Spiegel, NRC Handelsblad, and was broadcasted with interviews in several radio and TV programs.

He was invited and served in Energy Expert Panels by the American Institute of Chemical Engineers, California Energy Commission, the European Photovoltaic Industry Association, and the New York Academy of Sciences and gave several keynote presentations on photovoltaics and sustainability.

Fthenakis has received multiple Commendations and Certificates from the Department of Energy and also a Commendation from the Director of the National Renewable Energy Laboratory (NREL) for exemplary performance on PV safety analysis reviews.

Environmental Health and Safety Expert Services

SunPower Mexico (2017); International Renewable Energy Agency (IRENA) (2015-2016); 3M Corp. (2014-2015); International Energy Agency (IEA) (2007-2013); SunPower (2012); MEMC/SunEdison (2012-2014); Amonix (2012); World Bank (2012); Environment Canada (2012); Expert investigator of several major chemical industry accidents for legal offices in Louisiana and New Jersey (1995-2012); Exxon/Mobil, Fairfax, VA (5/1/2001-12/2002) ; Marfin Financial Group (2007); Dow Chemical, Pittsburg, CA (12/1999- 12/2000); 3M Corp., St. Paul, MN (7/1997- 8/1988); CITGO, Corpus Christi, TX (7/1995-7/1996); Webb, Murray & Associates, Inc., Houston, TX (8/1995-4/1996); Radian/SEMATECH, Austin, TX, 6/1994-12/9/1995); UNO-VEN, Lemont, IL (5/1992-12/1992); Allied Signal, Morristown, NJ (10/1992-12/1993); Tecsa, Bergamo, Italy (11/1992 – 11/1993); Amoco Chemical Co., Texas City, TX (1992); Industry Cooperative HF Mitigation Program (5/1990 - 12/1990); Ultramar Corp., Wilmington, CA (5/1991); Mobil Corp., Princeton, NJ (5/1990 - 1994); Amoco Corp., Chicago, IL (8/ 1990 - 1992); Eastman Kodak Co., Rochester, NY (6/1990); Standard Microsystems Corporation, Hauppauge, NY (5/1987)

Project Engineer **Fossil Energy Laboratory, Columbia University, NY (1979-1980)**
Performance evaluation studies on a moving bed coal-biomass gasifier.

Research Assistant **Catalysis Laboratory, Columbia University, NY (1977-1979)**
 Catalysis Research Co., Palisades Park, NJ (6/1977-9/1977)
Development of mathematical models for various catalytic chemical reactions.

Chemist **ChemiResearch, Chania, Greece (1974-1976)**
Laboratory work on Water Quality Analysis.

TEACHING EXPERIENCE

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|---|--------------------------------------|
| Adjunct Professor (1997-present) | Earth & Environ Engineering Dept., |
| Adjunct Associate Professor (1993-1996) | Columbia University |
| Adjunct Associate Professor (1992-1995) | Civil Eng. Dept., City College, CUNY |

Teaching Innovations

Architected and taught course Air Pollution Prevention and Control (EAEE E4150) since 1993
Architected and taught course Photovoltaics Systems Engineering & Sustainability (EAEE E4190) since 2012; wrote a text book for this course.

STUDENT ADVISOR/MENTOR

Thesis Advisor

Columbia University Students: Name/Thesis topic

Michael Ginsberg (DES) -TBD

Rebecca Trojanowski (DES) –Control of emissions of nanoparticulates from wood stoves

Adam Atia (MS/PhD) –PV sea-water RO desalination (MS, 2014); Variable Solar Powered Water Desalination/Decontamination (PhD)

Samet Oztuk (PhD) –Develop Integrated Life Cycle Analysis and Risk Analysis methodology: Applications in wind turbine life cycles
 Daniel Katz (MS; 2015) –PV for reducing demand charges in industrial and commercial applications
 Pablo Cassorla (MS); Sea water Pumped Storage for Chile
 Zhouan Zhang (MS); Cost Optimization Modeling of PV Recycling
 Cao Wei (MS); PV in Microgrids
 Lizhang Xie (MS); LCA of CSP with Thermal Storage
 Xingjan Ma (MS): LCA of BIPV
 Thomas Nikolakakis (MS/PhD) –PV-Wind Synergy (MS; 2012); RE generation and unit commitment and dispatch model development (PhD)
 Shiyue Li (MS; 2015)–Simulations of Thermal Performance, Power Generation and Energy Savings Potential of Semi-Transparent BIPV façade by EnergyPlus
 Olivier Morin (MS; 2014) –Waste to Energy LCA
 Keith Burrows (DES) –Recovery of Ag, In, Te and glass from thin-film displays and photovoltaics
 Irene Pavlakakis (MS; 2014) –CFD investigations of heat island effect in solar farms and PV-green-roofs
 Constantine Spanos (MS; 2013) –Battery LCA (MS); Battery life optimization (PhD)
 Rob van Haaren (PhD; 2014) –Storage optimization for PV ramp-rate control
 Marc Perez (MS/PhD) –LCA of PV (MS; 2011); Storage vs. high voltage transmission in global grids (PhD; 2014)
 Magdalena Klemun (MS; 2014) –LCA of HVDC networks
 Ioannis Konsoulas (MS; 2013) –PV and mining synergies in South Africa
 Katie Phillips (MS; 2013) -PV and mining synergies in Chile
 Boris Valensi (MS; 2013) –Comparative LCA of natural gas hydraulic fracturing and conventional recovery
 Rick Betita (MS) –Software tool for accounting power generation upstream energy and emissions; incorporated EPA eGrid data-base
 Jonathan Krones (MS; 2011) –LCA of electronic products
 Athanasios Bourtsalas (MS; 2011) –Review of nanomaterials use in PV
 Manos Avgerinos (MS, EE; 2010) –Reliability of PV
 Sandra Gualtero (MS; 2009) –Comparative LCA of nanomaterial life-cycle in PV
 Kevin Knight (MS; 2008) –LCA of low concentration PV (co-advised with Nikhil Krishnan)

International Visiting Students/Internships

Enrica Leccisi (PhD, U. Parthenope) –Energy Net Analysis; 2015
 Brendan Cleary (PhD, U. Ireland) –Wind-CAES grid integration; 2014
 Roberto Turconi, (PhD, Tech. U. Denmark)-RE grid integration; 2013
 Catia Baldassarri (PhD, U. Perugia) –LCA of Buildings; 2012
 Sander Mann (MS, Utrecht) –LCA of prospective advanced Si PV technologies; 2011
 Sebastian Britting (MS, Karlsruhe Institute Tech.) –Development of software tool for RPS implementation; 2010
 Jordi Dunjo (PhD, U. Barcelona) –Hazard and Operability Methodology development; 2008
 Birger Lofgren and Gustaf Zettergren (MS -Chalmers U.), Sweden; 2005 (BNL Internship)

Other Student Support

Racine Nassau (Senior undergrad project) –LCA of flywheels
 Skyler Shatkin (Senior undergrad-summer internship) –Combining eGrid and LCA data
 Tyler Lancaster (Junior independent research on PV)
 Yuahao Yu –(MS-ME, intern at CLCA -Heat Island effect on First Solar farm
 Kevin Ho (MS project) –Extreme value statistical analysis of solar data
 Tim Sheribam (lab) –Cd recovery from CdTe PV recycling effluents; 2008
 Jesse McManus (MS-MIT), 2008 (BNL Internship)
 Chris Graves (lab) -Cd recovery from CdTe PV recycling effluents; 2007
 Anuta Belova (lab) -Cd recovery from CdTe PV recycling effluents; 2007
 Daniel Churn, (BS-Columbia), 2004 (BNL Internship)

Postdoc Research Associates

Dr. Enrica Leccisi –PV LCA, 2017-2018
 Dr. Damon Turney –PV Recycling/LCA, BNL, 2011-2012.
 Dr. Annick Anctil –LCA of organic PV, BNL, 2012
 Dr. Jun-Ki Choi- PV Recycling Macro- and micro-economics, BNL, 2010-2013

Dr. Huyng-Chul Kim –LCA of PV, BNL & CU, 2005-2011
Dr. Noorie Rajvanshi –exploratory research on biomass life cycles, CU, 2010
Dr. Wenming Wang –PV Recycling, BNL, 2004-2007

Visiting Scholars

Dr. Marco Raugei, Oxford Brookes University–Energy Return on Investment: PV vs. fossil fuel life-cycles
Dr. Patrick Wrobel, Fraunhofer UMSICHT –Photovoltaics and Storage in German Electricity Grid
Dr. Daniel Wolf, Fraunhofer UMSICHT –Storage systems for future electricity grids: Adiabatic-CAES

DOCTORATE QUALIFYING/RESEARCH PROPOSAL/DEFENSE COMMITTEES

2017 Hang Xiao; Xiangbiao Liao
2016 Julia Green
2015 Constantine Spanos; Julia Green; Bianca Howard
2014 Keith Burrows; Rob van Haaren; Marc Perez; Thomas Nikolakakis; Josh Browne; Diego Villarreal; Tim Sharobem

HONORS/AWARDS

2017 US-Israel Integrated Energy Desalination Design Challenge; PI of the Columbia winning team
Emeritus Senior Scientist, Brookhaven National Laboratory
2016 Elected Member of the Board of the Clean Water Desalination Alliance, launched at COP21, Paris
2015 BNL Certificate of Recognition for “*thirty five years of distinguished service*”, 11/2015
2006 US DOE Certificate of Appreciation “*for superior technical, management and communications skills exhibited in photovoltaic environmental research and in effective dissemination of research results*”, 2/2006
2004 Fellow of the International Energy Foundation, 2/2004
2002 Fellow of the American Institute of Chemical Engineers, 2/2002 “*in recognition and appreciation of superior attainments, valuable contributions, and service to Chemical Engineering*”
1996 Certificate of Appreciation for *EH&S services*, Brookhaven National Laboratory, 11/27/96.
1992 Commendation from the Assistant Secretary for Conservation and Renewable Energy, DOE “*for exemplary performance on safety analysis*”, 9/1/92
1992 Commendation from the Director of NREL, for *Safety Review Analysis*, 3/6/92
1977-79 Graduate Research Scholarships (3), Columbia University

EDITOR

- Editorial Board of the Journal “Energies”, 2017-present
- Editorial Board of the Journal “Energy Technology”, Wiley, 2015-present
- Editorial Board of the “Journal of Loss Prevention”, 1998-present
- Editorial Board of the Journal “Progress in Photovoltaics Research and Applications”, 1996-present.
- Editor of the newsletter "Fossil Energy and the Environment", 1991-1993.

EXPERT PANELS, SCIENTIFIC BOARDS & COMMITTEES

2018 –33rd European Photovoltaics Conference (EU-PVSEC), Brussels, Belgium –Scientific Committee
2017 -32nd European Photovoltaics Conference (EU-PVSEC), Amsterdam, the Netherlands –Scientific Committee
-NSF International PV Sustainability Standards Development Committee
2016 –Founding and Board Member- Global Water Desalination Initiative
-31st European Photovoltaics Conference (EU-PVSEC), Munich, Germany –Scientific Committee
-Avian Solar Working Group
-NSF International PV Sustainability Standards Development Committee
2015 -Founding Member Global Water Desalination Initiative-H₂O without CO₂- launched in COP21, Paris, December 2015.
-Earth and Environmental Engineering, Columbia University -Junior Faculty Search Committee
-Solar Roundtable Chair/Moderator, United Nations/Columbia U. Sustainable Development Solutions Project
2014 -Executive Committee IGERT-NSF Solving Urbanization Challenges, Columbia U. (2012-2014)

- Chemical Engineering, National Technical University of Athens (NTUA) –External Faculty Election and Promotion Committee
- Earth and Environmental Engineering, Columbia University -Junior Faculty Search Committee
- 29th European Photovoltaics Conference (EU-PVSEC), Amsterdam, –Scientific Committee
- North America Student Energy Summit 2014, Expert Panel Discussion on Solar and Nuclear Energy, March 27, 2014.
- 2013 -28th European Photovoltaics Conference (EU-PVSEC), Paris, France –Scientific Committee
 - Expert Panel -Columbia University Forum “Closing the loop: Technology and Sustainability”, School of International and Public Affairs (SIPA), April 25, 2013.
- 2012 -PV Manufacturing Consortium-Albany: CIGS PV Roadmap Executive Steering Committee
 - Urban Green Council -90 by 50 Advisory Committee, May 2012 –to date
 - InTech Publishing Scientific Board 2012/2013
 - 27th European Photovoltaics Conference (EU-PVSEC), Frankfurt, Germany –Scientific Committee
 - Expert review panel CAES project Arizona, Jan 2012
 - Expert PV Assessment peer review Environment Canada, Feb-March 2012
- 2011 -26th European Photovoltaics Conference (EU-PVSEC), Hamburg, Germany—Scientific Committee
 - Earth Institute Sustainable Development Conference, New York
 - IEA Task 12 Expert Meeting, Jan. 24, 2010, Madrid, Spain
- 2010 -IPCC Special Report on Renewable Energy
 - EERE-DOE Solar Vision Study; co-led Env Impact & contributed to Policies Tasks
 - IEA PVPS Executive Committee, Montreal, Canada, October 2010
 - NSF Workshop “Catalyzing Innovation in PV Manufacturing”, May 6-7, 2010, Golden CO.
- 2009 IEA Task 12 Expert Meeting, Sept 24, 2009, Hamburg , GER
- 2008 New York Academy of Sciences, Expert Panel on McKinsey report/Energy Issues
 - IEA PVPS Executive Committee, Vienna, Austria, October 2008
- 2007 California Energy Commission Expert Workshop on *Nuclear Power in California*
 - European PV Industry Forum, Expert Panel on Sustainability Challenges
- 2004-10 BNL Research Library Advisory Committee
- 2004-06 BNL Equal Employment Opportunity Committee
 - Solar Cells 2004, International Scientific Advisory Committee, Badajoz, Spain.
- 2001 Petroleum Energy Research Forum (PERF) Modeling Subcommittee.
- 1996 Probabilistic Safety Assessment & Management (PSAM-III) Technical Programme Committee.
- 1992-96 AIChE, Health & Safety Division, Chair of Membership Committee & Member of Executive Committee.
- 1992-93 Advisory Committee for starting an Environmental Engineering Department at the Technical University of Crete, Greece.
- 1992 Expert Reviewer of the EPA Report to Congress on HF Mitigation, 1992.
- 1991 Panel of Experts - Center of Chemical Process Safety of the AIChE, Mitigation Workshop, 1991
- 1990 Coordinating Group on Computational Fluid Dynamics, ASME, Fluid Engineering Div.
- 1988-92 AIChE, Health & Safety Planning Committee.

SYMPOSIUM and ROUNDTABLE ORGANIZER & CHAIR

- Organizer & Moderator –United Nations Renewable Energy Roundtable, WashDC, October 9-10, 2014.
- Moderator-3rd International Recycling Workshop, February 26, 2013, Rome, Spain.
- Plenary Session -27th European Photovoltaics Conference (EU-PVSEC), Frankfurt, Germany
- PV velocity forum-38th IEEE Photovoltaic Specialists Conference, June 30, 2012
- 2nd International Recycling Workshop, January 25, 2011, Madrid, Spain
- 2nd Compressed Air Energy Storage (CAES), Columbia University, New York, October 2010.
- PV Markets, Plenary Session 6EP.3, 25th European Photovoltaics Solar Energy Conference, Valencia, Spain, 6-10 September 2010.
- IEA Task 12 Expert Meeting, September, 10, 2010, Valencia, Spain.
- 1st International Recycling Workshop, January 26, 2010, Berlin, Germany
- IEA Task 12 Workshop, January 25, 2010, Berlin, Germany
- NSF EPA workshop on Nano and the Environment, November 5-6, 2009, Chicago, IL NSF project no: CBET-0933674.
- Recycling Scoping Workshop, IEEE PV Specialists Conference, Philadelphia, 2009.

- Compressed Air Energy Storage (CAES), Columbia University, New York, October 2008.
- MRS Fall Meeting, Symposium “Life Cycle Analysis Tools for New Energy Conversion and Storage Systems, November 2007, Boston, MS.
- Organizer & Leader of International Energy Agency Task on PV EH&S, 5-yr task starting in 2007
- MRS Fall Meeting, Symposium “Life Cycle Analysis Tools for "Green" Materials and Processes Selection”, November 2005, Boston, MS.
- International Energy Agency (IEA) Environmental Aspects of PV Power Systems, PV Expert Workshop, Utrecht, Holland, June 25-27, 1997: "Health, Safety and Environmental Aspects of Cell Technologies".
- ESREL '96-PSAM III Conference, European Safety & Reliability Association, International Association for Probabilistic Safety Assessment and Management, "Environmental Impacts."
- AIChE 1994 Summer National Meeting, Denver, CO, August 14-17, 1994: "Chemical Risk Assessment of Fossil Fuel Power Plants and Refineries"
- AIChE 1993 National Meeting, Seattle, WA, Aug. 15-19, 1993: "Mitigation of Hazardous Releases through Design" and "Mitigation of Hazardous Releases: Modeling and Evaluation".
- AIChE 1992 National Meeting, Minneapolis, MN, Aug. 9-12, 1992: "Prevention and Control of Accidental Releases of Hazardous Gases"
- AIChE 1990 National Meeting, Orlando, March 18-22, 1990: "Safe Procedures for Accident Prevention in Chemical Industries"
- AIChE 1989 National Meeting, Philadelphia, Aug. 20-23, 1989: "Controls of Hazardous Gases I & II"

OTHER: Fellow of the American Institute of Chemical Engineers (AIChE), Fellow of the International Energy Foundation. He has been a member of the American Chemical Society (ACS), American Meteorological Society (AMS), Semiconductor Safety Association (SSA), Association of Environmental Engineering and Science Professors. Listed in “Who is Who in America” (1997-present) and “Who is Who in Science & Engineering” (1992-present).

PERSONAL: U.S. and Greek Citizen; married, two children.

PATENTS

Fthenakis V.M. and Wang W., BSA 10-16 –Nonprovisional S.N. 12/756,507 awarded 4/8/1010 –“System and Method for Separating Tellurium from Cadmium Waste”

Fthenakis V., W Wang W. “[Extraction; leaching; cation exchange resins; for recycling photovoltaic devices](#)”, US Patent 7,731,920, 2010

Fthenakis V.M. and Wang W. BSA European Patent No EP1888464

PUBLICATIONS

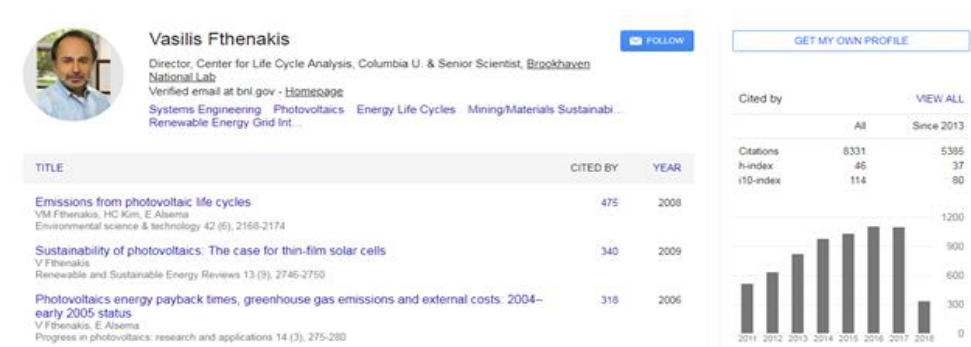
BOOKS

1. Fthenakis V.M., Prevention and Control of Accidental Releases of Hazardous Gases, Van Nostrand Reinhold, New York, 1993. (ISBN: 780442004897)
2. Fthenakis V.M. (editor), Advances in 3rd Generation Photovoltaics, InTech, 2012. (ISBN: 978-953-51-0304-2)
3. Fthenakis V.M. and Lynn P.A, Electricity from Sunlight: Photovoltaics Systems Integration and Sustainability, Wiley, 2nd edition, 2018. (ISBN 978-1-118-96380-7)
4. Letcher M. T. and Fthenakis V.M., (editors) A Comprehensive Guide to Solar Energy Systems: with special focus on photovoltaic systems, Elsevier, 2018-in press.
5. Fthenakis V.M., Dold P., Wambach K, (editors), Recycling of Photovoltaic Modules, Institution of Engineering and Technology (IET), in preparation.

CONFERENCE PROCEEDINGS/ JOURNAL (Guest Editor)

6. Papasavva S. and Fthenakis V. Symposium G: Life Cycle Analysis Tools for "Green" Materials and Processes Selection, Materials Research Society, Symposium Proceedings Volume 895, Materials Research Society, Warrendale, PA, 2006. (ISBN: 9781558998506)
7. Fthenakis V., Dilon A. and Savage N., Symposium R: Life Cycle Analysis for New Energy Conversion and Storage Systems, Materials Research Society, Symposium Proceedings Volume 1041, Materials Research Society, Warrendale, PA, 2008. (ISBN: 9781107408623)
8. Fthenakis V. and Rauegi M., Energies, Special Issue "Life-Cycle Assessment of Energy Systems in Current and Evolving Grids, May 2016.
http://www.mdpi.com/journal/energies/special_issues/LCA-energy-2016

PEER- REVIEW JOURNAL ARTICLES



Google Scholar h-index =46 (37 as of 2013); 8,300 Citations <https://scholar.google.com/citations?user=JAaO3voAAAAJ&hl=en>

9. Happel, J., Suzuki, I., Kokayeff, P., and Fthenakis V. Multiple Isotope Tracing of Methanation Over Ni Catalyst, Journal of Catalysis 65(1):57-77 (1980).
10. Happel, J., Suzuki, I., Kokayeff, P., and Fthenakis V. Multiple Isotope Tracing of Methanation, II, Journal of Catalysis 75(2):314-328 (1982).
11. Fthenakis, V.M. and Leigh, R.W. An Analysis of Selected Surface Characteristics and Latent Heat Storage for Passive Solar Space Heating, Alternative Energy Sources, 4(1):367-380, (1982).
12. Fthenakis, V.M. On the Effect of Melting Point in the Performance of Phase Change Thermal Storage, Alternative Energy Sources, 5(1):263-270, (1983).
13. Fthenakis, V.M. and Leigh, R.W. The Value of Improvements in Absorbing and Glazing Surfaces of Solar Devices, Solar Energy, 32(3):367-376 (1984).
14. Fthenakis, V.M., Moskowitz, P.D., and Lee, J.C. Manufacture of Amorphous Silicon and Gallium Arsenide Thin-Film Solar Cells: An Identification of Potential Health and Safety Hazards, Solar Cells, 13:43-58 (1984).
15. Wilenitz, I., Fthenakis, V.M., and Moskowitz, P.D. Costs of Controlling Emissions from the Manufacture of Silicon Dendritic Web Photovoltaic Cells, Solar Cells, 15:247-266 (1985).
16. Fthenakis, V.M. Electrical and Electromagnetic Hazards in Thin-Film Solar Cells Manufacturing, Solar Cells, 19(1):45-58 (1986).
17. Moskowitz, P.D., Fthenakis, V.M., Hamilton, L.D. and Lee J.C. Public health Issues in Photovoltaic Energy Systems: An Overview of Concerns, Solar Cells, 19:287-299 (1986).

18. Fthenakis, V.M., and Moskowitz, P.D., Characterization and Controls of Phosphine Hazards in Photovoltaic Cell Manufacture, Solar Cells, 22:303-317 (1987).
19. Morris S.C., Moskowitz, P.D., Fthenakis, V.M., and Hamilton, L.D., Chemical Emergencies: Evaluation of Guidelines for Risk Identification, Assessment, and Management, Environment International, 13:305-310 (1987).
20. Fthenakis, V.M., Moskowitz, P.D., and Hamilton, L.D. Personal Safety in Thin-Film Photovoltaic Cell Industries, Solar Cells, 19:269-281 (1986-1987).
21. Fthenakis, V.M., Moskowitz, P.D., and Sproull, R.D., Control of Accidental Releases of Hydrogen Selenide and Hydrogen Sulfide in the Manufacture of Photovoltaic Cells: A Feasibility Study, Journal of Loss Prevention, 1:206-212 (1988).
22. Fthenakis, V.M. and Moskowitz, P.D., Health and Safety Aspects of Thin-Film Photovoltaic Cell Manufacturing Technologies, Plant/Operations Progress, 7(4):236-241 (1988)
23. Fthenakis, V.M., The Feasibility of Unconfined Releases of Toxic Gases by Liquid Spraying, Chemical Engineering Communications, 83, 173-189, 1989.
24. Moskowitz, P.D., Fthenakis, V.M. and Lee J.C., Protecting Worker Health and Safety in Photovoltaic Research and Development Laboratories, Solar Cells, 27, 149-158, 1989.
25. Moskowitz, P.D. and Fthenakis, V.M., Toxic Materials Released from Photovoltaic Modules During Fires: Health Risks, Solar Cells, 29, 63-71, 1990.
26. Fthenakis, V.M. and Moskowitz, P.D., An Assessment of the Hazards of Silane Explosions, Solid State Technology, 33(1), 81-85, 1990.
27. Fthenakis, V.M., K.W. Schatz and V. Zakkay, A Theoretical Study of Absorption of Toxic Gases by Spraying, Journal of Loss Prevention, 3(2), 197-205, 1990.
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245. Fthenakis V., “Enabling Large Growth of Photovoltaics”, National Research Center “Demokritos”, Summer School, Athens, July 10, 2009. (Keynote)
246. “Sustainability of Thin-Film Photovoltaics”, InterSolar Conference, San Francisco, July 16, 2009. (Keynote)
247. Fthenakis V. “Sustainability of Photovoltaics”, Technical University of Crete, International Conference on renewable Energy under the auspices of the Patriarch, Sept 1-2, 2009, Chania, Greece. (Keynote)
248. Fthenakis V., “Long-term Estimates of Primary and Secondary Sources of PV materials: Recycling and Sustainability of PV”, PV Velocity Forum, 35th IEEE Photovoltaics Specialists Conference, Honolulu, Hawaii, June 20-25, 2010. (Plenary)
249. Fthenakis V. “Solar Energy”, 2010 Center Functioning Nanomaterials Retreat, Brookhaven Center, Brookhaven National Laboratory, July 22, 2010. (Keynote, Distinguished Guest Speaker)
250. Fthenakis V., “Environmental Aspects on Thin Film Module Production and Product Lifetime”, 25th European Photovoltaic Solar Energy Conference, Valencia, Spain, 6--4 Sept. 2010. (Plenary)
251. Fthenakis V. (with contributions from D. Turney, J. Blunden and L. Krueger), “Solar Energy Impacts and Management Measures”, Wildlife Society 17th Annual Conference, October 4, 2010, Snowbird, UT. (Keynote)
252. Fthenakis V. “Sustainability of Very Large PV Deployment”, Masdar Institute Forum on Solar-Electrical Energy Systems: Technologies for Benign and Perpetual Power”, Yas Island, Abu Dhabi, UAE, March 27, 2011. (Invited)

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254. Fthenakis V. “Sustainability of Large Deployment of Photovoltaics: Environmental Research and the SunShot Initiative”, Presented to the Solar Energy Technologies SunShot Seminar Series, January 17, 2012. (Invited)
255. Fthenakis V. Sustainability of Semiconductors and Photovoltaics Life-Cycles, Presented at the School of International and Public Affairs (SIPA), Columbia University Expert Panel “Closing the Loop: Technology and Sustainability, April 25, 2013 (Invited)<http://www.environment.columbia.edu/events/closingthelooptechnologysustainability>
256. Fthenakis V. and Nelson B., “Business Benefits of Green Manufacturing in the PV Industry”, InterSolar North America, San Francisco, July 10, 2012. (Invited)
257. Fthenakis V., Holistic Life Cycle Analysis with Focus on CdTe Photovoltaics, SwissPhotonics Workshop of Cost and Environmental Aspects of Photovoltaics, Zurich, Switzerland, October 22, 2013. (Invited)
258. Fthenakis V., Photovoltaics and the Environment, 1st International Workshop on Lithium, Industrial Minerals, and Energy, Antofagasta, Chile, January 8-10, 2014. (plenary)
259. Fthenakis V., North America Student Energy Summit 2014, Expert Panel Discussion March 27, 2014. (Invited) <https://www.youtube.com/watch?v=ei158DCeu9M>
260. Fthenakis V., Progress in Photovoltaics: Let the Power of the Sun Shine, Climate Reality Project, Columbia University Law School, June 21, 2014. (Invited)
261. Fthenakis V., Updating the Case for PV Life Cycle Management and Recycling, EUPVSEC 2015 (jointly with IEA) Workshop on PV Life Management and Recycling, Amsterdam, The Netherlands, September 23, 2014 (Keynote) <https://www.photovoltaic-conference.com/parallel-events/parallelevents-2014/pv-life-cycle-management-recycling-2014.html>
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264. Fthenakis V., Photovoltaics and Sustainable Development, Cold Spring Harbor Library, November 9, 2014. (Invited).
265. Fthenakis V., A Grand Solar Plan for Chile, hosted by the Columbia University Global Center, Santiago, Chile, Jan. 6, 2015 (invited/keynote).
266. Fthenakis V. Photovoltaics and Sustainable Development, U. of Chile, Santiago, January 7, 2015 (invited).
267. Fthenakis V., Tutorial on Life Cycle Analysis, 2nd International Workshop on Lithium, Industrial Minerals, and Energy, Antofagasta, Chile, Sept 29, 2015. (invited/plenary).

268. Fthenakis V., Energy-Water-Environmental Challenges: Sustainable Development Solutions, Earth and Environmental Engineering Seminar, Columbia University, November 10, 2015.
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