The Environmental Imperative of Nuclear Energy

Despite the Challenges

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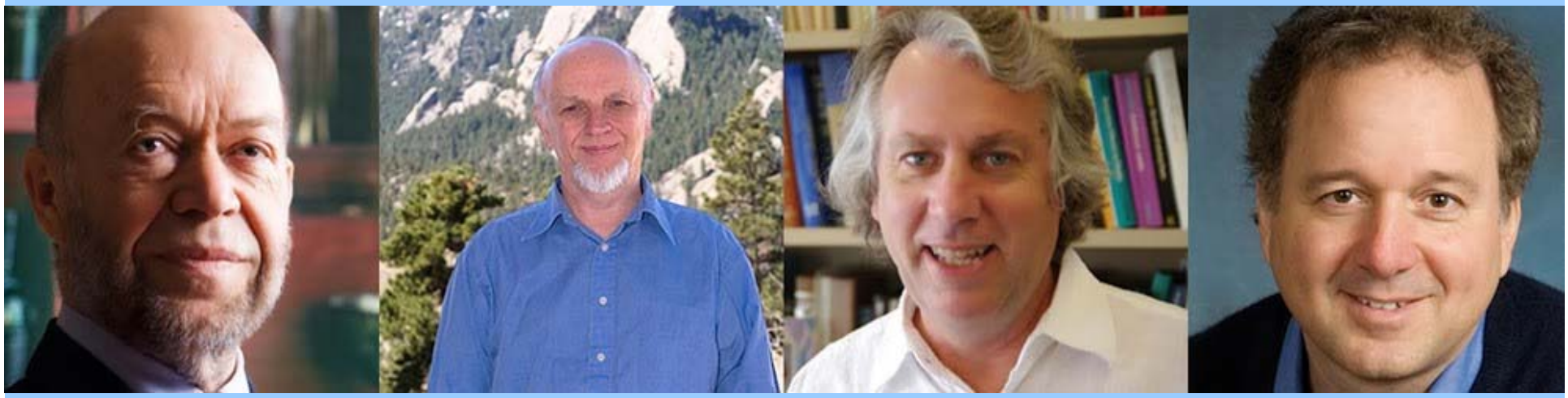
Past President

American Nuclear Society

Climate Scientists



James Hansen
Climate Scientist
Columbia University
Earth Institute

Tom Wigley
Climate Scientist
University of Adelaide
National Center of
Atmospheric Research

Kerry Emanuel
MIT Professor
Atmospheric
Scientist

Ken Caldiera
Senior Scientist
Dept of Global
Ecology
Carnegie Institution

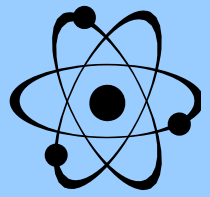
The Statement

To: Those influencing environmental policy

but opposed to nuclear power

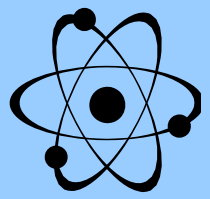
Purpose: "*Urge you to advocate the development and deployment of safer nuclear energy systems*"

Caution: "*Continued opposition to nuclear power threatens humanity's ability to avoid dangerous climate change*"



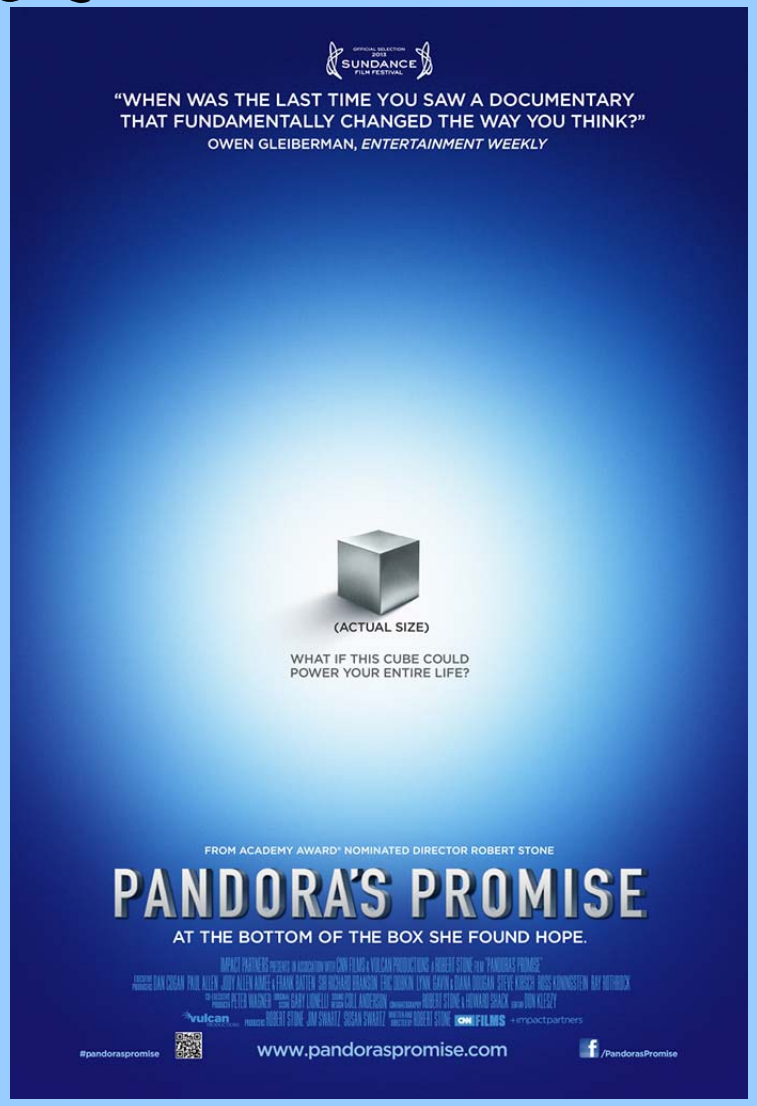
Key Points

- Renewables, solar and biomass will play a role but can not scale up fast enough to deliver reliable power economically
- Today nuclear power is far from perfect but there are modern new nuclear technologies that can reduce risk, deal with waste and be more economic.
- Nuclear needs to be encourage based on its *societal* benefits.



- There is NO credible path to climate stabilization that does not include a substantial role for nuclear power.
- Quantitative analysis shows that risk of nuclear plants are orders of magnitude smaller than fossil fuels.
- The time has come for a fresh approach to nuclear power in the 21st century.

https://plus.google.com/104173268819779064135/posts/Vs6Csiv1xYr



- Documentary Film on nuclear energy
- Directed by Robert Stone
  - "I've considered myself a passionate environmentalist for about as long as I can remember.“
- What if we got our views about nuclear energy wrong?
- Discusses views of environmentalists who now support nuclear power

Why Now ?

- Serious environmentalists are concerned about global climate change and recognize that to turn this around we need all sources including nuclear power
- They have researched the facts and concluded that we need nuclear energy if there is any hope of winning the climate battle.

Scientists and Engineers Letter

Richard Wilson
Former Chair
Dept of Physics
Harvard University

Neil Todreas
Former Chair
MIT Dept of
Nuclear Science
& Engineering

Richard Meserve
Former Chair US
Nuclear Regulatory
Commission

Andrew Kadak
Former President
American Nuclear
Society

Purpose

- To Support Climate Scientists Plea to Environmental Organizations
- Environmental scientists are not nuclear energy experts
- To provide a more technical foundation to their comments and typical concerns

http://www.slideshare.net/Revkin/dot-nuclear-1-2214-lettersigned-by-4-nuclear-scientists-and-engineers

Key Points

- Safety
- Cost
- Waste Management
- Proliferation Risk
- Life Cycle Emissions Analysis
- Accidents and impacts
- The Future
- Challenges

Safety

- Worldwide 432 Reactors supplying electricity to 32 nations without CO2 emissions
- Over 14,500 cumulative years of commercial reactor operation
- Three major accidents
  - Three Mile Island – operational error (1979)
  - Chernobyl – design and operational error (1986)
  - Fukushima – tsunami induced accident (2011)

Health Impacts of Accidents

- TMI – Stress on evacuated population
- Chernobyl – 28 workforce fatalities plus 3 to 4% additional cancer mortality in affected population – World Health Organization.
- Fukushima – World Health Organization Report (2013)
  - Outside affected areas –no observable increase in cancer
  - In most affected area – if exposed as infants, some increase in life time cancer risk of 4 to 7% and thyroid rate cancer rate goes from 0.70% + 0.50% for lifetime risk.

US Operating Record

- Nuclear plants performing at 90 % capacity (near maximum)
- No serious accident since 1979 (34 years)
- Continually apply lessons learned from
  - Three Mile Island
  - September 11, 2001 terrorist attack on US
  - Fukushima
- Many plant modifications and upgrades
  - To provide backup electricity & cooling water

Regulatory Oversight

- Nuclear Regulatory Commission stations 2 inspectors per plant
- Monitors performance daily
- Transparent process open to the public
- Continually upgrades regulatory requirements with changing information

Cost

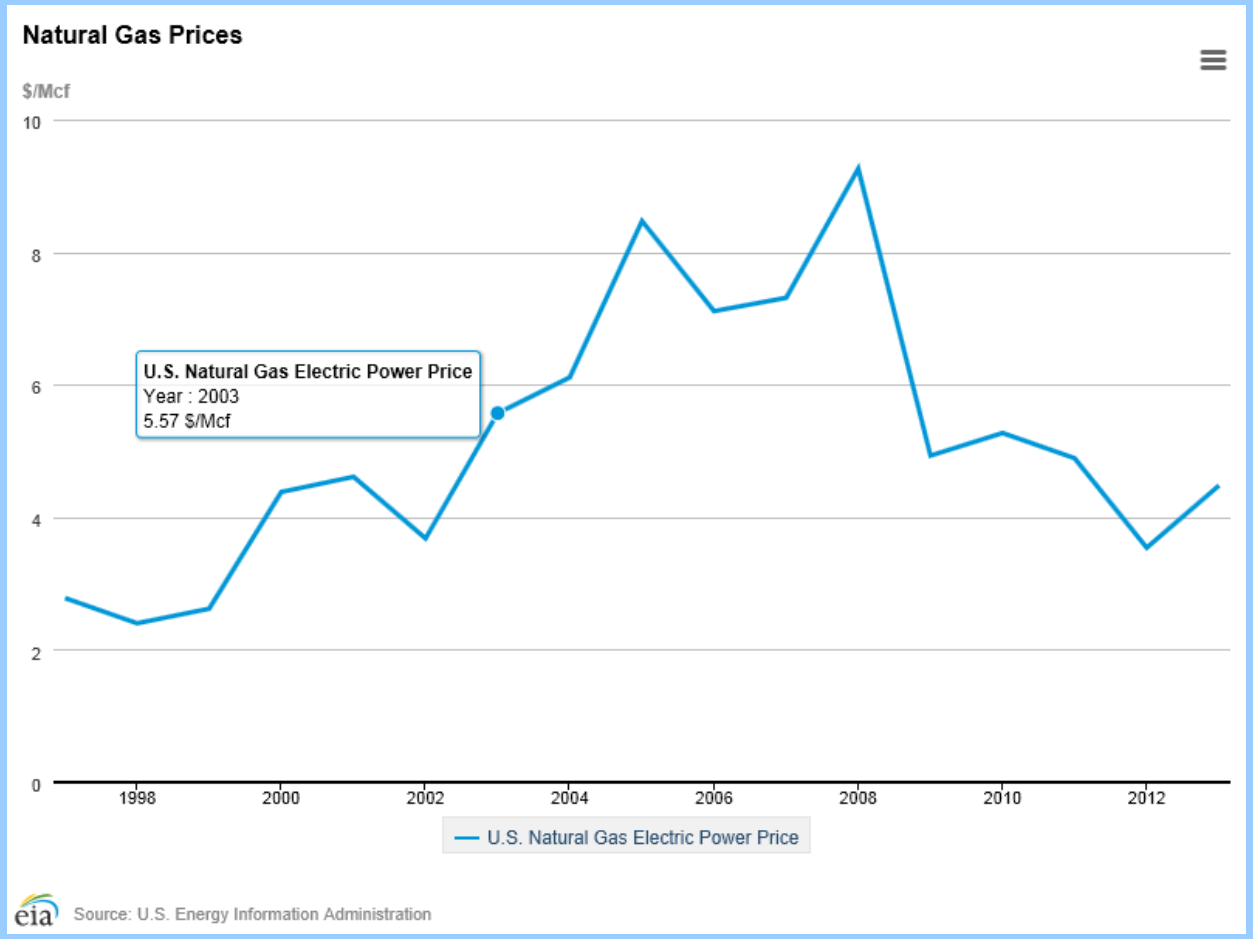
- Nuclear Power is a long term investment
  - 40 to 60 years
- More expensive to build than fossil plants but cheaper to operate – fuel cost less
  - Current production costs 2.4 c/kwhr (US)
- Offers predictable and not volatile cost of electricity
- New plants are expensive ~ $ 7 Billion
  - Cost of power estimate to be ~ 8.4 c/kwhr

Natural Gas

- A problem for the nuclear industry
  - Some old and new plants can not compete with low US gas price
  - Break even cost of new nuclear with gas is

    ~ $ 9.5/MMBtu (about 2 times current US price)
  - World price is about 3 times US price of natural gas

Price Volatility



Solar and Wind

- Heavily subsidized and still more expensive than new nuclear plants
- Not reliable capacity
  - Sun and wind issues
  - Need backup capacity
  - Considerably more land use
- Not scalable to meet future needs
  - Likely limited to 10% to 15 % of requirements

Waste Management

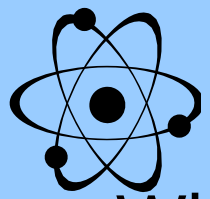
- Being safely managed at present at reactor sites and low level waste disposal facilities (US).
- Sweden and Finland have taken the lead o on consolidated storage and disposal solutions with repository plans.
- France leads in reprocessing and waste consolidation into vitrified glass logs.

US Situation on HLW Disposal

- Unfortunately Yucca Mountain project was “unfunded”.
- Now in a “start over” mode looking for interim storage sites and new disposal sites and new organization to take over.
- However, US court has told NRC to finish Yucca Mountain review.
- Waste disposal needs leadership from government to achieve political solution

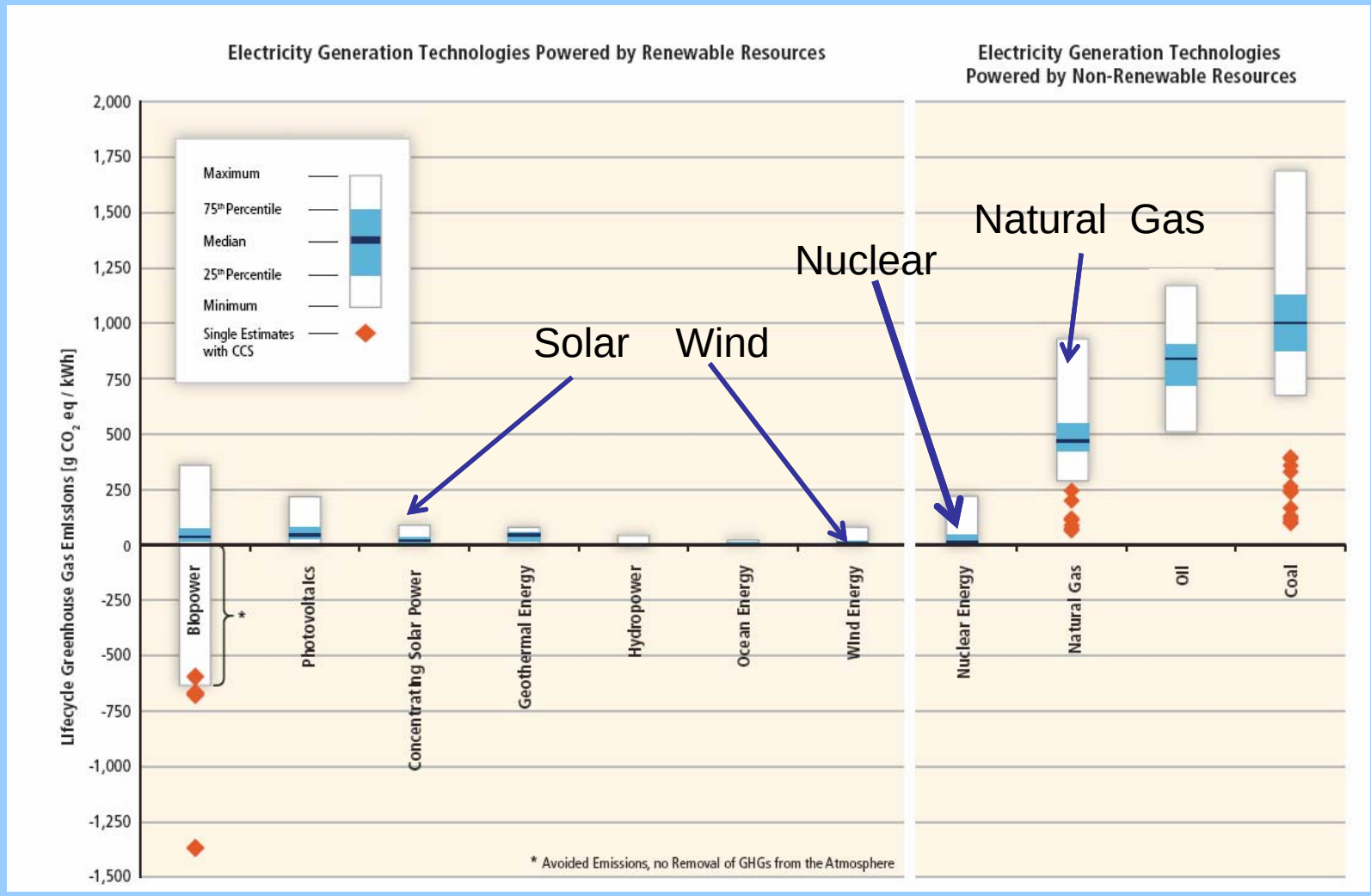
Proliferation Risk

- There is a risk that enrichment and reprocessing facilities can be diverted for weapons materials
  - International Atomic Energy Agency safeguards programs help prevent diversion by inspections and treaties.
  - New reprocessing technologies and reactor types can reduce risk
  - Commercial reactors however can not be easily modified for production of plutonium for weapons.



- While commercial nuclear programs can be used to mask initial covert weapons programs
  - Weapons development programs in most countries have be done independently, and prior to commercial deployment of reactors
  - Rogue nations such a North Korea can develop nuclear weapons without a commercial nuclear program
- Conclusion
  - Proliferation risk is not a compelling basis to oppose deployment of commercial nuclear plants.

Life Cycle Emissions Analysis



The Future Nuclear Technologies

- Small Modular Reactors
  - mPower – US
  - SMART – Korea
  - NuScale – US
- High Temperature Gas Reactors
  - Japan – HTTR
  - China – HTR-PM
- Others – Molten Salt (cooled and fueled), lead/bismuth, Sodium-PRISM, Traveling Wave, etc.
- Large New Light Water Reactors
  - AP1000, ESBWR, EPR, Mitsubishi APWR, ABWR

Pebble Bed Reactor Construction Site, China

Challenges

- Some believe:
  - Nuclear is too expensive to build
    - Still cheaper than wind and solar
  - Solar, Wind and conservation can do it all
    - No need for nuclear even if it is clean
  - Waste disposal is an insurmountable problem
    - Don’t build anymore until it is solved
    - Despite the politics preventing solution
  - Nuclear presents too many risks
    - Despite low overall risk compared to other technologies and human activity

Conclusion

- What do we say to the one Billion people that do not have electricity?
- Nuclear energy is scalable to meet future needs and environmentally comparable to renewable energy sources.
- We support the climate scientists in their efforts to bring this message to environmental and policy leaders.

Thank You

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