

CURRICULUM VITAE FOR ROBERT H. WILLIAMS

Education

Yale University, New Haven. Physics, BS, 1962.

University of California, Berkeley, Theoretical Physics, PhD, 1967.

Professional Positions

2015-Present: **Senior Research Scientist**, Andlinger Center for Energy and the Environment, Princeton University, Princeton, New Jersey.

1999-2015: **Senior Research Scientist and Associated Faculty**, Princeton Environmental Institute, Princeton University, Princeton, New Jersey.

1978-1999: **Senior Research Scientist**, Center for Energy and Environmental Studies, Princeton University.

1975-1978: **Research Scientist**, Center for Energy and Environmental Studies, Princeton University

1974-1975: **Director of Research**, Institute for Public Policy Alternatives, SUNY, Albany.

1972-1974: **Senior Scientist**, Ford Foundation's Energy Policy Project, Washington, DC

1970-1972, **Assistant Professor**, Physics, University of Michigan, Ann Arbor

1969-1970, **Research Staff Member**, Environmental Science Services Administration, Boulder, CO

1967-1969, **Post-Doctoral Fellow**, Environmental Science Services Administration, Boulder, CO

Bio-Sketch

Robert H. Williams is a Senior Research Scientist at the Andlinger Center for Energy and the Environment (ACEE), Princeton University, where he heads the Energy Systems Analysis Group (ESAG). Under the BP-supported University-Wide Carbon Mitigation Initiative (CMI), he leads the Carbon Capture Group.

Trained as a physicist, Williams joined the Physics Department, U. of Michigan, Ann Arbor, in 1970, where he shifted his research from basic physics to energy and environmental analysis. In 1972 he became Chief Scientist with the Ford Foundation's Energy Policy Project, where he was responsible for environmental and energy efficiency research. He joined Princeton University's Center for Energy and Environmental Studies in the fall of 1975, the Princeton Environmental Institute in 2001, and ACEE in 2015.

His energy systems research has included energy end-use efficiency, industrial cogeneration, renewable energy (especially biomass, wind, photovoltaic), nuclear energy (especially proliferation issues), synthetic fuels and systems that coproduce electricity and synthetic fuels in a carbon-constrained world, CO₂ capture and storage, fossil-renewable energy synergisms (especially coal/biomass with CO₂ capture and storage and wind/natural gas), energy in developing countries (especially energy in China), and energy policy (especially energy technological innovation policy).

Advisory and Related Activities

During 2014 Williams was one of thirty climate scientists and energy experts who co-authored a study led by Sir Robert Watson (former Chairman of the Intergovernmental Panel on Climate

Change) on early actions for carbon mitigation. This study (*Tackling the Challenge of Climate Change: A Near Term Actionable Mitigation Agenda*) was commissioned by the Republic of Nauru [former chair of the Alliance of Small Island States (AOSIS)] and presented to the UN Secretary General Ban Ki-Moon at the Secretary General's September 2014 UN Climate Summit in New York. In support of this report, Williams also co-authored a paper (**Toward Getting the Global CCS Enterprise Back on Track**) with Prof. Zheng Li of Tsinghua University pointing out the importance of a strategic partnership between the US and China for CO₂ capture and storage (CCS) market launch—exploiting simultaneously the US opportunity to launch promising CO₂ capture technologies in conjunction with CO₂ storage via enhanced oil recovery (CO₂ EOR) and the opportunity in China to gain early experience with CO₂ storage in deep saline formations by capturing at very low cost some of the streams of essentially pure CO₂ vented from hundreds of coal-based chemical and synfuel plants.

During 2014 a major activity for Williams was the crafting of a Public Comment (PC) on the US Environmental Protection Agency's proposed regulations on CO₂ emissions from existing power plants—a Public Comment (which Williams filed on 1 December 2014) suggesting an amendment to the EPA's proposed regulation that could possibly transform that regulation into a powerful enabler for market launch of promising CO₂ capture and storage technologies by allowing coal-dependent regions of the US to meet their obligations under the proposed regulation by enacting a Regional CO₂ Enhanced Oil Recovery Portfolio Standard (RCEPS).

In 2014 Williams became a member of the Technical Advisory Board of NICE, the National Institute of Clean and Low Carbon Energy—a Chinese institute in Beijing fully financed by the Shenhua Corporation—the world's largest coal company.

Williams has been a catalyzer of a possible new industry-led, government-assisted, action-oriented initiative to advance low-carbon energy from coal as a new dimension for the ongoing China/US collaboration on clean coal technology. Specifically, during 2013 Williams urged officials at the Shenhua Corporation and at Southern Company (a large investor owned electricity utility in the Southeastern United States) to consider collaborating in advanced low carbon energy from coal; the companies have signed a Memorandum and are currently exploring this possibility.

During 2013 and 2014 Williams was an advisor for the World Coal Association's new Strategic Research Institute and new *Cornerstone* magazine (on strategic coal issues) created by the then WCA Chairman Xiwu Zhang (Chairman of the Board of the Shenhua Corporation, China).

Williams was convening lead author of Chapter 6 (**Linking CO₂ from synfuel and coproduction plants to CO₂ EOR opportunities**) and a lead author of Chapter 3 (**Carbon capture in coal power generation and coal-based alternative fuels production systems**) of the 2012 report of National Coal Council report *Harnessing Coal's Carbon Content to Advance the Economy, Environment, and Energy Security*, prepared for US Department of Energy Secretary Steve Chu in response to his request for a report on CO₂ capture and storage for coal energy conversion technologies, with CO₂ storage via CO₂ enhanced oil recovery.

A lead author for Chapter 12 on **Fossil energy systems** for the *Global Energy Assessment: Toward A Sustainable Future* published by Cambridge University Press in 2012. Coordinated by the International Institute for Applied Systems Analysis (IIASA) with support from government and non-governmental organizations, the United Nations System, and the private sector, the GEA is a fully integrated energy assessment analyzing energy challenges, opportunities, and strategies for developing, industrialized and emerging economies.

An Advisory Board member for Climate Works Australia for the preparation of its Low Carbon Growth Plan report (2009-2010).

A Technical Advisor (2007-2008) to the National Energy Technology Laboratory for its Coal/Biomass to Liquids study.

Member (2007), Working Group on Coal to Liquids of the Transportation Fuels Initiative of the Western Governors Association (WGA), and coauthor of Coal-to-Liquids Report to the WGA.

Advisor (2006) to the International Energy Agency in the preparation of a chapter of *World Energy Outlook 2006* on the need to bring about a shift from biomass and coal to clean fluid fuels for cooking.

Lead Author for the IPCC *Special Report on CO₂ Capture and Storage* of the Intergovernmental Panel on Climate Change (IPCC), December 2005.

Member (1998-2004), Editorial Board of the *World Energy Assessment* (WEA) and Convening Lead Author of the Advanced Energy Supply Technologies Chapter (Chapter 8 of the WEA). The WEA was a joint project of the UN Development Programme, the UN Department of Economic and Social Affairs, and the World Energy Council. The WEA was initiated in response to the outcome of the Special Session of the UN General Assembly in 1997 ("Rio Plus Five" meeting) that reviewed progress in addressing the Agenda 21 goals established at the 1992 UN Conference on Environment and Development in Rio de Janeiro. The book *Energy and the Challenge of Sustainability—The World Energy Assessment* (2000) was prepared to inform discussion and debate about sustainable energy as an input to both CSD-9 and the "Rio Plus Ten" meeting of the UN General Assembly in 2002.

International Member (1993-2003), Working Group on Energy Strategies and Technologies (WGEST) for Phases I and II of the China Council for International Cooperation on Environment and Development (CCICED). For Phase III of the CCICED (begun in 2002), working groups were replaced by task forces, and Williams was an international member of the Task Force on Energy Strategies and Technologies (TFEST), which for the period through 2003 focused on policies for advancing polygeneration (co-production of synthetic fuels, chemicals, and electricity from coal via gasification) in China.

Member (1992-2008), Board of Directors, International Energy Initiative (IEI).

Member, Energy R&D Panel of the President's Committee of Advisors on Science and Technology (PCAST, 1997) and Chair of the Panel's Renewable Energy Task Force.

Member, PCAST Panel on International Cooperation in Energy Research, Development, Demonstration, and Deployment (1999) and Chair of the Panel's Energy Supply Task Force.

Member (1995-1998), Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF) and Chair of the STAP Climate and Energy Working Group.

Lead Author (1994-1995), IPCC Working Group IIa (Energy Supply Mitigation Options) for the IPCC's Second Assessment Report.

Honors

Fellow of the American Physical Society (APS).

Leo Szilard Award for Physics in the Public Interest (1988). Awarded by the Council of the American Physical Society for "applying physics to end-use energy efficiency and educating physicists, members of Congress, and the general public on energy conservation issues."

Sadi Carnot Award (1991). Awarded by the US Department of Energy for work related to energy efficiency.

MacArthur Foundation Prize (1993).

Joan Hodges Queneau Palladium Medal (1995). Awarded by the National Audubon Society and the American Association of Engineering Societies for innovative engineering solutions to environmental problems.

Volvo Environment Prize (2000); shared with Jose Goldemberg (Brazil), Thomas Johansson (Sweden), and Amulya Reddy (India).

Selected Publications

Peer-Reviewed Journal Articles

Williams, R.H. (1978). **Industrial cogeneration**, *Annual Review of Energy*, **2**: 313-356.

Feiveson, H.A., F. von Hippel, and R.H. Williams (1979). **Fission power: an evolutionary strategy**, *Science*, **203**: 330-337, 26 January.

Williams, R.H. (1985). **Potential roles for bioenergy in an energy-efficient world**, *Ambio*, **14** (4-5): 201-209.

Goldemberg, J., T.B. Johansson, A.K.N. Reddy, and R.H. Williams (1985). **Basic needs and much more with 1 kilowatt per capita**, *Ambio*, **14** (4-5): 190-200.

Goldemberg, J., T.B. Johansson, A.K.N. Reddy, and R.H. Williams (1985). **An end-use oriented global energy strategy**, *Annual Review of Energy*, **10**: 613-688.

Larson, E.D., M.H. Ross, and R.H. Williams (1986). **Beyond the era of materials**, *Scientific American*, **254** (6): 34-41, June.

Williams, R.H., E.D. Larson, and M.H. Ross (1987). **Materials, affluence, and industrial energy use**, *Annual Review of Energy*, **12**: 99-144.

Larson, E.D., and R.H. Williams (1987). **Steam-injected gas turbines**, *Journal of Engineering for Gas Turbines and Power, Transactions of the ASME*, **109** (1): 55-63, January.

Larson, E.D., and R.H. Williams (1990). **Biomass gasifier steam-injected gas turbine cogeneration**, *Journal of Engineering for Gas Turbines and Power*, **112**: 157-163, April.

Larson, E.D., J.M. Ogden, R.H. Williams, and M. Hylton (1990). **Biomass-fired steam-injected gas turbine cogeneration for the cane sugar industry**, *International Sugar Journal*, **92** (1095): 49-66, March/April.

Williams, R.H., and H.A. Feiveson (1990). **Diversion-resistance criteria for future nuclear power**, *Energy Policy*, **18** (6): 543-549, July/August.

Ogden, J.M., and R.H. Williams (1990). **Electrolytic hydrogen from thin-film solar cells**, *International Journal of Hydrogen Energy*, **15** (3): 155-169.

Weinberg, C.J., and R.H. Williams (1990). **Energy from the sun**, *Scientific American*, **263** (3): 147-155, September.

Hall, D.O., H.E. Mynick, and R.H. Williams (1991). **Cooling the greenhouse with biomass energy**, *Nature*, **353**: 11-12, September.

Williams, R.H. (1992). **The potential for reducing CO₂ emissions with new energy technology: an illustrative scenario for the power sector in China**, *Science and Global Security*, **3**: 1-42.

Williams, R.H., E.D. Larson, R.E. Katofsky, and J. Chen (1995). **Methanol and hydrogen from biomass for transportation**, *Energy for Sustainable Development: The Journal of the International Energy Initiative*, **I** (5): 18-34, January.

Johansson, T.B., R.H. Williams, J.A. Edmonds, H. Ishitani (1996). **Options for reducing CO₂ emissions from the energy supply sector**, *Energy Policy*, **24** (10/11): 985-1003.

Williams, R.H., and E.D. Larson (1996). **Biomass gasifier gas turbine power generating technology**, *Biomass and Bioenergy*, **10** (2-3): 149-166.

Blok, K., R.H. Williams, R.E. Katofsky, and C.A. Hendriks (1997). **Hydrogen production from natural gas, sequestration of recovered CO₂ in depleted gas wells, and enhanced natural gas recovery**, *Energy: the International Journal*, **22** (2/3): 161-168.

Lew, D., R.H. Williams, S. Xie, and S. Zhang (1998). **Large-scale baseload wind power in China**, *Natural Resources Forum*, **22** (3): 165-18.

Williams, R.H. (1998). **A technological strategy for making fossil fuels environment- and climate-friendly**, *World Energy Council Journal*, pp. 59-67, July.

Steinbugler, M.M., and R.H. Williams (1998). **Beyond combustion: fuel cell cars for the 21st century**, *Forum for Applied Research and Public Policy*, **13** (4), pp. 102-107, Winter.

Kartha, S., T.G. Kreutz, and R.H. Williams (2000). **Small-scale biomass fuel cell/gas turbine power systems for rural areas**, *Energy for Sustainable Development*, **4** (1): 85-89, June.

Henderick, P., and R.H. Williams (2000). **Trigeneration in a northern Chinese village using crop residues**, *Energy for Sustainable Development*, **4** (3): 13-29, October.

Payne, A., R. Duke, and R.H. Williams (2001). **Accelerating residential PV expansion: supply analysis for competitive electricity markets**, *Energy Policy*, **29**: 787-800.

Larson, E.D., R.H. Williams, and Leal, M. Regis L.V. Leal (2001). **A review of biomass integrated-gasifier/gas turbine combined cycle technology and its application in sugarcane industries, with an analysis for Cuba**, *Energy for Sustainable Development*, **V** (1): 54-76, March.

Williams, R.H. (2001). **Addressing challenges to sustainable development with innovative energy technologies in a competitive electric industry**, *Energy for Sustainable Development*, **V** (2): 48-73, June.

Williams, R.H. (2001). **Toward zero emissions from coal in China**, *Energy for Sustainable Development*, **V** (4): 39-65, December.

Goldemberg, J., T.B. Johansson, A.K.N. Reddy, and R.H. Williams (2001). **Energy for the New Millennium**, *Ambio*, **30** (6): 330-337, September (Volvo Environment Prize article).

TFEST (Task Force on Energy Strategies and Technologies¹) (2003). **Transforming coal for sustainability: a strategy for China**, *Energy for Sustainable Development*, **VII** (4): 21-30.

Williams, R.H. and E.D. Larson (2003). **A comparison of direct and indirect liquefaction technologies for making fluid fuels from coal**, *Energy for Sustainable Development*, **VII** (4): 89-115.

Ogden, J.M., R.H. Williams, and E. D. Larson (2004). **Societal lifecycle costs of cars with alternative fuels**, *Energy Policy*, **32**: 7-27.

¹ There were 7 Chinese and 5 international members of the TFEST. Profs. Ni Weidou (Chinese Co-Chair) and Li Zheng of Tsinghua University were among the Chinese members; Robert Williams was one of the international members.

Goldemberg, J., T.B. Johansson, A.K.N. Reddy, and R.H. Williams (2004). **A global clean cooking fuel initiative**, *Energy for Sustainable Development*, **VIII** (3): 5-12, September.

Duke, R., R.H. Williams, and A. Payne (2005). **Accelerating residential PV expansion: demand analysis for competitive electricity markets**, *Energy Policy*, **33**: 1912-1929.

Chiesa, P., S. Consonni, T. Kreutz, and R.H. Williams (2005). **Co-production of hydrogen, electricity, and CO₂ from coal with commercially ready technology. Part A: performance and emissions**, *International Journal of Hydrogen Energy*, **30**: 747-767.

Kreutz, T., R.H. Williams, S. Consonni, and P. Chiesa (2005). **Co-production of hydrogen, electricity, and CO₂ from coal with commercially ready technology, Part B: economic Analysis**, *International Journal of Hydrogen Energy*, **30**: 769-784.

de Lorenzo, L., P. Chiesa, T. Kreutz, and R.H. Williams (2005). **Carbon-free hydrogen and electricity from coal: options for syngas cooling in systems using a hydrogen separation membrane reactor**, *Proceedings of ASME Turbo Expo 2005*, Reno, NV, June 6-9, 2005. Selected as a “Best Paper Award” winner by the Coal, Biomass & Alternative Fuels Committee.

Succar, S., J. B. Greenblatt, and R.H. Williams (2006). **Arguing the case for storage**, *Windpower Monthly*, **22** (4): 8-10, April.

Hawkins, D.G., D.A. Lashof, and R.H. Williams (2006). **What to do about coal**, *Scientific American*, **295** (3): 68-75 (special issue: *Energy Future Beyond Carbon*), September.

Greenblatt, J.B., S. Succar, D.C. Denkenberger, R.H. Williams, and R.H. Socolow (2007). **Baseload wind energy: modeling the competition between gas turbines and compressed air energy storage for supplemental generation**, *Energy Policy*, **35** (3): 1474-1492.

K. Meng, R.H. Williams, and M.A. Celia (2007). **Opportunities for low-cost CO₂ storage demonstration projects in China**, *Energy Policy*, **35**: 2368-2378.

Xu, Y., R.H. Williams, and R.H. Socolow (2009). **China's rapid deployment of SO₂ scrubbers**, *Energy and Environmental Science*, **2**: 459-465.

Tilman, D., R. Socolow, J. Foley, J. Hill, E. Larson, L. Lynd, S. Pacala, J. Reilly, T. Searchinger, C. Sommerville, and R.H. Williams (2009). **Beneficial Biofuels – The Food, Energy, and Environment Trilemma**, *Science*, **325**: 270-271.

Larson, E.D., G. Fiorese, G. Liu, R.H. Williams, T.G Kreutz, and S. Consonni (2010). **Co-production of syngas and electricity from coal + biomass with zero net greenhouse gas emissions: an Illinois case study**, *Energy and Environmental Science*, **3**: 28-42. Our article was selected to be featured on the cover of this issue of *Energy and Environmental Science*.

Zheng, Z., E.D. Larson, Z. Li, G. Liu, and R.H. Williams (2010). **Near-term mega-scale CCS demonstrations in China**, *Energy and Environmental Science*, **3** (9): 1153-1169. Our article was selected to be featured on the cover of this issue of *Energy and Environmental Science*.

Williams, R.H., G. Liu, T. G. Kreutz and E. D. Larson (2011). **Biomass and coal to fuels and power**, *Annual Review of Chemical and Biomolecular Engineering*, **2**: 529-33.

Liu, G., E.D. Larson, R.H. Williams, T.G. Kreutz, and X. Guo (2011). **Making Fischer-Tropsch fuels and electricity from coal and biomass: performance and cost analysis**, *Energy and Fuels*, **25** (1): 415-437.

Succar, S., D. Denkenberger, and R.H. Williams. (2012). **Optimization of specific rating for wind turbine arrays coupled to compressed air energy storage**, *Applied Energy*, 222-234.

Liu, G., E.D. Larson, R.H. Williams, and X. Guo (2015). **Gasoline from coal and/or biomass with CO₂ capture and storage, Part A: Process designs and performance analysis**, *Energy and Fuels*, **29** (3): 1830-1844.

Liu, G., E.D. Larson, R.H. Williams, and X. Guo (2015). **Gasoline from coal and/or biomass with CO₂ capture and storage, Part B: Economic analysis and strategic context**, *Energy and Fuels*. **29** (3): 1845-1859.

Other articles, conference presentations, posters, etc.

Williams, R.H., and Li, Z., 2014: "Toward Getting the Global CCS Enterprise Back on Track," a contribution to *Tackling the Challenge of Climate Change: A Near Term Actionable Mitigation Agenda*, commissioned by the Republic of Nauru [former chair of the Alliance of Small Island States (AOSIS)] and presented at the 2014 Climate Summit, New York, NY, U.S; both papers are available at: www.aosis.org

Comments by Dr. Robert H. Williams of Princeton University's Princeton Environmental Institute on *Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units: Proposed Rule*. Federal Register, Vol. 79, No. 117 (June 18, 2014), 40 CFR Part 60, filed at Docket ID No. EPA-HQ-OAR-2013-0602 of the United States Environmental Protection Agency, 1 December 2014.

Williams, R.H., "Dissenting comment," on the report *Fossil Forward: Bringing Scale and Speed to CCS Deployment*, a report prepared by the National Coal Council for the Department of Energy at the request of Secretary Ernie Moniz, 13 February 2015.

Williams, R.H., "CO₂ capture technology cost buydown in EOR applications with alternative financing mechanisms", PPT paper prepared in support of a presentation with the same title at the Fall Annual Meeting of the National Coal Council, Pittsburgh, PA, 5 November 2015.

Williams, R.H., 2015: "Strategic Importance of BioNG/CCS Technology Market Launch in the Marcellus Region," poster presentation at the CMI Annual Meeting, 14-15 April 2015.

Williams, R.H., 2014: “Capture technology cost buydown in CO₂ EOR market applications under a state or regional Alternative Energy Portfolio Standard,” poster presented at GHGT-12, Austin, TX, 6-9 October, 2014.

Williams, 2013: “CO₂ enhanced oil recovery opportunity for early CCS projects,” 7th Sino-US Joint Conference of Chemical Engineering, Beijing, China, 14-18 October 2013.

Williams, R.H., 2013: “Coal/biomass coprocessing strategy to enable a thriving coal industry in a carbon-constrained world,” *Cornerstone*, **1** (1), 51–59. This article can be accessed at <http://cornerstonemag.net/coal-biomas-coprocessing-strategy-to-enable-a-thriving-coal-industry-in-a-carbon-constrained-world/>

Williams, R.H., 2013: “Toward market launch of coal/biomass coproduction technologies with CCS,” *Cornerstone*, **1**: (2): 55-60. This article can be accessed at <http://cornerstonemag.net/toward-market-launch-of-coal-biomas-coproduction-technologies-with-CCS/>

Williams, R.H., 2013: “A first step toward understanding the FOAK to NOAK cost transition for CO₂ EOR-coupled energy conversion systems,” poster presentation at the CMI Annual Meeting, 16 April 2013.

Larson, E.D., G. Liu, Q. Li, R.H. Williams, and R. Wallace, 2013: “Techno-economic analysis of jet fuel and electricity co-production from coal and biomass in the Ohio River Valley of the United States, with capture of CO₂ and storage via enhanced oil recovery,” powerpoint paper, 30th *Pittsburgh Coal Conference*, Beijing, 15-18 September 2013.

Liu, G., E.D. Larson, R.H. Williams, and X. Guo, 2013: “Gasoline from coal and biomass with CCS: performance and cost analysis,” powerpoint paper, 30th *Pittsburgh Coal Conference*, Beijing, 15-18 September 2013.

Books

EPP Staff (including Williams). (1974). *A Time to Choose: America's Energy Future*, the Final Report of the Energy Policy Project (EPP) of the Ford Foundation, Ballinger, Cambridge, October.

Williams, R.H., ed. (1975). *The Energy Conservation Papers*, a collection of special reports of the Energy Policy Project of the Ford Foundation, Ballinger, Cambridge.

Williams, R.H., ed. (1978). *Toward A Solar Civilization*, MIT Press, Cambridge, Mass.

Ross, M.H., and R.H. Williams. (1981). *Our Energy: Regaining Control*, McGraw Hill, January.

Goldemberg, J., T.B. Johansson, A.K.N. Reddy, and R.H. Williams. (1987). *Energy for a Sustainable World*, World Resources Institute, 119 p., September.

Goldemberg, J., T.B. Johansson, A.K.N. Reddy, and R.H. Williams. (1987). *Energy for Development*, World Resources Institute, 73 p., September.

Goldemberg, J., T.B. Johansson, A.K.N. Reddy, and R.H. Williams. (1988). *Energy for a Sustainable World*, Wiley Eastern, New Delhi, 517 pp.

Johansson, T.B., B. Bodlund, and R.H. Williams, eds.(1989). *Electricity: Efficient End-Use and New Generation Technologies, and Their Planning Implications*, Lund University Press, Lund, Sweden, 960 pp.

Ogden, J.M., and R.H. Williams. (1989). *Solar Hydrogen: Moving Beyond Fossil Fuels*, World Resources Institute, Washington, DC.

Johansson, T.B., H. Kelly, A.K.N. Reddy, and R.H. Williams, eds.(1993). *Renewable Energy: Sources for Fuels and Electricity*, Island Press, Wash., DC, 1160 pp.

Reddy, A.K.N., R.H. Williams, T.B. Johansson, *Energy After Rio, Prospects and Challenges*, United Nations Development Program, New York, NY, 1997. 176 pp.

WEA Editorial Board. (2000). Overview: *Energy and the Challenge of Sustainability—the World Energy Assessment*, 28 pp., UN Development Programme, New York. [The Overview of the World Energy Assessment (WEA) is the collective responsibility of the 10 convening lead authors of WEA chapters (of which Williams is one), the Chair, the 5 Vice Chairs, and the 3 representatives of the establishing institutions.]

J. Goldemberg, and T.B. Johansson, eds. (2004). *World Energy Assessment: Overview, 2004 Update* [with contributions from 21 authors, including Williams], United Nations Development Programme, New York, 85 pages. The WEA is a project of the United Nations Department of Economic and Social Affairs, and the World Energy Council.

Robert Watson *et al.* (2014): *Tackling the Challenge of Climate Change: A Near-Term Actionable Mitigation Agenda*, a study commissioned by the Republic of Nauru [former Chair of the Alliance of Small Island States (AOSIS)] and presented at the UN Climate Summit, New York, 23 September 2014. Available at www.aosis.org. R.H. Williams was one of the 31 authors of this report. [Sir Robert Watson is a physical chemist specializing in atmospheric chemistry. He chaired the IPCC 1997-2002. He became Chief Scientific Adviser to the Department for Environment, Food and Rural Affairs for the UK government in 2007. Earlier he was a science policy adviser to President Bill Clinton and for the World Bank.]

Chapters in Books

Johansson, T.B., H. Kelly, A.K.N. Reddy, and R.H. Williams (1993). **Renewable fuels and electricity for a growing world economy**, pp. 1-72, in *Renewable Energy: Sources for Fuels and Electricity*.

Williams, R.H., and E.D. Larson (1993). **Advanced gasification-based biomass power generation**, pp. 729-785, in *Renewable Energy: Sources for Fuels and Electricity*.

Hall, D.O., F. Rosillo-Calle, R.H. Williams, and J. Woods (1993). **Biomass for energy: supply prospects**, pp. 593-652, in *Renewable Energy: Sources for Fuels & Electricity*.

Johansson, T.B., H. Kelly, A.K.N. Reddy, and R.H. Williams (1993). A renewables-intensive global energy scenario, pp. 1071-1142, in *Renewable Energy: Sources for Fuels and Electricity*.

Williams, R.H. (1994). **Roles for biomass energy in sustainable development**, pp. 199-225, in *Industrial Ecology and Global Change*, R.H. Socolow et al. (eds.), Cambridge University Press, Cambridge.

Williams, R.H. (+ other lead authors) (1996). Chapter 19: **Energy supply mitigation options**, pp. 588-647, in *Climate Change 1995 - Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses*, R.T. Watson, M.C. Zinyowera, R.H. Moss, eds., Second Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, 879 pp.

Williams, R.H. (1998). Fuel decarbonization for fuel cell applications and sequestration of the separated CO₂, pp. 180-222, in *Eco-restructuring: Implications for Sustainable Development*, Ayres (ed.), United Nations University Press, Tokyo.

Williams, R.H., and B. Wells (1998). Solar-assisted hydrogen production from natural gas with low CO₂ emissions, pp. 503-512, in *Greenhouse Gas Mitigation: Technologies for Activities Implemented Jointly: Proceedings of the International Conference on Activities Implemented Jointly, May 26-29, 1997, Vancouver, British Columbia*, P.W.F. Riemer, A.J. Smith, and K.V. Thambimuthu (eds.).

Williams, R.H. (1999). **Hydrogen production from coal and coal bed methane, using byproduct CO₂ for enhanced methane recovery and sequestering the CO₂ in the coal bed**, pp. 799-804, in *Proceedings of the 4th International Conference on GHG Control Technologies, Interlaken, Switzerland, August 30 – September 2, 1998*, B. Eliasson, P. Riemer, and A. Wokaun (eds.), Pergamon, Amsterdam, 1205 p.

Williams, R.H. (1999). **Toward zero emissions for coal: roles for inorganic membranes**, *Proceedings of the International Symposium Toward Zero Emissions: the Challenge for Hydrocarbons*, Palazzo Colonna, Rome, Italy, March 11-13, 1999.

Williams, R.H. (Convening Lead Author). (2000). **Advanced energy supply technologies**, Chapter 8, pp. 274 to 329, in *Energy and the Challenge of Sustainability—the World Energy Assessment World Energy Assessment*, 508 pages, UN Development Programme, New York.

Goldemberg, J. (Convening Lead Author), and A.K.N. Reddy, K. Smith, and R.H. Williams (Lead Authors). (2000). **Rural energy for developing countries**, Chapter 10, pp. 369 to 389, in *Energy and the Challenge of Sustainability—the World Energy Assessment*, 508 pages, UN Development Programme, New York.

Williams, R.H. (2002). **Nuclear and alternative energy supply options for an environmentally constrained world: a long-term perspective**, Chapter 6, pp. 85-122, in *Nuclear Power and the Spread of Nuclear Weapons: Can We Have One Without the Other?*, P. Leventhal, S. Tanzer, and S. Dolley, eds., Brassey's, Washington, DC, 340 pp.

Kreutz, T.G., R.H. Williams, R.H. Socolow, P. Chiesa, G. Lozza (2002). **Production of hydrogen and electricity from coal with CO₂ capture**, in *Proceeding of the 6th International Conference on Greenhouse Gas Control Technologies (GHGT-6)*, Kyoto Japan. 30 September - 4 October.

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