

Annual Report

(July 1, 2014 – June 30, 2015)



Richard G. Lugar Center for Renewable Energy (LCRE),
Purdue School of Engineering and Technology,
Indiana University-Purdue University Indianapolis

June 30, 2015

The mission of the Richard G. Lugar Center for Renewable Energy is to:

Address the societal needs for clean, affordable and renewable energy sources, improve the nation's energy security, and help mitigate the negative impacts of climate change.

Promote research excellence in the area of renewable energy through collaborative efforts among faculty in the disciplines of engineering, chemistry, physics, biology, environmental affairs, and public policy.

Promote renewable energy applications through teaching, learning, civic engagement, and synergistic partnerships with industry, government labs and local communities.

Please visit our website at www.lugarenergycenter.org There is a **Give Now** button for your convenience in making tax exempt donations to advance the goals and mission of the Center

Introduction

The Richard G. Lugar Center for Renewable Energy (LCRE) is located on the campus of Indiana University Purdue University-Indianapolis (IUPUI), and is administratively housed in the Purdue School of Engineering and Technology, IUPUI. *The LCRE consists of 43 Research Members spanning multiple disciplines, 23 Advisory Board Members, and 13 Entrepreneurs-in-Residence, plus about 60 students, interns and post-doctoral researchers.*

The LCRE is an interdisciplinary research center, and strives to meet the societal and public needs and challenges in these key energy and environmental areas. The Center helps create a collaborative environment for solving these challenges. The following report summarizes these activities and represents the hard work and commitment of our Research Members, Advisory Board, staff, and entire LCRE family.

Focus Areas – Renewable Energy

- Batteries
 - Li-metal
 - Anode/cathode/electrolyte chemistry
 - Seawater flow battery
- Fuel Cells
 - Non-Pt catalyst for PEM
 - Hydrogen storage
 - Hydrogen generation
 - SOFC for APU and home energy
- Combustion Engines
 - Advanced gas turbines
 - Internal combustion engines
 - Power and propulsion systems
- MSW Energy from Waste
 - Heat, oils for refining, electricity
 - Advanced gasification
 - Gas-to-liquids biofuels
- Policy & Economics
 - Urban, State, Federal
 - Energy forecasting and land use
 - Environment & Human health
- Commercial/Institutional & Buildings
 - Sustainable institutions
 - Energy and resource recovery
- Traditional Renewables
 - Solar power (including Space Solar)
 - Wind power (including hydraulic)
- Installation & Maintenance
 - Training
 - Automation
 - Diagnostics
- Manufacturing Science
 - Photovoltaic semiconductors
 - Nanotechnology
 - Fuel Cells
 - High temperature ceramics and coatings
- Efficiency
 - Industrial assessment
 - Curriculum development
 - Sustainable Technologies Certificate
- Entrepreneurism
 - Economic pro forma & business plans
 - Incubators and mentoring
 - Raising capital
- Sustainability & Lifecycle Analysis
 - Electric vehicles
 - Energy storage
 - Urban environment
- Switchgear, Diagnostics & Cybersecurity
 - Single transistor inverter
 - Synchronous distributed generation (patented)
 - Microgrids

Summary of Research and Educational Activities

The LCRE is continuing to make progress and achieve results in its core research fields and to establish itself as a leader, especially with regards to fuel cells, lithium ion batteries, electric vehicle research, biomass conversion, and education. Additionally, the capabilities of the LCRE are being expanded in these and new areas as evidenced by the induction of several new Research Members.

Below is a summary of the latest updates with regard to existing and new research and educational programs at the LCRE:

Recent Publications

1. E. dos Santos, Advanced Power Electronics Converters: PWM Converters Processing AC Voltages, ISBN: 978-1-118-88094-4, 384 pages, November 2014, Wiley-IEEE Press.
2. A. Razban, A. Khatib, Yeou-Li Chu, Comparison of energy consumption between Lid resistive heating and immersion rod heating furnaces in aluminum die casting industry, NADCA Die Casting Congress, Sept. 2014.
3. Dumortier, Jerome, Saba Siddiki, Sanya Carley, Joshua Cisney, Rachel M. Krause, Bradley W. Lane, John A. Rupp, and John D. Graham. (2015). "Effects of providing total cost of ownership information on consumers' intent to purchase a hybrid or plug-in electric vehicle." *Transportation Research Part A: Policy and Practice* 72: 71-86.
4. Dumortier, Jerome. "Impact of agronomic uncertainty in biomass production and endogenous commodity prices on cellulosic biofuel feedstock composition." *Global Change Biology Bioenergy* (in press).
5. G. A. A. Carlos, E. C. dos Santos Jr., C. B. Jacobina, J. P. R. Mello, "Dynamic Voltage Restorer Based on Three-Phases Inverters Cascaded Through an Open-End Winding Transformer". (accepted) *IEEE Transactions on Power Electronics*, vol.PP, 2015.
6. G. A. de A. Carlos, C. B. Jacobina, E. C. dos Santos Jr., E. L. L. Fabricio, N Rocha. "Shunt Active Power Filter with Open-End Winding Transformer and Series Connected Converters". (in press) *IEEE Transactions on Industry Applications*, vol.PP, 2015.
7. I. S. Freitas, M. M. Bandeira, F. Salvadori, S. A. da Silva, L. Barros, C. B. Jacobina and, E. C. dos Santos Jr. "A Carrier Based PWM Technique for Capacitor Voltage Balancing of Single-Phase Three-level Neutral-Point-Clamped Converters". *IEEE Transactions on Industry Applications*, vol. 28, No. 3, March 2015.
8. E. C. dos Santos Jr., J. H. G. Muniz, E. R. C. da Silva, C. B. Jacobina, "Nested Multilevel Topologies". (accepted) *IEEE Transactions on Power Electronics*, 2015.
9. R. L. de A. Ribeiro, T. Oliveira, R. M. de Sousa, E. C. dos Santos Jr., A. M. N. Lima, "A Robust DC-Link Voltage Control Strategy to Enhance the Performance of Shunt Active Power Filters without Harmonic Detection Schemes". *IEEE Transactions on Industrial Electronics*, vol. 62, No. 2, Feb. 2015.
10. C. B. Jacobina, N. Rocha, G. A. de A. Carlos, E. C. dos Santos Jr. "Flexible Series/Parallel AC-DC-AC Motor Drive System". *IEEE Transactions on Industry Applications*, vol. 51, no 1, pp. 259-270, Jan./Feb., 2015.

11. E. C. dos Santos Jr., N. Rocha, C. B. Jacobina, "Suitable Single-phase to Three-phase AC-DC-AC Power Conversion System". IEEE Transactions on Power Electronics, vol.30, no.2, pp.860,870, Feb. 2015.
12. N. Rocha, C. B. Jacobina, E. C. dos Santos Jr., R. M. B. Cavalcanti, "Parallel Single-Phase Ac-Dc-Ac Shared-leg Converters: Modelling, Control and Analysis". International Journal of Electrical Power and Energy Systems, vol.61, pp. 27-38, Oct. 2014.
13. S. Sajadian, E. C. dos Santos Jr., "RCD Snubber Circuit Design for 5-Level 4-Switch DC-AC Converter". IECON 2014 - 40th Annual Conference of the IEEE Industrial Electronics Society, Oct. 29-Nov. 1, 2014, Dallas, TX, USA.
14. E. de Souza, O. Nezamuddin, E. C. dos Santos Jr., S. Sajadian, "Controlled Rectifier Five-Level Four-Switch Topology". IECON 2014 - 40th Annual Conference of the IEEE Industrial Electronics Society, Oct. 29-Nov. 1, 2014, Dallas, TX, USA.
15. G.A.A. Carlos, C. Jacobina, E. C. dos Santos Jr., "SAPF With Two Dc-links and Series Converters Feeding OEW Transformers for 3P4W Systems". IECON 2014 - 40th Annual Conference of the IEEE Industrial Electronics Society, Oct. 29-Nov. 1, 2014, Dallas, TX, USA.
16. G.A.A. Carlos, C.B. Jacobina, E.C. dos Santos Jr., "Investigation on Dynamic Voltage Restorer with Two DC-links and Series Converters for 3-phase Four-wire Systems." IEEE ECCE 2014 -IEEE Energy Conversion Congress & Expo, Pittsburgh, PA, Sept. 14-18, 2014.
17. N.S.M.L. Marinus, C.B. Jacobina, N. Rocha, E.C. dos Santos Jr., "AC-DC-AC 3-phase Converter based on Three Three-leg Converters Connected in Series" IEEE ECCE 2014 - IEEE Energy Conversion Congress & Expo, Pittsburgh, PA, Sept. 14-18, 2014.
18. Jae-Kwang Kim, Rani Vijaya, Likun Zhu, Youngsik Kim, "Improving electrochemical properties of porous iron substituted lithium manganese phosphate in additive addition electrolyte", Journal of Power Sources,275 (2015) 106 - 110.
19. Bo Yan, Cheolwoong Lim, Zhibin Song, Youngsik Kim, Likun Zhu, "Polarization Analysis Based on Realistic Lithium Ion Battery Electrode Microstructure Using Numerical Simulation", the 227th ECS Meeting (May 24-28, 2015) in Chicago.
20. Rani Penumaka, Sho Murakami, Youngsik Kim, Likun Zhu, "Development of Ceramic-Polymer Composite Electrolyte for All-Solid Lithium Ion Batteries", the 227th ECS Meeting (May 24-28, 2015) in Chicago.
21. Zhibin Song, Bo Yan, Cheolwoong Lim, Likun Zhu, "Modeling and Simulation of Heat of Mixing in Lithium Ion Batteries", the 227th ECS Meeting (May 24-28, 2015) in Chicago.
22. Cheolwoong Lim, Wen Chao Lee, Bo Yan, Zhibin Song, Vincent De Andrade, Francesco De Carlo, Youngsik Kim, Likun Zhu, "Geometric Characteristics of Lithium Ion Battery electrodes with Different Packing Densities", the 227th ECS Meeting (May 24-28, 2015) in Chicago.
23. Cheolwoong Lim, Rani Vijaya, Sho Murakami, Zhibin Song, Youngsik Kim and Likun Zhu, "Geometric Characteristics of Three-Phase Porous Microstructures for All Solid-State Lithium Ion Batteries", the 227th ECS Meeting (May 24-28, 2015) in Chicago.
24. Nicholson-Crotty, S., Carley, S. 2015. Effectiveness, Implementation Capacity, and Policy Diffusion: Or, "Can We Make that Work for Us?" Accepted at State Politics and Policy Quarterly.

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26. MacLean, L., Brass, J., Carley, S., El-Arini, A., Breen, S. 2015. Democracy and the distribution of NGOs promoting renewable energy in Africa. Accepted at Journal of Development Studies.
27. Carley, S., Nicholson-Crotty, S., Fisher, E. 2015. Capacity, Guidance, and the Implementation of the American Recovery and Reinvestment Act. *Public Administration Review* 75(1):113-125.
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29. Baldwin, E., Brass, J., Carley, S., MacLean, L. 2014. Issues of scale in distributed generation electrification for rural development. *WIRES: Energy and Environment*.
30. Graham, J. D., Cisney, J., Carley, S., Rupp, J. 2014. No time for pessimism about electric cars. *Issues in Science & Technology*.
31. Jasinowski, J., Carley, S. 2014. Op-Ed: Sustainable Manufacturing Makes Cents. *Manufacturing Leadership Journal*.
32. Carley, 2014. Response to Pollin, R. 2014. A Clean Energy Program for the United States. *Boston Review*. July/August Issue.
33. Carley, S., Jasinowski, J., Glassley, G., Strahan, P., Attari, S., Shackelford, S. October 2014. "Success Paths to Sustainable Manufacturing."
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35. Liu, K. and A. Tovar. An efficient 3D topology optimization code written in Matlab. *Structural and Multidisciplinary Optimization*, Vol. 50, Issue 6, Pages: 117-1196, 2015, doi:10.1007/s00158-014-1107-x.
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48. Min Wu and Yongzhu Fu “Li₂S Nanocrystals Confined in Free-Standing CNT Paper for High Performance Rechargeable Li-S Batteries”, 227th ECS Meeting, May 24-28, 2015, Chicago, IL.
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58. Majid Deldar, Afshin Izadian, Sohel Anwar, "Reconfiguration of a Wind Turbine with Hydrostatic Drivetrain to Maximize Annual Energy Production," IEEE Energy Conversion and Conference Exposition, ECCE 2015, Montreal, CA. Accepted.
59. Ashiqur Rahman, Sohel Anwar, Afshin Izadian, "Electrochemical Model Based Fault Diagnosis of a Lithium Ion Battery using Multiple Model Adaptive Estimation Approach," IEEE International Conference on Industrial Technology, ICIT 2015, Accepted.
60. Dan Shen, Afshin Izadian, "Sliding Mode Control of a DC Distributed Solar Microgrid," Accepted, IEEE Peci 2015. Accepted.
61. Masoud Vaezi, Afshin Izadian, "Energy Storage Techniques for Hydraulic Wind Power Systems," 3rd, International Conference on Renewable Energy Research and Applications, Milwaukee, USA. 2014.
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64. Dan Shen, Afshin Izadian, "Modeling and Control of A Combined Wind-Solar Microgrid," In proceedings of Industrial Electronics Conference, Dallas, TX, 2014.
65. Afshin Izadian, Gretchen Edelman, Steve Johnson, "Gate Driver of DC-DC Boost Converters using National Instruments LabVIEW and NImyDAQ," IEEE Electro-Information Technology Conference, Milwaukee, WI, June 2014.
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89. Xingye Guo, Jing Zhang, Zhe Lu, Yeon-Gil Jung, Theoretical prediction of thermal and mechanical properties of lanthanum zirconate nanocrystal, the 1st International Conference & Exhibition for Nanopia, Changwon Exhibition Convention Center, Gyeongsangnam-do Province, Miryang City, Korea, November 13-14, 2014
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92. Yi Zhang, Jing Zhang, Sang-Won Myoung, Yeon-Gil Yung, Ab initio calculation of the thermodynamic properties and pressure based phase transition of zirconia, the 1st International Conference & Exhibition for Nanopia, Changwon Exhibition Convention Center, Gyeongsangnam-do Province, Miryang City, Korea, November 13-14, 2014
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101. Linmin Wu, Jing Zhang, Study on the structural, thermal and mechanical properties of LiCoO₂ using first principles, IUPUI Nanotechnology Research Forum and Poster Symposium, Indianapolis, IN, October 24, 2014
102. Yi Zhang, Jing Zhang, Phase transition and thermodynamic properties study of zirconia using first principles method, IUPUI Nanotechnology Research Forum and Poster Symposium, Indianapolis, IN, October 24, 2014
103. Xingye Guo, Jing Zhang, Study of the Thermal and Mechanical Properties of La₂Zr₂O₇ Using First Principles Method. Joint Board of Advisors meeting, IUPUI, October 3, 2014
104. Michael Golub, Jing Zhang, Electric All Terrain Vehicle Conversions, Joint Board of Advisors Poster Session, IUPUI, October 3, 2014
105. Linmin Wu, Jing Zhang, Study on the Structural, Thermal and Mechanical Properties of LiCoO₂ Using First Principles Method, Joint Board of Advisors Poster Session, IUPUI, October 3, 2014
106. Yi Zhang, Jing Zhang, Phase Transition and thermodynamic properties study of zirconia using first principles method, Joint Board of Advisors Poster Session, IUPUI, October 3, 2014
107. Jing Zhang, Novel Lanthanum Zirconate Based Thermal Barrier Coatings for Gas Turbine Applications, 2014 NETL Crosscutting Research Review Meeting, Pittsburgh, PA, May 19 – 23, 2014
108. Xingye Guo, Jing Zhang, Study of the Thermal and Mechanical Properties of La₂Zr₂O₇ Using First Principles Method, IUPUI Research Day, Indianapolis, IN, April 11, 2014
109. Yi Zhang, Jing Zhang, Phase transition and thermodynamic properties study of zirconia using first principles method, IUPUI Research Day, Indianapolis, April 11, 2014
110. Linmin Wu, Jing Zhang, Study of the structural, thermal and mechanical properties of lithium cobalt oxide using ab initio calculation, IUPUI Research Day, Indiana University Purdue University Indianapolis, IN, USA, April 11, 2014
111. Xingye Guo, James Knapp, Li Li, Yeon-Gil Jung, Jing Zhang, Ab initio calculations of structural, thermal and mechanical properties of lanthanum zirconate. 17th U.S. National Congress on Theoretical and Applied Mechanics, Michigan State University, June 15-20, 2014
112. Yi Zhang, Yeon-Gil Yung, Jing Zhang, First principles study of structural and thermodynamic properties of zirconia, 17th U.S. National Congress on Theoretical and Applied Mechanics, Michigan State University, June 15-20, 2014
113. Linmin Wu, Yi Zhang, Yeon-Gil Yung, Jing Zhang, First principles study on the structural, thermal and mechanical properties of LiCoO₂, 17th U.S. National Congress on Theoretical and Applied Mechanics, Michigan State University, June 15-20, 2014
114. Xingye Guo, Jing Zhang, Yeon-Gil Jung, Li Li, James Knapp, ab initio Study of Thermal Properties of Lanthanum Zirconate, Proceedings of Materials Science & Technology 2014 (MS&T 2014), Mechanical Behavior of Technological Coatings and Thin Films, pp. 2069 – 2076, Pittsburgh, PA, USA, October 12-16, 2014

115. Yi Zhang, Jing Zhang, ab initio Study on High Pressure Phase Transitions of Zirconia, Proceedings of Materials Science & Technology 2014 (MS&T 2014), Computational Design of Ceramic Materials, pp. 1601 – 1608, Pittsburgh, PA, USA, October 12-16, 2014
116. Linmin Wu, Jing Zhang, First Principles Study of Lithium Ion Diffusion in Layered Li_xCoO_2 , Proceedings of Materials Science & Technology 2014 (MS&T 2014), Energy Storage IV: Materials, Systems and Applications Symposium, pp. 1625- 1632, Pittsburgh, PA, USA, October 12-16, 2014
117. Tushar Bakhtiani, Hazim El-Mounayri, Jing Zhang, Modeling of Effect of Die Coating on Aluminum Extrusion Process, Proceedings of Materials Science & Technology 2014 (MS&T 2014), Advanced Coatings for Wear and Corrosion, pp. 41- 48, Pittsburgh, PA, USA, October 12-16, 2014
118. Jing Zhang, Xingye Guo, Yeon-Gil Jung, James Knapp, Li Li, Quantitative Analysis of Pore Morphology in Lanthanum Zirconate Thermal Barrier Coating, Proceedings of Materials Science & Technology 2014 (MS&T 2014), Mechanical Behavior of Technological Coatings and Thin Films, pp. 2061- 2067, Pittsburgh, PA, USA, October 12-16, 2014
119. Jiayang Liu, Jing Zhang, Correlation between microstructure and electrochemical properties in microarc oxidation coated magnesium alloy, Proceedings of Materials Science & Technology 2014 (MS&T 2014), Computational Design of Ceramic Materials, pp. 1609 – 1616, Pittsburgh, PA, USA, October 12-16, 2014
120. Jing Zhang, Guihua Liu, Zaixin Feng, Michael Golub, Guangrong Yan, Yongtao Dong, Numerical simulation of extrusion process of complex aluminum alloy disks, Proceedings of Materials Science & Technology 2014 (MS&T 2014), Alloys and Composites I, pp. 1513- 1518, Pittsburgh, PA, USA, October 12-16, 2014
121. Jing Zhang, Spray Techniques for 3D Printing Process, Raytheon Additive Manufacturing Workshop, Indianapolis, Indiana, June 4, 2014
122. Jing Zhang, Engineering microarc oxidation coated magnesium alloy with controlled electrochemical behaviors, the 5th International Congress on Ceramics (ICC5), Beijing, China, August 17-21, 2014
123. Jing Zhang, Novel Lanthanum Zirconate Based Thermal Barrier Coatings for Gas Turbine Applications, the 5th International Congress on Ceramics (ICC5), Beijing, China, August 17-21, 2014
124. Jing Zhang, Rare-earth Zirconate Ceramics for Thermal Barrier Coating Applications, ASM Indianapolis Chapter Meeting, April 17, 2014

Patents Granted

1. Afshin Izadian, US 8,878,384, “Central Wind Turbine Power Generation.”
2. Peter Schubert, US 8,845,772, “Process and System for Syngas Production from Biomass Materials.”

Conferences attended, Invited Talks, Collaborations featuring LCRE

1. Ali Razban, National Association of Power Engineers (NAPE), Indianapolis Chapter, March 2015.

2. Sanya Carley, presentation made at the Annual Association of Public Policy Analysis and Management Conference.
3. Sanya Carley, invited speaker at the Lugar Center Spring Forum.
4. Soheli Anwar, panelist at the Lugar Center Spring Forum.
5. Jerome Dumortier, panelist at the Lugar Center Spring Forum.
6. Jake McKinlay, panelist at the Lugar Center Spring Forum
7. Sanya Carley, Mini University, Indiana University
8. Sanya Carley, University of Utah, S.J. Quinney College of Law, 20th Annual Stegner Symposium
9. Sanya Carley, University of North Carolina at Chapel Hill, Odum Institute.
10. Jake McKinlay, featured in the news sections of The Scientist, AAAS Science, Christian Science Monitor, IJB, and other websites and blogs. For more details see: <http://www.indiana.edu/~mckinlab/Press.html>
11. Jake McKinlay, R. Gaurth Hansen Award Lecture, Dept of Biochemistry and Molecular Biology, Michigan State University, East Lansing, MI.
12. Andres Tovar, Advances in Optimal Design of Structures for Crashworthiness. General Motors Corporation. Warren, Michigan.
13. Andres Tovar, Design for Additive Manufacturing (3D Printing). The Sciencetech Club. Indianapolis, Indiana.
14. Andres Tovar, Design for crashworthiness. 4th Symposium for Design Optimization and Simulation-Based Design, New Advancements, Technology and Future, Northwestern University, Evanston, Illinois.
15. Andres Tovar, Mathematical programming in topology optimization. University of Illinois at Urbana-Champaign, Dept. of Civil and Environmental Engineering.
16. Yongzhu Fu, "Rational Design of Cathode Materials for Rechargeable Lithium-Sulfur Batteries", Materials Science Center, University of Wisconsin-Eau Claire, Eau Claire, WI.
17. Yongzhu Fu, "Rational Design of Cathode Materials for Rechargeable Li-S and Li-O₂ Batteries", Battery Systems Group, General Motors R&D Center, Detroit, MI.
18. Whitney Yu, Plenary Lecture, GPU-accelerated Patient-Specific Computational Flow From Radiological Images to in vivo Fluid Dynamics, The 27th International Conference on Parallel Computational Fluid Dynamics Parallel CFD", Montreal, Canada
19. Whitney Yu, Z. Wang, C. Zhang, Nan Chen, Ye Zhao, Alan P. Sawchuck, Michael C. Dalsing, Shawn D. Teague, Yongguang Chen, GPU-accelerated Lattice Boltzmann method for anatomical extraction in patient-specific computational hemodynamics, The 67th Annual Meeting of the American Physical Society's Division of Fluid Dynamics, San Francisco, California, Nov. 2014.
20. Whitney Yu, Z. Wang, C. Zhang, N. Chen, A. P. Sawchuck, Y. Zhao, Y. Chen, M. C. Dalsing, A Unified Computational Tool for Patient-Specific Hemodynamics From radiological images to in-vivo flow structures in human arteries, 2014 BMES Annual Meeting, San Antonio, TX, October, 2014
21. A. P. Sawchuk, H. Yu, and M. C. Dalsing, "Rethinking The Cause And Effect Relationship Between Renovascular Hypertension And Renal Artery Stenosis", Midwest Vascular 2014, the 38th Annual Meeting of the Society, Coralville, IA, September, 2014.

Research Grants and Milestones

1. Ali Razban: PI of a \$15,000, EPA (U.S. Environmental Protection Agency) for “Modeling of Air handling unit for wireless monitoring”
2. Jake McKinlay: Office of Science, US Department of Energy Early Career Research Program, DE-SC0008131. Metabolism and evolution of a biofuel-producing microbial coculture, \$750,000 total, 2012-2017.
3. Andres Tovar, Honda R&D Americas. Title: Topology Crash Optimization of Progressively Buckling Thin-walled Structures using Tubular Compliant Mechanisms-Improved Conceptual Design using a Target Dynamic Response. Role: PI. Effort: 100%. Amount: \$120,336. Dates: June 2015 - Dec 2016.
4. Andres Tovar, Purdue Research Foundation (PRF) Doctoral Research Grant. Role: Research Advisor. Title: "Multiscale Topology Optimization of Nonlinear Structures". Role: Research Advisor. Amount: \$18,000. Dates: June 2015 - May 2016.
5. Andres Tovar, PI: Purdue Research Foundation (PRF) Summer Faculty Grant. Title: "Biometric topology optimization algorithms for 3D printed lightweight impact protective structures: From Safer Helmets to Enhanced Vehicle Crashworthiness," \$10,400, June - July 2015.
6. Andres Tovar, PI: Raytheon, “Additive Manufacturing Technologies Evaluation,” \$5,000, March - May 2015.
7. Andres Tovar, PI: Walmart U.S. Manufacturing Innovation Fund. Title: Optimal plastic injection molding tooling design and production through advanced additive manufacturing. Amount: \$291,202. June 2015 - Dec 2016.
8. Yongzhu Fu, PI: Advanced High-Energy Rechargeable Lithium-Sulfur Batteries (Phase I), National Aeronautics and Space Administration, Total budget: \$250,000
9. David Goodman, “Supplemental IAC Funding to Develop Ultrasonic Leak Detection Tools for Non-air Industrial Gasses”. (\$51,984). 2015-2016.
10. David Goodman, et al., “Aquaponics”, IUPUI Multidisciplinary Undergraduate Research Institute (MURI) Grant (\$13,500) 2014.
11. Whitney Yu, PI, “Integration of CT/MRI Angiography and Doppler Sonography with Fast Computational Modeling Analysis into Noninvasive Diagnose of Renal Stenosis Severity”, RIDTP, \$15,000,06/29/2015- 06/28/2016
12. Whitney Yu, EMPOWER Award, \$5000, 09/2014-08/2015, OVCR, IUPUI
13. Whitney Yu, Co-PI, “Collaborative Research: Self-circulating, self-regulating microreactor for on-chip gas generation from liquid reactants”, NSF(CBET-1264739), \$196,848, 2013-2016. PI; Likun Zhu from Mechanical Engineering Department, IUPUI
14. Whitney Yu, Co-I, “Integration of Patient-specific Computational Hemodynamics and Vessel Wall Shear Stress Analysis into Diagnostic MRI of Vascular Diseases”, IU Health Values Fund for Research, \$100,000 (my sharing: \$68,000), 2014-2016. PI: Stephen F. Kralik from Department of Radiology of IU Medical School.
15. Jing Zhang, Development of commercializing technology in fabricating anti-corrosion complex impeller through developing high-temperature sand mold and core, \$60,000, 12/2014-09/2016, Sponsor: Changwon National University. July 2014 – Dec. 2014 (National Science Foundation)
16. Euzeli C. dos Santos, Jr., NSF I-Corps: High Efficient Grid-Tie Inverter. Awarded: \$50,000.00. Principal Investigator.

Students Graduated (selected)

1. Rani Penumaka (Prof. Likun Zhu)
2. Liz Baldwin, Ph.D. (Prof. Sanya Carley)
3. Shuang Zhao, Ph.D. (Prof. Sanya Carley)
4. Kunal Khadke (Andres Tovar)
5. Anahita Emami (Andres Tovar)

New Equipment or Capabilities

1. Three fused filament fabrication (FFF) 3D printers (Andres Tovar).
2. One AirWolf AW3DXL Deluxe, AirFolF 3D Printers (Andres Tovar).
3. Two Steam Engine printers, 3D Parts Manufacturing, Indianapolis, Indiana (Andres Tovar).
4. One stereolithography (SLA) printer: Form 1+ FormLabs, Somerville, Massachusetts (Andres Tovar).
5. Arin BT 2043, Battery Tester with 40 Channels (Yongzhu Fu).
6. Arbin BT 2143, Battery Tester with 32 Channels (Yongzhu Fu).
7. Bio-Logic Model VSP with 3 Potentiostat Channels and 1 EIS Channel (Yongzhu Fu).
8. Espec Environmental Chamber BTZ-133 (-70 °C to 180 °C) (Yongzhu Fu).
9. MTI Compact Hydraulic Crimping Machine for coin cells CR 2032 (Yongzhu Fu).
10. MTI Automatic Film Coater with 12" W × 24" L glass bed and 250 mm adjustable doctor blade and 100 mm adjustable doctor blade (Yongzhu Fu).

Service Activities

- Yongzhu Fu, Reviewer for journals: ACS Applied Materials & Interfaces, Carbon, Chemical Communications, Energy & Environmental Science, Electrochimica Acta, Electrochemistry Communications, International Journal of Hydrogen Energy, Journal of Electrochemical Society, Journal of Materials Chemistry A, Journal of Nanomaterials, Journal of Natural Gas Science & Engineering, Journal of Power Sources, Journal of Physical Chemistry Letters, Nanoscale, New Journal of Chemistry, Polymer, Physical Chemistry Chemical Physics, Polymer Composites, Polymers for Advanced Technologies, Scientific Reports, and Solid State Ionics
- Andres Tovar, Reviewer: Ingeniare Chilean Journal of Engineering; Civil Engineering Infrastructure Journal; Structural and Multidisciplinary Optimization; Physica A; International Journal of Computational Methods; Austin Journal of Robotics and Automation; Journal of the Engineering School, University of Antioquia; Academic Journals; Mechanics Research Communications; Tecnura; PLoS ONE Journal; Engineering Structures; Journal of the Dental School, University of Antioquia, Colombia; Structural and Multidisciplinary Optimization.
- Andres Tovar, Editorial Board Member. Austin Journal of Robotics & Automation.
- Andres Tovar, Editorial Board Member. Journal of Surfaces and Interfaces of Materials.

- Andres Tovar, Scientific Committee Member: Journal Intekhnia, Saint Thomas Aquinas University.
- Andres Tovar, Symposium Co-organizer and Review Coordinator for the ASME 40th Design Automation Conference, Design of Engineering Materials and Structures Session, Boston.
- Andres Tovar, International Scientific Committee Member of the ISSMO 4th International Conference on Engineering Optimization (EngOpt 2014), Lisbon, Portugal,
- Andres Tovar, Symposium Co-organizer and Review Coordinator for the ASME 40th Design Automation Conference, Design of Engineering Materials and Structures Session, Buffalo, New York.
- Sanya Carley, Secretary/Treasurer, U.S. Association of Energy Economists, 2015.
- Sanya Carley, Editorial Board, State and Local Government Review, 2014-2016.
- Sanya Carley, Co-Chair Program Committee Member for Environment and Energy Track, Association of Public Policy Analysis and Management, 2014 - 2015.
- Sanya Carley, Conference Program Committee Member for Environment and Energy Track, Association of Public Policy Analysis and Management, 2013-2015.
- Likun Zhu. Provided battery, fuel cell, and nano CT demos to high school students in two summer camps in June 2015.
- Jake McKinlay, Ad hoc reviewer, DOE BER-Science Focus Area
- Jake McKinlay, Editorial board member. Applied and Environmental Microbiology, ASM.
- Peter Schubert, External Reviewer, MSc Thesis, U. of Malta.
- Peter Schubert, Moderator, Technical Track, Systems Engineering Division, American Society of Engineering Educators, Annual Conference, Seattle, WA.
- Peter Schubert, ARPA-E proposal reviewer (GENSETS)
- Whitney Yu, Panelist, Mechanical Engineering II, GRFP, NSF, review of 30 proposals.
- Whitney Yu, reviewer for 10 conference papers for BMES 2015.
- Jing Zhang, Panelist for NSF.
- Jing Zhang, ARPA-E proposal review panel

Outreach

The 2015 Spring Forum topic was “Energy Diversity for Indiana”, and drew 90 participants to the Campus Center. Twenty four speakers, moderators, and panelists presented, including elected officials, renewable energy installers, electric utility leaders, and subject matter experts including 6 LCRE Research Members. Sponsors were Mr. Robert McFarling, Indianapolis Power & Light, Krieg DeVault, and Earth-Solar Systems: we are most grateful for their support. For professional attendees we provided Continuing Legal Instruction credits for attorneys, and Continuing Education Credits for professional engineers. Speaker presentation materials are available on our website at:

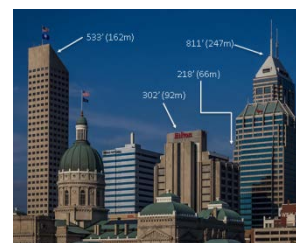
- <http://www.lugarenergycenter.org/index.php/events/>

The LCRE Annual Retreat was held at Launch Fishers in January 2015. Mayor Fadness of Fishers welcomed the crowd to his city, and Dean Russomanno provided opening remarks on the importance of renewable energy. Attendees included Research Members, Advisor Board members, and several of our Entrepreneurs-in-Residence. Drs. Fu and dos Santos presented

summaries of their research including several significant advances in the state-of-the-art. A review of LCRE activities over the prior calendar year was provided, along with a review of on-going initiatives at the Center level. A facilitated discussion brought out the topic for the Spring Forum, which attracted a record number of Research Members.

Other recent outreach activities include the following:

- Research Member Gabriel Filippelli was named as a **Jefferson Science Fellow** through the U.S. Department of State, and served a 1 year term. This honor was bestowed upon only 13 researchers in the nation. Filippelli is also Director of the Center for Urban Health at IUPUI.
- Executive Committee Member Eric Dannenmaier was appointed to Joint Public Advisory Committee of the North American Commission for Environmental Cooperation (JPAC) by **President Barack Obama**. This is a great honor for the Director of the Environmental, Energy, and Natural Resources Law Program at the IU McKinney School of Law, as well as for the LCRE.
- **Eric Dannenmaier** also organizes the Environment, Energy, Natural Resources Spring Conference held each year on the IUPUI campus. LCRE Director Schubert organized a panel discussion on “Renewable Energy & Air: The Market and Legal Policy Response to the Move from Fossil Fuels.” Panelists serving with Schubert were: Nick Melloh, President, Johnson-Melloh Solutions (Indianapolis), Angela Rapp Weber, Commissioner, Indiana Utility Regulatory Commission, and LCRE Executive Committee member M. Razi Nalim, Principal, Aerodyn Combustion (Indianapolis).
- LCRE Research Member Andres Tovar was announced as the **Grand Prize winner** of the ARPA-E 2015 LITECAR Challenge, sponsored by Local Motors. Out of 250 entries in a months-long competition, he and his team were awarded top honors for the WaterBone. The full title is "Aerodynamic water droplet with strong lightweight bone structure". News of this incredible achievement can be found on businesswire.com, greencarcongress.com, and in the Indianapolis Business Journal. Award: \$60,000.
- **Students for the Exploration and Development of Space (SEDS @ IUPUI)** is a student group advised by Dr. Peter J. Schubert. A dozen student members participated in a hands-on experiment to measure solar panel performance as a function of altitude above the city of Indianapolis, taking teams to the top of several skyscrapers, including the 1000 foot tall Chase Tower. Four students led the writing of a technical paper on the methodology and SEDS president Will Elkhatib presented the results at the Annual Conference of the American Society of Engineering Educators in Seattle, WA.
- **IUPUI Energy Club-** Research Member Dr. Ali Razban has assumed the faculty advisor role from Dr. Jerome Dumortier who served capably for two years. Fresh leadership from the student body stepped forward to assure continuity. Several field trips are in the planning stages.
- Director Schubert appeared in a **Fox Business Network** piece airing 30 Nov 14 covering the role of Go Electric (Anderson, IN) in the SPIDERS smartgrid project with DoD, DOE, and



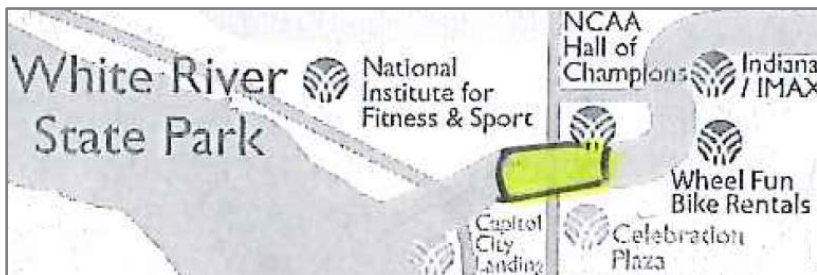
DHS. Go Electric won a \$3M contract for their distributed energy generation and storage system. Senior leaders from Go Electric have been speakers at the last two Spring Forum events by the LCRE. Also partnering with Go Electric on SPIDERS is Mechanical-Electrical Systems (Indianapolis) which has sponsored IUPUI student research on their custom inverter applications, and was a sponsor of the 2014 Spring Forum.

- The **Battery Innovation Center** (Crane, IN) has been working with LCRE researchers on joint grant proposals, and has a non-disclosure agreement in place to cover sensitive discussions of new technologies. The BIC joined with Research Member Yongzhu Fu on a **NASA Phase II** proposal. If awarded, the BIC will be a subcontractor for making large format battery cells for delivery to NASA.
- The LCRE is an Associate of the Joint Center for Electrical Storage Research (JCESR) run out of **Argonne National Labs** (Illinois). Dr. Yongzhu Fu attended on behalf of the LCRE at a workshop in Chicago, increasing our visibility to and our awareness of other potential collaborators in electronic energy storage.
- LCRE Research Member Todd Saxton is President of the **Venture Club of Indiana** and on 5 March 2015 sponsored a program organized by Director Schubert called “The Final Frontier” on local opportunities for space-related technology for entrepreneurs and investors. Panelists included Richard Godwin , CEO and President of Zero Gravity Solutions Inc. (Boca Raton), Rich Boling, VP at Techshot (Greenville, IN), and Brian Tanner, President of Spaceport Indiana (yes! we have a spaceport in our State). The event was well-attended, drawing in 120 people. Schubert also gave a Spotlight pitch on the use of space resources for Space Solar Power.


Student capstone course participation by LCRE:

- Director Schubert co-mentored a capstone design project for Mechanical Engineering students along with Mr. Matt Rubin – formerly of IURTC (IU’s technology transfer arm) and now with the Johnson Center for Entrepreneurship & Innovation at the Kelley School of Business at IUB. The project was titled “High Torque-Density Motor,” and is based on Rubin’s concept for bypassing a limiting factor in existing electric motors. Ms. Debbie Poppas, Senior VP at **Remy International** (Pendleton, IN), hosted a team of electric motor engineers to review the student’s work and guide the completion of their project.

- The White River State Park initiated a ME 462 capstone design project through the LCRE on the “White River Energy Recovery Project”. Students from IUPUI and Butler University designed



an irrigation system for Celebration Plaza using water from the **Indiana Central Canal** and powered by a water turbine at the discharge into the White River just south of the IUPUI campus. The students are planned to present their results to the Development Commission.

- In 2014 Indiana enacted a law permitting state-sponsored universities to conduct research into industrial hemp, a potentially lucrative business for Hoosier farm operations. Industrial hemp is best known for its use as fiber for rope and clothing, with 3 U.S. Presidents having grown this versatile plant. A team of graduate students from the School of Public and Environmental Affairs (SPEA) investigated the economics of growing hemp for nutraceuticals (essential fatty acids) and as an energy plant in the Midwest region. This project was co-mentored with the Indiana Hemp Industries Association, and engaged the LCRE with the top-ranked Agronomy Department at Purdue University which has planted hemp this season, the residues of which will be processed by the LCRE **biomass reactor** at 1000 Waterway to produce biochar. The biochar will aid in the growth of next season's crop, and the energy produced could be used to press vital oils from the hemp plants' healthy seeds.
- 
- **Whitney Yu** sponsored a study called “Human Aortic - Renal Artery Study” with a team of Mechanical Engineering seniors during Fall 2014.
 - A team of 8 summer interns began work on a novel architecture for Space Solar Power. Under the direction of Director Schubert each team member has a specific concentration, linked with others to create a cohesive system design team. Two students are already co-authors on a forthcoming technical paper, and other publications are in the works. In July the team visited the Bean Center at Fort Ben to see what was once the largest rooftop solar installation in the country. The hope is to attract NASA or DOE funding. Each student is working pro bono. The research team is shown below and consists of (from left-to-right): **Peter Schubert, Jonathan Nderitu, Moises Nascimento, Eddie Barks, Sheylla Pinto, Fatih Tokmo, Bruna Pires, Gabriel Goncalves, and Gaurav Bankar.**



New Personnel at LCRE

The LCRE continues to rely upon its highly qualified Research Members to advance its mission and benefit the university, city, state, and world. Below is a list of new personnel at the LCRE and some additional background about each:

Research Members

Lyudmila M. ‘Lyuda’ Bronstein, Ph.D., Senior Scientist, Chemistry Department, Indiana University

Dr. Bronstein’s academic preparation was conducted in Russia, and after serving as a Visiting Scientist at IU joined the faculty as a Research Scientist. Her areas of investigation include nanoparticle chemistry and how complex molecules manage energy; work which engages a great many colleagues and co-authors, graduate assistants, and undergraduate research students. Her technical publications number more than 190, and she has served as organizer, reviewer, and outreach coordinator in her fields of study.



James ‘Jake’ McKinlay, Ph.D., Assistant Professor, Department of Biology, Indiana University

Dr. McKinlay has degrees from Michigan State University and the University of British Columbia, and completed a post doctoral fellowship at the University of Washington in Seattle. A faculty member since 2011 he was awarded this year a \$6.26M multi-disciplinary research grant from the Department of Defense over 5 years studying prokaryotic evolution and biofuels. He also continues as principal investigator on a \$750,000 grant from the US Department of Energy – an Early Career Award on “biofuel-producing microbial coculture”. His work has attracted considerable attention lately, and he was connected via LCRE to NSF partner company Xylogenics, an IU-based start-up company working to make ethanol production more effective. Jake’s microbes have the potential to save millions of dollars per year at such facilities by producing yeast nutrients with microbes.



David V. Baxter, Ph.D., Professor of Physics, Indiana University

Dr. Baxter’s received degrees from the University of Alberta and the California Institute of Technology, and completed a postdoctoral fellowship from McGill University. He has been on the faculty of IU since 1988. He currently serves on the executive committee of the Center for Exploration of Energy and Matter and as Director of the Low Energy Neutron Source. His major field of study is materials physics, with emphasis on the development of new probes exploiting neutrons and X-rays to understand materials structure on length scales from nm to cm. These tools are invaluable in providing insight for nano-structured materials such as battery electrodes and fuel cell membranes.



Advisory Board Members

Steve Sherman, Partner, Krieg DeVault

Mr. Sherman has over 30 years of experience in energy, telecom, and utilities. His practices has included regulatory and trial work before state and federal regulatory bodies and courts. Steve is serving or has served on a number of boards for foundations and associations across the country. He was named as an Indiana Super Lawyer. His work has taken him overseas to address energy issues in the hinterlands of sub-Saharan, and connected him with decision-makers and national leaders. This work has helped connect the LCRE with those applications where our technologies are needed most.

Peter M. Fellegly, Vice President – Business Development, Fortune Wireless

Mr. Fellegly has extensive experience with commercial product and service implementation and deployment, mostly in the wireless and telecom business sector. His education includes a B.S. from Lehigh University and a MBA from Ball State. Peter serves on many advisory boards, including the Miller College of Business at his Indiana alma mater. He also served as President for the Indianapolis Symphonic Choir, and attended the Rotarian of the Century event honoring Senator Richard G. Lugar in 2013. Peter's networking and insight into successful ventures is of great interest to the commercial aspirations of LCRE Research Members.

Outlook for AY 2015-2016

Crude oil prices on the global market have remained this year at levels which spoil the financial prospects for alternative energy projects. Federal grants on energy have moved from R&D to assisting commercial companies in bringing near-term solutions to market. University research funding has become more competitive. Investment tolerance for new forms of renewable energy is soft. Amidst this challenging environment, the good news is that wind and solar installations continue to accelerate across the United States.

Several bright spots shine within the LCRE faculty community, including battery research funding from DOE and NASA, and fuel cell funding from NSF. Many of our Research Members are busy creating grant applications, conducting novel research, and publishing their results in top-rated journals from around the world. Relevance to the community expands through outreach and student engagement, plus public participation in events across the State and around the globe. Our researchers have been invited speakers and honored members, providing academic services to the organizations and events held world-wide.

Commercialization of renewable energy technology did not advance in the past year, despite considerable input from our Entrepreneurs-in-Residence (see Appendix D for a listing). Two business pitches in Silicon Valley in February 2015 helped us realize the dearth in investor funding for the cleantech sector is not limited to the Midwest. In an unfortunate development, the NSF has restricted SBIR applicants from being both a stakeholder in the small business and a subcontractor faculty member. This was our primary business model for the EiR program. Fortunately, neither USDA nor DOE have made a similar restriction.

As you can see from the extensive list of publications, professional service, and innovations in this report, our Research Members are relentlessly pursuing advancement of LCRE goals in myriad ways. The year ahead will challenge our creativity and capabilities as we compete at the highest level, and work to develop center-level grants which engage multiple Lugar Center co-PIs.

Appendix A

Executive Committee

1. Alan Jones, Ph.D., Assistant Professor of Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI
2. Rongrong Chen, Ph.D., Research Associate Professor of Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI
3. Steve Rovnyak, Ph.D. Associate Professor of Electrical and Computer Engineering, Purdue School of Engineering and Technology, IUPUI
4. Mark Goebel, Ph.D., Professor of Biochemistry and Molecular Biology, Indiana University School of Medicine
5. Eric Dannenmaier, Professor of Law and Dean's Fellow, Director, Environmental and Natural Resources Law Program, Indiana University Robert H. McKinney School of Law
6. M. Razi Nalim, P.E., Ph.D., Professor of Mechanical Engineering, Associate Dean for Research & Graduate Programs, Department of Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI

Appendix B

Advisory Board

The LCRE AB meets quarterly on campus to review progress and provide strategic advice.

1. Dr. Seth W. Snyder, Argonne National Laboratory, and President of the Council for Chemical Research.
2. Robert Galyen, Chief Technology Officer, Amperex Technology Limited.
3. John Kirkwood, JD, Partner, Krieg DeVault.
4. Keni Washington, Managing Director, Earth Solar Technologies Corporation.
5. Doug Wasitis, Director of Federal Relations, Indiana University.
6. Kelly Huntington, President and CEO, Indianapolis Power and Light (transitioning)
7. Lane Ralph, Private citizen, formerly State Director for Sen. Lugar.
8. Kären Haley, Executive Director, Indianapolis Cultural Trail, Inc.
9. Carey Lykins, President and CEO, Citizens Energy Group.
10. Dr. Wayne Eckerle, Vice President, Corporate Research and Technology, Cummins, Inc.
11. Cathy Tripodi, Senior Vice President, Council on Competitiveness.
12. Cary Aubrey, Manager, Bio-energy Development, Indiana State Department of Agriculture.
13. Steve Kozey, General Counsel, Midwest ISO.
14. Todd Colpron, VP of Business Development, IndyPowerSystems.
15. Dr. Maureen McCann, Director, Purdue Energy Center, Purdue University.
16. Doug Esamann, President, Duke Energy Indiana (transitioning).
17. (pending) Craig Herndon, Director of Critical Technology Innovation, NSWC Crane.
18. Dan M. Martin, Senior Scholar, Woodrow Wilson International Center .
19. Terry Hall, Partner, Faegre Baker Daniels.
20. Jim Wheeler, Thomas P. Miller and Assoc.
21. Dustin “Dusty” Wilson, Director of Energy Systems, SAIC
22. Steve Sherman, Partner, Krieg-DeVault
23. Peter Fellegly, VP-Business Development, Fortune Wireless

Appendix C

Research Members

1. Dr. Jie Chen, Mechanical Engineering, Purdue School of Engineering and Technology at IUPUI
2. Dr. Hazim El Mounayri, Mechanical Engineering, Purdue School of Engineering and Technology at IUPUI
3. Dr. M. Razi Nalim, Mechanical Engineering, Purdue School of Engineering and Technology at IUPUI
4. Dr. Yaobin Chen, Electrical and Computer Engineering, Purdue School of Engineering and Technology at IUPUI
5. Dr. Sohel Anwar, Mechanical Engineering, Purdue School of Engineering and Technology at IUPUI
6. Dr. David Goodman, Electrical and Computer Engineering Technology, Purdue School of Engineering and Technology at IUPUI
7. Dr. Stephen Hundley, Computer, Information, and Leadership Technology, Purdue School of Engineering and Technology at IUPUI
8. Dr. Afshin Izadian, Electrical and Computer Engineering, Purdue School of Engineering and Technology at IUPUI
9. Dr. Lingxi Li, Electrical and Computer Engineering, Purdue School of Engineering and Technology at IUPUI
10. Dr. Rongrong Chen, Mechanical Engineering, Purdue School of Engineering and Tech at IUPUI
11. Dr. Maher Rizkalla, Electrical and Computer Engineering, Purdue School of Engineering and Tech at IUPUI
12. Dr. Steven Rovnyak, Electrical and Computer Engineering, Purdue School of Engineering and Technology at IUPUI
13. Dr. Alan Jones, Mechanical Engineering, Purdue School of Engineering and Tech at IUPUI
14. Dr. Tamer Wasfy, Mechanical Engineering, Purdue School of Engineering and Technology at IUPUI
15. Dr. Dong Xie, Biomedical Engineering, Purdue School of Engineering and Technology, IUPUI
16. Dr. Jian Xie, Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI
17. Dr. Likun Zhu, Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI
18. Dr. Mark Goebel, Biochemistry and Molecular Biology, IU School of Medicine at IUPUI
19. Dr. Gabriel Filippelli, Professor of Earth Sciences, Director Center For Urban Health, Earth Sciences Department, Purdue School of Science at IUPUI
20. Dr. Asok Sen, Mathematical Sciences, Purdue School of Science at IUPUI
21. Dr. Xianzhong Wang, Biology, Purdue School of Science at IUPUI
22. Dr. Ken Richards, Public and Environmental Affairs/Law, IU School of Public & Environmental Affairs/IU Maurer School of Law

23. Dr. Eric Dannenmaier , Director, Environmental and Natural Resources Law Program, IU School of Law
24. Dr. Pierre Atlas, Political Science, Marian University
25. Dr. Carol Rogers, Indiana Business Research Center, Kelley School of Business, IUPUI
26. Patricia Fox, Organizational Leadership and Supervision, Purdue School of Engineering and Technology at IUPUI
27. Dr. Jan Cowan, Architectural Technology Program, Purdue School of Engineering and Technology at IUPUI (through 31 December 2014).
28. Dr. Jerome Dumortier, Public and Environmental Affairs, IU School of Public and Environmental Affairs
29. Dr. Peter J. Schubert, Electrical and Computer Engineering, Purdue School of Engineering and Technology at IUPUI
30. Dr. Jing Zhang, Mechanical Engineering, Purdue School of Engineering and Technology at IUPUI
31. Dr. Stephen K. Randall, Department of Biology, School of Science, IUPUI
32. Andres Tovar, Ph.D., Assistant Professor, Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI
33. Sanya Carley, Ph.D., Associate Professor, School of Public and Environmental Affairs (SPEA), Indiana University
34. Euzeli C. Dos Santos, Jr., Ph.D., Assistant Professor, Electrical and Computer Engineering, Purdue School of Engineering and Technology, IUPUI
35. Huidan “Whitney” Yu, Ph.D., Assistant Professor, Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI
36. Dr. Elaine Cooney, Professor of Electrical and Computer Technology, Department Head, Technology, IUPUI.
37. Dr. E. Jane Luzar, Professor of Economics, Professor of Public and Environmental Affairs, Dean, IUPUI Honors College.
38. Dr. Paul E. Sokol, Professor of Experimental Physics, Department of Physics, IU-Bloomington.
39. Dr. Ali Razban, Senior Lecturer, Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI.
40. Dr. Yongzhu Fu, Assistant Professor, Dept. of Mechanical Engineering, Purdue School of Engineering and Technology, IUPUI.
41. Dr. Lyudmila Bronstein, Research Scientist, IU Dept. of Chemistry (new this year!).
42. Dr. David V. Baxter, Professor, IU Dept. of Physics (new this year!)
43. Dr. James “Jake” McKinlay, Asst. Prof, Dept. of Biology (new this year!)

Appendix D

Entrepreneurs-in-Residence

The EIR program was initiated in December 2011 in cooperation with Dr. Joe Trebley of the Indiana University Research and Technology Corporation (IURTC) – the technology transfer organization for the IU system. Dr. Trebley heads the Startup Support and Promotion initiative to help faculty create businesses based on their intellectual property. The most crucial role for the EIRs is to serve as PI for federal Small Business Innovation Research (SBIR) grants made by spIn-Up companies which can then subcontract to university faculty. This allows faculty members to retain 100% appointments while benefiting from the entrepreneurial experience of the EIR and avoiding the federal requirement that the PI be 51% or more associated with the small company. Recently the NSF adopted funding opportunity language prohibiting this arrangement, and there is concern this could extend to other federal agencies. In addition to SBIRs, EIRs help develop business plans, often in concert with students from the Kelley School of Business and the School of Public and Environmental Affairs, and they bring networking opportunities to LCRE. The following individuals provide pro bono work on behalf of the university with the hope and expectation that, upon receiving funding, they can begin to draw a salary commensurate with their level of interest and availability, while creating commercially-viable going concerns based on research from LCRE Research Members:

1. Mr. John Craun
2. Dr. Randall Gatz
3. Dr. Shashikala K
4. Dr. James Logsdon
5. Mr. Joe Paganessi
6. Mr. Edward F. Plocharczyk
7. Dr. Seth Potter
8. Mr. Peter Price
9. Dr. Bob Rosenstein
10. Mr. Lee Saberson
11. Mr. Morris Stillabower
12. Ms. Anjali Sarda
13. Dr. Sy Ali

Appendix E

Director's Afterward

A great many people contribute to this organization. We are privileged to be administratively housed within the School of Engineering and Technology at IUPUI and to have the support of Dean David Russomanno and his staff. Administrators and facility services people from all across the Indianapolis campus have worked hard in creating an environment conducive to research and learning. Thanks to all of you who help make this important work possible.

The issue of climate change is poised to emerge from the pall of doubt and denial which have prevented this topic from being debated rationally in the U.S. In June 2015, Pope Francis issued an encyclical letter calling for worldwide action to address this daunting specter. It seems possible that Americans will wake up to the looming impacts of business as usual and step up efforts to accelerate adoption of energy efficiency, renewable energy, and sustainable practices.

