

French American Innovation Day

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Wind Energy

Universities and the

Energy Transition

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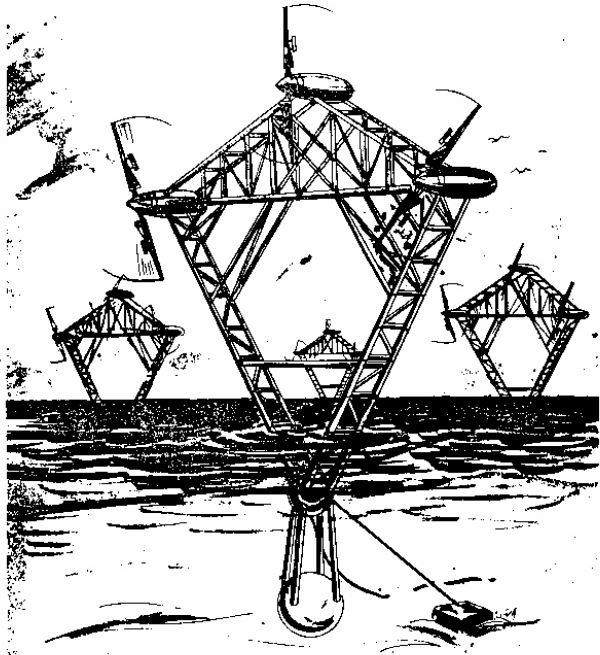


Synopsis

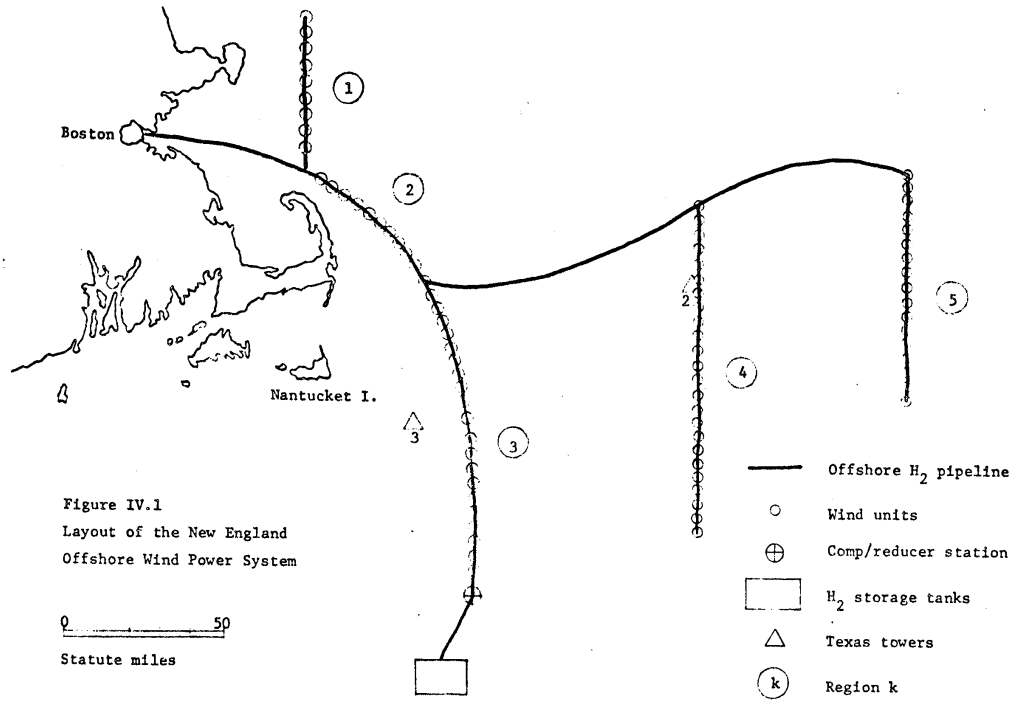
- Wind energy has evolved enormously since the 1970s
- Universities have played a major role in that evolution
- Wind will become major source the world's energy transition
- Evolution of wind energy is not over
- University research and education must continue at scale!



1970s Wind Energy Vision



POLLUTION-FREE ENERGY
FROM OFFSHORE WINDS



Prof. William Heronemus, UMass Amherst, 1973

1970s Wind Energy Reality



UMass Amherst WF-1, 1976

First wind farm, Crotched Mt, NH, 1980
US Windpower turbines, based on WF-1

Wind Energy in the 80s

- Small turbines
 - Poor reliability
 - High costs
- Progress
 - “School of hard knocks”
 - Science/engineering
 - Industry
 - National labs
 - Universities



Wind Energy Today

- Much larger turbines
- Much greater reliability
- Wind turbines are commercial
- Much lower cost of energy
 - Comparable to conventional sources



How Did This Happen?

- Better understanding of the wind itself and the turbine's response to it
- Rational design standards
- Detailed aerodynamic and structural dynamic design codes
- Application of information technology
 - Modern control, power electronics, better materials and understanding of those materials



Universities and Wind Energy

- Vision
- Fundamentals : science, math, engineering
- Research in all aspects of the evolution:
 - wind energy statistics, aerodynamics, structural dynamics, control, power electronics...
- Examples: computer codes, such as →
 - PROP, AeroDyn, YawDyn, FAST...



The Future

- International Energy Agency→
 - Wind: 50% of world's electricity by 2050
- Grand challenges remain!
 - Atmospheric science
 - Aero/structural dynamics
 - Energy system integration; all at large scale
- Addressing these challenges will require R&D+ education at the highest level



Path Forward

- Coordination/collaboration of university level research & education through, for example:
- European Academy of Wind Energy (EAWWE)
- North American Wind Energy Academy (NAWEA)



Extra Slides: Grand Challenges for Wind Energy



Grand Challenge 1

- Understanding the atmosphere: the science that resolves the physics of wind system behavior at all relevant spatial and temporal scales



Grand Challenge 2

- The aerodynamics, structural dynamics, and for offshore wind hydrodynamics of wind turbines must be fully understood at scales never before attempted.



Grand Challenge 3

- Systems science and control of wind power plants that form a foundation for the future electricity system
 - as the entire energy system is converted from fossil fuels- solid and liquid- to electricity

