

**THE GLOBAL CHALLENGES OF ENERGY  
PRODUCTION IN THE COMING DECADES**  
*COLLABORATIVE FIELD COURSE IN BRAZIL*



January 7<sup>th</sup> to 19<sup>th</sup>, 2013

São Paulo & Rio de Janeiro, Brazil

*Academic Host Institutions*



School of Engineering &  
Applied Sciences  
(SEAS)



Universidade de São Paulo  
Escola Politécnica  
(Poli-USP)



HARVARD UNIVERSITY  
David Rockefeller Center  
for Latin American Studies

David Rockefeller Center for  
Latin American Studies  
(DRCLAS)

*Field Sites & Collaborating Academic Institutions*

- ❖ Biogás Energia Ambiental
- ❖ Centro de Células a Combustível e Hidrogênio (CCCH-IPEN)
- ❖ Eletrobrás Eletronuclear
- ❖ Empresa Metropolitana de Águas e Energia (EMAE)
- ❖ Empresa de Pesquisa Energética (EPE)
- ❖ Laboratório de Sistemas Fotovoltaicos do Instituto de Eletrotécnica e Energia da Universidade de São Paulo (LSF-IEE)
- ❖ Odebrecht Energia
- ❖ Operador Nacional do Sistema Elétrico (ONS)
- ❖ Tectsis
- ❖ Voith Hydro

*Support*

*In addition to the support of the academic host institutions, this collaborative course was made possible thanks to the generosity of the Lemann Family, Brazil's CNPq, and the Fundação Centro Tecnológico de Hidráulica (FCTH)*

*Caros Participantes* (Dear Participants),

*Sejam bem-vindos!* We are delighted to welcome you to the fourth edition of the collaborative Harvard/Poli-USP environmental engineering field course. This initiative is a joint effort of Harvard University's School of Engineering and Applied Sciences (SEAS), the Universidade de São Paulo's Escola Politécnica (Poli-USP), and the Brazil Studies Program of Harvard's David Rockefeller Center for Latin American Studies (DRCLAS). Following last year's course, which took place in Cambridge, Boston, Vicksburg and New Orleans, we are excited to be back in Brazil. We are encouraged by the fact that past course participants from Poli-USP and SEAS have gone on to engage in longer-term international research at both the student and faculty levels.

The focus of the collaborative course this year is "Global Challenges of Energy Production." We will have the opportunity to learn in the field from senior practitioners in São Paulo and Rio de Janeiro. Site visits include a wide range of energy production facilities for biogas, hydrogen, solar, nuclear and wind power. We will also have the chance to visit the operator of Brazil's national electricity system. The classroom and lecture component of the course, which is tightly integrated with site visits, requires active student participation. This year, we have also organized an expert panel discussion during the second week of the course focused on "Innovations in Ethanol" and open to Harvard and USP alumni in Brazil.

In January 2013, we are welcoming eight returning students and five professors who have participated in previous years. We have added a new core faculty member from Harvard and from Poli-USP and two internationally-focused staff members from SEAS, all of whom actively participated in course planning and will join us in Brazil for the first time. While the majority of the course's 28 students are undergraduates, the group includes two Ph.D. candidates as well as a Master's student from Harvard's Graduate School of Design. The 15 Poli-USP participants are studying Environmental Engineering, Electrical Engineering and Architecture, Urbanism and Civil Engineering. Harvard students are pursuing degrees in Biomedical Engineering and Computer Science, Electrical Engineering, Environmental Science, and Mechanical Engineering and Material Science. The group is diverse in terms of nationalities as well, with the following countries represented: Belgium, Brazil, China, Colombia, Italy, Nigeria, Palestine and Zimbabwe.

To all who contributed to the creation and execution of this collaborative field course, please know that we are deeply grateful. This initiative would not have been possible without the vision and support of many individuals and institutions in Brazil and the United States. We appreciate the ongoing engagement and support of the Deans Poli-USP and SEAS. Thanks are also due to professors who are not able to join us this year but who continue to strengthen the broader Harvard-USP collaboration by hosting students and researchers in their labs. Finally, we would like to express our sincere appreciation to the Lemann Family, Brazil's CNPq, and the Fundação Centro Tecnológico de Hidráulica (FCTH) without whom none of this would be possible. *Muito obrigado!*

Grande abraço,



Monica Porto

Full Professor and Chair, Department of Hydraulic and Sanitary Engineering, Escola Politécnica da Universidade de São Paulo (Poli-USP)



Steven Wofsy

Abbott Lawrence Rotch Professor of Atmospheric and Environmental Science, Harvard School of Engineering and Applied Sciences (SEAS)



Jason Dyett

Director, Brazil Office  
Harvard University  
David Rockefeller Center for Latin American Studies (DRCLAS)

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## TABLE OF CONTENTS

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<b>TABLE OF CONTENTS .....</b>	<b>3</b>
<b>ACADEMIC HOST INSTITUTIONS.....</b>	<b>4</b>
HARVARD’S SCHOOL OF ENGINEERING AND APPLIED SCIENCES .....	4
UNIVERSIDADE DE SÃO PAULO’S ESCOLA POLITÉCNICA .....	4
HARVARD’S DAVID ROCKEFELLER CENTER FOR LATIN AMERICAN STUDIES..	4
<b>COURSE SCHEDULE – JANUARY 2013 .....</b>	<b>5</b>
<b>FACEBOOK.....</b>	<b>11</b>
CORE COURSE FACULTY .....	11
GUEST LECTURERS AND PANELISTS .....	11
ORGANIZERS.....	12
STUDENTS.....	13
<b>COURSE LOCATIONS.....</b>	<b>15</b>
<b>SITE VISITS .....</b>	<b>19</b>
BIOGÁS ENERGIA AMBIENTAL - ATERRO BANDEIRANTES.....	20
CCCH-IPEN – CENTRO DE CÉLULAS A COMBUSTÍVEL E HIDROGÊNIO.....	20
ELETROBRÁS ELETRONUCLEAR – ANGRA 2 & 3 .....	20
EMAE – EMPRESA METROPOLITANA DE ÁGUAS E ENERGIA .....	21
EPE - EMPRESA DE PLANEJAMENTO ENERGÉTICO .....	22
LSF-IEE – LABORATÓRIO DE SISTEMAS FOTOVOLTAICOS DO INSTITUTO DE ELETROTÉCNICA E ENERGIA DA UNIVERSIDADE DE SÃO PAULO .....	22
ONS – OPERADOR NACIONAL DO SISTEMA ELÉTRICO.....	23
TECSIS – WIND TURBINE BLADES COMPANY .....	23
VOITH HYDRO .....	23
<b>WORKING GROUPS &amp; FINAL PRESENTATIONS .....</b>	<b>25</b>
<b>PARTICIPANT BIOGRAPHIES .....</b>	<b>27</b>
<b>EMERGENCY CONTACT INFORMATION.....</b>	<b>44</b>

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## ACADEMIC HOST INSTITUTIONS

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### **HARVARD'S SCHOOL OF ENGINEERING AND APPLIED SCIENCES**

Harvard University's School of Engineering and Applied Sciences (SEAS) serves as the connector and integrator of the University's teaching and research efforts in engineering, applied sciences, and technology. Its core tenets are educating broad-minded students; interdisciplinary research; integration across disciplines; and balancing theory, experimentation, and practice. SEAS offers undergraduate concentrations in Applied Mathematics, Biomedical Engineering, Computer Science, Electrical Engineering, Engineering Sciences, and Mechanical Engineering and graduate programs (S.M., M.E., and Ph.D.). Graduate students may work towards a Master's of Science (S.M.), Master's of Engineering (M.E.), and Doctor of Philosophy (Ph.D.) degree in Applied Mathematics, Applied Physics, Computational Science and Engineering, Computer Science, Bioengineering, Electrical Engineering, Environmental Science and Engineering, Mechanical Engineering (including a Materials Science track), and Secondary Field in Computational Science and Engineering (as part of the Ph.D.). Faculty number approximately seventy (68 FTEs) who have particularly close ties with the departments of Physics, Earth and Planetary Science, and Chemistry and Chemical Biology. Over the past decade, undergraduate enrollments in Applied Mathematics, Computer Science, and Engineering Sciences have ranged from 300 to over 500. For additional information, please see: [www.seas.harvard.edu](http://www.seas.harvard.edu).

### **UNIVERSIDADE DE SÃO PAULO'S ESCOLA POLITÉCNICA**

The University of São Paulo (USP) is the largest institution dedicated to higher education and research in Brazil, with nearly 90,000 students. It is highly acclaimed around the world, especially in Latin America, and is responsible for training a large part of Brazilian academics working in colleges, universities and research institutes. USP is a public university, free of charge and with open access for students selected by the *vestibular* (Brazilian admissions exam for universities). It is composed of 48 educational and research units, five hospitals, five museums, five specialized institutes, multiple experimental laboratories as well as scientific and cultural centers spread across seven campus locations. The primary campus in metropolitan São Paulo houses the Escola Politécnica (Poli-USP), which has fifteen departments and over 100 laboratories. Founded in 1893, the Poli was incorporated into the Universidade de São Paulo in 1934. Poli-USP has 336 full time faculty and offers undergraduate (4,557 students), master's, doctoral (1,574 students) courses and degrees. For additional information, please see: [www.poli.usp.br](http://www.poli.usp.br).

### **HARVARD'S DAVID ROCKEFELLER CENTER FOR LATIN AMERICAN STUDIES**

The David Rockefeller Center for Latin American Studies (DRCLAS) is one of 11 inter-faculty initiatives at Harvard University and is overseen by the Office of the University Provost, with an administrative home in the Faculty of Arts and Sciences (FAS). DRCLAS was founded in 1994 as an initiative to promote high-quality teaching and research on Latin America and related fields at Harvard University. The mission of the DRCLAS Brazil Office in São Paulo and Brazil Studies Program in Cambridge is to enhance collaborative research among Harvard faculty and their Brazilian counterparts; encourage faculty engagement with Brazil and student participation in language programs, internships and research projects in Brazil; and provide a hospitable environment for Brazilians at Harvard and for Harvard scholars in Brazil. Since the launch of the Brazil Office in June 2006, more than four hundred Harvard faculty and students have engaged in and with the country across a range of disciplines with support or involvement of the Office. For additional information, please see: [www.drclas.harvard.edu/brazil](http://www.drclas.harvard.edu/brazil).

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## COURSE SCHEDULE – JANUARY 2013

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### Sunday, January 6<sup>th</sup> – São Paulo

- Morning**                      **International student arrivals** – *Harvard’s David Rockefeller Center for Latin American Studies (DRCLAS) Brazil Office staff will await you at the São Paulo – Guarulbos International Airport (GRU) arrivals area.*
- Afternoon**                      **Hotel check-in for all students.** Rest and free time.
- 7:15 pm**                        **Informal welcome dinner.**  
Bazar da Pizza  
Rua Henrique Monteiro, 35 – Pinheiros (three blocks from hotel)

### Monday, January 7<sup>th</sup> – São Paulo

- 8:45 am**                        **Depart hotel.**
- 9:15 – 10:30 am**                **Driving tour of Cidade Universitária, USP’s main campus.**
- 10:30 – 11:00 am**                **Walking tour of USP Engineering School (Poli-USP).**  
Tour in five sub-groups, which will be led by Poli-USP students.
- 11:00 am – 12:15 pm**            **Welcome and Collaborative Course Overview.**  
Professor José Roberto Cardoso, Poli-USP Dean welcome students. Each student briefly introduces herself/himself. Jason Dyett provides overview of what to expect in the next two weeks. Monica Porto and Chad Vecitis explain academic objectives and course plan. Patrick Ulrich briefly speaks about internationalization at SEAS.
- 12:30 – 2:00 pm**                **Group lunch.**
- 2:15 – 3:45 pm**                **Lecture & Discussion: The Global & Local Challenges of Energy Production.**  
José Goldemberg, Professor, USP. President of USP from 1986 through 1990, Minister of Education in Brazil from 1991 to 1992. Discussion will include international comparisons. (30-45 minute lecture followed by group questions and discussion).
- 4:00 – 5:30 pm**                **Visit to USP Labs (walking tour).**
- 5:30 pm**                        **Return to hotel.**

**Evening**                      **Free.** Students encouraged to get to know other members of their groups.

**Tuesday, January 8<sup>th</sup> – São Paulo**

- 8:30 – 10:00 am**            **Lecture & Discussion: Wind Power Generation – Overview and Innovations.**  
Maurício Salles, Professor, Department of Electrical Engineering, Poli-USP.
- 10:00 – 11:45 am**            **São Paulo Downtown Area tour**  
We will visit the Altino Arantes building to have a panoramic view of the downtown São Paulo, and will take a walk in its outskirts.
- 12:00 – 1:30 pm**            **Lunch** at Bar Salve Jorge Centro.
- 2:00 – 3:30 pm**            **Site Visit: Laboratório de Sistemas Fotovoltaicos, IEE-USP.**  
The Photovoltaic Systems Laboratory of the USP's Institute of Electrical and Energy started its activities in 1995 and is an important tool for academic research conducted by Masters and Ph.D. students from USP and for Brazil's National Institute of Metrology, Standardization and Industrial Quality (Inmetro).
- 3:45 – 5:15 pm**            **Lecture & Discussion: Principles of Hydropower Generation.**  
Prof. José Rodolfo Scarati Martins, Assistant Professor of Civil and Environmental Engineering, Poli-USP.

**Wednesday, January 9<sup>th</sup> – São Paulo**

- 8:30 am**                      **Depart** hotel.
- Morning & Afternoon**            **Site Visit: EMAE – Empresa Metropolitana de Águas e Energia (Billings Reservoir, Pedra Dam and Henry Borden Power Plant)**  
EMAE's principal activity is the generation and marketing of electric energy. It is proprietor and operator of the hydraulic and electric energy generation system located in the metropolitan area of São Paulo, Medium Tietê and Paraíba do Sul River Valley.
- Evening**                      **Free.** Students from Harvard & Brazil encouraged to have joint informal activities/outings.

**Thursday, January 10<sup>th</sup> – São Paulo**

- 8:00 am**                      **Depart** hotel.
- 9:00 am – 2:00 pm**            **Site Visit: Voith Hydro.**  
Voith Hydro is a joint venture between Voith and Siemens created to provide turbines and generators for hydropower. It is responsible for generating more than 50% of hydropower consumed in Brazil.
- 2:45 – 4:15 pm**            **Lecture & Discussion: Overview of Hydropower Development in Brazil - Odebrecht Energia.**
- 4:30 – 5:45 pm**            **1<sup>st</sup> Discussion of group research themes** for each of the 5 student

Working Groups. Course Faculty will provide information to help students progress in their thinking on the program.

7:00 pm                    **Group Dinner.** Optional.

**Friday, January 11<sup>th</sup> – São Paulo**

8:30 am                    **Depart** hotel.

10:00 – 11:45 am        **Site Visit: Biogás Energia Ambiental – Aterro Bandeirantes**  
The Bandeirantes Landfill Gas to Energy Project was developed by the City of São Paulo to collect and process biogas from the Bandeirantes Landfill to generate electricity at an on-site power plant.

12:30 – 1:45 pm        **Lunch.**

2:00 – 3:30 pm            **Lecture & Discussion: Waste-to-Energy Technologies.**  
Chad Vecitis, Assistant Professor of Environmental Engineering, SEAS, Harvard University.

3:45 – 5:15 pm            **Lecture & Discussion: Nuclear Electric Power.**  
Michael Aziz, Gene and Tracy Sykes Professor of Materials and Energy Technologies, SEAS, Harvard University.

5:30 pm                    **Return** to hotel.

Evening                    **Free.** Students from Harvard & Brazil encouraged to have joint informal activities/outings.

**Saturday, January 12<sup>th</sup> – São Paulo & Paraty**

7:30 am                    **Breakfast and check-out.** Participants should check-out and take luggage to the bus for trip to Paraty.

8:00 am                    **Depart** hotel.

8:30 – 10:00 am        **Visit** to Ibirapuera Park or Museu do Futebol.

10:30 am                    **Lecture & Discussion: Impacts of Energy Production on the Atmosphere and on Climate: Past, Present & Future.**  
Steven Wofsy, Abbott Lawrence Rotch Professor of Atmospheric and Environmental Science, SEAS, Harvard University.

12:00 pm                    **Harvard-DRCLAS Brazil Office visit** and brunch before bus trip to Paraty, RJ.

1:00 pm                    **Travel to Paraty, RJ.** Group bus. Approximately five hours.

Evening                    **Hotel check-in.** Rest and free time.

### Sunday, January 13<sup>th</sup> – Paraty

9:00 am	Breakfast.
10:00 am	Joint informal outing for all participants. Mandatory.
1:00 pm	Lunch.
Afternoon & Evening	Rest and free time.

### Monday, January 14<sup>th</sup> – Paraty

8:30 am	Depart hotel.
9:00 am	Visit to Serra da Bocaina National Park (TBC).
12:00 – 1:30 pm	Lunch.
1:30 – 4:30 pm	2 <sup>nd</sup> Discussion of group research themes for each of the 5 student Working Groups. Course Faculty will provide information to help students progress in their thinking on the program.
7:00 pm	Group Dinner generously offered by Eletobrás Eletronuclear.

### Tuesday, January 15<sup>th</sup> – Angra dos Reis

7:30 am	Breakfast and check-out. Participants should pack and take luggage to the bus for afternoon trip to Rio de Janeiro.
8:30 am	Depart hotel for Central Nuclear Almirante Álvaro Alberto (CNAAAA).
9:30 am – 4:00 pm	<b>Site Visit: Eletrobrás Eletronuclear (Angra 2, Angra 3, and Nuclear Waste Control Center)</b> Eletrobras Eletronuclear was established in 1997 in order to build and operate nuclear power plants in Brazil. Subsidiary of Eletrobras, it is a mixed capital company and is responsible for the generation of approximately 3% of the electricity consumed in Brazil.
4:00 pm	Travel to Rio de Janeiro, RJ. Group bus. Approximately three hours.
Evening	Hotel check-in. Rest and free time.

### Wednesday, January 16<sup>th</sup> – Rio de Janeiro

8:00 am	Breakfast and check-out. Participants should pack and take luggage to the bus for late afternoon trip to São Paulo.
10:00 am	Depart hotel.
10:30 – 11:45 am	<b>Site Visit: EPE – Empresa de Pesquisa Energética</b> Established in March 2004, the Empresa de Pesquisa Energética (Energy

Research Company) is a public company under the Ministry of Mines and Energy which aims to provide services in the area of studies and research to support the planning of the energy sector.

12:00 – 1:30 pm	<b>Lunch.</b>
2:00 – 4:00 pm	<b>Site Visit: ONS – Operador Nacional do Sistema Elétrico</b> The National Interconnected System (SIN) is formed by companies from South, Southeast, Midwest, Northeast and parts of the North of Brazil. Only 3.4% of electricity production capacity of the country is out of SIN, in small isolated systems located mainly in the Amazon region.
4:00 pm	<b>Travel to São Paulo, SP.</b> Group bus. Approximately six hours.
Evening	<b>Hotel check-in.</b> Rest and free time.

#### Thursday, January 17<sup>th</sup> – São Paulo

8:00 am	<b>Depart</b> hotel.
8:30 am	<b>Welcome Coffee.</b>
9:00 – 10:30 am	<b>Panel: Innovations in Ethanol</b> ( <i>separate agenda will be distributed</i> ).  <b>1. Carlos Labate</b> , Associate Professor, Department of Genetics, Escola Superior de Agricultura Luiz de Queiroz da Universidade de São Paulo;  <b>2. Marcos Jank</b> , Board Member, Instituto de Estudos do Comércio e Negociações Internacionais (ICONE).
10:30 – 10:45 am	<b>Coffee Break.</b>
10:45 am – 12:15 pm	( <i>Panel continued</i> ) <b>3. Márcia Azanha F. Dias de Moraes</b> , Professor, Department of Business, Economics and Sociology, Escola Superior de Agricultura Luiz de Queiroz da Universidade de São Paulo;  <b>4. Francisco Mello</b> , Post-Doctoral Fellow at Center of Nuclear Energy on Agriculture, Escola Superior de Agricultura Luiz de Queiroz da Universidade de São Paulo.
12:30 – 1:45 pm	<b>Lunch.</b>
2:00 – 4:00 pm	<b>Site Visit: CCCH-IPEN – Centro de Células a Combustível e Hidrogênio do Instituto de Pesquisas Energéticas e Nucleares</b> The CCCH-IPEN's mission is to generate scientific and technological knowledge, innovation, and human resources training in the area of fuel cells in order to improve the quality of life of people.
4:15 – 5:30 pm	<b>3<sup>rd</sup> Discussion of group research themes</b> for each of the 5 student Working Groups. Course Faculty will provide information to help students progress in their thinking on the program.

**Friday, January 18<sup>th</sup> – São Paulo**

- 8:00 am**                      **Depart hotel.**
- 8:30 – 10:00 am**            **Lecture & Discussion: Smart Grids – An Overview.**  
Nelson Kagan, Full Professor, Department of Electrical Engineering,  
Poli-USP.
- 10:15 am – 11:30 pm**    **Lecture & Discussion: Solar Energy Technologies and Innovation.**  
Racine Tadeu Araujo Prado, Professor, Department of Electrical  
Engineering, Poli-USP.
- 11:45 am– 12:45 pm**    **Lunch.**
- 12:45 pm**                      **Depart for Tecsis.**
- 2:00 – 5:30 pm**              **Site Visit: Tecsis Wind Turbin Blades Company.**  
Since its inception in 1995, Tecsis has been a supplier of blades to the wind  
energy sector.
- Evening**                      **Free.** Time to finish group presentations.

**Saturday, January 19<sup>th</sup> – São Paulo**

- 8:30 am**                      **Depart hotel** for Poli-USP.
- 9:00 – 10:30 am**            **Online course evaluation.**
- 10:45 am – 12:45 pm**    **Group presentations.**
- 1:00 – 2:30 pm**              **Closing lunch.**
- Evening**                      **Departure** of all international participants.

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## FACEBOOK

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### CORE COURSE FACULTY

#### *From Harvard*



**Steven Wofsy**  
Abbott Lawrence Rotch  
Professor of Atmospheric and  
Environmental Science,  
Harvard School of Engineering  
and Applied Sciences (SEAS)



**Michael Aziz**  
Gene and Tracy Sykes Professor  
of Materials and Energy  
Technologies,  
Harvard School of Engineering  
and Applied Sciences (SEAS)



**Chad Vecitis**  
Assistant Professor of  
Environmental Engineering,  
Harvard School of Engineering  
and Applied Sciences (SEAS)

#### *From Poli-USP*



**Monica F. A. Porto**  
Full Professor and Chair,  
Department of Hydraulic and  
Sanitary Engineering,  
Escola Politécnica da  
Universidade de São Paulo



**José Carlos Mierzwa**  
Associate Professor of  
Environmental Engineering and  
Water Treatment,  
Escola Politécnica da  
Universidade de São Paulo



**José Rodolfo Scarati Martins**  
Assistant Professor of Civil and  
Environmental Engineering,  
Escola Politécnica da  
Universidade de São Paulo



**Maurício Salles**  
Assistant Professor,  
Department of Electric Energy  
and Automation Engineering,  
Escola Politécnica da  
Universidade de São Paulo

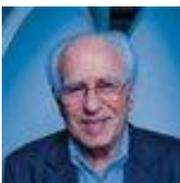
### GUEST LECTURERS AND PANELISTS



**Carlos Alberto Labate**  
Associate Professor,  
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Luiz de Queiroz da  
Universidade de São Paulo



**Francisco F. de Castro Mello**  
Post-Doctoral Fellow at Center  
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**José Goldemberg**  
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Universidade de São Paulo



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**Marcos S. Jank**  
Board Member, Instituto de Estudos do Comércio e Negociações Internacionais (ICONE)



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**Racine Tadeu A. Prado**  
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**ORGANIZERS**



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## STUDENTS

### *From Harvard*



**Anisa Li**  
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**Stephen Lee**  
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A.B. in Biomedical Engineering  
and Computer Science



**Natália Takahashi Margarido**  
6<sup>th</sup>-year undergraduate student  
in Environmental Engineering,  
Poli-USP - Escola Politécnica da  
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**Pedro Ludovico Bozzini**  
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**Renan B. Muller**  
4<sup>th</sup>-year undergraduate student  
in Electrical Engineering,  
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## COURSE LOCATIONS

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### Brazil

With a population of over 193 million people, Brazil is the fifth most populous country in the world and the fourth largest democracy. After decades of military rule (1964-1985), Brazil now sustains a vibrant open society, with a lively media and a large participatory civil society and middle class, and has developed strong macroeconomic stability over the past decade.



Brazil is the world's largest exporter of iron ore and soya; it will soon be the largest exporter of frozen meat. Brazilian industry produces more cars than Mexico and more steel than Italy. Thanks to the development of offshore fields, the nation has vast oil reserves. It also has the world's largest reserves of tropical forest, freshwater and of bio-diversity, and is the country outside the G8 with the best science base, as measured by the frequency its scientific papers are quoted. Brazil plays an active role in international negotiations on climate change and has been extremely active in building partnerships on biofuels.

Brazil is at the forefront of efforts to deepen Latin American integration. It founded and plays a coordinating role in the G20 group of nations in WTO negotiations. Brazil is an active and influential member of the United Nations, and has for several years led the UN peacekeeping force in Haiti (it was the first country to contribute to the Haiti Reconstruction Fund). Under President Lula (2002-2010) and the current President Dilma Rousseff, the country's first female president, Brazil has worked in closer coordination with emerging powers, particularly India, South Africa, China and Russia. Brazil has encouraged closer co-operation between Latin America and the Middle East. Africa has also been a stated priority of President Rousseff's administration.

Slightly larger than the continental United States, Brazil borders nine countries in South America. It is comprised of 26 states and the Federal District where the capital, Brasília, is based. States have considerable autonomy, being responsible for such issues as security and education. The majority of population live in coastal states, particularly in the South-east, which includes the cities of São Paulo and Rio de Janeiro. The country is framed by two of the world's largest river systems: the Amazon in the North, and the Paraná river in the South. The Amazon basin covers some 60% of Brazil's surface, and holds 20% of the world's fresh water supply. In addition to rain forests, Brazil has savannah and wetlands.

### **São Paulo, São Paulo**

The first week and the final three days of the field course will take place in the city of São Paulo. São Paulo is the most populous city in the southern hemisphere and capital of the state of São Paulo. While São Paulo's core population is around 11.3 million, the greater metropolitan area is home to approximately 20 million inhabitants, making it one of the most populous cities in the world. Metropolitan São Paulo's GDP accounts for approximately 12% the country's total economic output. The city is home of the Bovespa, the largest stock exchange in Latin America. The State of São Paulo is a major supplier of consumer goods, capital goods, consumer materials and technical services to other Brazilian states and to foreign countries.

São Paulo is a melting pot of nationalities, cultures, beliefs, philosophies and ideals. It is Italian, German, Jewish, Portuguese, Japanese, Chinese, French, African, Arab, Spanish, Latino, Brazilian and Paulistano. The city brings together approximately 3 million people of Portuguese descent, 3 million of Italian descent, 1.5 million of African descent, 1 million of German descent, 850 thousand of Lebanese descent and more than 1 million people of Japanese descent (it is the largest Japanese city outside of Japan).

## **Paraty, Rio de Janeiro**

We will spend three days (including a weekend) in the beautiful colonial city of Paraty, which is considered a National Historical Monument. By exploring Paraty's downtown on foot, course participants will have the chance to travel back in time, where walking has to be done at a leisurely pace due to the irregular rounded cobblestone pavement of its streets.

In the words of Lucio Costa, the influential architect and urban planner who designed Brasília, "Paraty is a town where the sea and land paths meet, or rather, intertwine." This geography was the reason for its importance and richness, when its port was the outlet of commodities which came down through the trail in the mountains to be shipped to Portugal: the Minas Gerais gold and Paraíba Valley coffee, as well as the best *cachaça* (sugar cane spirit) produced in its 150 distilleries.

With the discovery of gold in Minas Gerais at the end of the 17<sup>th</sup> century, the village of Paraty became the entryway for the thousands who wanted to make a fortune in the Brazilian "Eldorado." From its port, gold and precious stones were loaded for Rio de Janeiro, to be sent from there to Lisbon, Portugal. A great amount of gold and riches came through the village, protected by its many fortifications and its troops. Its port was busy with the arrival of fabrics, tools, food supplies and slaves for the mines and São Paulo. In the beginning of the 19<sup>th</sup> century, the coffee plantations in the Paraíba Valley brought a new impulse to Paraty as a commerce centre, its port being from where coffee was exported, and where European manufactured goods arrived to go the interior, including luxury items for the coffee barons. The urban centre was enlarged and its streets improved; new buildings appeared, more elegant; one-storey houses were transformed in two-storey houses; and in 1844 the village was elevated to the condition of a town.

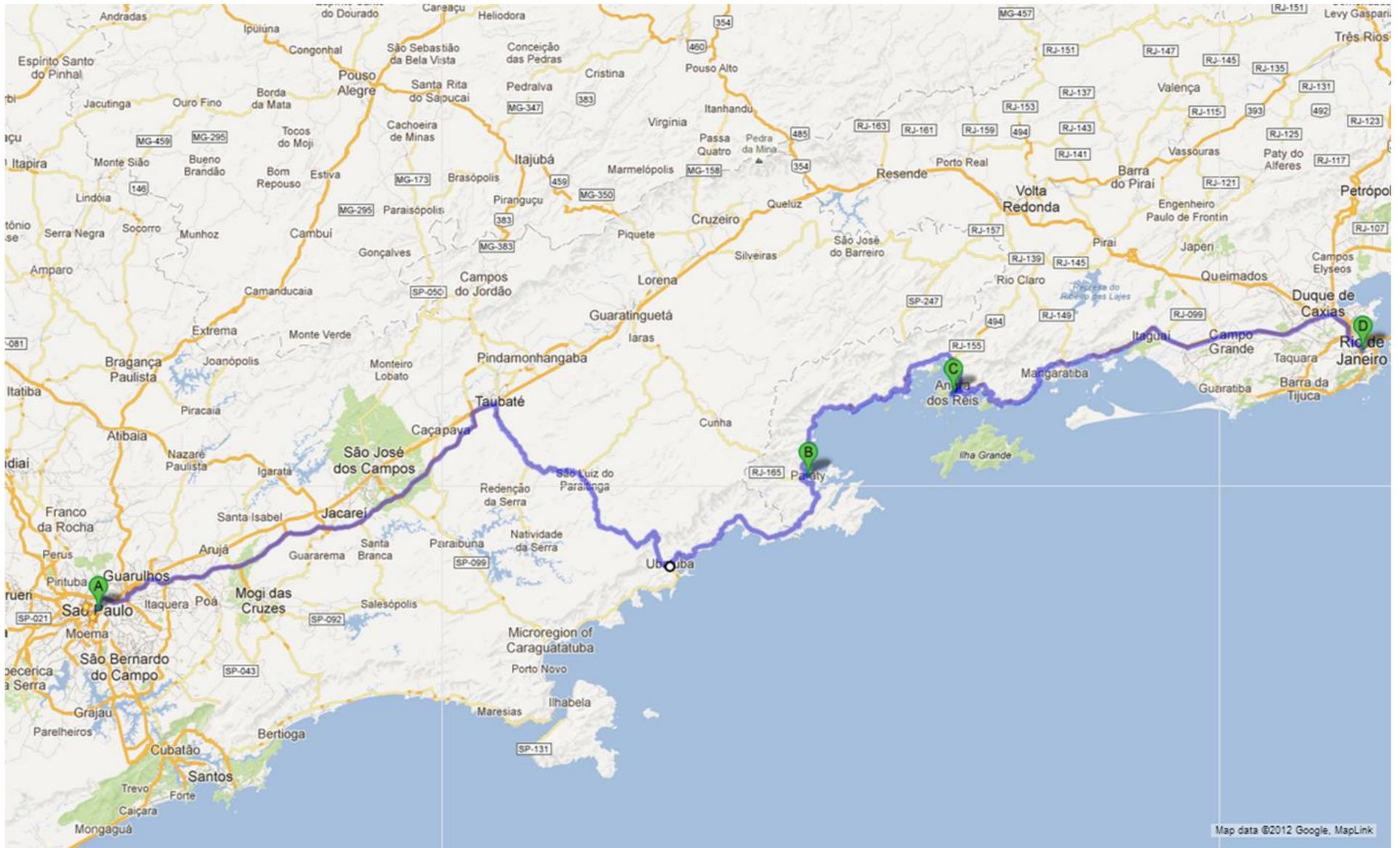
## **Angra dos Reis, Rio de Janeiro**

During our time in the state of Rio de Janeiro, we will take a full day trip to Angra dos Reis, home to Brazil's sole nuclear power plant and to 365 islands and 2,000 beaches. Commonly referred to simply as "Angra," the city is located in the southwest of the state, one and a half hours from Paraty and three hours from the city of Rio de Janeiro, our subsequent destination. Most of the drive is along the State's beautiful coastline.

## **Rio de Janeiro, Rio de Janeiro**

We will spend one night in metropolitan Rio de Janeiro, which is known as the "Cidade Maravilhosa" (Marvelous City) for its natural beauty. The second largest city in Brazil, Rio was the country's capital for nearly two centuries until the capital moved to Brasília in 1960. It is the most visited city in the southern hemisphere, and is also known for its natural settings, carnival celebrations, samba, Bossa Nova, and balneario beaches. Rio also has the largest and second largest urban forests in the world.

Course Locations: *São Paulo, Paraty, Angra dos Reis, and Rio de Janeiro.*



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## SITE VISITS

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### An Important Note of Thanks to our Field Site Hosts:

*On behalf of all its participants, the course organizers would like to thank the tremendous generosity, openness and hard work of the many institutions and individuals who have made the following field site visits possible. Unfortunately, we are certain to miss many of you in this brief note of acknowledgement. Please know that, despite our omissions in the listing below, we appreciate your contributions and recognize that you are integral to this collaborative course's existence and success.*

<b>Biogás Energia Ambiental</b>	<ul style="list-style-type: none"><li>❖ Júlio César do Prado;</li><li>❖ Aparecida Lopes;</li><li>❖ Anderson Alves da Silva.</li></ul>
<b>CCCH-IPEN – Instituto de Pesquisas Energéticas e Nucleares</b>	<ul style="list-style-type: none"><li>❖ Marcelo Linardi.</li></ul>
<b>Eletrobrás Eletronuclear</b>	<ul style="list-style-type: none"><li>❖ Leonam dos Santos Guimarães;</li><li>❖ Luiz Carlos Siqueira.</li></ul>
<b>EMAE – Empresa Metropolitana de Águas e Energia</b>	<ul style="list-style-type: none"><li>❖ Ricardo Borsari.</li></ul>
<b>EPE – Empresa de Pesquisa Energética</b>	<ul style="list-style-type: none"><li>❖ José Marcos Bressane;</li><li>❖ Angela Livino.</li></ul>
<b>Laboratório de Sistemas Fotovoltaicos, Instituto de Eletrotécnica e Energia, Universidade de São Paulo</b>	<ul style="list-style-type: none"><li>❖ Roberto Zilles;</li><li>❖ André Ricardo Mocelin;</li><li>❖ Tadeu Osano de Oliveira.</li></ul>
<b>Odebrecht S.A.</b>	<ul style="list-style-type: none"><li>❖ Gabriel Azevedo.</li></ul>
<b>ONS – Operador Nacional do Sistema</b>	<ul style="list-style-type: none"><li>❖ Tristão Araripe;</li><li>❖ Jayme Darriba Macedo;</li><li>❖ Caroline Timm Maltaz;</li><li>❖ Marcelo Prais;</li><li>❖ Angela Livino.</li></ul>
<b>Tecsis Wind Power</b>	<ul style="list-style-type: none"><li>❖ Bento Koike;</li><li>❖ Carolina Magoga;</li><li>❖ Sabrina Ramos.</li></ul>
<b>Voith Hydro</b>	<ul style="list-style-type: none"><li>❖ Osvaldo San Martin;</li><li>❖ Carlos Haluska Junior;</li><li>❖ Luciana Munaretti Viudes.</li></ul>

## **BIOGÁS ENERGIA AMBIENTAL - ATERRO BANDEIRANTES**

Biogás Energia Ambiental S.A. (Biogas Environmental Energy S.A.) is the largest user of biogas for electricity production in the world. The company was established in 2004 after the signing of a concession agreement between the Bandeirantes Landfill and the Municipality of São Paulo for gas exploration. The plant was inaugurated on the date of the 450<sup>th</sup> anniversary of the city of São Paulo. Through 2009, Biogás had reduced its methane gas emissions by 190,000 tons.

The Bandeirantes Landfill, one of the largest in the world, received an average of 7,000 tons per day of waste produced by the city of São Paulo. It operated from 1976 until March 2007, receiving a total of 30 million tons of trash. If the gasses produced were simply burned, they would have emitted millions of tons of pollutants into the atmosphere. Landfill biogas, which is approximately 50% methane, is generated by the decomposition of waste and offers great potential for use in the production of electricity. The plant is connected to four Eletropaulo (a major Brazilian power distributor in the state of São Paulo) 13.2 Kw feeders through a switching station. The distributed capacity provides important benefits to the electric system in terms of reduced transmission and distribution costs, lower electrical losses and improved quality of service.

Biogás Energia Ambiental captures and directs up to 12,000 m<sup>3</sup>/hour of biogas to generators 24-hours a day, 365 days per year. To produce this amount of gas, Biogás installed 43 km of HDPE pipes and connected them to 250 vertical wells in addition to the equipment needed for suction, drying and burning of excess gas. The biogas produced and processed is used to drive motor 24 sets of 925 Kw generators, that corresponds to a net power of 20,000 kilowatts, enough electricity for approximately 400,000 inhabitants.

## **CCCH-IPEN – CENTRO DE CÉLULAS A COMBUSTÍVEL E HIDROGÊNIO**

The Centro de Células a Combustível e Hidrogênio – CCCH (Fuel Cell and Hydrogen Center) is a research center of the Instituto de Pesquisas Energéticas e Nucleares - IPEN (Institute of Energy and Nuclear Research). IPEN focuses on technological development of fuel cell and hydrogen production. It does so by generating scientific knowledge and innovation by investing in human resources in the area of fuel cells and hydrogen technologies. In addition to research activities, CCCH offers a continuous learning program for undergraduate and graduate students. This program consists of technological disciplines teaching topics on fuel cells, hydrogen and hydrogen economy issues.

CCCH is linked with de Brazilian program of hydrogen (Pro-H<sub>2</sub>) coordinated by the Brazilian Ministry of Science and Technology. It was created to develop cheaper and more efficient technologies for the production and storage of hydrogen and to increase the number of people trained in technologies needed to establish standards of safety and efficiency in the industry.

## **ELETRÓBRÁS ELETRONUCLEAR – ANGRA 2 & 3**

Eletrobras Eletronuclear was established in 1997 to build and operate nuclear power plants in Brazil. A subsidiary of Eletrobras, it accounts for the generation of about 3% of the electricity consumed in Brazil and 50% of the electricity consumed in the state of Rio de Janeiro. It's proportion of total electricity generation will expand considerably when Angra III, the third plant of the Central Nuclear Almirante Alvaro Alberto – CNAAA, comes online.

The Center, located in the city of Angra dos Reis, is named as a tribute to the pioneering researcher of nuclear technology in Brazil and the primary promoter of a national policy for the sector. While

building the first plant was his inspiration, the admiral, who was born in 1889, died in 1976, before Angra I began generating power.

CNAAA is currently operating Angra I, which has a capacity of 657 megawatts, and Angra II, which generates about 1,350 megawatts. Angra III, which is almost a replica of Angra II, incorporates the technological advances that have occurred since the construction of the initial plant. It is expected to generate 1,405 megawatts.

The National Energy Plan (PNE 2030), that underpins the Government's strategy for expanding energy supply by 2030, points to the need of building new nuclear plants in the Northeast and Southeast.

## **EMAE – EMPRESA METROPOLITANA DE ÁGUAS E ENERGIA**

The primary activity of the Empresa Metropolitana de Águas e Energia – EMAE (São Paulo Metropolitan Water and Energy Company) is the generation and marketing of electricity. It is proprietor and operator of the hydraulic and electric energy generation system located in the metropolitan area of São Paulo (Mid Tietê and Paraíba do Sul River Valley). The company deals with the planning, construction and maintenance of production systems, storage, preservation and marketing of energy and water dams. It has five hydroelectric and two thermoelectric plants in Brazil, and nearly 800 employees. Its hydraulic and electric generation system consists of reservoirs, channels, power plants and associated structures, that call for the rational use of surface waters and appropriate use of the significant available hydraulic resources that provide generation capacity at strategically located sites and charge centers that consider flood management and water preservation. Its origins date back to the British "São Paulo Railway, Light and Power Company Limited", founded in Brazil in 1899. Light's first hydroelectric power plant, the Parnaíba Power Plant, began operations in 1901.

### **Billings Reservoir**

Located in the highlands of greater metropolitan São Paulo, the Billings Reservoir encompasses areas of the Municipalities of São Paulo, Santo André, São Bernardo do Campo, Diadema, Ribeirão Pires and Rio Grande da Serra. With approximately 1.1 billion cubic meters of water (35 billion cubic feet, or more than 264 billion gallons), it is EMAE's largest accumulation reservoir. It was built in 1937 with the objective of receiving the waters from the Tietê and Pinheiros Rivers, by means of pumping action of the Traição and Pedreira step-up plants, in addition to the waters of its own basin, for the electric energy generation at Henry Borden Power Plant in Cubatão. In 1981, the reservoir was divided by means of the construction of the Anchieta Dam, at Riacho Grande, next to the Anchieta Highway, resulting in two compartments: the Pedreira and the Rio Grande. The objective of this division was to preserve the quality of the water of the Rio Grande compartment, from which SABESP collects water for general public supply. Designed for multiple uses, this reservoir system uses water to generate energy, provide public drinking water, manage flooding, support leisure activities, and more.

### **Billings-Pedras Dam**

The Billings-Pedras Dam is located between the Billings Reservoir and the Billings-Pedras Channel. This structure is intended to control the water flow from the Billings Reservoir to the Rio das Pedras Reservoir, where the water intakes of the Henry Borden Power Plant are located (in the city of Cubatão). The regulated discharges to the Rio das Pedras Reservoir are performed by three wagon-type floodgates, which supply a total flow rate of 400 cubic meters/second (14,125 cubic feet/second). It has a maximum height of 28 meters (92 feet) and a 359 meter-long ridge (1,178 feet).

## **Henry Borden Hydroelectric Power Plant**

The Henry Borden complex, located at the foot of the Serra do Mar, in Cubatão, encompasses two high (720 meters; nearly 2,400 feet) fall power plants, called External and Underground, with 14 groups of generators, powered by Pelton turbines, totaling an installed capacity of 889 MW, for a flow rate of 157 cubic meters/second (5,545 cubic feet/second).

**External Power Plant:** The oldest of the power plants encompasses eight penstock, and a conventional power house. The first unit was inaugurated in 1926, and the others were installed until 1950, totaling eight generation groups, with an installed capacity of 469 MW. Each generator is powered by two Pelton type turbines, activated by the waters driven from the Rio das Pedras Reservoir, which reach the Valves' Housing where, after passing through two butterfly valves by means of penstock, go down the hillside reaching their respective turbines, completing an approximate distance of 1,500 meters (nearly 5,000 feet).

**Underground Power Plant:** The Power Plant encompasses six generation groups, installed inside the rocky massive of the Serra do Mar, in a cave 120 meters long (394 feet), 21 meters wide (69 feet) and 39 meters (128 feet) high, with 420MW of installed capacity. The first generation group started operating in 1956. Each generator is powered by one Pelton turbine, activated by four water jets.

## **EPE - EMPRESA DE PLANEJAMENTO ENERGÉTICO**

The Empresa de Pesquisa Energética - EPE (Energy Research Company) is a government-owned company under the Ministry of Mines and Energy that aims to provide research services and support for the energy sector, such as electricity, oil and natural gas and its derivatives, coal, renewable energy sources and energy efficiency, among others.

One of the most important drivers for the creation of EPE was the rationing and blackouts that occurred early in the 2000's, due to lack of planning and drought. The blackout crisis was national in scope, affecting the supply and distribution of electricity. Major blackouts occurred on July 1<sup>st</sup>, 2001 and September 27<sup>th</sup>, 2002. Lack of rain during this period had left several dams empty.

At the beginning of the crisis, forced interruption of power supply were considered across the country. At the time, there was a great possibility of blackouts, especially in large cities. Fortunately, the application of these cuts, which would have produced severe losses to the Brazilian economy, were avoided – thanks, in large part, to the strong results of a campaign for the voluntary rationing of energy. Recently, Brazil has undergone successive blackouts due to lack of investment, primarily in equipment maintenance.

## **LSF-IEE – LABORATÓRIO DE SISTEMAS FOTOVOLTAICOS DO INSTITUTO DE ELETROTÉCNICA E ENERGIA DA UNIVERSIDADE DE SÃO PAULO**

The Laboratório de Sistemas Fotovoltaicos do Instituto de Eletrotécnica e Energia LSF-IEE (Photovoltaic Systems Laboratory of the Electrical and Energy Institute) at the Universidade de São Paulo is an accredited laboratory for the evaluation of photovoltaic modules in Brazil. Its facilities, which combine a solar simulator, a climate chamber, and a salt spray chamber, allow testing for approval of modules within the Brazilian Labeling Program (PBE) of the National Institute of Measurement, Standardization and Industrial Quality (INMETRO). In addition to the approval of modules within the Brazilian Labeling Program, its main fields of research include network connected photovoltaic systems, rural electrification, and power storage for pumping photovoltaic systems and for ice production systems.

## **ONS – OPERADOR NACIONAL DO SISTEMA ELÉTRICO**

The Operador Nacional do Sistema Elétrico – ONS (Operator of the National Electric System) is a non-profit entity created in 1998. ONS is responsible for coordinating and controlling the operation of generation and transmission facilities in the National interconnected Power System (NIPS) under the supervision and regulation of the National Electric Energy Agency (ANEEL). ONS is composed of associate members and participants that are focused on power generation, transmission and distribution and on importing and exporting from the basic grid.

NIPS installed capacity was 115,000 megawatts (MW) as of August 2011, 54% higher than its capacity of 74,800 MW in December 2001. This major increase required systemic coordination of the National Interconnected System (SIN) to ensure that the energy produced by the 2,475 generating plants in operation (as of July 2011) reaches consumers in a secure manner and to enable a continuous, quality supply that is affordable for all (universal service).

In order to operate the National Interconnected System, the ONS has five operations centers around the country. They must continuously work together to supervise and control the entire Brazilian electric energy matrix. To provide a better idea of this work, these centers oversee more than 49,000 maintenance operations per year, receive more than 40,000 meter readings every 4 seconds, record more than 10 million data readings per day, and have 761 operating instructions and 1,040 up-to-date diagrams at their disposal. Only 3% of electricity generation capacity is outside the SIN, in small scale electrical systems sized only to meet localized needs, mainly in the Amazon region.

## **TECSIS – WIND TURBINE BLADES COMPANY**

Since its founding in 1995, Tecsis has been a supplier of blades to the wind energy sector. It manufactures blades and related products for leading wind turbine producers worldwide. There are currently over 12,000 Tecsis blades operating in over 10 countries. More than 10,000 of Tecsis' blades operate in turbines with a power rating of 1MW or more.

The company is the second largest independent producer of blades worldwide and is the leader in the Brazilian industrial fans. Tecsis focuses on two markets through its Wind Energy Division and its Division of Industrial Fans. It exports approximately 87% of its products. Clients include some of the largest companies in the world: Siemens, Hamon Group, Companhia Vale do Rio Doce (CVRD) and Petrobras.

## **VOITH HYDRO**

Voith provides full-line service in the field of hydropower. The company has been building power plants for generations. Its range of solutions includes large hydropower plants, pumped storage power plants, small hydropower plants, automation systems and innovative technology for utilizing the energy of the oceans, the modernization of power plants, as well as full life cycle service. Voith produces at its own locations in Asia, Europe and North and South America. At four research and development centers worldwide, company engineers are working to create the electricity generation of tomorrow.

Voith produced its first turbine in 1870. In the following years, the company established its position in the German and then international hydro power markets. At the start of the last century, it received a very large order from Canada in Heidenheim to supply the turbines to the Ontario Power Company at Niagara Falls. Between 1903 and 1913, the company delivered 12 Francis spiral turbines to Canada. The twin turbines, each capable of over 12,000 HP, were among the largest and most powerful of the time. In 1910, the company installed a turbine at the Shi Long Ba hydro power plant in Yunnan province, China. This was China's first hydroelectric power plant.

## **Voith in Brazil**

Part of the Brazilian Federal Government's Growth Acceleration Program (PAC), the Estreito hydro project is considered one of Brazil's most important. Located in the northeast of the country, it will operate the largest Kaplan turbines ever manufactured in Brazil. Each of the eight 138.6 MW runners has a diameter of 9.5 meters. The first unit started operating in February 2012, with an additional unit scheduled to do online every two months.

The Peixe Angical project is located on the Tocantins River in the northeast of Brazil and is connected to the North-South Interconnexion for power supply. Voith supplied three Kaplan turbine generators with a total installed capacity of 452 MW. At 880 cubic meters per second, water runs through Peixe Angical's turbines generating enough electricity to provide four million people. In order to guarantee a safe operation of the plant, Voith equipped Peixe Angical with a monitoring system. By detecting vibration instabilities, analyzing the machine's behavior and - if needed - activating appropriate safety alarms, the system is able to secure and optimize the operation of all three machine sets.

Voith also supplied complete electro-mechanical equipment for the Brazilian hydro power plant of Baguari, which is located 600 kilometers north of Rio de Janeiro.

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## WORKING GROUPS & FINAL PRESENTATIONS

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The following guide for final presentations is designed to drive the discussion and learning of students during the course. Students will be divided in the following five sub-groups:

- A.** Distributed generation versus centralized generation: advantages and disadvantages;
- B.** Economics of power generation technologies: costs, capital investments, and maintenance costs;
- C.** Environmental impact of power generation: a comparison of different energy sources;
- D.** Integration of power generation technologies: co-generation, networks and smart grids;
- E.** A comparison between different sources for electrical energy from the point of view of production capacity: capacity factor, complementarities, firm energy.

<b>Name</b>	<b>School</b>	<b>Nationality</b>	<b>Group</b>
Anisa Li	Harvard College	USA	A
Arthur Santos	Poli-USP	Brazil	A
Canaan Khoury	Harvard College	Palestine	A
Elena Fumagalli Romario	Poli-USP	Italy	A
Luciana C. Mascarenhas	Poli-USP	Brazil	A
Antonio Sweet	Harvard College	USA	B
Bethany Kantan	Harvard College	USA	B
Bruno Erlinger de Oliveira	Poli-USP	Brazil	B
Edgar Bernardi Righi	Poli-USP	Brazil	B
Kevin Hernandez	Harvard College	USA	B
Natália Margarido	Poli-USP	Brazil	B
Fernando Beck	Poli-USP	Brazil	C
Giovanni Rincon	Harvard GSD	Colombia	C
Guilherme Menten	Poli-USP	Brazil	C
Kayla Shelton	Harvard College	USA	C
Mariana Santos	Poli-USP	Brazil	C
Stephen Lee	Harvard College	USA	C
Guilherme Cesar	Poli-USP	Brazil	D
Jason Smith	Harvard College	USA	D
Jessica Wu	Harvard College	China; USA	D
Junling Huang	Harvard SEAS	China	D
Natalia D'Alessandro	Poli-USP	Brazil	D
Fernando Coelho	Poli-USP	Brazil	E
John Azubuike	Harvard College	Nigeria; USA	E
Kim Smet	Harvard SEAS	Zimbabwe; Belgium	E
Ligia Silva	Poli-USP	Brazil	E
Pedro Ludovico Bozzini	Poli-USP	Brazil	E
Renan Mueller	Poli-USP	Brazil	E

**Group A:**

*Anisa Li, Arthur Santos, Canaan Khoury, Elena Romario and Luciana Mascarenhas.*



**Group B:**

*Antonio Sweet, Bethany Kanteen, Bruno Erlinger, Edgar Rigbi, Kevin Hernandez and Natália Margarido.*



**Group C:**

*Fernando Beck, Giovanni Romero, Guilherme Menten, Kayla Shelton, Mariana Santos and Stephen Lee.*



**Group D:**

*Guilherme Cesar, Jason Smith, Jessica Wu, Junling Huang and Natália D'Alessandro.*



**Group E:**

*Fernando Coelho, John Azubuike, Kim Smet, Lígia Monteiro, Pedro Bozzini and Renan Muller.*



At the closing ceremony of this collaborative course, each group of students will briefly present (15-20 min per group) its conclusions addressing the following points of view (*see student assignments in the chart at page 25*):

1. Give a brief presentation of the topic: definitions and impressions;
2. Comparison between U.S. and Brazil: advantages and disadvantages in terms of available resources, technical difficulties, and legal/institutional challenges;
3. Identify what you consider to be the main points in this subject;
4. How do you view further collaboration in this topic between our institutions?

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## PARTICIPANT BIOGRAPHIES

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*(Alphabetical by first name)*



**Anisa Li**

Harvard College, Class of 2014,  
S.B. in Mechanical Engineering

Anisa Li grew up in Petaluma, California, a small town near San Francisco. She is currently a junior at Harvard University, studying Mechanical Engineering, and interested in the design process and in engineering's interaction with and effect on society. She is interested in applying her studies to the environment and sustainable solutions, as well as to interactive installations combining art and engineering, geared towards being informative on scientific principles that have direct impacts, such as energy. She is passionate about art and volunteering, and is a design editor on the Harvard Crimson, as well as President of Stories for Orphans, a club that writes and illustrates individualized story books for orphans abroad. She is currently working on wearable devices at the Walsh Lab. One of her longest-standing goals is to travel everywhere possible, and she is excited to be spending her January term in Brazil.



**Antonio Sweet**

Harvard College, Class of 2014,  
S.B. in Electrical Engineering

Antonio Sweet, born and raised in Los Angeles, CA, is in his fourth year at Harvard College enrolled in the five-year in Electrical Engineering concentration with a secondary concentration in Economics. He is studying these fields to better understand alternative energy technology and energy markets in various parts of the world. He is very excited to explore and better understand energy production issues and methods during this course, particularly in the largest emerging economy in Latin America. Previously, Antonio has worked for Toyota U.S.A. in one of their strategic planning teams and was exposed to their plans for their alternative energy vehicle designs both for US and international markets. More recently, he was an intern for Sempra Energy, a public utility holding company whose focus is managing the natural gas and electrical grid for Southern California. He spent his time in their Energy Efficiency Strategic Planning department developing benchmarking methodologies and researching best practices and emerging technologies to help California residents reduce their resource consumption and meet new regulatory standards. At Harvard, Antonio serves as the Director of Undergraduate Affairs for the Society of Latino Engineers and Scientists (Harvard SOLES) and as a board member of the Pforzheimer House Committee. In his free time, he works on graphic design, music production and writing, and is a Brother and Executive Officer in Harvard's chapter of the Sigma Chi Fraternity.



**Arthur Santos**

3<sup>rd</sup>-year undergraduate student in  
Environmental Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Arthur Santos, a São Paulo native, began studying environmental engineering at Poli-USP in 2010. He is currently in his third year of the course. One of the motivating reasons for studying environmental engineering was to learn about the ways to produce energy from reusable sources, given that this is key in maintaining the population growth and the sustainable development of the country. During his free time, Arthur likes to play sports like rugby, swimming, and running. He also enjoys going out with his friends and playing electric guitar.



**Bethany Kanten**

Harvard College, Class of 2015,  
A.B. in Environmental Science and  
Engineering

Bethany is a second-year undergraduate at Harvard College concentrating in Engineering Sciences, with a focus in Environmental Science and Engineering. She was born and raised in Park City, Utah. Her academic interests lie in the field of renewable energy technologies, but she also enjoys courses in music, art, and religion. Bethany is a member of the Harvard Varsity Women's Soccer team with which she has won one Ivy League title. She is also a member of STAHR (Student Astronomers of Harvard- Radcliffe) and the Harvard Outing Club. In her free time, she enjoys all things outdoors; including soccer, running, biking, skiing, and hiking. Her life as a soccer player has drawn her interest to Brazil from an early age because of their passion for the game. Along with this and her interest in renewable energy technologies, Bethany is thrilled to be a part of the collaborative field course in Brazil in January 2013.



**Bruno Erlinger de Oliveira**

5<sup>th</sup>-year undergraduate student in  
Environmental Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Bruno Erlinger de Oliveira is a 5th year undergraduate student in Environmental Engineer at Poli-USP and his primary interests relate to waste management and renewable energy. He was born and raised in São Paulo, an upbringing that has inspired him to explore engineering solutions for the growing necessities of an increasingly crowded world. Bruno spent much of his free time during graduation teaching Math, Physics and Chemistry to high school students. He has taken time off to travel abroad, and loves meeting people from different cultures and sharing experiences. His personal interests include movies, American football, gourmet cooking, and following engineering science and environmental news. Professionally speaking, the course will progress his educational awareness of future research on new alternative energy sources and will enable him to continue performing in the field of energy in which he has worked. Since he took part in the third SEAS/Poli-USP Collaborative Field Course in 2012, Bruno wants to use this program as a continuation of his learning process and, by interacting and sharing experiences with participants, contribute to positive development through sustainability and profitability.



**Canaan Khoury**

Harvard College, Class of 2013,  
S.B. in Mechanical Engineering and  
Material Science

Canaan Khoury is a senior at Harvard College from the only remaining Christian village in Palestine called Taybeh. His goal is to explore and engineer renewable energy resources for sustainable development in Palestine and throughout the Middle East. Born in the USA and raised in Palestine, Canaan grew up tinkering with and training employees to use the machines of the only microbrewery in Palestine, Taybeh Brewing Co. There, he developed a passion for engineering that he is now pursuing through his Bachelors in Mechanical Engineering and Material Science. He is currently working on his thesis, Recycling for Energy: Using Soda Cans for Solar Water Heating, which involves using soda cans to construct solar heating panels in developing countries. Concurrently, Canaan has been a research assistant at Schlumberger Doll Research since last summer, where he has been studying diffusion. In his free time, Canaan enjoys brewing beer, playing table tennis, and traveling the world.



**Carlos Alberto Labate**

Associate Professor,  
Department of Genetics,  
Escola Superior de Agricultura Luiz de  
Queiroz da Universidade de São Paulo

Carlos Alberto Labate is an Associate Professor at the Department of Genetics at Escola Superior de Agricultura Luiz de Queiroz da Universidade de São Paulo (ESALQ-USP). Prof. Labate serves as reviewer for a number of journals, including the Journal of Tropical Ecology, Genetics and Molecular Biology and the Brazilian Journal of Animal Science. He has experience in the area of genetics, with emphasis on Physiological Genetics and Molecular Biology of Plants, acting on eucalyptus wood formation, photosynthesis, biotechnology and genomics, transcriptomics and proteomics. He holds a degree in Agricultural Engineering (1981) and MSc in Agronomy with focus on Plant Breeding and Genetics (1984) from the Universidade de São Paulo and a Ph.D. in Biochemistry and Physiology of Plants from the University of Sheffield (1989).



**Chad Vecitis**

Assistant Professor of Environmental  
Engineering,  
Harvard School of Engineering and  
Applied Sciences (SEAS)

Chad D. Vecitis is Assistant Professor of Environmental Engineering at Harvard's School of Engineering and Applied Sciences. Research in the Vecitis Lab focuses on the environmental implications and applications of emerging technology through investigations of the fundamental physical chemical processes behind these technologies. One area of his research interests is environmental nanotechnology with a focus on carbon nanomaterials such as fullerenes and carbon nanotubes (CNTs). Environmental implications of large-scale CNT use on aquatic chemistry and ecosystems will be investigated through examining their antimicrobial mechanism and aquatic photochemistry. Environmental applications of CNTs as electrochemically-active water treatment membranes for pathogen inactivation, pollutant oxidation, and in situ fouling reduction are also being investigated. Another area of research interest is environmental chemistry occurring at aqueous interfaces with a focus on the air-water interface. Interfacial reaction mechanisms and kinetics are often at variance with homogeneous chemistry due to mass transfer, molecular orientation, and catalytic effects. The air-water interface is important for advanced water treatment processes such as ozonolysis and sonolysis and the

reactions of gaseous atmospheric oxidants with aerosols. Prior to joining Harvard, Vecitis was a Yale Institute of Biospheric Sciences Postdoctoral Fellow working with Professor Menachem Elimelech. Professor Vecitis holds a B.S. in Chemistry from Johns Hopkins University and a Ph.D. in Environmental Physical Chemistry from the California Institute of Technology.



**Edgar Bernardi Righi**

3<sup>rd</sup>-year undergraduate student in  
Electrical Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Edgar Bernardi Righi is currently a third-year undergraduate student at the Escola Politécnica of the Universidade de São Paulo (Poli-USP) majoring in Electrical Engineering. He is interested in advanced computer programming, numerical analysis of mechanical systems, entrepreneurship and renewable energy sources. Due to his programming skills, Edgar won a silver medal in the Brazilian Olympiad in Informatics (OBI) in 2008. The following year, he attended Escola Avançada de Energia Nuclear, at Instituto de Pesquisas Energéticas e Nucleares (IPEN). After that, he started a research project about city waste gasification. This project was a finalist in FEBRACE 2010, an engineering fair organized by Poli-USP, and won the SOS Mata Atlântica prize. His current research topic is about computer modeling and simulation of acoustic transducers. In the future, he wants to extend his project to other electrical and mechanical systems, such as electricity generators and power lines, and increase their energetic efficiency. In his free time, Edgar engages in extracurricular activities and volunteer work. Furthermore, he likes to listen to music, play tennis, program computers and hang out with friends and family.



**Elena Fumagalli Romario**

4<sup>th</sup>-year undergraduate student in  
Environmental Engineering,  
Escola Politécnica da Universidade de  
São Paulo

Elena Fumagalli Romario is a fourth-year undergraduate student at Poli-USP. She was born and raised in Italy, where she graduated in Chemical Engineering, and she now lives in Brazil, where she is completing a double degree in Environmental Engineering. She also lived in the US for a year, attending her senior year of high school in Portland, Oregon. She is very interested in chemical processes, energy production and sustainable development. In particular, she is focusing her studies on bioenergy and wants to write her final thesis on biofuels. Since she arrived in Brazil, she has been actively exploring this subject, attending workshops about challenges and business opportunities in bioenergy, as well as the present situation and future possibilities of energy sources in Brazil. She aims to learn more about this subject during SEAS/Poli-USP Collaborative Field Course. She has been actively involved in social activities since 2006; she works as a volunteer for CISV International, an NGO that promotes peace education and global friendship, developing activities for youth on Human Rights, Conflict and Resolution, Identity and Sustainable Development. She has organized and participated in activities and projects in Indonesia, France, Philippines, Guatemala, Germany and Romania. During her free time she likes learning new languages, traveling, playing tennis, rock climbing, skiing and playing the piano.



**Fernando Beck**

2<sup>nd</sup>-year undergraduate student in  
Electrical Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Fernando Beck is a second-year undergraduate student at the Escola Politécnica da Universidade de São Paulo (Poli-USP) majoring in Electrical Engineering. He is interested in alternative energy production not only because it is crucial for the preservation of the planet, but also because he will discover the applications of the control and automation skills he will acquire during his studies. He currently works on a scientific research project, designing a railway gear simulator in order to study the consumption of electrical energy of trains and its possibilities for improvement. He has already participated in exchange programs and believes that international opportunities, such as this collaborative course between Harvard and the Poli-USP, will help him to build the knowledge to achieve his goals. During his free time, he enjoys practicing sports and spending time with his friends and family.



**Fernando Augusto Coelho**

4<sup>th</sup>-year undergraduate student in  
Environmental Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Fernando Augusto Coelho was born in São Paulo and is in the fourth year of Environmental Engineering at Escola Politecnica da Universidade de São Paulo. He was always interested in improving the course, participating in the Academic Center and representing students in the Department of Hydraulic Engineering. He volunteered as professor of mathematics in Cursinho da Poli. He has developed scientific initiation in the area of solid waste, focusing specifically on garbage collection. He loves to travel as much as he can and he likes to go to the beach to surf and be in touch with nature.



**Francisco F. de Castro Mello**

Post-Doctoral Fellow at Center of  
Nuclear Energy on Agriculture,  
Escola Superior de Agricultura Luiz de  
Queiroz da Universidade de São Paulo

Francisco Fujita de Castro Mello is a Post-Doctoral Fellow at the Center of Nuclear Energy on Agriculture, an institution based at the Universidade de São Paulo. His research is related to Land Use Change and greenhouse gas emissions resulting from sugarcane production in South Central Brazil. Results of this project will improve the scientific basis for promoting sound policies for sustainable development related to bioenergy production. Francisco is an agronomic engineer, having received his Master's degree in soil science and plant nutrition from Universidade de São Paulo in 2007 and a PhD in Chemistry in Agriculture and Environment in 2012. He is a 2011-2012 alumni Fellow in the Sustainability Science Program at the Harvard Kennedy School of Government.



**Giovanni Rincon Romero**

Harvard Graduate School of Design,  
Class of 2013,  
Master of Architecture  
in Urban Design

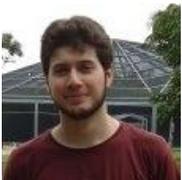
Giovanni was born in Cali, Colombia. He graduated as an architect in 2007 and worked in São Paulo for two years in sustainable civil construction. After experiencing the Brazilian culture, he traveled to Ahmedabad-India to study the challenges of infrastructure in developing countries and extreme socio-economic contexts. In 2010, he worked as a consultant for several master plans in the growing southwest region of Colombia. Currently at Harvard he studies the interactions between energy, water and urban growth. His future plans include participating in Colombian national priority projects and integrating strategic decisions from international project design. In his free time, Giovanni enjoys mountain sports and traveling.



**Guilherme A. Nogueira Cesar**

5<sup>th</sup>-year undergraduate student in  
Architecture, Urbanism and Civil  
Engineering, Poli/FAU-USP  
Escola Politécnica da  
Universidade de São Paulo

Guilherme Arruda Nogueira Cesar was born in the countryside of the state of São Paulo and is currently enrolled in the double undergraduate program between USP's Architecture and Urbanism School (FAU) and Poli-USP. He is primarily interested in natural resources and their correlation with two different scales: the macro-scale (the urban environment), and the micro-scale (the buildings that compound this environment, and how this relation impacts the dynamics of energy consumption, water use, resources consumption and social consequences). This double major experience reinforces his vision of the correlation between those scales and alerts how to take action, since the design phase is used to minimize the environmental and social impacts of the construction, operation and maintenance phases. He worked on a scientific research project about the Applicability of Parametric CADs in Practice and Teaching in Brazil, where he studied a specific software about Building Information Modeling (BIM) and its correlation with Brazilian standards. He participated in a workshop with IUAV (Università IUAV di Venezia) in 2011 on remodeling a favela area in São Paulo, which was then disseminated in the Brazilian Embassy in Rome. Outside of the classroom, his passions include playing piano, cooking and drawing.



**Guilherme Menten**

3<sup>rd</sup>-year undergraduate student in  
Environmental Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Guilherme Menten is a third-year undergraduate student at the Escola Politécnica da Universidade de São Paulo, majoring Environmental Engineering. He started studying materials engineering but after three years, transferred to environmental engineering to seek knowledge more applicable in his daily life. He just wants to have a good life- with good friends and plenty of good moments- and desires to make the world around him a better place for people to live, even if just a little. That is why he chose to study environmental engineering; it opens possibilities for him to have an economically good position and at the same time, help the society and the world. Outside the classroom, Guilherme spends his time with family and friends and plays online games.



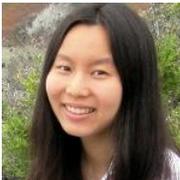
**Jason Dyett**  
Program Director, Brazil Office  
of Harvard University's David  
Rockefeller Center for Latin American  
Studies (DRCLAS)

Jason Dyett manages the activities and operations of the Brazil Office of Harvard's David Rockefeller Center for Latin American Studies (DRCLAS). He first moved to São Paulo in 1996, after two and a half years at the DRCLAS in Cambridge during the Center's launch. From 1997 to 2002, he established the Brazil office of the Economist Intelligence Unit's telecommunications research division and went on to gain experience growing technology companies backed by local and international investors. Jason rejoined DRCLAS from the Corporate Executive Board, a Washington, DC-based organization that provides executive education to public and private companies. Since the creation the DRCLAS Brazil Office in 2006, he and the Brazil-based team have worked to develop and strengthen opportunities for Harvard student and faculty engagement with Brazil in close collaboration with the Brazil Studies Program at Harvard University. He has a Master's of Business Administration (MBA) from the University of Chicago Graduate School of Business (2004) and graduated Phi Beta Kappa with a B.A. in Political Science and Spanish from the University of Vermont (1994).



**Jason Smith**  
Harvard College, Class of 2015,  
A.B. in Environmental Engineering

Jason Smith is a sophomore concentrating in environmental engineering at Harvard College. He was born and raised on his family's rural cattle ranch 17 miles outside the small town of Big Timber, Montana. Throughout his life, he has been interested in alternative energy and energy production, and in this course, he hopes to further those interests and learn more about the world. He spent the last summer working on the family ranch and recording data for a micro hydro-electric generator that he is co-installing on the ranch. Jason is the Vice President of the Mens Club Ice Hockey team at Harvard, as well as the treasurer of the Harvard College Agricultural Community (HCAC). He frequents the climbing wall and volunteers as a wall-staffer there.



**Jessica Wu**  
Harvard College, Class of 2014,  
S.B. in Mechanical and Materials  
Engineering

Jessica Wu was born in Taishan, China and was raised in Boston, Massachusetts. She is currently a junior in Leverett House pursuing a degree in Mechanical Engineering. She's spent her past two summers working in fire suppression and researching robotic navigation. As an alumna of last year's course, she looks forward to reconnecting with past participants, forming new bonds, and learning about the infrastructure of various types of power plants. Jessica has an affinity for languages – she has attempted Chinese, French, Italian, Latin, Japanese, and Bengali – and would like to learn some Portuguese. Jessica enjoys volunteering, rowing, and embroidering in her spare time.



**Jill Larson**  
Area Administrator for Environmental  
Sciences and Engineering,  
Harvard School of Engineering and  
Applied Sciences (SEAS)

Jill has a B.S. in Ceramic Engineering and worked in industry for 10 years, lastly as an engineering manager. She earned a Masters of Liberal Arts (ALM) in Business Management at the Harvard University Extension School. Jill started her career at Harvard in 2001 and joined the SEAS team in 2009. Among other responsibilities as Area Administrator in Environmental Sciences and Engineering, one of her functions includes working with students on community building activities.



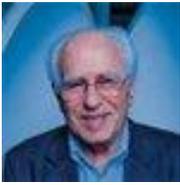
**John Azubuike**  
Harvard College, Class of 2013,  
A.B. in Engineering Sciences

John Azubuike is a fourth-year undergraduate at Harvard College concentrating in Engineering Sciences. He was born in Aba, Nigeria and was raised in the Bronx, New York. His academic interests include neurobiology, medical devices, and systems engineering. In his time with the Harvard-USP Field Course, John aims to learn about the different factors and stakeholders in the environmental development process and about the evaluation of risks and rewards in large scale building projects. He is the Vice-President of the Consent, Assault-Awareness, and Relationship Educators (CAARE) as well as the Secretary of the Harvard Society of Black Scientists and Engineers (HSBSE). His laboratory experiences include developing low-cost diagnostics equipment in George Whitesides Group, serving as the intern for the Harvard Center for Nanoscale Systems, and serving as a Harvard College Research Fellow developing and testing neural materials for prosthetic purposes. John has spent his summers researching bio-engineering topics, working in finance, teaching history and study skills to middle school students, teaching math and science to high school students. He is an avid fan of American football.



**José Carlos Mierzwa**  
Associate Professor of Environmental  
Engineering and Water Treatment,  
Escola Politécnica da  
Universidade de São Paulo

José Carlos Mierzwa is an Associate Professor of Environmental Engineering and Water Treatment at the Escola Politécnica da Universidade de São Paulo (Poli-USP). His area of primary expertise is in Sanitary Engineering, with a focus on Environmental Engineering, particularly in terms of water, waste water treatment, conservation, planning, management and environmental quality, and cleaner production. He has developed a number of research projects on water treatment systems (including direct drinking water treatment by spiral wound ultrafiltration membranes), waste stream management, industrial processes, and water conservation and reuse. In 1997 he participated in the International Extension Program at the University of California, Riverside, and in 1993 spent time at the International Atomic Energy Agency working on management of radioactive waste from nuclear power. Since 2007, he has been a reviewer in the Brazilian Higher Education National Evaluation System. Prof. Mierzwa earned a bachelor's degree (1989) in Chemical Engineering from the Universidade de Mogi das Cruzes and a master's in Nuclear Technology (1996) as well as a doctorate in Civil Engineering (2002) from the Universidade de São Paulo (USP). In 2011, Prof. Mierzwa was on leave from Poli-USP as a visiting researcher at Harvard's SEAS in Cambridge.



**José Goldemberg**

Professor, Instituto de Eletrotécnica e Energia, Universidade de São Paulo

José Goldemberg is an internationally recognized expert on energy and environment issues. He earned his Ph.D. (1954) in Physics from the Universidade de São Paulo, which he led as President from 1986 to 1989 after having directed the Energy Company of the State of São Paulo. From 1990 to 1992 he served the Brazilian federal government in various capacities: as Secretary of State for Science and Technology, then as Minister of Education, and finally as interim Minister of the Environment, during which he administered Brazil's participation in the 1992 Earth Summit in Rio de Janeiro and was responsible for ending Brazil's nuclear weapons program, which also led Argentina to shut down its program under a joint agreement. From 2002 to 2006 Dr. Goldemberg served as the Secretary for the Environment of the State of São Paulo. He currently presides the Council of Environmental Studies at the Federação de Comércio do Estado de São Paulo (Fecomercio). He was awarded the Volvo Environmental Prize (2000), the Blue Planet Prize (2008) from the Asahi Glass Foundation (Japan), and was honored by *Time* magazine (2007) as one of its "Heroes of the Environment", highlighting how Goldemberg in 1978 "co-authored a paper in the journal *Science* that showed the world what Brazil had discovered: that it's both possible and profitable to harvest a clean and renewable fuel, ethanol, from the country's abundant sugarcane." He has authored many technical papers and books on nuclear physics, environment, and energy and has served as president of the Brazilian Association for the Advancement of Science. Dr. Goldemberg also served as Chairman of the Editorial Board and a lead author of the UNDP World Energy Assessment, and spent time as a visiting professor at the University of Paris (France), University of Toronto (Canada), Princeton, and Stanford.



**José Rodolfo Scarati Martins**

Assistant Professor of Civil and Environmental Engineering, Escola Politécnica da Universidade de São Paulo

José Rodolfo Scarati Martins is currently an Assistant Professor at the Escola Politécnica da Universidade de São Paulo where he teaches courses on civil engineering, environmental engineering and architecture. He specializes in the areas of hydraulics, applied hydraulics, and water resources, with a particular focus on urban water drainage, water supply, mathematical modeling applied to hydraulics and flood control, including research on hydraulic transients for calibration and leak detection purposes. He is a coordinator at the Brazilian Association of Technical Standards (ABNT - Associação Brasileira de Normas Técnicas) and in 2005 was president of the Fundação Centro Tecnológico de Hidráulica (FCTH). Prof. Scarati Martins earned a bachelor's degree (1981) in Civil Engineering and a master's degree (1989) and doctorate (2002) in Hydraulic Engineering from the Escola Politécnica da Universidade de São Paulo.



**Junling Huang**

Ph.D. candidate in Environmental & Energy Sciences, Harvard School of Engineering and Applied Sciences

Junling Huang is a Ph.D. student at the Harvard School of Engineering and Applied Sciences. He received his undergraduate degree from the School of Physics, Peking University. His research interests include: renewable energy resources assessment and management; the effects of interconnection of geographically distant wind power bases on the variability of electricity supply; and analysis of

contemporary and historical budget of atmospheric CO<sub>2</sub>.



**Kayla Shelton**  
Harvard College, Class of 2013,  
A.B. in Mechanical Engineering

Kayla Shelton was born and raised in Detroit, MI. She is currently a Senior at Harvard College, concentrating in Mechanical Engineering with a Secondary in Spanish. Over the past two summers and a portion of her sophomore January Term, Kayla has been an intern at DTE Energy, a utilities company that distributes gas and electricity to residents in Michigan. There, she worked in the power plants as well as in gas pipeline integrity. When she graduates, she will continue to work with the company, now as a full time engineer and eventually, will pursue an MBA. Kayla hopes to learn more about the processes of water treatment and other environmental issues while taking this course. As Mentorship Chair for the Harvard Society of Black Scientists and Engineers, she is currently working on a project called Science Day, where high school students get college advice from undergrads and middle school students have the opportunity to work on science experiments. In the Winthrop House Committee, she is the leader of Winthrop Wednesday- a fun, interactive, dining event once a month that promotes community building. Along with participating on the Worship Team for the Black Christian Fellowship, she also serves as a tour guide for both the Harvard Admissions Office and the School of Engineering and Applied Sciences. As a participant of the program last January, she hopes to continue building on the knowledge and relationships she has already made.



**Kevin Hernandez**  
Harvard College, Class of 2014,  
A.B. in Environmental Engineering

Kevin Hernandez is junior at Harvard concentrating in Environmental Engineering from Covina, CA, a suburb of Los Angeles. Outside of the classroom, he gives tours as a member of the Crimson Key Society and sings in the Harvard Radcliffe Chorus. Previously, he rowed for two years on the beautiful Charles River as a member of the Lightweight Crew Team. He has also conducted research on the megacities of Asia, Africa, and South America with Harvard professor, Peter Rogers, looking for their ideal populations. When free time is available, Kevin enjoys playing beach volleyball, hanging out with friends, and going on adventures. In the summer of 2011, he traveled to Argentina and looks forward to returning to South America to explore the country of Brazil.



**Kim Smet**  
Ph.D. candidate in Environmental  
Engineering,  
Harvard School of Engineering and  
Applied Sciences

Kim Smet is a second year Ph.D. student in Environmental Engineering in the School of Engineering and Applied Sciences at Harvard University. She was born and grew up in Zimbabwe and previously lived in Vancouver, Canada, where she studied Environmental Science at the University of British Columbia. Upon graduation, she worked as a contaminated sites consultant to the petroleum industry in British Columbia for two years. Kim's current research is looking at several different aspects of flood risk reduction on the Mississippi River, including issues of financing as well as the incorporation of greater

flexibility in design.



**Ligia Monteiro**

4<sup>th</sup>-year undergraduate student in  
Environmental Engineering  
Escola Politécnica da  
Universidade de São Paulo

Ligia Monteiro is a fourth-year undergraduate student concentrating in Environmental Engineering at Escola Politécnica da Universidade de São Paulo (Poli-USP). She has great interest in topics related to energy and is looking forward to learn more about renewable and nonrenewable sources. She is also very interested in the sanitary field and would like to work either with sewage or water treatment in the future. Currently, she works on an undergraduate research project in the energy field, which aims to optimize hydropower generation using a Nonlinear Programming Model. In her free time, she likes to play the piano, watch movies and travel.



**Luciana C. Mascarenhas**

5<sup>th</sup>-year undergraduate student in  
Environmental Engineering  
Escola Politécnica da  
Universidade de São Paulo

Luciana has lived her entire life in São Paulo, but she loves to travel and learn about new cultures and places. She loves the environment, especially the ocean. She is currently an undergraduate student at Poli-USP, concentrating in Environmental Engineering. She's interested in learning more about sustainable urban and social development and alternative green technologies in water quality and solid waste. She intends to obtain a Masters degree in Europe. She participated in SEAS/Poli-USP Collaborative Field Course in Cambridge in 2012, and gained a lot from it. Outside school, Luciana likes to practice sports, such as volleyball and scuba diving. Right now she is organizing the Environmental Engineering Students National Meeting with other students from Poli-USP. She loves her school and hopes to make a difference in the world.



**Manoel Carlos Pereira Neto**

Program Analyst, Brazil Office of  
Harvard University's David Rockefeller  
Center for Latin American Studies  
(DRCLAS)

Manoel Carlos Pereira Neto joined the Brazil Office of Harvard University's David Rockefeller Center for Latin American Studies in March 2009. In 2008, he was selected by the U.S. Embassy in Brazil to become a Youth Ambassador in a program that targets students with leadership skills, positive attitude, proven social consciousness and academic excellence. During the program's trip to the United States, he met with public and private sector organizations and visited schools and social projects. Prior to moving to São Paulo, Manoel lived for two years in Curitiba, a city in the south Brazil, where he worked as an administrative assistant and coordinator for a web commerce company. In 2002, Manoel was awarded a Microsoft National Talents award for distinguished leadership in social entrepreneurship for volunteer work developed at his school's computer lab, when he was twelve. As a Program Analyst at the Brazil Office, Manoel is responsible for the coordination of events, programs and collaborative courses. He provides support for Harvard students, staff, and faculty as well as for overall office administration. Manoel is a senior at the Pontifícia Universidade Católica de São Paulo (PUC-SP), where he is earning an A.B in Business Administration.



**Márcia Azanha F. Dias de Moraes**

Professor, Department of Business,  
Economics and Sociology,  
Escola Superior de Agricultura Luiz de  
Queiroz da Universidade de São Paulo

Márcia Azanha Ferraz Dias de Moraes is currently a Professor at the Department of Business, Economics and Sociology at Escola Superior de Agricultura Luiz de Queiroz da Universidade de São Paulo (ESALQ-USP). She has experience in the area of economics, with emphasis on Industrial Organization and Industrial Studies, acting on sugarcane agribusiness, industrial organizations, sugarcane sector, and the labor market in this industry. Márcia is also a coordinator at GEMT, a extension research group on the agricultural labor market. In 2004, she was responsible in preparing a study for the World Bank on "Labour Market of Sugarcane Industry". Prof. Azanha holds a degree in Mechanical Engineering from the Universidade Estadual de Campinas - UNICAMP (1983), and M.A. in Economics (1996) and Ph.D. in Economics (1999) from the Universidade de São Paulo.



**Marcos S. Jank**

Board Member, ICONE - Instituto de  
Estudos do Comércio e Negociações  
Internacionais

Marcos S. Jank is a board member at the Brazilian Institute for International Trade Negotiations (ICONE). He was ICONE's founding president and also president and CEO of the Brazilian Sugarcane Industry Association (UNICA). For twenty years, Dr. Jank was a Professor at the Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo (FEA-USP), at the Instituto de Relações Internacionais da Universidade de São Paulo (IRI-USP), and at the Escola Superior de Agricultura Luiz de Queiroz da Universidade de São Paulo (ESALQ-USP). He has worked as Special Expert in Trade at the Integration, Trade, and Hemispheric Issues Division of the Inter-American Development Bank (IDB) in Washington, DC, and was a visiting professor at Georgetown University and at the University of Missouri-Columbia. Dr. Jank also held consulting and project coordination positions at the World Bank, IADB, the Food and Agriculture Organization (FAO), the United Nations Development Program (UNDP), the Organization for Economic Cooperation and Development (OECD), the Hewlett Foundation, the Swiss Development and Cooperation Agency (SDC), and the United Kingdom International Cooperation Department (DFID). He is a Counselor to the Presidency of the Republic of Brazil at the Economic and Social Development Council (CDES), a member of the advisory council to Brazil's Energy Planning Corporation (EPE), and a member of the advisory council of the Chamber of Foreign Trade (Camex). Dr. Jank is a member of the Inter-American Dialogue board of directors and of the Woodrow Wilson International Center for Scholar's Brazil Institute. Jank is also part of the Federation of the Industries of the State of São Paulo (FIESP), where he holds the position of Director of the Agribusiness Department and is also a member of the Council of Foreign Trade (COSCEX) and of the Council of Agribusiness (COSAG). Marcos Jank has published over 200 works and presented about 500 lectures in events in the country and abroad, and has over 20 years of experience in topics related to the sugar-ethanol industry. Dr. Jank received his Bachelor's degree in Agronomy from ESALQ-USP, a Master's degree in Agricultural Policies from IAMM, Montpellier, France, and a Ph.D. from FEA-USP.



**Mariana Ormelezi Santos**

3<sup>rd</sup>-year undergraduate student in  
Environmental Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Mariana Ormelezi Santos was born in São Paulo and raised in Atibaia. She returned to São Paulo when she was seventeen to pursue a degree in Environmental Engineering at the Escola Politécnica da Universidade de São Paulo. She is interested in researching ways to make better use of water resources, such as technologies of rational use and water reuse. She is working on an undergraduate research project in which she develops a conceptual model for decision making between nonpotable water centralized or decentralized systems. She is also member of the Organizing Committee of the XI Environmental Engineering Students National Meeting. In 2013, she will begin a double degree program at École des Ponts et Chaussées, in France. She received an academic award for being the best student of the final year of high school. Mariana likes to play sports in her free time; she has done classic ballet for ten years and she has taken part of the Poli-USP Athletics Team for one and a half years.



**Maurício Salles**

Assistant Professor,  
Department of Electric Energy and  
Automation Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Maurício Salles is Assistant Professor in the area of electrical machines at the Escola Politécnica da Universidade de São Paulo. From 2006 to 2008, he joined the researcher team of the Institute of Electrical Machines at the RWTH Aachen University, in Germany. He has experience with computational modelling and dynamic analysis of wind power in power systems and with Finite Element Method-based analysis of electromagnetic devices. His main interests are distributed generation, power generation, power system dynamics and stability, wind turbines, induction generator and renewable energy. He earned his bachelor's degree in Electrical Engineering from Universidade Presbiteriana Mackenzie. In 2004, he obtained the M.Sc. degree in the area of Wind Farms and Power Systems from the Universidade Estadual de Campinas (UNICAMP), and a doctorate degree at the Universidade de São Paulo, also in the area of Wind Power Generation.



**Michael Aziz**

Gene and Tracy Sykes Professor of  
Materials and Energy Technologies,  
Harvard School of Engineering and  
Applied Sciences (SEAS)

Michael J. Aziz has been a member of the faculty at what is now the Harvard School of Engineering and Applied Sciences since he joined in 1986 and is now Gene and Tracy Sykes Professor of Materials and Energy Technologies. Aziz has made significant contributions to a number of fields in applied physics and materials science. He is a Fellow of the American Physical Society, the American Association for the Advancement of Science, and the Materials Research Society. Among his research interests are novel materials and processes for energy technology and greenhouse gas mitigation. He is the Faculty Coordinator for Harvard's University-Wide Graduate Consortium on Energy and Environment, for which he developed a popular course on Energy Technology for a group of students in diverse disciplines. He received a Ph.D. in Applied Physics from Harvard in 1983.



**Monica F. A. Porto**

Full Professor and Chair, Department  
of Hydraulic and Sanitary Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Monica F. A. Porto is a Full Professor and current Chair of the Department of Hydraulic and Sanitary Engineering (PHD) at the Escola Politécnica of the Universidade de São Paulo (Poli-USP), where she has taught since 1984. She is also President of the Fundação Centro Tecnológico de Hidráulica (FCTH), and previously was president of the Brazilian Association of Water Resources (ABRH). She has been an active member of a number of major water organizations including the Global Water Partnership (GWP), the Stockholm International Water Institute (SIWI), and the International Water Resources Association (IWRA). She is a researcher of the Brazilian National Council for Scientific and Technological Development (CNPq) in urban water quality. Her areas of expertise include water quality and water management of reservoirs and rivers. Courses taught at USP include “Introduction to Environmental Engineering”, “Natural Resource Management,” and “Urban Water Systems”. Prof. Porto earned a bachelor’s degree (1978), a Master’s (1983), and a Ph.D. (1993) in Civil Engineering from the Universidade de São Paulo (USP), and carried out post-doctoral research in 1994 and 1995 at Colorado State University (CSU).



**Natália D'Alessandro**

3<sup>rd</sup>-year undergraduate student in  
Environmental Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Natalia Torres D'Alessandro is a third-year student in Environmental Engineering at Escola Politécnica da Universidade de São Paulo. Always dedicated and driven by challenges, in high school she participated in several scientific Olympiads, including outstanding showings in national Chemistry and Astronomy Olympiads. In 2009, she was selected to participate in the 2<sup>nd</sup> Advanced School of Nuclear Energy at the Institute for Energy and Nuclear Research (IPEN), where she learned about the different uses and implications of nuclear energy. In the second year of her undergraduate studies, she joined the Universidade de São Paulo’s extension project Bandeira Científica, of which she is presently the academic director. In an interdisciplinary nature, the project aims to improve the health of a city in the interior of Brazil. The engineering team is responsible for the complete study of infrastructure and sanitation conditions of the city and elaborates on projects and proposals for improvement. In the project, she has already experienced several Brazilian realities, such as the Amazon and northeastern backlands. Additionally, she participated in the World Summit Students for Sustainability 2012, which was held in Nairobi, Kenya and was organized by the World Student Community for Sustainable Development in partnership with the United Nations Environment Programme (UNEP)'s EETU. In 2013 she will complement her studies with a double degree program at Politecnico di Milano in Italy. She believes to gain the most complete training possible, it is essential to confront different realities, theories and technologies with respect to today’s challenges, which are ever more complex and interdisciplinary. She loves dancing, reading, traveling and spending time with family and friends.



**Natália Takahashi Margarido**

6<sup>th</sup>-year undergraduate student in  
Environmental Engineering,  
Escola Politécnica da  
Universidade de São Paulo

Natália is a sixth-year Environmental Engineering undergraduate student at Escola Politécnica da

Universidade de São Paulo, expecting to graduate in December 2012. She is specifically interested in the urban areas and its contemporary problems, such as the ones related to energy, water and waste management. She developed a scientific research project that analyzes the variability of electrical energy's cost in Brazil by correlating electricity demands and economic variables. She has previously interned within the contaminated areas management field and now she's getting experience within the environmental impacts assessment area. Between 2011 and 2012, she spent one year in Nancy, France, as part of an exchange program with an engineering school in the "Process, Energy and Environment" department. Natália was born in São Paulo, but lived almost ten years in Santos. She is passionate about traveling, and in her free time she also enjoys swimming, reading, cooking and spending time with family and friends.



**Nelson Kagan**

Full Professor, Department of Electric Energy and Automation Engineering, Escola Politécnica da Universidade de São Paulo

Nelson Kagan is a Full Professor at Universidade de São Paulo, where he has lectured since 1983. His main interests are related to power quality, electric power distribution networks, intelligent systems and smart grids. He has coordinated the Center for Regulation and Power Quality Studies at the University since its founding in 2000. He received his Bachelor's (1982) and Master's (1988) degrees in Electrical Engineering from the Universidade de São Paulo and his Ph.D. in Electrical Engineering from the University of London, UK (1993).



**Patrick Ulrich**

Assistant Director for Undergraduate Studies in Environmental Sciences and Engineering, Harvard School of Engineering and Applied Sciences (SEAS)

Patrick Ulrich is the Assistant Director for Undergraduate Studies in Environmental Sciences & Engineering at SEAS. He started in this position in June 2012, and prior to that he was a Graduate Student Researcher and Graduate Student Instructor at the University of California, Berkeley. His Ph.D. dissertation research studied the production and cycling of methylmercury in tidal wetlands in San Francisco Bay. As a graduate student, Patrick received two research fellowships, including a National Science Foundation Graduate Research Fellowship and a CALFED/Bay Delta Science Program Predoctoral Fellowship, and was awarded an Outstanding Graduate Student Instructor Award from the university for his work in a course on water chemistry. Patrick received a Ph.D. (2011) and M.S. (2006) in environmental engineering from UC Berkeley and a B.S. (2005) in physics from the Pennsylvania State University.



**Pedro Ludovico Bozzini**

5<sup>th</sup>-year undergraduate student in Environmental Engineering, Escola Politécnica da Universidade de São Paulo

Pedro Ludovico Bozzini is a 5<sup>th</sup>-year undergraduate student concentrating in Environmental Engineering at Poli-USP. He was born and raised in São Paulo, where his interest in problems of large urban centers began. Pedro took part in undergraduate research projects in Hydrology, focused on Hydroelectricity. He works at FTCH-USP with urban drainage. In the upcoming course, he expects to

learn more about energy production and the challenges of planning the system operation. During his free time, he likes to listen all kinds of music, play games, and watch movies.



**Racine Tadeu A. Prado**

Associate Professor, Department of  
Civil Engineering, Escola Politécnica da  
Universidade de São Paulo

Racine Tadeu A. Prado is an Associate Professor at the Department of Civil Engineering at Universidade de São Paulo. Since 1988, he has taught Building Physics and other matters related to building energy performance in civil engineering to both undergraduate and graduate students at the Poli-USP. He has developed several research projects in the area of sustainable buildings, including topics as thermal comfort and indoor air quality, building automation, solar energy for water heating, photovoltaics, solar concentrator collectors for air conditioning, steam and hydrogen production. Most of the projects were sponsored by the Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP (São Paulo State Research Foundation). Prof. Prado is also a researcher for the Brazilian National Council for Scientific and Technological Development (CNPq). He is a member of ABRAFAC (Brazilian Facilities Association), and also of ASHRAE (American Society of Heating, Refrigerating & Air Conditioning Engineers). Racine earned a Master's (1992) and Ph.D. degree (1996), both in Civil Engineering from the Universidade de São Paulo.



**Renan B. Muller**

4<sup>th</sup>-year undergraduate student in  
Electrical Engineering, Poli-USP -  
Escola Politécnica da  
Universidade de São Paulo

Renan is a fourth-year undergraduate student in Electrical Engineering with emphasis in Energy and Automation. Since his second-year, Renan has been engaged in the development of energy efficient medical devices, particularly in the optimal design of an energy transmitter for an artificial heart. This research awoke his interest for mathematical modeling and optimization methods. One of his goals is to apply such concepts to improve the efficiency of power systems. Renan is the student representative of his course. He also intends to pursue an academic career and become a professor. He was born in São Paulo and has lived in Bahia and Rio de Janeiro. In his spare time, he enjoys listening to music and playing basketball.



**Stephen Lee**

Harvard College, Class of 2013,  
A.B. in Biomedical Engineering  
and Computer Science

Stephen Lee, from Albany, California, is a senior undergraduate student at Harvard College studying biomedical engineering and computer science. After college he plans to enter the rapidly developing field of biotechnology. He wants this course to provide exposure to other engineering problems and solutions outside of biotech and looks forward to studying with the Brazil team and learning Portuguese. He is a calculus teaching fellow at the Harvard Extension School. He enjoys playing guitar, travelling and hopes to one day go to space.



**Steven Wofsy**

Abbott Lawrence Rotch Professor of  
Atmospheric and Environmental  
Science,  
Harvard School of Engineering and  
Applied Sciences (SEAS)

Steven Wofsy was born in New York City in 1946 and is currently Abbott Lawrence Rotch Professor of Atmospheric and Environmental Chemistry at Harvard University, Division of Engineering and Applied Science and Department of Earth and Planetary Sciences. He studied chemical physics at University of Chicago (BS, 1966) and Harvard (Ph.D. 1971), shifting to atmospheric chemistry in 1971. His work has focused on changes in the composition of the stratosphere and troposphere, at first in theory and modeling and later in field and laboratory studies. His current research emphasizes the effects of terrestrial ecosystems on the global carbon cycle, and the impacts of climate change and land use on ecosystems and atmospheric composition. Several projects focus on quantitative measurements of ecosystem carbon fluxes, for time scales spanning instantaneous to decadal and spatial scales from meters to thousands of kilometers, combining physical, chemical and biological methods. His awards include AGU's McIlwaine prize and NASA's Distinguished Public Service Medal.

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