中国的温室气体排放将使世界不堪重负吗？
Will China Overwhelm the World with its Greenhouse Gas Emissions?

马克·列文
Mark D. Levine
劳伦斯伯克利国家实验室
Lawrence Berkeley National Laboratory
For EESI
April 5, 2011

劳伦斯伯克利国家实验室的中国能源研究室
China Energy Group at Lawrence Berkeley National Lab

- 成立于1988 Established 1988
- 宗旨：中国能源研究室与中国以及其他国家地区紧密合作，以实现:

Mission: China Energy Group works collaboratively with groups in China and elsewhere to:
- 提高中国能效机构的运作能力
  enhance the capabilities of Chinese institution that promote energy efficiency
- 促进节能政策的发展
  assist in energy efficiency policy development
- 研究中国的能源使用动态
  research the dynamics of energy use in China.
主要成就 Key Successes

- 电器能效标准
  Appliance energy efficiency standards

- 工业节能自愿协议
  Voluntary agreements for industry efficiency
Major New Undertaking

Leadership of 5-yr program: U.S. China Clean Energy Research Center – Building Energy Efficiency

$25M over for 5 years U.S. side matched by equal contribution from China
中国的能耗和二氧化碳排放
Energy and Carbon Dioxide Emissions in China

从中国之外看中国
View from Outside China Looking in

好消息：第1部分
Good News Part I

1980-2002
这期间经济增长和能源消耗增长的“脱钩”并不是偶然的：这是由于中国于1979年制定的政策目标，同时也实施了一系列强有力的政策措施。

This “decoupling” between economic and energy growth was not an accident: it was a goal of China declared in 1979 and was accompanied by a collection of very strong policies.
坏消息
The Bad News

2002-2005

从2002到2005年期间，中国的能源强度（单位\textit{GDP}的能源消耗）出现了自1980年以来的第一次上升，并产生了显著影响。

\textbf{From 2002-2005, intensity (energy/unit GDP) increased for the first time since 1980 with very significant consequences}
中国的能源强度

平均每年下降5%
Average Annual Decline of 5% per year

平均每年上升5%
Average Annual Increase of 5% per year

美国和中国年均能源相关二氧化碳排放

- **Reasons for Dramatic Increase in Energy Growth**
  - Unprecedented construction boom: houses, commercial buildings, roads, rail
  - Entrance to WTO: export boom
  - Fruits of inattention to energy efficiency policy apparatus

中国钢铁和水泥产量
China’s Steel and Cement Production

中国的钢铁产量
China’s Steel Production
1990 – 2007

中国的水泥产量
China’s Cement Production
1990 – 2007

中国和美国的钢铁和水泥产量
China and U.S. Steel and Cement Production

中国的钢铁产量
China’s Steel Production
1990 – 2008

中国的水泥产量
China’s Cement Production
1990 – 2008

来源：中国钢铁协会；中国建筑材料工业协会；美国地质调查局。


百万吨
Million Metric Tons
Good News Part II
2005-2010

2005 Announcement by Politburo mandating a 20% energy intensity reduction in 5 years

Followed by similar statements and actions by the Premier, the National Peoples Congress, and NDRC

And a multiplicity of actions on the provincial and local levels

中国能源强度（1980年至今）
China’s Energy Intensity (1980-present)

1980-2002: Average Annual Decline of 5% per year
2002-2005: Average Annual Increase of 5% per year
2005-2009: 15.6% Decrease
几乎所有的政策都实现了它们的目标。

*Almost all of the policies achieved their goals*

实现降低20%能源强度所实施的政策

*Policies implemented to achieve the 20% energy intensity target*

**工业 Industry**

- 十大重点节能工程 Ten Key Projects
  - 燃煤工业锅炉（窑炉）改造工程 renovation of coal-fired industrial boilers
  - 区域热电联产工程 district level combined heat and power projects
  - 余热余压利用工程 waste heat and pressure utilization
  - 节约和替代石油工程 oil conservation and substitution
  - 电机系统节能工程 motor system energy efficiency
  - 能量系统优化工程 energy systems optimization
- 千家企业节能行动 Top-1000 Enterprise Program
- 关闭小火电和淘汰落后产能 Small Plant Closures
政策（续） Policies (cont)

建筑 Buildings
十大重点节能工程 Ten Key Projects
建筑节能工程 Incentives for energy efficiency and conservation in buildings
绿色照明工程 Energy-efficient lighting
政府机构节能工程 Government procurement of energy efficiency products
电器标准和能效标识 Appliance standards and energy-efficiency labels
加强建筑能源标准的实施 Enhanced enforcement of building energy standards
中国北方地区（寒冷地区）建筑节能改造 Heating energy retrofits in N. China
工业结构调整 Industrial restructuring

财政激励 Financial Incentives
中央政府奖励基金 Central government funds
地方政府奖励基金 Provincial government funds
节约每吨标煤奖励 200-250元的奖励项目 200-250 RBM/tce saved award program

对未来的想法 A View of the Future
2010-2050
**LBNL 中国能源研究室**
**终端能源消耗模型的结果**
**Results of LBNL China Energy End-Use Model**

四年努力的结果：周南（负责人）、范德维、郑昕、柯晶、蒲思琳和马克·列文
Four-year effort: Nan Zhou (lead), David Fridley, Nina Zheng, Jing Ke, Lynn Price, and Mark Levine

---

**Assumptions #1**

- **Urbanization:** 50% (now); projected to increase to 80% (2050)
  - U.S. 2008: 81.7%, Japan 2008: 66.5%
- **Population:** increase of only 80 million in 40 years
- **GDP Annual Growth Rate:** 7.7% (2010 – 2020); 5.9% (2020 – 2030); 3.4% (2030 – 2050)
  - U.S.: 2% in 2007, 0.4% in 2008. Japan: 2.4% in 2007, -0.7% in 2008
- **Production of cement, iron & steel, aluminum, glass, polyethylene and ammonia:** physical drivers
  - e.g. ammonia production is driven by sown area and fertilizer intensity
- **Car ownership:** cars owned per 1000 people—today: 470 in U.S.; 215 in Korea; 435 in Japan; for China in 2050, 250.
Assumptions #2

- **Urban residential floor area per capita**: 24 m² (today); 46 m² (2050)
  - U.S. 2005: 75.8 m², Japan 2003: 35.5 m²
- **Urban appliance saturation**: major appliances all close to saturation in 2009
- **Appliance efficiency**: U.S. levels in 2020; continued improvement
- **Commercial floor area per employee**: 52 m² – between current levels in Japan (36 m²) and the US (62 m²)
- **Building lifetime**: 30 years
  - U.S. commercial buildings: 65 – 80 years, Japan: 30 – 40 years
- **Renewable and nuclear energy capacity**: wind and nuclear will grow to 450 GW and 300GW respectively by 2050 in CIS, and 500GW and 550GW in AIS.
  - Wind: U.S. had 35.16 GW in 2009, Japan had 2.2 GW in 2009
  - Nuclear: U.S. 2008: 101 GW nuclear installed capacity, Japan 2009: 47.5 GW net capacity
- **Ultra super critical share of coal generation**: reaches 33% in 2020 and 83% in 2050 in CIS, and 42% in 2020 to 95% in 2050 in AIS
### Fleet of Transport Vehicles

- **2005:**
  - Buses: 11.2 million
  - Motorcycles: 173.9 million
  - Cars: 360.7 million

- **2030:**
  - Buses: 45.2 million
  - Motorcycles: 360.7 million
  - Cars: 685.4 million

- **2050:**
  - Buses: 58.4 million
  - Motorcycles: 585.4 million
  - Cars: 940.7 million

### Total Primary Energy Use by Sector

#### Continued Improvement

- **2000:**
  - Agriculture: 5.1
  - Industry: 5.2
  - Transport: 5.4
  - Commercial: 5.6
  - Residential: 5.8

- **2050:**
  - Agriculture: 5.1
  - Industry: 5.2
  - Transport: 5.4
  - Commercial: 5.6
  - Residential: 5.8

#### Accelerated Improvement

- **2000:**
  - Agriculture: 4.4
  - Industry: 4.5
  - Transport: 4.7
  - Commercial: 4.8
  - Residential: 4.9

- **2050:**
  - Agriculture: 4.5
  - Industry: 4.6
  - Transport: 4.7
  - Commercial: 4.8
  - Residential: 4.9

### Note

- The graphs illustrate the expected growth in fleet vehicles from 2005 to 2050, with a focus on the transition from Buses, Motorcycles to Cars.
- The energy consumption by sector is shown for continued and accelerated improvement scenarios, highlighting the trends in primary energy use.
Carbon Emissions Outlook for CIS and AIS Scenarios (without Carbon Capture and Storage)

两个情景下的碳排放预期（不考虑碳捕获与存储）

总一次能源消耗：与其他主流的预测分析比较

Note: Y-axis not scaled to 0.
ERI: China Energy Research Institute; IEA Conv: IEA convention for converting primary electricity; IND: Industry; OID: Other Industry GDP; CR: Growth Rate; MAC: Macroeconomics; DI Et: Other Industry Energy Intensity; HI P: Heavy Industrial Production; COM: Commercial; FA: Floor Area; LIC: Lighting & Other Intensity; LC: Low Carbon; RES: Residential; EAF: Electric Arc Furnace; TRA: Transport; EV: Electric Vehicles; CIS: Continued Improvement Scenario; OFA: Ocean Freight Activity; AIS: Accelerated Improvement Scenario
36

劳伦斯伯克利国家实验室的情景分析与其他分析之间的重要区别: 我们的分析显示中国的能源消费将在2025年（加速改进情景）或2030年（持续改进情景）开始进入一个平台期

**Important Difference between LBNL scenarios and the others: our cases show a plateau beginning around 2025 (AIS) or 2030 (CIS)**

The reason our results are from a modeling point of view is that our model has tremendous detail at the end-use level: We account for saturation and energy performance of appliances, heating and cooling equipment, buildings, individual industrial sectors, all types of vehicles.
结论 I Conclusions I

• 通常认为中国的二氧化碳排放将会在本世纪内持续增长，并且会成为世界最主要的排放国。我们认为不太可能出现这种情况，因为:
  • 电器、居民和商用建筑面積、公路、铁路、化肥使用等都将会在2030年的时间范围达到饱和
  • 城市化率将会在2030年或2035年之后接近峰值
  • 高耗能工业的出口将会降低
  • 人口增长趋缓

• It is a common belief that China's CO$_2$ emissions will continue to grow throughout this century and will dominate the world's emissions. We believe this is not likely to be the case because:
  • Appliances, residential and commercial floor area, roadways, railways, cement, steel, fertilizer use, etc. will saturate in the 2030 time frame
  • Urbanization growth rate peaks by 2030 or 2035
  • Exports of energy-intensive industry will decline
  • Low population growth

结论 II Conclusions II

• 到2025年之前，中国的能源需求增长非常不确定，因为中国将继续建设更多的基础设施
  Until around 2025 – energy demand growth will be highly uncertain in China as it continues to build out its infrastructure
  - 这与发达国家不同，发达国家可以依靠现有政策将能源增长维持在～1%
    - This is in contrast to developed countries who can count on an energy growth of ~1% with current policies

• 因此，对中国来说现在接受碳排放绝对值的限制是不合道理的。
  As a result, it makes no sense for China to accept an absolute cap on emissions at this time

• 而另一方面，降低碳排放强度是合理的，因为这保证了进步的空间，无论经济增长是否出现不确定性。
  Reduction of carbon intensity on the other hand makes sense, as this assures improvement regardless of uncertain economic growth rates
谢谢！！
Thank you!!