Dr. S. Julio Friedmann

Leadership in global strategy and vision in clean-energy technology RD&D and analysis.
Accomplishment and strong management in government, academia, and industry.
Partnership in the research, industrial, financial, and policy communities in the U.S.
International leadership in clean energy & climate (specialty in China, Australia & Middle East).

MAJOR PROFESSIONAL EXPERIENCE

Senior Scientist & Head Carbon Wrangler, (2022-pres) **Carbon Direct**

New company dedicated to creating new CO_2 removal projects and companies while providing CO2 removal services to public and private customers. https://carbon-direct.com

Senior Research Scholar (2018-2021) **Center for Global Energy Policy, Columbia Univ.**

Leading a new team and new effort, the Carbon Management Research Initiative (CaMRI), focused on creating new knowledge, scholarship, ideas, and partnerships around CCS, CO_2 use, and CO_2 removal as a climate and energy solution. Grew from 1 person to 16 people and from zero budget to $6M budget in three years. https://energypolicy.columbia.edu/our-work/topics/carbon-management-research-initiative

CEO and President, (2017-pres) **Carbon Wrangler, LLC**

New company dedicated to helping others achieve deep decarbonization through application of advanced technology, practice, and project execution.

Distinguished Associate (2017-2020) **Energy Futures Initiative**

Providing new scholarship and insight on large-scale carbon management and deep-decarbonization: https://energyfuturesinitiative.org

Senior Advisor for Energy Innovation (2016-2017) **Lawrence Livermore Natl. Laboratory**

New position in Lab Director's Office: to develop and execute strategy around LLNL's entire clean energy and environment enterprise

Principal Deputy Asst. Secretary (2014-2016) **Office of Fossil Energy (FE), U.S. DOE**

Planned, budgeted and executed ~$630M fossil energy R&D program: grew budget >$150M in 3 years.
Managed team of >130 technical and administrative staff, including the Strategic Petroleum Reserve.
Provided direction and oversight to National Energy Technology Lab (~500 staff; $1B budget).
Liaised with White House, Congress, and other federal agencies on RD&D and energy issues, including policy support and development for science, technology, and finance of clean energy and climate.
Led successful efforts to kick-start large-scale CCUS efforts in the US, China, and other countries.
Expert on China energy system, companies, policy, and government functions.
Served on executive committee and support RD&D across the >$6 billion Office of Science and Energy, including cross-cutting effort on energy-water, subsurface science, and advanced materials.
Advised the Secretary and Deputy Secretary of Energy on technology, science, policy and international affairs related to clean energy technology, energy infrastructure, and climate change.

Deputy Asst. Secretary for Clean Coal and Carbon Management (2013-2014)**, U.S. DOE**

Planned and executed ~$400M energy research program across FE: successfully grew budget >$80M.
Managed team of ~30 technical and administrative staff, including budget process.
Liaised with White House, Congress, and other federal agencies on RD&D and energy issues, including policy support and development for science, technology, and finance of clean energy.
Led successful efforts to develop new RD&D programs, including $130M subsurface science initiative.

Coordinated and partnered with Offices of Energy Efficiency & Renewable Energy and Nuclear Energy.
Served on executive steering committee for the >$6 billion Office of Science and Energy.

Chief Energy Technologist (2011-2013) **Lawrence Livermore Natl. Lab**, Livermore, CA

Coordinated and managed the ~$60M energy research program across LLNL.
Served as primary business, governmental, and media interface on energy issues.
Co-Led a successful $150M initiative in smart grid tech. development and deployment with CA utilities.
Helping lead new programs in shale gas, renewable integration, and advanced computing for energy.

Director, Carbon Management Program (2003 – 2011) **LLNL,** Livermore, CA

Built a >$15 million dollar research program in 5 years.
Engaged LLNL in five commercial CCS projects (Weyburn, In Salah, Snohvit, Shenhua, Cranfield)
Managed research staff of >40 investigators
Technical Leader, US-China Clean Energy Research Center (CERC) for Coal and CCUS

Assistant Research Scientist (2001-2004) **University of Maryland**, College Park
Award: Best Lecturer, 2003
Sr. Research Geol. (1998-2000) **ExxonMobil Upstream Research Co.**, Houston
Research Geologist (1996-1998) **Exxon Production Research Co.**, Houston

Research Experience:
Carbon Capture and Storage (CCS),
CO2 removal (CDR), including Direct Air Capture (DAC) and Bioenergy w/ CCS (BECCS)
Carbon-to-value (CO2 recycling and use)
Hydrogen production & use
Industrial energy and decarbonization
Advanced power cycles and energy conversion
Shale gas and tight hydrocarbon science, technology development and practice
Smart grid design, planning and operations, including renewable integration
Chinese energy systems, conversion, and networks
Geology and geophysics (emphasis on stratigraphy and geomechanics)

Oil and Natural Gas Exploration/Production Experience: Venezuela, Nigeria (Deepwater), Gulf of Mexico, North Sea (U.K. & Norway), Congo Basin, Angola/S.Angola (Deepwater)

Other relevant experience:
Co-director, US-China Clean Energy Research Center (Adv. Coal Technology Consortium)
Short course development and direction: Shale Gas exploration, production, and technology

EDUCATION

Ph.D. **Univ. of Southern California** (1995)
Dissertation: *Shadow Valley basin, eastern Mojave Desert, California: Structural and stratigraphic evolution of a supradetachment basin &its implications for extensional tectonics*

M.S. **Massachusetts Institute of Technology** (1990)
B.S. **Massachusetts Institute of Technology** (1988)

AWARDS

Greenman Award (IEA): Significant contributions for CO_2 removal, storage, and utilization (2016)

CONGRESSIONAL TESTIMONY

Congressional testimony, Senate Energy and Natural Resources (full committee), July 2020
Congressional testimony, House Energy and Commerce Committee (full committee), Sept. 2019
Congressional testimony, Senate Energy and Natural Resources (full committee), May. 2019
Congressional testimony, Senate Committee on Environment & Public Works, March. 2018
Congressional testimony, Senate Committee on Environment & Public Works, Nov. 2017
Congressional testimony, House Committee on Appropriations, oversight sub-committee, Feb. 2014

BOARDS, COMMERCIAL TECHNICAL ADVISORY (subset, 2007-2021)

Advisory Board, 8 Rivers, 2018-2021
Distinguished Associate: Energy Futures Initiative, 2017-2021
Senior Fellow, Breakthrough Institute, 2018-2020
Senior Advisor, Global CCS Institute, 2016-2020
Advisory Board for CCS, Total SA, 2016-2018
Minorities in Energy (Champion): 2014-16
Co-director, US-China Clean Energy Research Center, Adv. Coal Tech. Consortium, 2010-2013

PUBLICATIONS (2005-2021 ONLY)

Co-author, 2021, Carbon Mineralization Roadmap, Innovation for a Cool Earth Forum, Dec. 2021, https://www.icef-forum.org/roadmap/

Joppa, L., Leurs A., Willmott E., **Friedmann** S.J., Hamburg S., Broze R, Microsoft's carbon dioxide removal program – lessons for getting to net-zero, Nature, v.597, Issue 7878 https://www.nature.com/articles/d41586-021-02606-3

Friedmann, S.F. & Mills R., 2021, The UAE's Role in the Global Hydrogen Economy, Qamar Energy Report, https://www.qamarenergy.com/sites/default/files/The%20UAE%27s%20Role%20in%20the%20Global%20Hydrogen%20Economy.pdf

Fan, Z., Ochu, E.R., Braverman S., Lou Y., Smith, G., Bhardwaj A.A., Brouwer J., McCormick, C.M., **Friedmann**, S.J., 2021, Green hydrogen in a circular carbon economy: opportunities and limits, Center on Global Energy Policy report, https://www.energypolicy.columbia.edu/sites/default/files/file-uploads/GreenHydrogen_CGEP_Report_082521-8.pdf

Friedmann, S.J., Agrawal, M., Bhardwaj, 2021, Evaluating Net-Zero Hubs in the United States: A Case Study in Houston, Center on Global Energy Policy report, https://www.energypolicy.columbia.edu/research/report/evaluating-net-zero-industrial-hubs-united-states-case-study-houston

Bhardwaj, A.A., McCormick, C., **Friedmann**, S.J., 2021, Opportunities and limits of CO_2 recycling in a circular carbon economy: techno-economics, critical infrastructure needs, and policy priorities, Center on Global Energy Policy report: https://www.energypolicy.columbia.edu/research/report/opportunities-and-limits-co2-recycling-circular-carbon-economy-techno-economics-critical

Fan, Z., and **Friedmann**, S.J., 2021, Low-Carbo**n** Production of Iron & Steel: Technology Options, Economic Assessment, and Policy, Joule, 5, 1-31, April, https://doi.org/10.1016/j.joule.2021.02.018

Co-lead, Biomass Carbon Removal and Storage Roadmap, Innovation for a Cool Earth Forum, Dec. 2020, https://www.icef-forum.org/roadmap/

Friedmann, S.J., Fan, Z., Ochu, E.R., Byrum, Z.S., Bhardwaj, A.A., Sheerazi, H.A., 2020, Levelized Cost of Carbon Abatement: An improved cost-estimation methodology for a net-zero emissions world,

Center on Global Energy Policy Report: https://www.energypolicy.columbia.edu/research/report/levelized-cost-carbon-abatement-improved-cost-assessment-methodology-net-zero-emissions-world

Friedmann, S.J., Zapantis, A., Page, B., Consoli, C., Fan, Z., Havercroft, I., Liu, H., Ochu, E.R., Raji N., Rassool, D., Sheerazi, H.A., Townsend, A. 2020, Net-zero and Geospheric Return: Actions today for 2030 and beyond, Center on Global Energy Policy Report: https://www.energypolicy.columbia.edu/research/report/net-zero-and-geospheric-return-actions-today-2030-and-beyond

Lott, M. & **Friedmann**, S.J., 2020, Electricity Oversupply: Maximizing zero-carbon power to accelerate the transition from fossil fuels, Center on Global Energy Policy Commentary: https://www.energypolicy.columbia.edu/research/commentary/electricity-oversupply-maximizing-zero-carbon-power-accelerate-transition-fossil-fuels-0

Sivaram, V., Hart, D., Cunliff, C., **Friedmann**, S.J. & Sandalow, D., 2020, Energizing America: *A Roadmap to Launch a National Energy Innovation*, Center on Global Energy Policy Report: 120 p. https://www.energypolicy.columbia.edu/energizing-america

Friedmann, S.J., 2020, Congressional Testimony & Technical Addendum, Senate Energy and Natural Resources Committee, Hearing on Carbon Management and Removal, https://www.energy.senate.gov/public/index.cfm/hearings-and-business-meetings?Id=F27BA80E-72A0-4A59-82A8-33C6E2E72C89&Statement_id=A2EBA029-011E-4C6F-867F-DF85BD033E88

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Co-lead, Industrial Heat Decarbonization Roadmap, Innovation for a Cool Earth Forum, Dec. 2019, https://www.icef-forum.org/roadmap/

Friedmann, S.J., Fan Z., Tang K. 2019, Low-Carbon Heat Solutions for Heavy Industry: Sources, Options, and Costs Today, Center for Global Energy Policy Report: 100 p. https://energypolicy.columbia.edu/research/report/low-carbon-heat-solutions-heavy-industry-sources-options-and-costs-today

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Lead Author, Advancing Large-Scale Carbon Management: Expansion of the 45Q Tax Credit, Policy Paper, Energy Future Initiative, May 2018, https://static1.squarespace.com/static/58ec123cb3db2bd94e057628/t/5b0604f30e2e7287abb8f3c1/1527121150675/45Q_EFI_5.23.18.pdf

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Friedmann, SJ, 2018, Congressional Testimony, Senate Environment & Public Works Committee The USE IT Act and CCUS Deployment https://www.epw.senate.gov/public/_cache/files/6/8/68543b44-27ad-4a98-b03b-0101e9c66543/B5CEB3DDBCD44E586388A553B4C2918B.04.11.2018-friedman-testimony.pdf

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Co-Chair, Chapter 7 (Carbon removal), UN Environmental Program Emissions Gap Report, Nov. 2017 https://wedocs.unep.org/bitstream/handle/20.500.11822/22070/EGR_2017.pdf

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Five solicited postings for the Atlantic Monthly: James Fallows sabbatical replacement:

Why we need a quadrennial energy review: http://www.theatlantic.com/technology/archive/2011/04/why-we-need-a-quadrennial-energy-review/73371/

Saving the planet – just like cleaning our room: April 2, 2011: http://www.theatlantic.com/technology/archive/2011/04/saving-the-planet-just-like-cleaning-our-room/73369/

A way to think about converting energy units: April 1, 2011: http://www.theatlantic.com/technology/archive/2011/04/a-way-to-think-about-converting-units-of-measurement/73324/

Green China Rising: March 31, 2011 http://www.theatlantic.com/technology/archive/2011/03/green-china-rising/73263/

Why it's hard to talk about energy: March 29, 2011. http://www.theatlantic.com/technology/archive/2011/03/why-its-hard-to-talk-about-energy/73147/

Simon AJ, Kaahaaina NB, **Friedmann** SJ, Aines RD, 2010, Systems analysis and cost estimates for large-scale capture of carbon dioxide from air, *Energy Procedia*,

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Buscheck TA, Sun Y, Hao Y, Aines RD, Wolery TJ, Tompson AFB, Jones ED, **Friedmann** SJ, 2010, Combining brine extraction, desalination, and residual-brine injection with CO2 storage in saline formations: implications for pressure management, capacity, and risk management, *Energy Procedia*,

Morris JP, Detwiler RL, **Friedmann** SJ, Vorobiev OY, Hao Y, 2010 The large-scale effects of multiple CO_2 injection sites on caprock and formation stability, *Intl. J. of Greenhouse Gas Control*,

Esposito RA, Monroe LS, **Friedmann** SJ, 2010, Deployment Models for Commercialized Carbon Capture and Storage, *Environmental Science and Technology*, v.44

Newmark, RA, **Friedmann**, SJ, Carroll, SJ, 2010, Water Challenges for Carbon Capture and Sequestration*, Environmental Mana*gement, DOI 10.1007/s00267-010-9434-1.

Friedmann, SJ 2009, Accelerating Development of Underground Coal Gasification: Priorities and Challenges for U.S. Research and Development, *in*, Coal Without Carbon, Clean Air Task Force, www.coaltransition.org, pp 1-16.

Friedmann, SJ and Newmark, RA, 2009, Commercial Deployment of Geologic Carbon Sequestration: Technical Components of an Accelerated U.S. Program, *in*, Coal Without Carbon, Clean Air Task Force, www.coaltransition.org, pp 59-76.

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Aines RD, Leach MJ, Weisgraber TH, Simpson MD **Friedmann** SJ, Bruton CJ, 2008 Quantifying the potential exposure hazard due to energetic releases of CO2 from failed sequestration wells, 9th Greenhouse Gas Technology Conference, Washington, DC

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Forbes SM, Verma P, **Friedmann** SJ, Curry TE, Wade SM, Venezia J, 2008, WRI CCS Guidelines and Emerging Geologic Sequestration Regulations: A Comparative Assessment International Energy Agency's Greenhouse Gas Control Technology Conference no. 9, Washington, DC, Nov. 2008

Morris JP, Johnson SM, **Friedmann** SJ, 2008, Geomechanical Simulations of Caprock Integrity using the Livermore Distinct Element Method, 7th Annual NETL conference on Carbon Capture and Sequestration, Pittsburgh, PA ExchangeMonitor

Ramirez A, **Friedmann** SJ, 2008, Joint reconstruction of CO_2 plumes using disparate data, 7th Annual NETL conference on Carbon Capture and Sequestration, Pittsburgh, PA ExchangeMonitor

Burton, E, **Friedmann**, SJ, Upadhye, R, 2006, Best Practices in Underground Coal Gasification (draft), Lawrence Livermore National Laboratory Report UCRL-TR-225331-DRAFT, 119 p.

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Friedmann, S.J., 2007, Testimony for the Senate Commerce Committee, Science, Technology and Innovation Sub-committee Hearing: "Technical feasibility of rapid deployment of geological carbon sequestration", Nov. 16, 2007

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Friedmann, S.J., 2007, Testimony for the House Energy and Commerce Committee, Energy and Air Quality Sub-committee Hearing: "Carbon Capture and Sequestration: An Overview", March 6, 2007

Friedmann, SJ, 2007, Geological Carbon Dioxide Sequestration, *Elements*, v.3, 179-184

Wilson EJ, **Friedmann** SJ, Pollak MF, 2007, Research for Deployment: Incorporating Risk, Regulation and Liability for Carbon Capture and Sequestration, Environment and Science Policy, v.41, 5945-5952

Gee, MJR, Gawthorpe, RL, Bakke, K, **Friedmann**, SJ, 2007, Seismic Geomorphology and evolution of submarine channels from the Angolan Continental Margin, *J. Sedimentary Research*,

Chiaramonte, L., Zoback, M., **Friedmann**, SJ, Stamp, V., 2007, Seal integrity and feasibility of CO2 sequestration in the Teapot Dome EOR pilot: geomechanical site characterization, *Environmental Geoscience*, v.53

Friedmann, SJ 2007, Operational protocols for geologic carbon storage: Facility life-cycle and the new hazard characterization approach, 6th Annual NETL conference on Carbon Capture and Sequestration, Pittsburgh, PA ExchangeMonitor, Oral 034

Burton, E., **Friedmann**, SJ, Wagoner J, 2007, Application of Site Assessment Methodology for Geologic Storage of CO_2: A Case Study of the Southern San Joaquin Valley, California, 6th Annual NETL conference on Carbon Capture and Sequestration, Pittsburgh, PA ExchangeMonitor, Poster

Friedmann, S.J., 2006, Testimony for the CA Assembly Legislature Utilities and Commerce Committee, Lawrence Livermore National Laboratory Report, UCRL-TR-220473, 7 p.

Friedmann, S.J., 2006, "Big Iron" Linux clusters driving step changes in interpretation, simulation, American Oil and Gas Reporter, v49, p. 80-84

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Homer-Dixon, T., and **Friedmann**, S.J., 2005, Coal in a Nice Shade of Green, New York Times, Op-ed piece, March 25

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