COLUMBIA UNIVERSITY
CENTER FOR LIFE CYCLE ANALYSIS (CLCA)

Proposal to Water Information Certification Systems DAO LLC (WaterDAO)**.**

Scope: Expand the utility-of the Solar Energy Desalination Analysis Tool (SEDAT) which was developed at the CLCA with data and process models needed to assist corporations in becoming "water neutral by 2030". The software will enable cost-parity comparisons of water production via sustainable water desalination (on various sources and process technologies) with utility water rates and with other alternatives for producing water in select locations. Specifically, the scope of work during 2023, will focus on US Brackish Water resource data GIS mapping and incorporating into SEDAT a model of Osmotically Assisted Reverse Osmosis (OARO) Desalination and a model of Crystallizer for zero liquid discharge (ZLD) desalination of brackish water. Furthermore, Columbia will modify the SEDAT input/output data structure so that it can be migrated onto the cloud by WaterDAO.

Task 1 –Detail and quantify sources of brackish water by county by combining US Hydrologic Unit Code Unit (HUC) watershed classification data and USGS well (point) data on depth, TDS, and well yield and compile a database of brackish water salinity, depth and estimated resource for each county of the US.

Task 2 -Develop, test and incorporate an OARO and a Crystallizer model into SEDAT.

Task 3. Modify SEDAT so that it can be migrated onto the cloud. Columbia will support WaterDAO in setting SEDAT on the cloud and WaterDAO will migrate, host and maintain it there. The software will remain Open Access.

Task 4: Detail current water price structures by utility and combine these with data from corporations available via the WaterDAO network. Mapping those on ArcGIS. Introduce "water neutrality" cost and credit algorithms to compare desalination with other water supply alternatives available to corporations.

Task 5: Results Dissemination via a conference presentation.

Team: V. Fthenakis, PI; Z. Zhuoran, G. Yetman, graduate students TBD
Schedule: 12 months January to September 2023: Tasks 1, 2, 3 and 4 would be completed by June 30, 2023; Task 5 by December 2023.

Budget: $100,000 (as Research Gift Center for Life Cycle Analysis, Columbia University for "Support of Solar Desalination Research"); in two $50,000 each installments on 1/1/2023 and 6/1/2023.

Deliverables: Report, Software, slides and manuscript for conference or journal submission

Vasilis Fthenakis, CLCA Director

926 S. W. Mudd, Mail Code 4711 500 West 120th Street New York, NY 10027 (212) 854-8885 Cell: (631) 618-1717

Greg Yetman
gyetman@ciesin.columbia.edu

Professional Preparation:

Saint Mary's University	Geography	B.A. 1996
McGill University	Geography	M.A. 2000

Appointments:

Associate Director, October 2014 – present
Columbia University Center for International Earth Science Information Network, Palisades, NY
Adjunct Lecturer, September 2017 – present
Columbia University School of International and Public Affairs, New York, NY
Senior Consultant/Business Analyst, September 2011 – September 2014
Esri Canada, St. John's, NL, Canada
Senior Staff Associate (Senior Geospatial Developer), August 2007 – September 2011
Columbia University Center for International Earth Science Information Network, Palisades, NY
Adjunct Lecturer, January – May, 2011
Columbia University Mailman School of Public Health, New York, NY
Adjunct Lecturer, September 2008 – December 2010
Columbia University Department of Earth and Environmental Engineering, New York, NY
Consultant, November 1996 – November 1998
Commission for Environmental Cooperation, Montreal, QC, Canada.

Select Publications

Dilley, M., R.S. Chen, U. Deichmann, A.L. Lerner-Lam, M. Arnold with J. Agwe, P. Buys, O. Kjekstad, B. Lyon, and G. Yetman. 2005. "Natural Disaster Hotspots: A Global Risk Analysis". Washington, D.C.: World Bank.

Gaffin, S., C. Rosenzweig, X. Xing, G. Yetman. Downscaling and geo-spatial gridding of socio-economic projections from the IPCC Special Report on Emissions Scenarios (SRES), 2004. In *Global Environmental Change*, January, 2004.

Selected Scientific, Technical and Management Experience

1. Co-Investigator, GIS-based Graphical User Interface Tool for Analysis of Solar Thermal Desalination Systems and High Potential Implementation Regions. Lead development of GIS database and open software to query data, collect input parameters, run solar desalination models, and display the results.
2. Principal Investigator, Building data for climate change adaptation. York State funded projects to assess potential flood impacts at the building level for New York State. Yetman managed the project, developing workflows including automated data extraction from LiDAR, flood data assessment and integration, data quality assurance procedures, and system design for the data delivery application.
3. Principal Investigator, Co-Investigator, and technical lead on a number of population modeling and settlement mapping projects, including CIESIN contributions to the WorldPop project, the development of the new High Resolution Settlement Layer (HRSL) in collaboration with the Facebook Connectivity Lab, and multiple versions of the Gridded Population of the World dataset developed by SEDAC.

COLUMBIA UNIVERSITY
CENTER FOR LIFE CYCLE ANALYSIS (CLCA)

Zhuran Zhang
zz2322@columbia.edu

EDUCATION

Columbia University in the city of New York (CU), NY, US Aug 2018-present
Ph.D. Student in the School of Engineering and Applied Science
Department: Earth and Environmental Engineering
- Current GPA: 4.18/4.33
- Coursework includes: Solar Thermal Engineering, Energy Sources and Conversion, Urban Hydrologic System, Air Pollution Control, Particle Technology, Artificial Intelligence, Machine Learning, Numerical Mathematics

Columbia University in the city of New York (CU), NY, US Aug 2014-Feb 2016
Master Graduate Student in the School of Engineering and Applied Science
Department: Earth and Environmental Engineering
- GPA: 3.77/4.33
- Coursework includes: Photovoltaic System Engineering, Industrial Ecology, Aquatic Chemistry, Environmental Data Analysis & Modeling, Industrial Catalysis, Carbon Capture and Sequestration, ArcGIS

Tsinghua University (THU), Beijing, China Aug 2010-Jul 2014
B.S. in Environmental Engineering
- GPA: 3.63/4.0
- Coursework includes: Water Quality Control Engineering, Hydrodynamics, Air Pollution Control Engineering, Environmental Data& Mathematic Models, Environmental Monitoring

Tsinghua High School, Guiyang, China Sep 2007-July 2010
B.S. in Environmental Engineering
- GPA: 3.63/4.0
- Coursework includes: Water Quality Control Engineering, Hydrodynamics, Air Pollution Control Engineering, Environmental Data& Mathematic Models, Environmental Monitoring

EXPERIENCE

Current research Sep 2021-Present
PhD Student, Department of Earth and Environmental Engineering, CU, NY, US
- Working with NREL on the integration of desalination models into WaterTAP framework
- Working toward a life cycle analysis of solar thermal desalination technologies

Development of a Solar Energy Desalination Analysis Tool (SEDAT) Sep 2018-Sep 2021
PhD Student, Department of Earth and Environmental Engineering, CU, NY, US
- Generalized existing desalination models and developed new models for software applications
- Developed Python wrappers for the integration of techno-economic models
- Participated in designing the graphical user interface
- Completed the coursework requirement of the PhD program

Adaptive RO Desalination with Load Flexibility and PhD Program Application Oct 2017-June 2018

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Research Assistant, Life Cycle Analysis Center, CU, NY, US

- Worked on the optimization model and economic analysis of adaptive RO in grid
- Contributed to the Columbia University Team to win the award on a DOE project for solar thermal desalination technologies: "*GIS-Based Graphical User Interface Tools for Analyzing Solar-Thermal Desalination Systems and High-Potential Implementation Regions*", and applied the PhD program in Columbia University for this project

Unit Commitment and Economic Dispatch Model for Grid with Renewable Energy Mar 2017-Sep 2017

Research Assistant, Life Cycle Analysis Center, CU, NY, US

- Extended the existing GAMS model to consider the contribution from solar field
- Applied the model to New York region

Analysis on First Solar's Recycling Processes of Thin Film Solar Cell Sep 2016-May 2017

Research Assistant, Life Cycle Analysis Center, CU , NY, US

- Summarized the recycling process of PV modules in First Solar
- Evaluated the cost and impact of each recycling process using optimization in GAMS model
- Provided solutions on reducing cost based on parameter sensitive analysis

World Resource Institute (WRI), Beijing, China (Remote in NY between Sep-Dec) July 2015-Dec 2015

Independent Consultant, Climate Change Research Team

- Supported a China's climate change program *'Greenhouse Gas Accounting in Petrochemical Industry'*
- Contributed to a working paper used as suggestions to governmental policy makers
- Took field trip to petrochemical enterprises to design an introduction info-graphic of petrochemical industry

Modeling on the Water Quality of Urban Rivers in Foshan City, Beijing, China Sep 2013-June 2014

(One of China's Major Science and Technology Programs for Water Pollution Control and Treatment)
Student, Environmental System Analysis Research Institution, School of Environment, THU

- Digitized the target rivers using ArcGIS for the simulation in EFDC model
- Simulated and predicted the time series of water quality indicators
- Applied Bayesian theory and Markov Chain Monte Carlo in Matlab to evaluate the model uncertainty

Coursework for Environmental Science and Engineering Sep 2010-June 2014

Student, School of Environment, THU, , Beijing, China-Completed studies for the Bachelor's degree

Publications

- *Fthenakis V., Zhang Z. and Choi J-K, Cost Optimization of Decommissioning and Recycling CdTe PV Power Plants, Poster at 44th IEEEPVSC, June 2017, Washington DC.*
- *Zhang, Z., et al. "Comparative techno-economic assessment of osmotically-assisted reverse osmosis and batch-operated vacuum-air-gap membrane distillation for high-salinity water desalination." Desalination 532 (2022): 115737.*
- *Ginsberg, M., Zhang, Z., Atia, A. A., Venkatraman, M., Esposito, D. V., & Fthenakis, V. M. (2022). Integrating Solar Energy, Desalination, and Electrolysis. Solar RRL, 6(5), 2100732.*
- *Fthenakis, V., Yetman, G., Zhang, Z., Squires, J., Atia, A. A., Alarcón-Padilla, D. C., ... & Zaragoza, G. (2022). A solar energy desalination analysis tool, sedat, with data and models for selecting technologies and regions. Scientific Data, 9(1), 1-20.*

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

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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 enabling sustainable pathways for a transition to clean and affordable renewable energy. His Grand Plan for Solar Energy study is one of the very first comprehensive studies showing the feasibility of solar energy to satisfy most of the energy needs of the U.S. while addressing the challenge of climate change.

EDUCATION

New York University, New York Ph.D. in Fluid Dynamics and Atmospheric Science, 1991.
Thesis topic: Modeling of water spraying of toxic gas releases; with Dr. Victor Zakkay
Columbia University, New York M.S. in Chemical Engineering, 1978.
Thesis topic: Modeling on the methanation of carbon monoxide; with Dr. John Happel.
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. Fthenakis is leading GCWDA efforts to integrate PV with desalination making it both clean and affordable.

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 with Ken Zweibel and James Mason 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 ~300 journal and conference papers (in a total of more than 450 publications on energy and environmental topics). As of January 2022, Fthenakis articles have been cited more than 13,000 times by Google Scholar, and his h-index is 56 (43 since 2017). 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

sPower (2019); OneRenewableEnergy (2018); 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

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

Anthony Peters (DES) Solar Power Satelited
Zhuoran Zhang (PhD)- GIS-based Analysis Tool for Solar Thermal Desalination
Boris Yin (MS) – Solar-enabled Membrane Distillation Modeling
Michael Ginsberg (DES) –Dynamic operation optimization of solar powered electrolyzers
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

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Daniel Katz (MS; 2015) –PV for reducing demand charges in industrial and commercial applications
Pablo Cassorla (MS); Sea water Pumped Storage for Chile
Zhuoran 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 Pavlakis (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 (Post-doctoral Research Associate, Perovskite LCA)
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, 2017-2019
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

2022 Anthony Peters, Solar Power Satellite-New Horizon
2022 Zhuoran Zhang, Technoeconomic Analysis and Models of Solar Desalination
2022 Rebecca Trojanoswski, Understanding and characterizing residential biomass hydronic heater performance under realistic operation
2021 Medhi Zadshir, Modeling and Experimental Study of Thermal Management for Infrastructure Surface Materials
2021 Rong Deng, U. New South Whales (UNSW), Australia, End-of-life Recycling of Silicon Photovoltaic Modules: Towards A Circular Economy
2021 Adam A. Atia, Technical and Economic Modeling for Sustainable Desalination: Renewable-Powered, Adaptive Reverse Osmosis Desalination with Load Flexibility and Pathways to Zero Liquid Discharge, January 2021
2020 U. Caldera, Finland. The role of renewable energy based seawater reverse osmosis (SWRO) in meeting the global water challenges Lappeenranta-Lahti University of Technology (LUT), LUT August 2020
2020 Yu Cheng, Atmospheric Boundary Layer studies, Jan. 2020
2019 Samet Ozturk, Wind turbine maintenance investigation, PhD awarded May 2019
2019 Sherrif Khalifa, Single junction perovskite solar cells, Chem. Eng. Dpt., Drexel University, 12/6/18-5/30/2022.
2019 Marina Monteiro Lunardi, Comparative Life Cycle Assessment of Silicon Based Tandem Solar Cells, School of Photovoltaic & Renewable Energy Engineering, U. New South Whales (UNSW), Australia, 1/31/19
2019 Christos-Spyridon Karavas, ΑΝΑΠΤΥΞΗ ΣΥΣΤΗΜΑΤΩΝ ΔΙΑΧΕΙΡΙΣΗΣ ΕΝΕΡΓΕΙΑΣ ΠΟΥ ΕΝΣΩΜΑΤΩΝΟΥΝ ΥΠΟΛΟΓΙΣΤΙΚΗ ΝΟΗΜΟΣΥΝΗ ΓΙΑ ΤΟ ΣΧΕΔΙΑΣΜΟ ΚΑΙ ΕΛΕΓΧΟ ΑΥΤΟΝΟΜΩΝ ΜΙΚΡΟΔΙΚΤΥΩΝ, Dept. of Natural Resources and Agricultural Engineering, Agricultural University of Athens, Greece, 5/27/2029
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

2022 Awarded Karl Boer Solar Energy Medal of Merit for *"distinguished contributions to quest for sustainable energy"*.

2021 Elected Fellow of the Institute of Electrical and Electronics Engineers (IEEE) "*for outstanding and extraordinary qualifications and contributions to photovoltaics technology"*

2020 Elected Senior Member of the Institute of Electrical and Electronics Engineers (IEEE) for *"outstanding conributions to photovoltaics technology*"

2018 IEEE William Cherry Award "*for his pioneering research at the interface of energy and the environment that catalyzed photovoltaic technology advancement and deployment world-wide*".

2017 US-Israel Integrated Energy Desalination Design Challenge; PI of the Columbia U. winning team

2017 Distinction -Emeritus Senior Scientist, Brookhaven National Laboratory

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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

2010 BNL Service Award '*in grateful recognition for thirty years of service*", 12/2010

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 Elected Fellow of the International Energy Foundation, 2/2004

2002 Elected 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

EDITOR
- Editor-in-Chief, *Energies*, Energy-Environment Section
- Associate Editor, *Progress in Energy*
- Guest Editor, *Energy Technology*,
- Guest Editor, *Energies*, Special Issue "Life-Cycle Assessment of Energy Systems in Current and Evolving Grids" https://www.mdpi.com/journal/energies/special_issues/LCA-energy-2016.
- Guest Editor, Energies, Special Issue, "Renewable Energy for Water Desalination" Energies https://www.mdpi.com/journal/energies/special_issues/Energy_for_Desalination
- 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*", Brookhaven National Laboratory 1991-1993.

EXPERT PANELS, SCIENTIFIC BOARDS & COMMITTEES
2022 8th World Conference on Photovoltaic Energy Conversion, 26–30 September 2022, Milan, Italy International Scientific Committee.
2021 – Scientific Council of PVThin: https://pvthin.org/about-us-pvthin-scientific-council/
-36th European Photovoltaics Conference (EU-PVSEC), Lisbon, Portugal, –Scientific Committee
2020 - William R. Cherry Award Committee Chair,
- Governing Board of the IEEE Photovoltaic Specialists Conference
–35th European Photovoltaics Conference (EU-PVSEC), Virtual –Scientific Committee
2019 –William Cherry AwardvCommittee, the Governing Board of the IEEE Photovoltaic Specialists Conference
-Latin America Desalination International Investment Conference
–34th European Photovoltaics Conference (EU-PVSEC), Marseilles, France –Scientific Committee
2018 –Geography 2050: Repowering our Planet, Expert Panel, American Geographical Society, Columbia University
–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, Wash DC, October 9-10, 2014.
- Moderator-3rd International Recycling Workshop, PVCYCLE, February 26, 2013, Rome, Spain.
- Plenary Session -27th European Photovoltaics Conference (EU-PVSEC), Frankfurt, Germany

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• PV velocity forum-38th IEEE Photovoltaic Specialists Conference, June 308, 2012
• 2nd International Recycling Workshop, PVCYCLE, 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, PVCYCLE, 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, Fellow of the Electrical and Electronic Engineers (IEEE); Member of the Association of Advancement of Science (AAS). Also 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. CdTe PV recycling, BSA European Patent No EP1888464

Atia A.A. and Fthenakis V.M., Renewable-powered reverse osmosis desalination with active feedwater salinity control for maximum water production efficiency with variable energy input, patent application 2018-07-26, WO2018136848A1, https://patents.google.com/patent/WO2018136848A1/

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.

5. Fthenakis V.M. and Sark W.G.J.H.M. van (editors), Comprehensive Renewable Energy, Second Edition, Elsevier, 2022.

6. Fthenakis V.M., Kammen D., Lynn P., Bhattacharya S., Onshore and Offshore Wind Energy, Wiley, 2nd edition, in preparation.

CONFERENCE PROCEEDINGS/ JOURNAL (Guest Editor)

7. 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)

8. 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)

9. Fthenakis V. and Raugei 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

10. Gude G. V. and Fthenakis V., Energies, Special Issue "Renewable Energy for Water Desalination", Dec. 2018. https://www.mdpi.com/journal/energies/special_issues/Energy_for_Desalination#published

PEER- REVIEW JOURNAL ARTICLES

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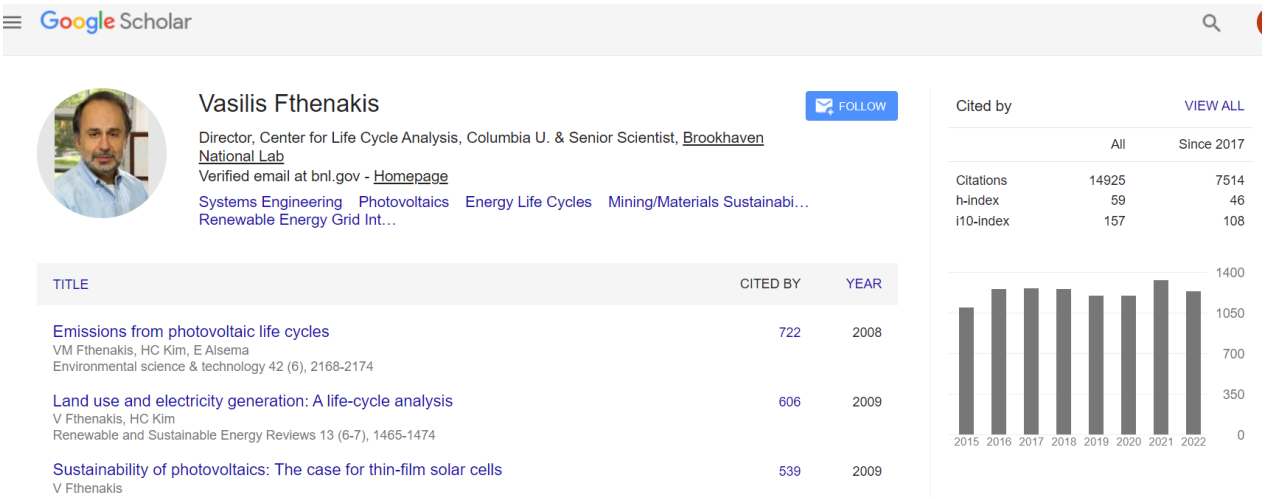

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11. Happel, J., Suzuki, I., Kokayeff, P., and Fthenakis V. Multiple Isotope Tracing of Methanation Over Ni Catalyst, Journal of Catalysis 65(1):57-77 (1980).

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