

Phil De Luna

Highlights

2019 Forbes Top 30 Under 30 – Energy
Carbontech Co-founder & Finalist (1 of 10 globally) in \$20M Carbon XPRIZE
Youngest director in the history of the National Research Council Canada
39 publications in high-impact journals with multiple in *Nature* and *Science*
Over 7 years of experience in research and development of clean energy technologies

Education

2015 – 2018	University of Toronto	PhD Materials Science & Engineering
2017	University of California, Berkeley	Visiting Scholar
2013 – 2015	University of Ottawa	MSc Chemistry
2009 – 2013	University of Windsor	BSc [H] Chemistry

Experience

Program Director at National Research Council Canada

Feb 2019 – Present

- Built and led a \$57M collaborative research program on Canada-made energy materials to decarbonize the oil & gas/petrochemical industry.
- Manages a team of 40 FTE in three thrusts – CO₂ recycling, H₂ technology, and AI for materials discovery.
- Member of the OECD Advanced Materials Steering Committee on collaborative research.

Member of the Board of Directors at Carbon Management Canada

Sep 2019 – Present

- Providing strategic direction and assessing the health of a non-profit that accelerates the development and testing of GHG-reducing technologies to market. Oversaw hiring of firm's latest CEO.

Mentor at Creative Destruction Labs

May 2020 – Present

- Helping early stage founders change the world by building massive and scalable technology companies. Specialization in advanced materials and founding mentor of the Matter stream.

Co-Founder & Finalist at Carbon XPRIZE

Sep 2016 – Mar 2019

- Finalist (1 of 10 globally) and raised \$2.0M in non-dilutive funding.
- Led a team to scale up CO₂ conversion technology from bench to prototype.
- 2019 Creative Destruction Lab – Energy cohort, a highly competitive startup accelerator.

Researcher at University of Toronto

Sep 2015 – Jan 2019

- Pioneering contributions to the fields of CO₂ recycling, artificial intelligence for materials discovery, artificial photosynthesis, and hydrogen technologies. Governor General Gold Medalist.
- Brokered funded research projects to oil and gas/ petrochemical corporations such as Total, Suncor, and Dow. More than \$5M in awarded funds and partnerships.

Research Scientist at Toyota Research Institute

Jun 2018 – Sep 2018

- Developed machine learning models and descriptors for accelerated discovery of fuel cell and battery materials for next-generation electric vehicles. Provided technical feedback for venture reviews.

Research Scientist at IBM TJ Watson Research Center

May 2016 – Sep 2016

- Performed large scale computational simulations on supercomputers for point-of-care biosensing materials.

Publications

* denotes equal contribution

1. Zhong, M.,* Tran, K.,* Min, Y.,* Wang, C.,* Wang, Z., Dinh, C. T., **De Luna, P.**, Yu, Z., Rasouli, A. S., Brodersen, P., Sun, S., Voznyy, O., Tan, C. S., Askerka, M., Che, F., Liu, M., Seifitokaldani, A., Pang, Y., Lo, S. C., Ip, A., Ulissi, Z., & Sargent, E. H. Accelerated discovery of CO₂ electrocatalysts using active machine learning. *Nature*, 2020, 581, 178-183
2. Nam, D. H.,* **De Luna, P.**,* Rosas-Hernandez, A., Thevenon, A., Li, F., Agapie, T., Peters, J. C., Shekhah, O., Eddaoudi, M., & Sargent, E. H. Molecular enhancement of heterogeneous CO₂ reduction. *Nature Materials*, 2020, 19, 226-276
3. Coskun, H., Aljabour, A., **De Luna, P.**, Sun, H., Nishiumi, N., Yoshida, T., Koller, G., Ramsey, M. G., Greunz, T., Stifter, D., Strobel, M., Hild, S., Hassel, A. W., Sariciftci, N. S., Sargent E. H., & Stadler, P. Metal-Free Hydrogen-Bonded Polymers Mimic Noble Metal Electrocatalysts. *Advanced Materials*, 2020
4. **De Luna, P.**, Hahn, C., Higgins, D., Jaffer, S. A., Jaramillo, T. F., & Sargent, E. H. What would it take for renewably powered electrosynthesis to displace petrochemical processes? *Science*, 2019, 364, 6438
5. Ross, M. B., **De Luna, P.**, Li, Y., Dinh, C. T., Kim, D., Yang, P., & Sargent E. H. Designing materials for electrochemical carbon dioxide recycling. *Nature Catalysis*, 2019, 2, 648-658
6. Liu, M., Liu, M., Wang, X., Kozlov, S. M., Cao, Z., **De Luna, P.**, Li, H., Qui, X., Liu, K., Hu, J., Jia, C., Wang, P., Zhou, H., He, J., Zhong, M., Lan, X., Zhou, Y., Wang, Z., Li, J., Seifitokaldani, A., Dinh, C. T., Liang, H., Zou, C., Zhang, D., Yang, Y., Chan, T. S., Han, Y., Cavallo, L., Sham, T. K., Hwang, B. J., & Sargent, E. H. Quantum-Dot-Derived Catalysts for CO₂ Reduction Reaction. *Joule*, 2019, 3, 1-16
7. Duan, G., Chen, L., Jing, Z., **De Luna, P.**, Wen, L., Zhang, L., Zhao, L., Xu, J., Li, Z., Yang, Z., & Ruhong, Z. Robust Antibacterial Activity of Tungsten Oxide (WO_{3-x}) Nanodots. *Chemical Research in Toxicology*, 2019, 32(7), 1357-1366
8. Nandi, S., **De Luna, P.**, Maity, R., Chakraborty, D., Daff, T. D., Burns, T. D., Woo, T. K., Ramanathan, V. Imparting Gas Selective and Pressure Dependent Porosity into a Non-Porous Solid via Coordination Flexibility. *Materials Horizons*, 2019, 6, 1883-1891
9. Pang, Y., Li, J., Wang, Z., Tan, C. S., Hsieh, P. L., Zhuang, T. T., Liang, Z. Q., Zou, C., Wang, X., **De Luna, P.**, Edwards, J. P., Xu, Y., Li, F., Dinh, C. T., Zhong, M., Lou, Y., Wu, D., Chen, L. J., Sargent, E. H., & Sinton, D. Efficient electrocatalytic conversion of carbon monoxide to propanol using fragmented copper. *Nature Catalysis*, 2018, 2, 251-258
10. Dinh, C. T.,* Jain, A.,* de Arquer, F. P. G.,* **De Luna, P.**, Wang, N., Zheng, X., Cai, J., Gregory, B. Z., Voznyy O., Zhang, B., Liu, M., Sinton, D., Crumlin, E. J., & Sargent, E. H. Multi-Site Catalysts Destabilize Water Molecules and Achieve High-Activity Neutral Hydrogen Evolution. *Nature Energy*. 2018, 4, 107-114
11. Li, J.,* Che, F.,* Pang, Y.,* Zou, C.,* Howe, J. Y., Burdynyn, T., Edwards, J. P., Wang, Y., Li, F., **De Luna, P.**, Dinh, C. T., Zhuang, T. T., Saidaminov, M. I., Cheng, S., Wu, T., Finprock, Y. Z., Ma, L., Hsieh, S. H., Liu, Y., Botton, G., Pong, W. F., Du, X., Guo J., Sham, T. K., Sargent, E. H., & Sinton, D. Copper adparticle enabled selective electrosynthesis of n-propanol. *Nature Communications*. 2018, 9, 4614
12. Zhuang, T. T.,* Pang, Y.,* Liang, Z. Q., Li, Y., Tan, C. S., Li, J., Din, C. T., **De Luna, P.**, Hsieh, P. L., Burdynyn, T., Li, H. H., Liu, M., Wang, Y., Li, F., Proppe, A., Johnston, A., Wu, Z. Y., Zheng, Y. R., Ip, A. H., Tan, H., Chen, L. J., Yu, S. H., Kelly, S. O., Sinton, D., & Sargent, E. H. Copper nanocavities

- confine intermediates for efficient electrosynthesis of C3 alcohol fuels from carbon monoxide. **Nature Catalysis**. 2018, 1, 945-951
13. Ross, M. B., Li, Yi., **De Luna, P.**, Kim, D., Sargent, E. H., & Yang, P. Electrocatalytic Rate Alignment Enhances Syngas Generation. **Joule**. 2018, 3 (1), 257-264
 14. Kibria, M. G., Dinh, C. T., Seifitokaldani, A., **De Luna, P.**, Burdyny, T., Quintero-Bermudez, R., Ross, M. B., Bushuyev, O. S., de Arquer, F. P. G., Yang, P., Sinton, D., & Sargent, E. H. A Surface Reconstruction Route to High Productivity and Selectivity in CO₂ Electroreduction Toward C₂+ Hydrocarbons. **Advanced Materials**. 2018, 30 (49), 1804867
 15. Liang, Z.,* Zhuang, T.,* Seifitokaldani, A., Tan C. S., Li, Y., **De Luna, P.**, Huang, C. W., Hsieh, P. L., Dinh, C. T., Wang, Y., Quintero-Bermudez, R., Zhou, Y., Li, J., Chen, P., Pang, Y., Lo, S. C., Chen, L. J., Tan, H., Xu, Z., Zhao, S., & Sargent, E. H. Copper-on-nitride enhances the stable electrosynthesis of multi-carbon products from CO₂. **Nature Communications**. 2018, 9, 3828
 16. **De Luna, P.**, Liang, W., Mallick, A., Shekhah, O., Garcia de Arquer, F. P., Proppe, A., Todorovic, P., Kelley, S. O., Sargent, E. H., & Eddaoudi, M. Metal-Organic Framework Thin Films on High-Curvature Nanostructures Towards Tandem Electrocatalysis. **ACS Applied Materials Interfaces**. 2018, 10 (37), 31225–31232
 17. Nam, D. H., Bushuyev, O. S., Li, J., **De Luna, P.**, Seifitokaldani, A., Dinh, C. T., Garcia de Arquer, F. P., Wang, Y., Liang, Z., Proppe, A. H., Tan, C. S., Todorovic, P., Shekhah, O., Gabardo, C. M., Jo, J. W., Choi, J., Choi, M. J., Baek, S. W., Kim, J., Sinton, D., Kelley, S. O., Eddaoudi, M., & Sargent, E. H. Metal-Organic Frameworks Mediate Cu Coordination for Selective CO₂ Electroreduction. **Journal of the American Chemical Society**. 2018, 140 (36), 11378–1138
 18. García de Arquer, F. P.,* Bushuyev, O. S.,* **De Luna, P.**,* Dinh, C. T., Seifitokaldani, A., Saidaminov, M. I., Quan, L. N., Proppe, A., Kibria, M. G., Kelley, S., Sinton, D., & Sargent, E. H. 2D Metal Oxyhalide-Derived Catalysts for Efficient CO₂ Electroreduction. **Advanced Materials**. 2018, 1802858
 19. Zhou, Y.,* Che, F.,* Liu, M.,* Zou, C., Liang, Z.Q., **De Luna, P.**, Yuan, H., Li, J., Wang, Z., Chen, P., Bladt, E., Quintero-Bermudez, R., Sham, T. K., Bals, S., Hofkens, J., Sinton, D., Chen, G., & Sargent, E. H. Dopant-induced electron localization drives CO₂ reduction to C₂ hydrocarbons. **Nature Chemistry**. 2018, 10, 974–980
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 21. Dinh, C. T.,* Burdyny, T.,* Kibria, M.,* Seifitokaldani, A.,* Gabardo, C., de Arquer, F. P. G., Kiani, A., Edwards, J., **De Luna, P.**, Bushuyev, O., Zou, C., Quintero-Bermudez, R., Pang, Y., Sinton, D., & Sargent E. H. Sustained high-selectivity CO₂electroreduction to ethylene via hydroxide-mediated catalysis at an abrupt reaction interface. **Science**. 2018, 360 (6390), 783-787
 22. He, S., Zhang, Y., Qiu, L., Zhang, L., Zhang B., Xie, Y., Pan, J., Chen, P., Song, H., Hu, Y., Wang, B., Dinh, C. T., **De Luna, P.**, Banis, M. N., Wang, Z., Sham, T. K., Gong, X., Peng, H., Sargent, E. H. Chemical-to-Electricity Carbon: Water Device. **Advanced Materials**. 2018, 1707635
 23. Bushuyev, O.S.* **De Luna, P.**,* Dinh, C.T., Tao, L., Saur, G., van de Lagemaat, J., Kelley, S. O., Sargent, E.H. What should we make with CO₂ and how can we make it? **Joule**. 2018, 2 (5), 825-832
 24. **De Luna, P.**,* Quintero-Bermudez, R.* Dinh, C. T., Ross, M. B., Bushuyev, O., Todorovic, P., Regier, T., Yang, P., & Sargent, E. H. Electro-redeposited catalysts control morphology and oxidation state for

selective carbon dioxide reduction. **Nature Catalysis**. 2018, 1 (2), 103-110

25. **De Luna, P.**, Wei, J. N., Bengio, Y., Aspuru-Guzik, A., & Sargent, E. H. Use machine learning to find energy materials. **Nature**. 2017, 552 (7683), 23-25
26. Zheng, X.* , Zhang, B.* , **De Luna, P.***, Liang, Y., Comin, R., Voznyy, O., Garcia de Arquer, F. P., Liu M., Dinh, C.T., Dynes, J., Regier, T., Xin, H. L., Prendergast, D., Du, X., & Sargent, E. H. Theory-driven design of high-valence metal sites for water oxidation confirmed using *in-situ* soft X-ray absorption. **Nature Chemistry**. 2017, 10 (2), 149-154
27. Zheng, X.* , **De Luna, P.***, Garcia de Arquer, F. P., Zhang, B., Becknell, N., Ross, M., Liu, M., Banis, M. N., Voznyy, O., Dinh, C.T., Zhuang, T., Du, X., Yang, P., & Sargent, E. H. Sulfur-modulated tin sites enable efficient electrochemical reduction of CO₂ to formate. **Joule**. 2017, 1 (4), 794-805
28. Coskun, H., Aljabour A., **De Luna, P.**, Farka D., Greunz, T., Stifter, D., Kus, M., Zheng, X., Liu, M., Sariciftci, N. S., Sargent, E. H., & Stadler, P. Biofunctionalized conductive polymers enable efficient CO₂ electroreduction. **Science Advances**. 2017, 3 (8), e1700686
29. Ross, M. B., Dinh, C. T., Li, Yi., Kim, D., **De Luna, P.**, Sargent, E. H., & Yang, P. Cu-Enrichment of Nanostructured Catalysts Enables Designer Syngas Electrosynthesis from CO₂. **Journal of American Chemical Society**. 2017, 139 (27), 9359–9363
30. Klinkova, A., **De Luna, P.**, Sargent, E. H., Kumacheva, E., & Cherepanov, P. V. Enhanced electrocatalytic performance of palladium nanoparticles with high energy surfaces in formic acid oxidation. **Journal of Materials Chemistry A**. 2017, 5, 11582-11585
31. **De Luna, P.**, Mahshid, S., Das, J., Luan, B., Sargent, E. H., Kelley, S. O., Zhou, R. High-Curvature Nanostructuring Enhances Probe Display for Biomolecular Detection. **Nano Letters**. 2017, 17 (2), 1289–1295
32. Zhang, W., Ye, C., **De Luna, P.**, Zhou, R. Snatching the Ligand or Destroying the Structure: Disruption of WW Domain by Phosphorene. **The Journal of Physical Chemistry C**. 2017, 121 (2), 1362–1370
33. Gu, Z., **De Luna, P.**, Yang, Z., Zhou, R. (2017). Structural Influence of Proteins Upon Adsorption to MoS₂ Nanomaterials: Comparison of MoS₂ Force Field Parameters. **Physical Chemistry Chemical Physics**. 19, 3039-3045
34. Klinkova, A.* , **De Luna, P.***, Dinh, C.T., Voznyy, O., Larin, E.M., Kumacheva, E., Sargent, E.H. Rational Design of Efficient Palladium Catalysts for Electroreduction of Carbon Dioxide to Formate. **ACS Catalysis**. 2016, 6 (12), 8115-8120
35. Liu, M.* , Pang Y.* , Zhang, B.* , **De Luna, P.***, Voznyy, O., Xu, J., Zheng, X., Dinh, C.T., Fan, F., Cao, C., García de Arquer, F. P., Safaei, T. S., Mephram, A., Klinkova, A., Kumacheva, E., Filleter, T., Sinton, D., Kelley S. O., & Sargent, E. H. Enhanced Electrocatalytic CO₂ Reduction via Field-Induced Reagent Concentration. **Nature**. 2016, 537 (7620), 383-386
36. Briard, J.G*, Fernandez, M.* , **De Luna, P.**, Woo, T.K., Ben, R.N. QSAR Accelerated Discovery of Potent Ice Recrystallization Inhibitors. **Scientific Reports**. 2016, (6), 26403
37. Zhang, B., Zheng, X., Voznyy, O., Comin, R., Bajdich, M., García-Melchor, M., Xu, J., Liu, M., García de Arquer, F. P., Dinh, C.T., Fan, F., Yuan, M., Yassitepe, E., Janmohamed, A., Chen, N., Reiger, T., Han, L., Liu, P., Li, Y., **De Luna, P.**, Xin, H.L., Zheng, L., Vojvodic, A., & Sargent, E.H. Homogeneously-Dispersed Multi-Metal Oxygen-Evolving Catalysts. **Science**. 2016, 352 (6283), 333-337
38. Nandi, S., **De Luna, P.**, Daff T.D., Liu, M., Buchanan, W., Hawari, A.I., Woo, T.K., Vaidhyanathan, R. A Single Ligand Ultra-Microporous MOF with Exceptional CO₂ Capacity and Selectivity. **Science**

Advances. 2015, 1 (11), e1500421

39. **De Luna, P.**, Bushnel, E. A., & Gauld, J. W. A Molecular Dynamics Examination on Mutation Induced Catalase Activity in Coral Allene Oxide Synthase. *The Journal of Physical Chemistry B.* 2013, 117 (47), 14635–14641
40. **De Luna, P.**, Bushnell, E. A., & Gauld, J. W. A Density Functional Theory Investigation into the Binding of the Antioxidants Ergothioneine and Ovothiol to Copper. *The Journal of Physical Chemistry A.* 2013, 117 (19), 4057–4065
41. Ion, B. F., Bushnell, E. A., **De Luna, P.**, & Gauld, J. W. A Molecular Dynamics (MD) and Quantum Mechanics/Molecular Mechanics (QM/MM) Study on Ornithine Cyclodeaminase (OCD): A Tale of Two Iminiums. *International Journal of Molecular Sciences.* 2012, 13(10), 12994-13011.

Awards

- 2020 Mission Innovation Champion – Canada, Mission Innovation
- 2019 Forbes Best of Canada Top 30 Innovators, Forbes
- 2019 Forbes Top 30 Under 30 – Energy, Forbes
- 2019 Governor General’s Gold Medal, Governor General of Canada
- 2019 GreenBiz Top 30 Under 30, GreenBiz Magazine
- 2017 Massey College Catherall Award, Massey College
- 2016 Michael Smith Foreign Study Supplement, NSERC
- 2016 Alexander Graham Bell Canada Graduate Scholarship (CGS-D), NSERC
- 2015 Atsumi Ohno Scholarship, University of Toronto
- 2015 Dr. Yu Graduate Scholarship, University of Ottawa
- 2014 uOttawa Teaching Assistant Excellence Award, University of Ottawa
- 2014 Top Poster Prize Award, Carbon Management Canada (CMC) Annual Conference
- 2014 Honourable Mention Poster Award at the Transformational Technologies in Materials Science (TTMS) Summer School, University of Wisconsin-Madison
- 2013 Tito Scaiano Graduate Scholarship, University of Ottawa
- 2013 Department of Chemistry Undergraduate Excellence Award, \$5000 University of Windsor
- 2012 Top Undergraduate Poster Award at the 25th Canadian Symposium for Theoretical and Computational Chemistry (CSTCC), University of Guelph

Extra-Curricular & Volunteer Activities

Organization for Economic Co-operation and Development (OECD) | May 2019 - Present
Member of the Advanced Materials Steering Committee

Carbon XPRIZE Competition | September 2016 – January 2019
Finalist (1 of 10 worldwide, only Ontario team ever to advance)
Director of Catalyst Design & Advanced Characterization

Massey College | August 2016 – January 2019

Junior Fellow
Co-Chair Junior Fellow Lecture Series
Co-Chair Quarter Century Fund
Lionel Massey Fund Committee Member
Junior Fellow/Senior Fellow Liaison Committee Member
Science at Massey Committee Member
House Committee Member
Massey Tutors Program High School Tutor

Canadian Institute for Advanced Research | September 2015 – January 2019

Bio-inspired Solar Energy Graduate Student Fellow
Meeting recorder, co-organizer

Epilepsy Canada Charity Gala | January 2015

Organizer, Fundraiser, Logistics Management, Procurement

Ottawa Bluesfest | 2013-2015
Volunteer

Collaboratory on Energy Research and Policy (CERP) | January 2014 – September 2015
Founding Member, Lead Science Advisor

Conference Co-Chair and Organizer

Gordon Research Seminar on Solar Fuels | 2020

Massey College Clean Energy Roundtable | March 2018

UofT-CIFAR Machine Learning Seminar Series | August 2017

University of Toronto Connaught Industry Alliance Symposium | October 2016

98th Canadian Chemistry Conference and Exhibition | June 2015

Thousand Islands Energy Research Forum (TIERF) | October 2014

International Congress on Physical Organic Chemistry 22 (ICPOC22) | August 2014