

**Collected testimonials and well-wishes for
Robert H. Williams
upon his retirement from Princeton University**

updated as of 4 April 2017

Additional contributions to this collection are welcome and will be included in future updates of this document.

Please email all contributions by **1 May 2017** to Eric Larson
(elarson@princeton.edu)

The collection as of 1 May 2017 will be bundled for presentation to Bob.

From: Ross, Marc C. [mailto:mcrec@slac.stanford.edu]
Sent: Sunday, February 12, 2017 4:44 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Re: Bob Williams retiring

Dear Eric,

I am writing to respond to your invitation on behalf of my father, Marc Ross.

My father now lives in Palo Alto and his health is poor. He won't be able to attend, unfortunately. He sends his best wishes to Bob.

Bob and my father had a very close collaborative relationship. Bob meant a great deal to him and I believe their work together was a highlight of his career. Upon his retirement about 10 years ago my father gave a copy of the book he wrote with Bob to each grandchild. This was, for him, the best symbol of his life-long effort.

Marc C. Ross

Stanford University, February 2017

From: MAD [mailto:madelucchi@berkeley.edu]
Sent: Saturday, February 11, 2017 4:11 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Re: Bob Williams is retiring!

Wow, congrats on a long and super distinguished career! Send my best.

And "hi" to you Eric, hope all is well with you.

Best,

Mark Delucchi
Research Scientist
Transportation Sustainability Research Center
Institute of Transportation Studies
U. C. Berkeley
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(510) 356-4822

From: Sally M Benson [mailto:smbenson@stanford.edu]
Sent: Sunday, February 12, 2017 11:36 PM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Re: Bob Williams is retiring

Hi Sarah,

I wanted to provide some remarks for Bob's retirement party.

Dear Bob,

I learned so much from you about energy systems analysis. Your seminal work on hydrogen, CCS, and biomass plus CCS, to name a few. Your thoughtful and compelling analysis that revealed synergies and co-benefits of different technology options was always an eye opener for me. I look forward to keeping in touch and hearing about your latest ideas.

All the best,

Sally

From: Forrest Meggers [mailto:fmeggers@princeton.edu]
Sent: Monday, February 13, 2017 8:49 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>; Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: Re: Bob Williams is retiring

Hi Sarah,

My quote for Bob is: "Bob is truly an energy sage - an encyclopedia of knowledge, and someone with generous advice and wisdom who was always willing to steer me in the right directions, no matter how many times I kept going off course. He will be missed!"

Forrest Meggers - Assistant Professor - Director of [CHAOS](#)

Princeton University School of Architecture & Andlinger Center for Energy + the Environment
physical: S03 Architecture Building or 215 Andlinger Building, 609-258-7831
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virtual: <http://soa.princeton.edu/#397>, Skype: forrestmeggers

From: Dismukes, Gerard [mailto:dismukes@chem.rutgers.edu]
Sent: Saturday, February 18, 2017 3:14 PM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: bob williams

Sarah Jackson (sjacks@princeton.edu)

Sarah,

Eric Larson indicated you are collecting messages for the dedication to be given to Bob Williams. Here is mine.

Bob has been an important influence on my career and I am indebted to him as both a source of invaluable facts and predictive models in the energy sector, but equally important as an inspiration for his devotion to solving problems in the energy sector. The duration of his focus on this topic and impact of his technical work has laid a solid foundation upon which we can make smart decisions for our energy future. Personally, I consider him as one of the individuals who influenced me to spend more of my intellectual energy on the real energy problems of our world. I will forever be grateful for the inspiration that he gave me and personal courage to act on it. We need more Jedis like Bob. Through his teachings, knowledge of how to use the “force” for the good of our planet.

Charles

G. Charles Dismukes
Distinguished Professor
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<https://www.waksman.rutgers.edu/dismukes/home>
dismukes@rutgers.edu

From: Jeffery Greenblatt [mailto:jbgreenblatt@lbl.gov]
Sent: Monday, February 20, 2017 3:37 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Re: Bob Williams is retiring!

Eric,

Please see my written remarks on working with Bob over the years.

Bob was first introduced to me by Rob Socolow, I think, at an early Carbon Mitigation Initiative (CMI) meeting. "This is Bob - you should get to know him!" Perhaps he pushed me toward Bob because of my chemistry training; for a theoretical physicist, Bob had an excellent grasp of the subject. Over the ensuing months, I saw the laser-like intensity of Bob's thinking firsthand, demonstrated by his command of the many chemical transformations necessary to convert fuels into more environmentally benign forms. I saw the intricate AspenPlus chemical engineering models he and others had developed to describe these envisioned plants, and was amazed (and somewhat bewildered) by his depth of knowledge. His understanding of the economics of these systems also became abundantly evident. In addition to his mastery of these disciplines, Bob possessed an understanding of the subtleties of industrial-scale plant operations and how they fit into a larger context.

Bob also displayed a flexibility of thinking that was constantly pushing him "out of the box" of conventional assumptions. This was perhaps best encapsulated by his love of hybrid systems that, for instance, combined coal and biomass feedstocks, or produced hydrogen and electricity as outputs, sometimes with the flexibility to shift between products as market demands changed. These concepts invoked the industrial ecology approach - recycling "waste" from one plant component into useful inputs for another - that was often eclipsed by the more typical atomistic thinking in our disciplines. I still draw upon Bob's style of thinking in my own work.

Bob's interests have spanned many topics in the field of energy over the years, including nuclear power, energy efficiency, carbon sequestration, hydrogen, low-carbon fuels, renewable electricity, and electricity storage. He said he liked to apply himself intensively to a new question or idea that had been overlooked by others, and write the first, usually defining, paper in that discipline. After others had been drawn into the field, he would tend to move onto other interesting topics. In this way, his influence has been felt broadly across many disciplines.

Probably the most transformative moment in my time at Princeton - and perhaps in my career, for it represented a pivotal shift in my professional research direction - was when I walked into Bob's office one day, after months of frustrated reading and thinking about how to solve the climate problem, and asked him why we seemed "stuck" with an inefficient, polluting energy system despite the availability of clean choices like wind power. After a pause, he smiled and said, "I've got a project for you." Thus began a two-year apprenticeship of sorts, which also pulled in two other young researchers (Samir Succar and David Denkenberger) that transformed all of our thinking about wind power, electricity storage, and how it could compete with fossil fuel combustion.

As I got to know Bob better, I began traveling with him to conferences and speaking engagements, and glimpsed the political alliance-building side of him, at which he was equally adept. I remember my head spinning with a web of unfamiliar influential names after dinner one night, as Bob told me of his plans to unite the coal, oil, agricultural and automotive communities together to create a brighter future. It was exciting to be made a part of this, though I was too naive at the time to understand the enormity of what he was attempting to take on. Ultimately, that particular plan did not pan out, as many players and events evolved in ways that were, of course, out of his control, but the boldness of Bob's attempt to realize this vision stayed with me.

Once I left Princeton to make my own career in the world, Bob's name often came up in unlikely contexts, and I was made aware of the far reach of his influence, both in terms of his visionary thinking and the number of people who were familiar with him and his work. I began to understand how Bob's long career had touched many other people when they were young like me, who subsequently applied some version of his thinking to their own work, always with a grateful remembrance of who had helped them to get there. While it may not seem so in our current state of political turmoil, I believe the world is in a better place, with more energy system options available to it to combat climate change, because of Bob Williams' contributions. We, as recipients of his influence, owe it to the world to continue his work and pass on what we've learned to the next generation.

Thank you, Bob, for your years of service to humanity!

Jeff Greenblatt

21 February 2017

Dear Bob,

We first met outside Chicago circa 1971 when I interviewed you for the chapter on the Colorado Committee for Environmental Information in *Advice and Dissent: Scientists in the Political Arena*. You told me about the unbelievable situation you helped end in Colorado: plutonium fires in Rocky Flats, fracking with nuclear explosions and nerve gas piled up at the end of the Denver airport runway.

Then we were fellow residents in DC in 1973-74 while you were chief scientist at the Ford Foundation's Energy Policy Project showing how much more efficiently the world could use energy. I remember admiring Wesley in his crib on the evenings Elinor and you had me – then a lonely bachelor – over for dinner.

Then, in 1976, I enticed you to Princeton where you and I joined Hal's Feiveson's questioning of plutonium breeder reactors. For me, the high point was in 1977, when you, Tom Cochran and I were insurgents on the outside steering committee of the Energy Research and Development Administration's review of the Liquid Metal Fast Breeder Reactor. Our greatest contribution was challenging the growth projection for nuclear power – 2300 GWe by 2010 – that was being used to justify the requirement of breeder reactors and the associated “plutonium economy.” Of course, we were right: nuclear power in the United States plateaued at 100 GWe around 1990. I attach a plot of the AEC's projection and what actually happened, suitable for framing.

After that, our efforts diverged. You kept inventing the energy future and I continued my struggle to deal with the various dangers from nuclear weapons and nuclear energy. We did write a few more papers together. I remember working on the book, *Towards a Solar Civilization* (1980), that you edited. My greatest contribution was vetoing your proposed title for the chapter on biomass, “Green Coal.”

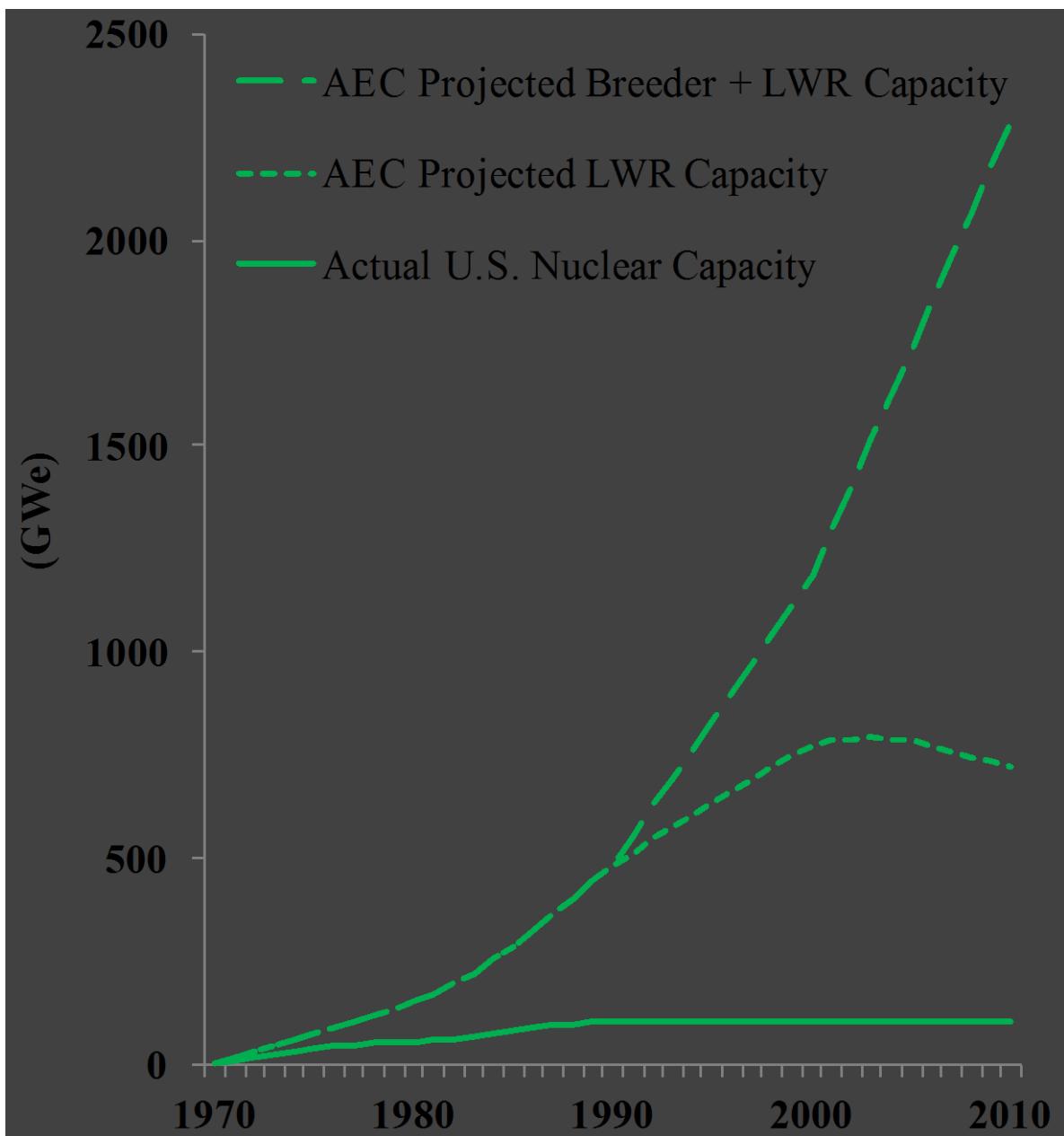
During the past 35 years, however, perhaps my main contribution to energy policy, however, has been listening to you explain your latest idea for a key technology that could help facilitate a more sustainable energy future: cogeneration, aircraft-derived gas turbines, alcohol-fueled cars in Brazil, hydrogen fuel cells, CO₂ for enhanced oil recovery and tri-generation of transportation fuels, electricity and sequestered carbon dioxide from coal and biomass. (See, I was listening!)

Most precious to me during this period, however, has been Elinor's and your friendship – especially during your first decade in Princeton when I was a bachelor, lonely and miserable most of the time with a young son who occasionally visited me in Princeton for a weekend. You and Elinor would have us over for dinner and a swim in your pool. The dinners continued after Paul grew up and I married Pat and included your hosting us in Denver when we decided to motor through the Rockies to Santa Fe.

Your and Elinor's friendship has enriched my intellectual and social life for more than 40 years. I look forward to the next chapter.



Frank von Hippel



The U.S. Atomic Energy Commission's 1974 projection of U.S. nuclear capacity showed huge growth dominated after 1990 by breeder reactors. In actuality, U.S. nuclear capacity grew more slowly – not at all since 1990 – and the U.S. abandoned its breeder reactor commercialization program in 1983. (U.S. Atomic Energy Commission, *Proposed Environmental Statement on the Liquid Meta/ Fast Breeder Receptor Program*, WASH-1535, 1974.)

From: M. V. Ramana
Sent: Tuesday, February 28, 2017 12:04 AM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Re: Bob Williams is retiring

Dear Sarah,

I will be attending the symposium and I do have a short memory of Bob that I would like to share.

When I first came to Princeton in 1997, Frank had asked Bob to give me and Zia a presentation on energy issues of relevance to India and Pakistan. What struck me about the presentation was that Bob had the thickest wad of transparencies for the overhead projector (these were the old days, before power point became popular), that he showed us one after the other. At some point, I asked him something about the status of solar photovoltaics. Whereupon Bob dug into his bag and produced another thick wad of transparencies on solar PV technology. On top of all this, I also remember being impressed with the fact that Bob answered any questions in complete sentences, with no fumbling or searching for words.

Best wishes,

Ramana

From: Lee, Henry [mailto:Henry_Lee@hks.harvard.edu]
Sent: Tuesday, February 28, 2017 10:55 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: RE: Bob Williams is retiring

Eric

Bob has been a stalwart in his field for the three decades that I have worked at Harvard and has earned the respect of all of us working in the energy space. I am delighted that Princeton is honoring him.

Best

Henry

From: Charles Christopher [<mailto:charles@co2store.net>]
Sent: Monday, February 20, 2017 1:18 PM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: Bob Williams

Hi Sarah,

I will not be able to attend the event but would like to include a note for Bob.

Retirement is such “sweet sorrow”. It is nice to sleep late and read all the books you have always wanted to read but not having contact with friends and colleagues you have made over the years is the sorrowful part. Bob was full of energy and always ready to take the time to explain his latest idea. That was one of my favorite things to do when I visited Princeton. I always found Bob’s ideas well thought out and built on many years of sound engineering work. The field will miss him as will I.

Regards,

Charles Christopher

(713) 502-3008 Cell

(512) 712-5673 Home

From: Xiaoping Wang [mailto:xwang3@worldbank.org]
Sent: Sunday, March 5, 2017 9:08 AM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: Re: Bob Williams -- follow-up

Dear Eric,

Thanks very much for your emails and for bringing the news. It's been such a long time. Trust all is well with you and family and the research group in ACEE.

This is an amazing occasion to celebrate Bob's remarkable career over four decades. As a practitioner in development, I have witnessed the influence of Bob's cutting-edge thinking of clean energy solutions in the real world, including my own work at the World Bank in helping the developing countries embark on a sustainable energy path and bring electricity services to all. His guidance and insistence on critical thinking served me well during the my PhD years and thereafter. I still remember the wonderful Thanksgiving dinner at his home and "mandatory" neighborhood walk before the desserts 17 years ago.

I moved to Thailand two years ago and will regretfully miss the symposium. Please send my best regards and wishes to Bob.

Best regards,

Xiaoping

P.S. I apologize for not being able to reply earlier. These days I travel a lot in rural areas of Myanmar to get 6 million people electrified in the next 5 years.

Bob is so talented and kind and I always feel proud that I know him.

Rajeshri Chokshi

Princeton Environmental Institute

March 2017

From: Benjamin Court [mailto:benjamincourt@alumni.princeton.edu]
Sent: Monday, March 6, 2017 10:51 AM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>; Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: Re: Bob Williams -- follow-up

Hello Eric

I will be in Paris thus not able to attend

Please send my "warm regards and congratulations" to Bob

Working with him was always a pleasure.

He was always challenging the way i was thinking in a constructive manner.

I will keep fond memories of working with him

Benjamin

Benjamin Court Ph.D.

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-----Original Message-----

From: Haiming Jin [mailto:jin@jinnovation.com]
Sent: Monday, March 6, 2017 5:34 PM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Bob Williams

Sarah, greetings.

Attached is some thoughts I have about Bob Williams. I was a postdoc with Bob and Eric in 1998-1999, and later collaborated with them in 2001-2005.

Regards.

Haiming Jin, Ph.D.
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It was a great fortune and honor for me having the opportunity of working abreast with Dr. Bob Williams when I was a postdoc at Princeton in 1998. I was deeply impressed by Bob's consistent dedication to work with all-rounded attention to details. On the Christmas Eve that year, Bob was polishing a PowerPoint presentation for a conference in Beijing. In despite of his tight daily schedule, he still worked until odd hours weeding out all the typos and inaccurate expressions. This shows the high standards and passion Bob kneaded into his profession and his empathy toward his audience. I was there burning midnight oil with him and surely he turned into my role model.

Bob is very humble in nature and mocked himself on a few occasions that he was quite incompetent at managing people. In reality, Bob is a man of words. He is not only an ace communicator, but also an exceptional action taker leading by example. Bob is my teacher, my friend and more importantly my inspiration in the past, in the present and in the years to come. Thank you, Bob.

Haiming Jin, Ph.D.
President of Jinnovation Inc.

From: Susanne Stundner [mailto:susanne.stundner@pik-potsdam.de]
Sent: Wednesday, March 8, 2017 4:42 AM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: Re: Bob Williams -- followup/reminder

Dear Eric,

Ottmar would like to ask you to include this note in whatever format you have chosen for the contributions:

*It is both a great pleasure and honor to celebrate with Bob on the occasion of his retirement.
I was also delighted being able to contribute to the symposium as a tribute to Bob's life work.
All best wishes to a great colleague, a very knowledgeable expert and an enthusiastic promoter for a sustainable energy supply.*

Best wishes,
Susanne (for Ottmar Edenhofer)

-----Original Message-----

From: Sigurd Wagner [mailto:wagner@princeton.edu]
Sent: Wednesday, March 8, 2017 2:49 PM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: For Bob Williams's retirement dinner.

Dear Bob:

You are my model for quiet but confident optimism. Over the years I came to understand its source: You are able to turn every challenge into an opportunity.

Thank you for giving me so many thoughts and ideas.

I wish you many happy years along the Front Range !

Sigurd.

From: Jose Goldemberg [mailto:jgoldemb@gmail.com]
Sent: Wednesday, March 8, 2017 3:32 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: goldemb@iee.usp.br; Robert H. Williams <rwilliam@exchange.Princeton.EDU>; Robert H. Socolow <socolow@exchange.Princeton.EDU>; Sarah E. Jackson <sjacks@exchange.Princeton.EDU>; Caitlin M. Daley <cdreyer@exchange.Princeton.EDU>; Kristina K. Corvin <kcorvin@exchange.Princeton.EDU>; Holly P. Welles <hwelles@exchange.Princeton.EDU>; Presidencia <presidencia@fapesp.br>
Subject: Re: Can Jose take part in Bob Williams's Retirement Symposium

Dear Eric

Thanks for the E-mail regarding my participation in Bob's retirement symposium. Unfortunately, I cannot be present (among other things because I am 88 years old!) but will contribute alone the lines you proposed.

1. Please leave my name in the Program. My thoughts on the carbon mitigation problem that Rob might want to mention in the panel are outlined in Annex I
2. Some thoughts on Bob's careers to be mentioned in the diner are in Annex II
3. CV and photo are also attached (Annex III and photo in .jpg)

Truly yours,
Jose

Thoughts on the significance of Bob's work

José Goldemberg, March 2017

It is generally accepted that the 1986 book by the "Gang of Four"

José Goldemberg, Thomas B. Johansson, Amulya K.N. Reddy, and Robert H. Williams, *Energy for a Sustainable World*, Wiley Eastern

is a landmark of energy analysis. Among other things, the book clearly articulated the ideas of sustainability that were later incorporated in the 1987 Brundtland Commission Report on sustainable development (*Our Common Future*).

Bob's unlimited capacity of work and competence shaped the main messages of the book, which are:

- The fundamental importance of energy efficiency and advanced technologies from the industrialized world, of which Bob was at the time the undisputed leader due to his previous work with the Ford Foundation's Energy Policy Project;
- Technological leapfrogging as the key strategy for development in developing countries.

The authors of the book were listed alphabetically, which really didn't do justice to the key significance of Bob's contributions to the work.

From: Iwan, Laura [mailto:Laura.Iwan@afcc-auto.com]
Sent: Wednesday, March 8, 2017 5:30 PM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: thoughts about Bob Williams

Hi Sarah and Eric,

Below are my thoughts and recollections of Bob Williams for his upcoming retirement celebration. It will be an interesting and important event!

Best Wishes,

Laura

As a graduate student in Princeton's Center for Energy and the Environment from 1994-1997, I was inspired by Bob's visionary ideas and his enthusiasm for "putting all the pieces together" to show how to transform his visions into reality. It was from Bob that I first heard of:

- Carbon sequestration (which is now being implemented around the world)
- Powering a house with a fuel cell vehicle (some fuel cell vehicles now offer this, such as the Toyota Marai in Japan)
- The viability and high mileage capability of commercially-available hybrid gasoline-electric vehicles (which are ubiquitous now)

Bob's ideas and analysis supported a "can-do" approach that has helped pave the way for implementation of novel energy and emissions strategies in the last few decades.

Laura Iwan *97
MSE, Princeton University
Senior Systems Engineer, Automotive Fuel Cell Cooperation Corp.
Burnaby, British Columbia, Canada

From: Worrell, E. (Ernst) [<mailto:E.Worrell@uu.nl>]
Sent: Friday, March 10, 2017 7:33 AM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: Note for Bob's retirement

Dear Sarah,
Please find attached a short note for Bob's retirement. I will also try to look up some old pictures and scan one of those (if the quality is sufficient).
Please do not hesitate to contact me in case of any queries.
Thank you.
Take care,
Ernst Worrell

Dear Bob,

Retirement..... I never imagined you as being retired, and I bet you will continue to remain active in the work needed to help save the planet. I am sorry that I cannot be personally in Princeton to give you my best wishes. It has been a while since we last have seen each other; a lot has happened since. Yet, my year as post-doc working with you in Princeton seems like yesterday. Having worked with you during your visits in Utrecht, on my PhD committee, the move to Princeton was the best opportunity to keep working together. I remember your drive, your energy, the nights to prepare for testimony in Congress, but also Thanksgiving with your family. You gave me a lot of freedom working at the Center in Princeton, and I was blessed with people like you, Eric, Rob, and also the other post-doc's Sivan, Debbie, Lars, Kelly and the others there.

I also fondly remember the great atmosphere at the Center, the openness to discuss so many issues, and to explore new research directions. Only a few months ago, I was reminded how far ahead we were in some of our research, as I ran into a researcher here in The Netherlands that was looking at using metals to store energy. A very explorative study by us on using iron oxide to "store" hydrogen turned out to be 20 years ahead of its time. The work on waste gasification was also ahead of its time, as it keeps popping up around the world. The unique atmosphere of the Center, the unique people, the inspiring campus, all were the ingredients that made this possible.

Personally, it was also a great year for me, as it really has been the start of my international career, as I returned to the United States only a few years later, to spend 7 years on the other coast of the country. While, I am now back at Utrecht University as a full professor, I still see your drive and energy, the opportunity to work with you, as the exciting first steps in my career as (a then....) young scientist. The contacts made in that year are still going strong. I am in regular contact with Debbie and Lars, and we work even on exciting projects together.

Bob, I hope that you look back fondly at your contributions to the Center and the world. You have made an impact in this big world, and you have helped to grow the next generation energy scientists. People that are now having an impact in this world, and help grow the next generation once again. Thank you for all the opportunities you offered, and most importantly the one to work with you directly. I wish you the best of luck with your first steps in this new phase in your life. I hope that you and your family can now also visit those places that have provided fond memories for you all and those places that you want to visit together. Enjoy this new phase, and also keep up the good work!

Ernst Worrell
Utrecht, March 10th, 2017

From: brian@andersonenergy.com [mailto:brian@andersonenergy.com]
Sent: Friday, March 10, 2017 9:27 PM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Bob Williams (retiring)



Dear Sarah,

I was given your contact by Dr. Eric Larson so that I could pass on my comments about Dr. Williams on his retirement.

I first met Bob (and Eric) when we were all three working for the China Council for International Cooperation on the Environment and Development, in China, on the Energy Working Group which was tasked with helping the Chinese government to plan its energy development for the following 50 years. I was Chairman of Shell North East Asia at the time (based in Beijing, where I was chairman of Shell China) and was involved for about 5 years in total with this initiative.

I must say that we, with tremendously valuable input from Bob and Eric and Princeton University and others, developed some very good ideas, with widespread use of clean coal technologies and coal gasification being key components of what we proposed to the government.

However in the end China didn't follow through with much of our advice, though warned of the consequences, and we now see the results in the very high levels of air and soil pollution in China today. The switch now to cleaner energy production systems is obviously very costly indeed.

I remember the Chinese Premier, Zhu Rongji, telling us at one of our meetings with him that China would not contemplate taking the more expensive route to energy production that we were proposing until the country had developed to the level of a GDP/capita of USD4,000! In fact the very additional high existential costs involved in their proposed development plan at the time were clearly outlined in our report.

I was very much impressed by Bob's and Eric's technical advice on the key issues we studied, together with our colleagues in the Council from Tsinghua University, and I will remember Bob very warmly for his very professional input. I wish him a very happy and productive retirement!

Best regards,

Brian Anderson

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From: Guangjian Liu [mailto:liugj@ncepu.edu.cn]
Sent: Tuesday, March 14, 2017 8:26 AM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: 答复: Bob Williams -- follow-up

Hi Sarah,

This is Guangjian. I worked as postdoc in Princeton University with Eric Larson, Tom Kreutz and Bob Williams from 2008 to 2010.

I got news from Eric that there would be a public symposium for Bob's retirement in April. Unfortunately, I can't attend.

As Eric suggested, I wrote a short letter to Bob to express my best wishes. Please check the attachment.

Thanks and with best regards,
-Guangjian

Dear Bob,

I miss the wonderful time when I worked at Princeton University with Eric, Tom and you, not only because I stepped into fascinating energy systems studies, but also because I benefitted from observing the spirit of your daily life.

First, you are forever curious about new things in your research field. I was surprised and inspired by your enthusiasm in energy systems studies, including every branch of energy -- energy economics, energy policy, thermodynamics, etc. You read and work voraciously -- like a young student! After not so long a time, you know much more about energy systems than most other researchers. Maybe that's the secret of your successful career.

Second, you are dedicated to finding success. I have read every milestone paper in your publication list. The complex, elegant papers tell people good stories about energy systems. Your 1978 paper on 'Industrial Cogeneration' published in Annual Review of Energy was the starting point of polygeneration energy systems studies, which you have now worked on for almost 40 years. Now more and more people, including Chinese researchers and entrepreneurs, have embraced your idea. It's really exciting and a true mark of success for a researcher. You have set a good example for me.

Last, but not least, you are always nice to your closest friends. You know, Chinese people are silent or subtle when it comes to emotional expression. They usually do not say love to their relatives. Sometimes they criticize their closest friends without a second thought. But I saw how respectful and sweet the relationship is between you and Elinor. I will never forget the kindness that both of you showed to Huimin and Xiang. You let me know that love is power.

Now, since you have chosen retirement, I send you my best wishes for slow and peaceful years ahead.

Yours sincerely,
Guangjian
March, 14, 201

From: Kim Hegelbach
Sent: Tuesday, March 14, 2017 1:34 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: RE: Follow-up/friendly reminder

Hi Eric,

Thank you very much for your invitation. Unfortunately, I will be out of town. Here are my thoughts about Bob.

It was so long ago when I worked for Bob and Frank Von Hippel. My memory of Bob is that he kept revising his chapter that he wrote with Profs. Amulya Reddy and Thomas Johansson.

In those days, I had to walk over to Stanhope Hall to send his messages by telex. He was quite absent-minded, but you couldn't rely on it. One day, I drove him, Eric and Joan Ogden to the airport, and on the way, I casually asked if they had their passports for the trip to Jamaica. Joan said "no". So, I dropped Bob and Eric off at the airport and took Joan back to Princeton. But Bob had his passport and he made the flight.

Bob was so passionate about his research on biomass. Bob, Congratulations on your retirement. You were ahead of your time in your research for renewable energy.

Kim

From: scottandhella@aol.com [mailto:scottandhella@aol.com]
Sent: Wednesday, March 15, 2017 11:10 AM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Re: Bob Williams is retiring!

Thanks to my good wife -- and her dexterity with our computer -- I am delighted to send you herewith the two-pager, "small cars."

This is one of 152 stories in my book, *Surprise Encounters with Artists and Scientists, Whales and Other Living Things*, p. 321.

In lively anticipation of the big day.

Scott & Hella

small cars

In 1956, I bought a beige Volkswagen in Berlin to allow ready travel about the three western sectors of the city, the French, the British, and the American. This purchase was made possible through a generous loan from my father, who forgave the loan upon the occasion of Hella's and my marriage on August 9, 1958.

For another seven years, Hella and I drove that beloved vehicle in Berlin and in this country right up to the time I had pieced together \$1500 to buy a new VW in 1963.

Then I spied an ad in our local weekly, *Town Topics*, which listed a "mint condition" Mercedes with red leather seat covers for the same sum. We bought it, and when I rolled into our local gas station, three guys were all over it, polishing the windows, the head lamps, even the side mirrors – things I had done myself.

Fast forward. Here in Princeton is a physicist, Robert H. Williams (BS in physics at Yale, 1962, PhD in theoretical plasma physics, Berkeley, 1967), who is an authority on various forms of energy. He has written and co-written books and papers on many facets of the energy field and has been a consultant to China since 1991. In 1993, he received a MacArthur Fellowship, often referred to as a "genius" award.

James Ferland, for many years CEO, president, and chairman of PSE&G (1986-2004), was knowledgeable about all applied aspects of energy. He said he would like to meet Williams, perhaps over dinner since he was constantly being interrupted at work.

I arranged a dinner in Morristown in the mid-1990s and was the proverbial fly-on-the-wall when the two of them interacted for more than two hours touching on every aspect of the field from coal to oil to natural gas to wind to sun to geothermal to nuclear.

Some time later, P. Roy Vagelos, then CEO and chairman of Merck and author of 100 scientific papers, said he'd like to talk to Williams. Vagelos said energy was wholly outside his field, but he had heard from Ferland that he had enjoyed meeting with Williams.

I arranged for a meeting at Merck's headquarters in Rahway (before the move to Elysian Fields in Whitehouse Station). Bob and I traveled from Princeton to Rahway in his Honda Civic which got 60 miles to a gallon of gas.

When we arrived at the gate, I cranked down the window. The security guard asked what we wanted.

"Where might we park the car?" I asked.

He replied, "Go to the end of this lot and then proceed to the back of the second lot, and you will find a third lot. Park at the back of the third lot."

We hoofed it back to the gate. The guard said, "What do you want now?"

"Could you please advise us where Mr. Vagelos' office is?" He blanched and pointed the way.

Moral: In our society we tend to judge somebody by the size and status of his car.

From: Simone Hochgreb [mailto:sh372@cam.ac.uk]
Sent: Thursday, March 16, 2017 7:00 AM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Bob Williams roast

Dear Eric,

Below are some of my reminiscences on Bob, you, and my early days at Princeton.

It may be said that great men change the course of history. Well, I can certainly say that Bob Williams changed the course of *my* history. I first met Bob when, as an undergraduate in São Paulo, I went to work with Diomedes Christodoulou, who had been a former master's student at Princeton, and was now working with the local energy company on a variety of energy assessment issues. I ended up writing up my undergraduate thesis on the technical and economic feasibility of transporting biogas from the many alcohol distilleries for cogeneration. Bob had been working on the subject for a while, and came to visit. I loved the idea of being able to take forward these ideas, and was very enthusiastic about working with Bob's group at Princeton. Bob, Eric Larson, Joan Ogden and Rob Socolow were incredibly welcoming, and the center was always a hub of interesting people. Bob was a great mentor, always respectful and enthusiastic about unconventional paths.

This great experience really sold me on becoming a researcher for life. I eventually had to find out why such great ideas were not being put into practice, and veered into the more technical aspects of energy transformation as the career went onwards. But I never forgot the really great start I had, the idealistic bunch we all were, and hopefully all still are.

I made life long friends at the center, met my husband at Princeton, and lived happily ever after... so here is to Bob, who made it all possible.

Professor Simone Hochgreb
University of Cambridge
email: simone.hochgreb@eng.cam.ac.uk
phone: +(44)(0)1223 764098
mob: +(44)(0)7736 491192
web: <http://www.eng.cam.ac.uk/~sh372>
<http://www-g.eng.cam.ac.uk/reactingflows>

From: Gray, Edward [mailto:edgray@antaresgroupinc.com]
Sent: Thursday, March 16, 2017 2:39 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: RE: Follow-up/friendly reminder

Hello Eric,

Looks like an amazing symposium. I hope you tape the policy discussion at the close so that we who cannot attend in person can all hear it and find a spark of hope.

What always struck me about Bob was his dedication to the principal that good science should be a foundation for good public policy. He is not alone but he was the most enthusiastic proponent I have ever met and ardent in his efforts to inform policy makers. I wish him well as he carries on with that battle!

Maybe we will see him at the March for Science in WDC in April.

Best Wishes,

Edward E. Gray, P.E.
President
Antares Group Incorporated
Main: 301 731 1900
edgray@antares.org
Direct: 301 363 2791
Cell: 240 354 9620
www.antares.org

From: Alan Miller [mailto:astanley92@gmail.com]
Sent: Thursday, March 16, 2017 2:36 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Re: Carbon Mitigation Initiative annual meeting in Princeton, April 4-5

In order to properly understand the significance of Bob Williams contributions to our understanding of energy issues and their central place in so many domestic and global affairs, some historical context is required. Fortunately, being (almost) as old as Bob, I have some recollection of this long-ago era. In 1984, I joined the newly formed World Resources Institute assigned to work on energy and climate issues. Oil prices were low, climate change was not on the agenda for any national environmental group, energy for development meant building power plants burning fossil fuels, and the NGO where I had been working decided clean energy was “a California issue” and consequently that I should work on more serious environmental issues -- like air and water pollution.

Among my first assignments was to help Bob and his international collaborators – widely referred to as “the Gang of Four” – to produce a shorter and less technical version of their seminal work *Energy for a Sustainable World*. Once Bob accepted that I was there to help and not to argue with him, we became friends in relatively short order. And in retrospect, what an extraordinary and influential body of work it was, the fundamental principles for a set of beliefs about the energy system and development that have come to dominate virtually every domain of energy planning and policy this side of OPEC and (what’s left of) the coal industry.

As I know there are many others who will comment on this body of work in some detail, I will only say what a great honor – and influence it was for me personally – to have some early insight into this brilliant, far-sighted, and under-appreciated man.

Alan Miller

From: Baxley, J. Steven [mailto:JSBAXLEY@SOUTHERNCO.COM]
Sent: Thursday, March 16, 2017 4:36 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: RE: Follow-up/friendly reminder

Eric,

With regrets a prior commitment will prevent me from attending the symposium in honor of Bob Williams' retirement. Sounds like great event and best wishes to Bob on his retirement.

Regards,

Steve Baxley, PE

Manager- Renewables, Storage, and Distributed Generation R&D

Southern Company | Research and Environmental Affairs

Phone: 205.257.7608 | Cell: 205.910.5225 | E: jsbaxley@southernco.com



From: Gordon Thompson [mailto:gthompson@irss-usa.org]
Sent: Thursday, March 16, 2017 6:39 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: Paula Gutlove <pgutlove@irss-usa.org>; Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: Re: Good news Re: Bob Williams is retiring

Hi Eric

Attached is my note of appreciation of Bob.

Best regards, Gordon

An Appreciation of Robert Williams

by Gordon Thompson
<gthompson@irss-usa.org>

16 March 2017

I came to know Bob Williams while working at Princeton in 1979 and 1980. Since then I have had the pleasure of intersecting with Bob on various occasions, and of following his work at a distance.

In the personal sphere, Bob and Elinor Williams have been remarkably generous in opening their Princeton home to visitors and colleagues. I have fond memories of dinners and other events they graciously hosted. They have provided a refuge from the tribulations of the energy/environment policy arena.

In the professional sphere, Bob has been a role model for me and for many others. By relentlessly examining a range of issues regarding energy and the environment, Bob has made important contributions to creating the technical basis for a sustainable civilization. Moreover, in making those contributions, Bob has maintained the highest standards of transparency and accountability. Where others might be tempted to hide an analytic assumption, Bob puts it on display.

Bob has a healthy ego. Yet, he is always ready to explain an issue, or to encourage work by others. Above all, there is never any doubt that Bob is committed to serving the public interest.

Thank you, Bob, for your work and your example.

From: Jose Moreira [mailto:rmoreira69@hotmail.com]
Sent: Friday, March 17, 2017 10:07 AM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Subject: Re: Bob Williams is retiring

Dear Eric and Sarah

Please, see my note about Bob Williams.

I will not be at the ceremony, unfortunately.

Thanks

Jose Moreira

Dear Bob Williams

Considering your retirement from the Princeton University, I believe it is a nice opportunity to talk about your strong ties with Brazil, mainly due your interest in renewable biomass-based energy. As old as 1984 I was introduced to your ideas about biomass gasification and the use of the gas as a fuel for combined cycle gas turbines. Your initial calculation anticipate a generation potential of more than 300 kWh per tonne of cane, in a moment when average electricity generation on sugar mills were around 40 kWh.

The proposed technology has not yet achieved commercial application but the sugar cane potential to generate increased amounts of electricity was object of many political and technological meetings, involving people from the academy, government and entrepreneurs. Through the leading of Jose Goldemberg, your initial idea has yielded commercial results. Nowadays, some sugar mills are exporting 140 kWh/tcane, on top of using in the ethanol producing processes 40 kWh/tcane. Furthermore, these units run year round, since during the 7 months of the harvest season they are able to save sugar cane residues to operate during the non-harvest period at full electric power.

During 2016, some 35 TWh has been sold by sugar mills, still a modest value, since only 50% of the mills are selling electricity to the grid, and from these, more than half are below the performance above described. As bioelectricity gains space, considering the availability of 700 Million tonnes of sugar cane the potential production could reach 98 TWh/yr, without further technology progress. This represents today 1/6 of total Brazil's electricity generation. You have initially driven such result.

With the IPCC, your participation has been extremely useful during my activity in the preparation of the report Carbon Dioxide Capture and Storage, during 2004/05, when for the first time we presented the concept of BECCS (Bioenergy Carbon Capture and Storage) to the Panel. The achievement required many discussion since the initial purpose of the report was to, essentially, analyze CCS from fossil fuels.

Due the evolution of our contact, we had other opportunities to sell new ideas to Petrobras, considering zero CO₂ emission. No fruit has already shown but the discussion proceeds.

Dear Bob, I am sure that your contribution has influenced colleagues in other countries, and what I am reporting here is just a small share of your significant help to the progress of science. Furthermore, knowing you so well, I can anticipate that new ideas will continue to flow from your mind and science will continue to be pushed by you.

Regards,

Jose Roberto Moreira

Senior Professor

Institute of Energy and Environment

University of Sao Paulo, Sao Paulo, Brazil

From: 李政 [mailto:lz-dte@tsinghua.edu.cn]
Sent: Friday, March 17, 2017 9:22 PM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Eric D. Larson <elarson@exchange.Princeton.EDU>; lizheng1965@outlook.com
Subject:

Dear Sarah
Here attached please find my note to Bob.
Best wishes,
zheng

Prof. Zheng LI
Dean, Department of Thermal Engineering
Director, Tsinghua BP Clean Energy Research and Education Center
Tsinghua University
Beijing 100084, China

Dear Bob,

It is a great pity that I can't join your retirement symposium for reasons I can't control. I apologize. Instead, I'd like to write a few words to express our appreciation for your great contribution to China. You are one of the first people to propose the concept of "polygeneration" to China, and it has been accepted and practiced as an important solution for sustainable energy development in China. Your name is tightly bonded to this great idea! I thank you also for mentoring me in many aspects. The book—"Pasteur's Quadrant"—you presented to me enlightens me so much and has great influence on my later career. At the moment you are going to retire, I just want to show my respect to your wonderful professional career and wish great enjoyment in your retired life, although I am quite sure that you won't go away from the research you love. I am happy to keep contact with you in the future.

Best wishes!

Zheng
Prof. Zheng LI
Dean, Department of Thermal Engineering
Director, Tsinghua BP Clean Energy Research and Education Center
Tsinghua University
Beijing 100084, China

From: Zhong Zheng [mailto:zzheng@alumni.princeton.edu]
Sent: Saturday, March 18, 2017 6:41 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Re: Bob Williams is retiring!

Hi Eric,

Here is a short note -- I hope it is fine!

Bob is retiring from Princeton today -- However, never expect Bob to stop generating new ideas to save the world! I believe you will continue to find Bob's name in research papers!

best,

Zhong

From: Ellen D. Williams [mailto:edw@umd.edu]
Sent: Sunday, March 19, 2017 3:53 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Re: Bob Williams -- follow up

Hi Eric,

Sorry to be late. If possible, I'd still like to add my note for Bob's memory board:

"Dear Bob,

I will never forget your illuminating work on the real opportunities and real costs of changing the energy system. You have made a big difference in how I and many others think about energy.

With best wishes for your next stage of endeavors,

Ellen"

Kind regards,

Ellen

Ellen D. Williams
Distinguished University Professor
Department of Physics and IPST
University of Maryland

Room 1111 IPST
Phone: 301-405-3291
email: edw@umd.edu

From: Baldwin, Sam [mailto:Sam.Baldwin@ee.doe.gov]
Sent: Tuesday, March 28, 2017 12:19 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Cc: Maureen A. Novozinsky <mnovozin@exchange.Princeton.EDU>
Subject: FW: April 3 symposium

Eric:

Below is my tribute to Bob—I trust that this can be extracted and put into the book, or is it useful for me to send this to you separately? As for my slides, I am still working on them and may not be able to get them to you before Saturday—how much of a problem will that be?

All the best,

Sam

Bob:

Since we first met in 1985 when I was a Hewlett Fellow, you have been a wonderful mentor, colleague, and friend. Your boundless energy and enthusiasm for energy analysis, and your deep insights into areas such as your 1 kW study, hydrogen, biomass and CBTL, CCS, and so many others have been an inspiration and model for me. You may be retiring from Princeton, but certainly not from energy analysis, and I look forward to having the opportunity to continue to work with you into the future.

All the best,

Sam

Subject: Re: Bob is retiring
Date: Tue, 21 Mar 2017 11:48:14 -0400
From: Tom Kreutz <kreutz@princeton.edu>
Organization: Princeton University
To: Sarah E. Jackson <sjacks@princeton.edu>

Dear Sarah,
A note to Bob on his retirement.
Tom

Dear Bob,

It has been such a privilege to work closely with you over the last decade, to witness first hand your passion, drive, and vision, and to be guided by your deep knowledge and experience. The range of your interests and abilities is breathtaking: from the most detailed technical issues to the broadest geopolitical perspectives. But what strikes me most is your unfailing optimism and indefatigable pursuit of technological strategies to make the world a better place. I have seen your progress checked time and again by technical and political obstacles, and each time watch you dust yourself off and then obstinately proceed to creatively construct a route around the obstruction, devising an even better and more robust solution than before. You're absolutely undauntable!

The lessons you've imparted, both explicitly and by example, are many, and I value them tremendously. We'll all miss your smiling face around here, but look forward to working with you remotely from Denver - well, as much as your grandchildren will allow! And I take particular vicarious pleasure at the thought of you and Elinor roaming the back country together for many years to come.

Thanks again for everything,

Tom

From: Robert H. Socolow
Sent: Saturday, April 1, 2017 12:43 PM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: My testimonial for Bob, attached

Dear Bob: What a ride! Already nearly half a century together in the Rational Underground (Murray Gell-Mann's name for us). You have been a kindred spirit, a continual source of inspiration, a hero.

My first assignment after arriving at Princeton that required me to do something beyond the campus came from Carl Kaysen. He charged me with keeping an eye on you as you acquired influence in the Ford Foundation project! I calmed him down, and you shepherded a shelf of books into existence that is still the best collective product from a single project. You set the agenda for the following half century, and, alas, for the half century ahead of us as well.

I so appreciate that we co-hosted so many wonderful people at Princeton, that we shared a passion for energy efficiency and the Second Law in our early years, that you carried me through a dry spell when I ended the CEES buildings energy program, that you joined me in reaching out to scientists and engineers working on *energetika* in Brezhnev's Soviet Union, and that you had that insight about how CO₂ sinks could be mated to CO₂ sources that launched a global CCS effort and – by the by - brought about CMI.

You are the master at fusing stovepipes. Fossil fuels and renewables are a twain that never meets except when you force them to understand why they need each other. I know that you will keep at it, and that there will be a few successes.

You are also the master of Think Global. Energy Studies would be significantly less cosmopolitan, had you not brought the Gang of Four into existence and made that extraordinary effort so productive.

Through it all, always kind, generous, and supportive – with an occasional “Arghh” in the margin of a draft of something I’ve written, setting me straight.

And it has been wonderful to know Elinor as a friend.

There is so much more to do!

Yours, Rob

From: Xu Yuan [mailto:yuanxu@cuhk.edu.hk]
Sent: Sunday, April 2, 2017 5:40 AM
To: Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: RE: Dinner guests, Monday, April 3

Dear Eric,
Thanks a lot. Here are a note I write for Bob.

I was a Ph.D. student in the Program in Science, Technology and Environmental Policy of the Woodrow Wilson School from 2004 to 2010. I was extremely lucky to have Bob in my thesis committee and benefited tremendously from his guidance. He has countless ideas to make our world energy-smart and environmentally friendly. My five-and-a-half years at Princeton was critical in my transition from studying purely atmospheric sciences before to analysing interdisciplinary public policy at present. Bob educated me on how to integrate technologies in understanding energy and environmental policy. The journey would be certainly much harder without his insights and mentorship.

Bob taught me much about serious scholarship and serves as a lifetime role model. I had always been nervous before meetings with him because I was worried that my work might not be good enough. When I started the Ph.D. study at the Woodrow Wilson School, I planned not to work in academia after graduation. However, when I finished, I had already been firmly determined to take academia as the lifetime career. A key factor was that I started enjoying mind-challenging research tremendously. Bob was one of the most important people who led me to taste, and showed me the essence of, the hardship and happiness of serious research.

My appreciation to Bob will certainly last for a lifetime.

Thanks,
Yuan

Yuan Xu, Ph.D.
Associate Professor
Department of Geography and Resource Management
& Institute of Environment, Energy and Sustainability
The Chinese University of Hong Kong
Email: yuanxu@cuhk.edu.hk; Tel: +852-39436647
Website: <http://yuanxu.weebly.com/>

From: Stefano Consonni [mailto:stefano.consonni@polimi.it]
Sent: Sunday, April 2, 2017 11:39 PM
To: Sarah E. Jackson <sjacks@exchange.Princeton.EDU>
Cc: Maureen A. Novozinsky <mnovozin@exchange.Princeton.EDU>; Eric D. Larson <elarson@exchange.Princeton.EDU>
Subject: Thoughts on Bob

Sarah and Eric,
sorry this doesn't get to you much on time ... but I had to wait for some inspiration.
Hope there's still time to add these thoughts to the ones you already got for tomorrow's dinner.
See you tomorrow morning !
Stefano

Thoughts on Robert Williams from a former graduate student

Bob has been not only a constant source of inspiration for the people around him, but also an unrelenting promoter of intelligent thinking and effective new ways to use energy.

As it normally happens with good things - free lunch is rare, right ? - the bounty of ideas, motivations, brilliant thoughts would come at a cost, however. Particularly if you were a graduate student.

When I got to the Center for Energy and Environmental Studies as graduate student – just a few years ago ... in 1985 – the name of the game was steam-injected gas turbines. Bob had just published a paper (with Eric) that outlined the future of the new concept. Industrial experience had just started with the installation of a cogeneration plant serving a process for the production of potato chips. Bob got me involved in the subject, which matched nicely my desire to work on applied thermodynamics. But despite Bob's proclaims that it would be just a matter of few "back-of-the-envelope" calculations, I found myself caught in an overwhelming effort. Fortunately, when despair seemed to take over I could count on the secret hope to gain a free, unlimited supply of potato chips. Even more when I got to visit the plant in San José, although more than the steam injection and the chips I felt motivated by the liberal outfits of the girls in the bay area.

These distractions notwithstanding, I eventually managed to complete my doctorate. As any good graduate student should do, I guess, I went beyond the original idea put forward by my advisors (Bob and Rob), but the initial thrust toward mixed gas-steam cycles marked both my Thesis and the rest of my academic and professional career. For which I am indebted to Bob for his far-reaching vision, commitment and unconditioned thinking.

Anyone who's had the privilege to work with him knows well that his retirement doesn't mean he's going to stop working. All the best to Bob for a happy and fruitful new stage of his life in Colorado !

Stefano Consonni

Princeton, April 3rd 2017

REMARKS AT DINNER, 3 APRIL 2017

From: Alan Miller [mailto:astanley92@gmail.com]

Sent: Tuesday, April 4, 2017 3:08 PM

To: Eric D. Larson <elarson@exchange.Princeton.EDU>

Subject: My after dinner remarks

I did not quite follow the script but the gist of my remarks is included here! Hope it was ok, thanks for including me in this memorable event.

Alan Miller

Alan Miller, After Dinner Toast, April 3, 2017

While Bob is known for his many published works, some of his most influential achievements have been within committees and advisory groups and not always with any recognition. One that I happen to know from first hand observation is his service as a member of the Scientific and Technical Advisory Panel of the Global Environment Facility, the STAP.

To my knowledge, the STAP is a unique body insofar as it has a very direct role in the operations of a global environmental fund, advising not only on broad strategic direction but also reviewing individual projects. Their views are circulated with project documents for review by the GEF Council, the decision making body for approval of projects.

So far as I could find, there is no official history of the STAP. However, it was part of the GEF from its origins as a pilot program in the early '90s and formalized with the legal agreement in 1994. Bob was among its initial members, chosen specifically for his expertise on clean energy technologies. In that role, he was a central figure in developing an Operational Program – essentially a funding strategy – for commercializing new energy technologies. This was, and to some extent remains, a largely heretical concept within international financial institutions which have traditionally viewed developing countries as places for the tried and true and inappropriate for experimentation. Bob forcefully presented the rationale for subsidizing the introduction of a new generation of clean energy technologies based on an appreciation of learning curves, opportunities for cost reductions associated with mass production, and the replacement of dirty fossil fuels with limited reserves by free, clean, renewable energy.

And as we all know, Bob can be a VERY effective advocate – despite being an outsider, as he was in an audience of bankers, economists, and development professionals. Watching Bob in front of a skeptical audience was always entertaining as besides being in command of the facts he was fearless!

The Operational Program he promoted led to the commitment of hundreds of millions of dollars for technologies that included solar thermal power plants; grid connected PV power; fuel cells for stationary and mobile applications; and others. I am convinced that in some cases, GEF financial support was the largest source of funding for actual projects in the world at that time.

As with many early stage projects, the implementation of these projects took longer – much longer – sometimes cost more, and did not always succeed. As with some other of Bob's visions, his ideas were sometimes a little ahead of their time! But from the vantage point of 2017, it is remarkable how on the mark he was. Over the weekend, a front-page article in the Washington Post described the rapid growth of solar power projects in Chile, perhaps the best location in the world due to its large expanse of high altitude desert. Solar and wind energy is competitive or cheaper than fossil fuels in a growing number of countries – independent of any credit for greenhouse gas reduction – and increasingly providing clean energy for the hundreds of millions living off the grid. While GEF operational strategies have changed in the 20 years since Bob was a STAP member, his influence continues. The energy related loan portfolios of the international financial institutions are dominated by renewable energy projects, and there is a much greater willingness to consider early stage investments in new technologies of development benefit.

A Genius Obsessed

Reminiscences for a celebration of Bob Williams, Princeton, 3 April 2017

Frank von Hippel

According to Bob, we first met at the International House of Pancakes in Denver in 1970. He was on the research staff of the Environmental Science Services Administration in Boulder and I was on the staff at Argonne National Laboratory outside Chicago.

Nuclear explosions, plutonium fires and nerve gas in Colorado

I interviewed Bob for a chapter in the book I was writing about "Scientists in the Political Arena." I was interested in the Colorado Committee for Environmental Information within which Bob was a key activist. The group had picked fights with both the U.S. Atomic Energy Commission and the U.S. Army.

It had fought with the Atomic Energy Commission – the AEC for short – about two issues:

1. The AEC's proposal to use underground nuclear explosions for what we call fracking today, and
2. A fire at the factory in Colorado where the AEC was producing the plutonium pits for U.S. nuclear warheads.

Although Bob and his colleagues strove mightily, they were unable to stop the AEC, at the height of its power from conducting a nuclear fracking test western Colorado in 1969. The explosion had three times the power of the Hiroshima bomb and the waves it made in the ground a few miles away threw people and their cars eight inches into the air.

Bob and his colleagues fought against the test in the press, in court and in the governor's office without success. The group did, however, get a U.S. District Court judge in Denver to require that the AEC make public the radioactivity in the gas that had been freed. Not surprisingly, it contained radioactive tritium. The AEC argued that the doses from cooking stoves would be insignificant but the public was not convinced. Furthermore, to significantly increase the U.S. natural gas supply, thousands of underground explosions would have been required. Given the public opposition to its first test, the AEC decided that large scale nuclear fracking would not be politically feasible.

So, Bob and his friends lost the battle but won the war.

The AEC's Rocky Flats plutonium pit production plant was halfway between Denver and Boulder. In 1969, the plant had a huge fire involving tons of plutonium – enough for one thousand nuclear bombs.¹ Plutonium smoke is a ferocious carcinogen. The collective inhalation of 1 milligrams into the lungs would cause several cancer deaths. The AEC claimed that no significant amount of plutonium had escaped into the environment but the Colorado Committee found a local expert who they persuaded to do soil measurements. He found one thousand times more plutonium than would have been consistent with the AEC's claims.

Eventually, it turned out that the plant had been having more than one plutonium fire per month on average. The Committee's findings made the plant a local issue and 20 years later, when making nuclear bombs was no longer a Cold War priority, thirty car loads of armed FBI and EPA agents surprised the plant's armed guards and seized it for evidence of environmental crimes. Four years later, it was shut down permanently and cleaned out at a cost of more than \$10 billion. The ground is still contaminated, however, and has been declared a wildlife preserve.

The problem the Colorado Committee had with the Army, was that the Army had stored 20,000 cluster bombs, each filled with 20 gallons of nerve gas at the Rocky Mountain Arsenal, half way between Denver and its airport. A week after the Colorado Committee made the danger public, the Army decided to ship the nerve gas east and load it on ships to be sunk in the Atlantic.

The Army called its plan Project CHASE, for "Cut Holes And Sink 'Em." The idea of shipping the nerve gas through multiple cities did not go over, however, and the Army ultimately was forced to ship it to Utah for detoxification at a cost of \$7 billion. Then the Rocky Mountain Arsenal too became a wildlife preserve.

So, Bob was a successful and seasoned policy activist even before he got into energy policy.

Plutonium breeder reactors and nuclear terrorism

During 1972-74, while he was Chief Scientist at the Ford Foundation's Energy Policy Project, Bob discovered many things. Others will discuss the importance of Bob's work on energy efficiency. I will mention that he got into another plutonium issue.

Ted Taylor, a former nuclear weapons designer, had become concerned with how sloppy the AEC was in its shipments of plutonium. Weapon-quantities of plutonium were being shipped in unaccompanied packages. Some shipments were even hijacked by people who wanted to go to Cuba. Fortunately, the Cubans did not check the cargoes before returning the planes to the U.S.

The AEC was sloppy in part because it thought that making a bomb out of plutonium would be too hard for terrorists. Ted thought differently. In any case, as I have already mentioned, plutonium could be used to make what is today called a "dirty bomb." Bob commissioned Ted to co-author a book on the issue and, in parallel, John McPhee wrote what became a famous book about Taylor and his concerns, *The Curve of Binding Energy*. Both books were published in 1974.

¹ <https://www.osti.gov/opennet/forms.jsp?formurl=document/press/pc24.html>

Bob came to Princeton in 1976 and I had the good fortune of working with him for his first few years here.

Our first joint effort, with Hal Feiveson, focused on the plutonium breeder reactor. As I showed this morning, the AEC projected in 1974 that, by the year 2000, the U.S. would be building 100 plutonium breeder reactors a year. At a price of \$10 billion each, that would be about \$1 trillion per year. Bob wondered if the country would have any money left to make the capital investments required to use all that electricity. The three of us began to critique the AEC's projection.

Our criticisms became well known and, in 1977, Bob and I were recruited by President Carter's White House to be on the steering committee of a review of the breeder reactor commercialization program. We ended up co-authoring a report that showed once again that the electricity demand projection that was being used to justify the need for the reactors was impossibly high. It was a minority report and the Energy Research and Development Administration tried to bury it but we got it to President Carter who took our side and put the program on hold. Congress ended the U.S. demonstration plutonium breeder reactor project six years later after its projected cost had increased five-fold.

Moscow

In 1984, Bob and Hal Feiveson and I went to Moscow at the invitation of Evgeny Velikhov, who we learned the following year, when Gorbachev became General Secretary of the Soviet Communist Party, was Gorbachev's informal science advisor.

Bob gave a briefing on energy efficiency in Velikhov's office at the Soviet Academy of Sciences. When Bob started talking about the chips in U.S. automobile engines, Velikhov did a double take and realized how far behind the Soviet Union had fallen in computerization. He persuaded Gorbachev to launch a computer initiative but it was too late.

On that same trip, Bob also gave a public lecture. His suitcase had been lost and he had arrived wearing tennis shoes and a sweat suit. So, he borrowed a suit and shoes. The shoes were too tight and the word I would use to describe the way Bob walked around in them would be "mincing."

Ten years later, when I was working in the White House, Velikhov came in with an idea based on something else Bob had told him: that jet engines could be used as gas turbines for power generation. Velikhov had gotten Gorbachev to shut down most of the Soviet Union's plutonium production reactors. But three were still operating because they provided heat and electricity for two nuclear cities. Velikhov proposed that the U.S. pay for converting a Soviet military jet-engine factory into a factory for gas-turbine co-generation plants whose first production would be to replace the reactors. Russia's nuclear establishment wanted new reactors, however. Ultimately, after 25 years, the reactors were finally replaced with coal-fired co-generation plants.

Working with industry

Although he has spent his career in academia, Bob has been uninterested in academic pursuits like teaching courses or administration. Instead, his focus has been on changing the larger world.

As a result, he often pitches his ideas to industry as well as government.

I remember Bob coming back from a visit at Dupont. He told me that the Dupont Vice President who had been hosting him ended the meeting by saying, "Okay, why don't we have my staff get together with yours to work out the details?" Bob's response was, "I am my staff."

A personal note

Finally, I would like to add a personal note: I will forever be grateful to Bob and Elinor for befriending me and my son Paul in my early years in Princeton before I met Pat.

Bob and Elinor, **Thanks!**