

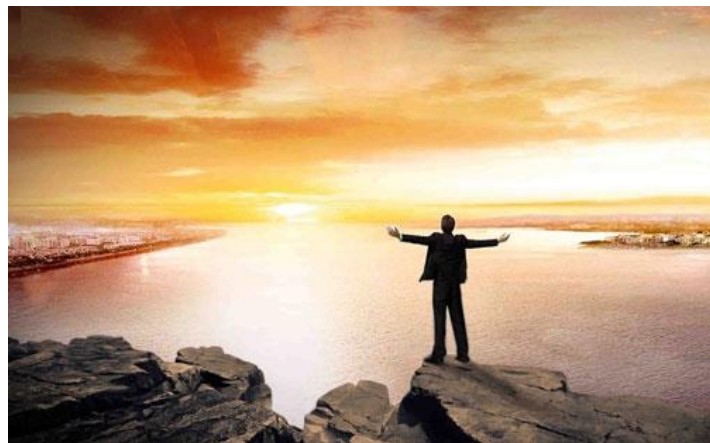


# 哈佛大学科研见闻及感悟

韩杏宁、廖诗武

2017-06-19

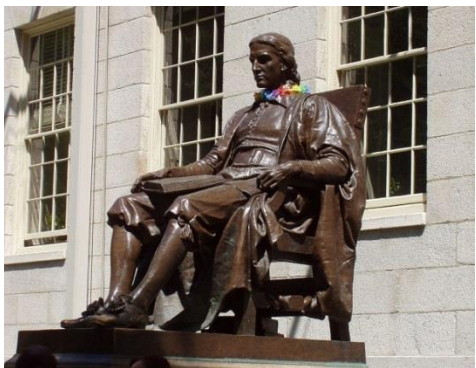
## 一、所见与所闻



## 二、感悟与思考



- 1636年 established New College
- 1639年 Harvard College



[John Harvard statue, Harvard Yard](#)



[校训: Veritas \(真理\)](#)















- 知名校友：8名美国总统、多国领袖和政治要员、62名富豪企业家、335位罗德学者
- 152名诺贝尔奖得主现在或曾经于Harvard学习或工作

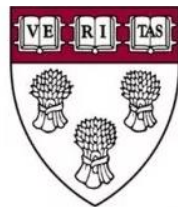
## ➤ 学院组成

College/school	Year founded
Harvard College	1636
Medicine	1782
Divinity	1816
Law	1817
Dental Medicine	1867
Arts and Sciences	1872
Business	1908
Extension	1910
Design	1914
Education	1920
Public Health	1922
Government	1936
Engineering and Applied Sciences	2007



## ➤ 学院院徽

 Harvard Business School	 Harvard College	 Graduate School of Arts & Sciences	 Harvard John A. Paulson School of Engineering and Applied Sciences
 Division of Continuing Education	 Harvard School of Dental Medicine	 Harvard Kennedy School	<u>Harvard Law School</u>
 Harvard Divinity School	 Faculty of Arts & Sciences	 Harvard Medical School	 Radcliffe Institute for Advanced Study
 Graduate School of Design	 Harvard Graduate School of Education	 Harvard T.H. Chan School of Public Health	



Harvard Law School 曾用院徽

Engineering and applied sciences at Harvard began with the creation of the **Lawrence Scientific School** in **1847** (named for donor [Abbott Lawrence](#)).

To support faculty and research in engineering applied sciences underwent several reorganizations (ranging from a graduate school, department (several), and division) and names (from DEAP to DAS to DEAS).

In **2007**, the University **transitioned the former Division of Engineering and Applied Sciences into a school**.

On June 3, **2015**, the school was renamed the Harvard John A. Paulson School of Engineering and Applied Sciences following a \$400 million gift by [Harvard Business School](#) alumnus [John A. Paulson](#).



## UNDERGRADUATE CONCENTRATIONS

- > Applied Mathematics
- > Biomedical Engineering
- > Computer Science
- > Electrical Engineering
- > Engineering Sciences (A.B. & S.B.)  
(Incl. Environmental Science & Engineering)
- > Mechanical Engineering

## GRADUATE PROGRAMS

- > Applied Mathematics
- > Applied Physics
- > Computational Science and Engineering
- > Computer Science
- > Data Science
- > Engineering Sciences  
(Incl. Environmental Science & Engineering)
- > Master in Design Engineering
- > MS/MBA

## RESEARCH

- > Applied Mathematics
- > Applied Physics
- > Bioengineering
- > Computer Science
- > Electrical Engineering
- > Environmental Science & Engineering
- > Materials & Mechanical Engineering
- > Science, Technology & Public Policy

## ELECTRICAL ENGINEERING

- + Circuits and VLSI
- + Computer Engineering and Architecture
- + Robotics and Control
- + Signal Processing

## ENVIRONMENTAL SCIENCE AND ENGINEERING

- + Atmospheric and Climate Measurements and Modeling
- + Energy and Environmental Technologies
- + Engineering, Economic Development, and Resource Management
- + Environmental Chemistry and Microbiology
- + Instrumentation and Field Measurements
- + Oceans and Geophysics
- + Pollution Monitoring

- **HARVARD-CHINA** PROJECT on Energy,  
Economy and Environment



<https://chinaproject.harvard.edu/home/>

- 成立于1993年
- Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS)



➤ **Project Chair: Prof. Michael B. McElroy**

• **Gilbert Butler Professor of Environmental Studies**

Research Interests:

- atomic physics
- planetary science
- atmospheric chemistry
- climate science
- global climate change mitigation
- power and energy science and policy
- challenges posed for sustainable development in China
- 250+ journal articles , 3 books
- 30+ articles in Nature and Science



➤ **Executive Director : Mr. Chris P. Nielsen**

- collaborating Chinese universities and across the schools of Harvard led by Prof. Michael McElroy



➤ **Program Administrator: Miss Tiffany Chan**

- 事务性工作（财务、办公环境、学术活动组织等等）

➤ **Faculty and Senior Researchers(30)**

➤ **Post-docs(4)**

➤ **Visiting Fellows/Students(17)**

## 主要研究方向

- 大气污染与温室气体研究
- 可再生能源及其并网研究
- 经济与政策
- 城市交通、土地使用以及环境健康
- 上述研究方向的交叉、综合

## ➤ 主要研究内容

- 大气污染物形成与控制
- 排放清单建立及污染源分析
- 雾霾成因及影响分析
- 大气污染物传输模型
- 全球大气环境及对人类影响

## ➤ 主要研究内容

- 风能资源潜力评估及接纳分析
- 热-电联合系统风电接入、电动汽车
- 可再生能源技术及生命周期污染情况研究
- 风电接入潜力及环境效益评估

- GEOS-5历史气象数据
- 地形条件（坡度、可用率）
- Capacity factor
- 年可发电量

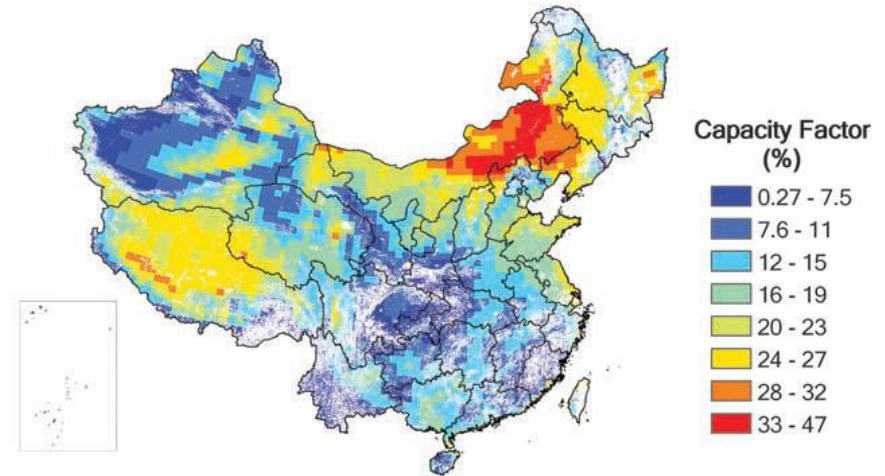
数据全面分析与处理

普适性结论的量化

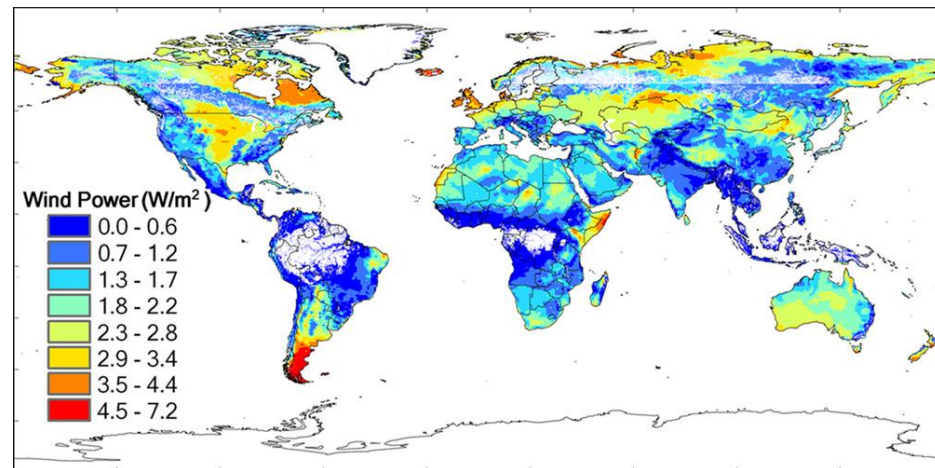
[1] Xi Lu, Michael B. McElroy, and Juha Kiviluoma. 2009. "[Global potential for wind generated electricity](#)." Proceedings of the National Academy of Sciences, 27, 106: 10933-10938s.

[2] Michael B. McElroy, Xi Lu, Chris P Nielsen, and Yuxuan Wang. 2009. "[Potential for wind generated electricity in China](#)." Science, 5946, 325: 1378-1380.

中国风电CF分布（采用1.5MW风机）



全球陆地风能资源分布



风电 2015	中国	美国
容量/GW	145.1	75
发电量/TWh	186.3	190.9

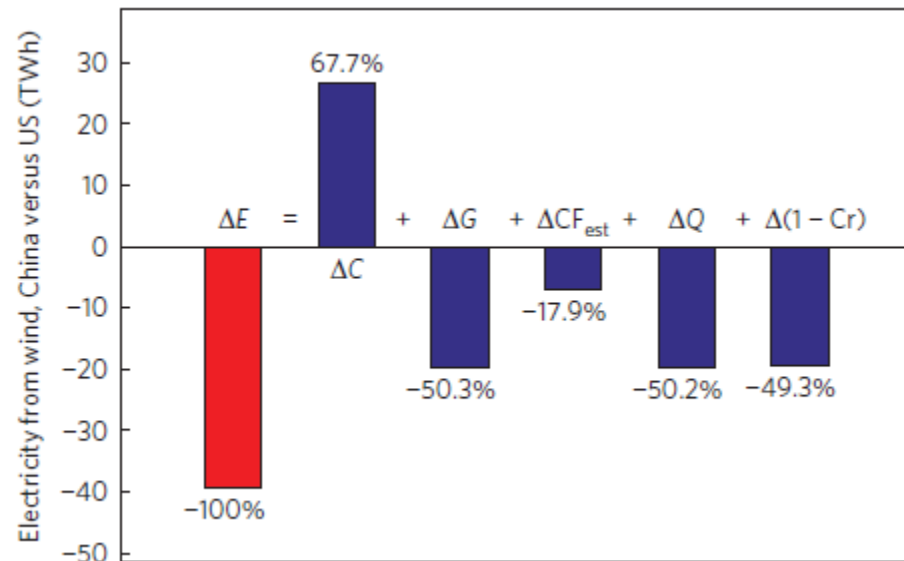
$$E = C_{OP} \cdot CF \cdot (1 - Cr) \cdot 8760$$

$$= [C \cdot G] \cdot [CF_{est} \cdot Q] \cdot (1 - Cr) \cdot 8760$$

C 装机容量；G 理论发电量；CF 发电因数；  
Q 质量；Cr 弃风率

于美国风电发展相比，中国

- 风电资源条件略差
- 风机质量相对较差
- 风电场并网工程发展滞后
- 电网灵活性较差



[1] Xi Lu, Michael B. McElroy, Wei Peng, Shiyang Liu, Chris P. Nielsen, and Haikun Wang. 2016. "[Challenges faced by China compared with the US in developing wind power.](#)" Nature Energy, 6, 1.

封面文章

问题研究

因素影响分析及量化

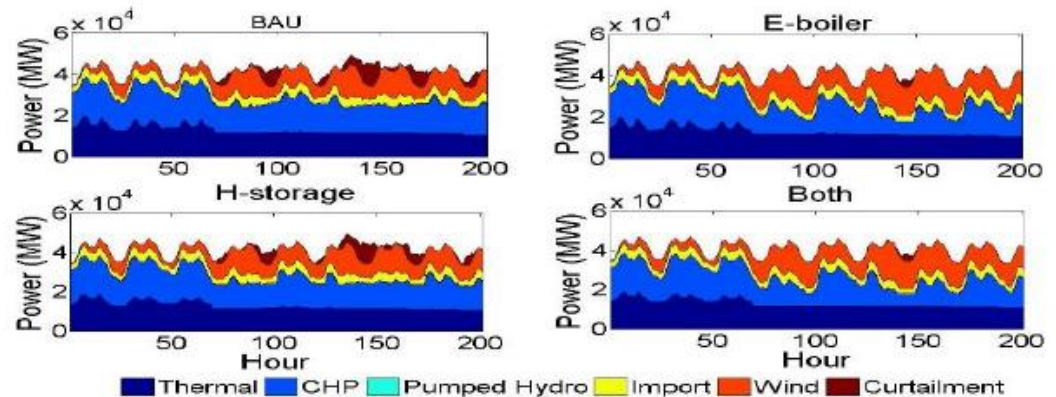
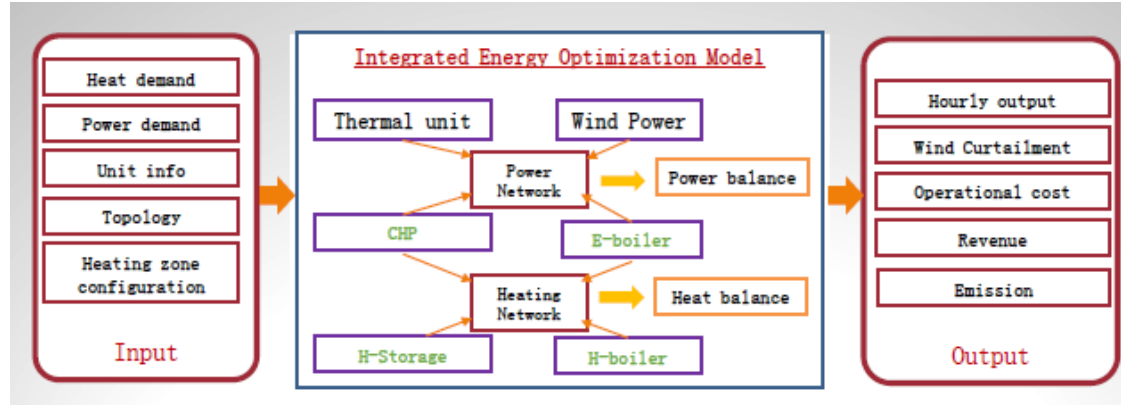
衍生政策建议

## 综合能源系统

- 减小弃风
- 时序电力平衡
- 时序及区域热力平衡
- CHP、电锅炉、储热装置

## 热力系统建模

与工程实际相关



[1] Xinyu Chen, Michael B. McElroy, and Chongqing Kang. Submitted. “[Integrated energy systems for higher wind penetration in China: Formulation, implementation, and impacts.](#)” IEEE Transactions on Power Systems.

[2] CHEN Xinyu, KANG Chongqing, Mark O’Malley. [Increasing the Flexibility of CHP with Heat Storage and an Electrical Boiler for Wind Power Integration in China: Modeling and Implications.](#) IEEE transaction on Power Systems, 2015.30 (4), pp.1848-1857.

[3] Ning Zhang, Xi Lu, Chris P Nielsen, Michael B. McElroy, Xinyu Chen, Yu Deng, and Chongqing Kang. 2016. “[Reducing curtailment of wind electricity in China by employing electric boilers for heat and pumped hydro for energy storage.](#)” Applied Energy, 184: 987-994.





- 初步结论：替代火电机组发电带来的碳排放减小占全生命周期产生的碳排放的一半。

## ➤ 主要研究内容

- 环境经济
- 能源经济
- 能源及环境政策
- 中国电力市场改革

## ➤ 主要研究内容

- 城市交通发展及其环境影响
  - Chengdu Survey 2005 vs 2015
- 土地使用及变迁情况研究

- 校际研究合作
- 城市级研究：成都市2000+家庭上门访问
- 研究形式：问卷调查
  - 问卷设计、样本选择、采访员培训等
- 人民交通出行行为的变化分析经济、城市化发展、土地使用、空气质量、环境影响等
- 2005年 vs 2016年 时间尺度上的发展变迁
  - 滴滴、uber
  - 地铁


**Director: William W. Hogan**

*Raymond Plank Professor of  
Global Energy Policy, Harvard  
Kennedy School*



能源：天然气、页岩气  
 电力：市场、电价、核电、  
 新能源（清洁能源计划）  
 政策：碳税、碳市场  
 巴黎协定

CONSORTIUM FOR  
Energy Policy Research at Harvard

 HARVARD Kennedy School  
 MOSSAVAR-RAHMANI CENTER  
 for Business and Government

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#### SEMINAR SERIES

[Spring 2017](#) | [Fall 2016](#) | [Spring 2016](#) | [Fall 2015](#) | [Spring 2015](#) | [Fall 2014](#) | [Spring 2014](#)  
[Fall 2013](#) | [Spring 2013](#) | [Fall 2012](#) | [Spring 2012](#) | [Fall 2011](#) | [Spring 2011](#) | [Fall 2010](#) | [Spring 2010](#) | [Fall 2009](#) | [Spring 2009](#) | [Fall 2008](#) | [Spring 2008](#)

#### Spring 2017

*Monday, February 6, 12pm-1:30pm*

**The Great Swap: Addressing Climate Change with a Carbon Tax**  
[Link to Summary](#)

Joe Aldy, Associate Professor of Public Policy, HKS  
 Bell Hall, 5th Floor, Belfer Building, HKS

Link to papers: [Long-term Carbon Policy: The Great Swap](#) and [Designing and Updating a US Carbon Tax in an Uncertain World](#)

*Monday, February 13, 12pm - 1:30pm*

**The Brazilian Power Sector**

[Link to Summary](#)

Mauricio Tolmasquim, Visiting Fellow, Harvard Electricity Policy Group, Professor, Federal University of Rio de Janeiro, and former President of Brazil's *Empresa de Pesquisa Energética* (Energy Research Company)  
 Bell Hall, 5th Floor, Belfer Building, HKS

*Monday, February 27, 12pm-1:30pm*

**Competitiveness Issues with a Carbon Tax**

[Link to slides](#)

[Link to Summary](#)

Gilbert Metcalf, Professor of Economics, Tufts University  
 Bell Hall, 5th Floor, Belfer Building, HKS

*Monday, March 6, 12pm - 1:30 pm*

**Carbon prices, preferences, and the timing of uncertainty** (work in progress)

[Link to slides](#) (note: this is a revised/updated version of the slides, as presented at Yale 4/26/2017)

[Link to Summary](#)

Gernot Wagner, Research Associate, Harvard's School of Engineering and Applied

#### SEARCH

Search this site

#### CONTACT

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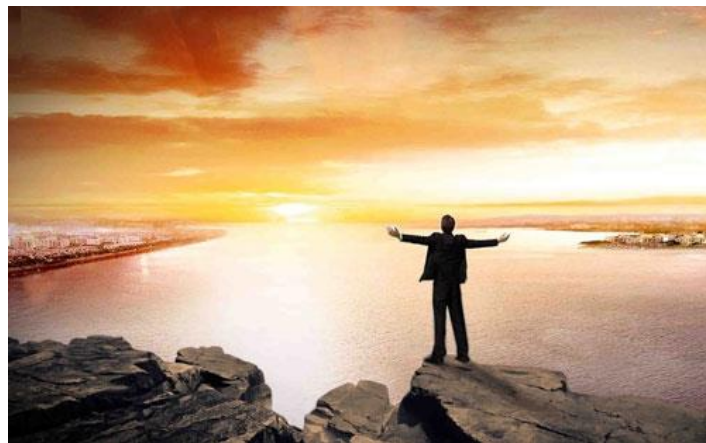
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## 一、所见与所闻



## 二、感悟与思考



## 表

- 硬件条件
- 学术交流
- 人员分工

## 里

- 科研动机
- 研究方法
- 工作氛围
- 精神氛围
- 服务精神

## 思考

- 科学探索
- 工程研究
- 变革图新



## 表

- 硬件条件
- 学术交流
- 人员分工

- 每层公用打印机
- 24小时
- 小厨房
- 超算（定期提供使用培训、答疑解惑）



## 表

- 硬件条件
- 学术交流
- 人员分工

- Seminars (学界、业界、政府)
- 各领域培训
- Ticket
- 响应速度
- 软件

## 表

- 硬件条件
- 学术交流
- 人员分工

- 大量行政人员
- 专人专责
- Director

心无旁骛做科研

## 里

- 科研动机
- 研究方法
- 工作氛围
- 精神氛围
- 服务精神

- 科研动机：求知
- 研究方法：问题导向；数据核心；合理假设；简单模型
- 工作氛围：轻松、高效、劳逸结合
- 精神面貌：活动、幽默、经历丰富
- 服务精神：志愿服务、积极主动

科研使人快乐

## 思考

- 科学探索
  - 工程研究
  - 变革图新
- 科研工程相结合
  - **以推动社会进步为目的**

**汇报结束，谢谢大家！**