

A Vision for Nuclear Science Education and Outreach



*An outgrowth of the Workshop on
Education & Public Outreach in Nuclear Science
Brookhaven National Lab, Dec. 1-3, 2006 and lots of community input.*



Process

- NSF and DOE Charge to NSAC includes:

“Education of young scientists is central to the mission of both agencies and integral to any vision of the future of the field. We ask NSAC to discuss the contribution of education in nuclear science to academia, medicine, security, industry and government, and strategies to strengthen and improve the education process and to build a more diverse research community.”

- The workshop looked at
 - What problems do we face?
 - Goals for meeting those problems must
 - Be actionable and achievable
 - Specifically address nuclear science needs
 - Build on existing strengths and programs
 - Concentrated in areas where as a community we can make an impact
 - Once we decided on goals, we discussed strategies for implementation
- We used the NSAC Education report and surveys therein as a starting point



Competitiveness

- 'Gathering Storm'[#] and other recent reports paint a dire picture for the future of America in S&T
 - Shirley Jackson calls it the "Quiet Crisis", driven by&:
 - **The decline in the number of young people interested and prepared to enter science and engineering.**
 - **The aging of the science and engineering workforce launched fifty years ago by Sputnik and the "Space Race."**
 - **And, post 9/11 policy and better opportunities abroad which make it harder to lure international scientists and students to work and study in America.**
 - The need for physical scientists is expected to increase by 14% from 2002-2012*.
 - Between 1973 - 2003 - in academia - the percentage of foreign-born staff in physical sciences doubled from 13 - 25% (all positions)*.
 - Indicators are that the number of foreign students planning to stay is leveling off or decreasing*.
- These reports have led to bipartisan support in Washington for increased funding for science, training more science & math teachers, etc.

<http://www.nap.edu/catalog/11463.html>

& <http://www.rpi.edu/homepage/quietcrisis/index.html>

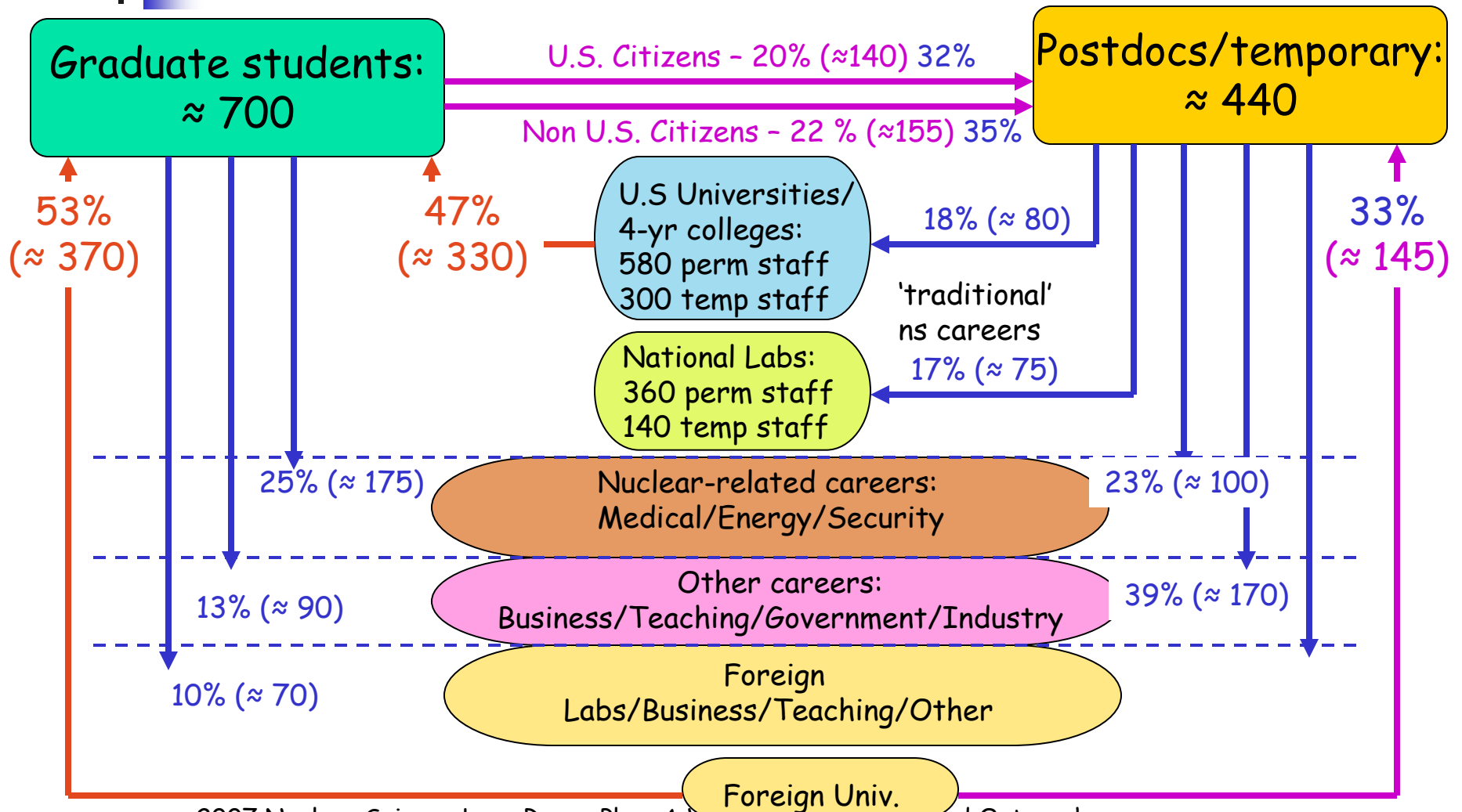
* <http://www.nsf.gov/statistics/seind06/>



Issues for nuclear science

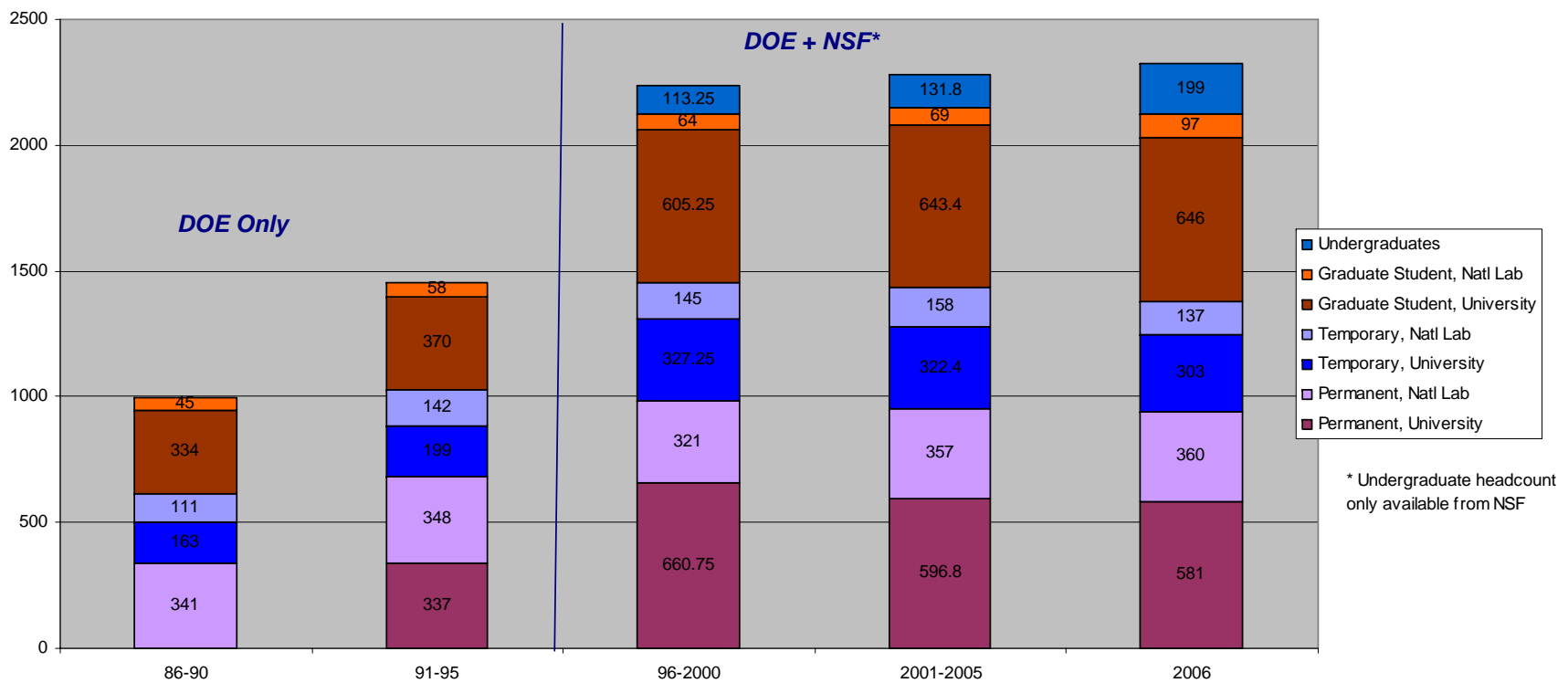
- Do we have the same problems as overall STEM disciplines?
 - Physics is only 0.2% of STEM disciplines and nuclear physics only 4% of physics, so maybe the issues don't apply to us
 - We know we have severe problems in nuclear chemistry, but what is the overall health of field?
- Will there be an increased need for nuclear scientists in the future?
 - In basic research in nuclear science
 - In applications important to society
- Will there be an increased need for U.S. nuclear scientists in the future?
 - Will we be able to continue to import talent?
 - Do we have the obligation to train students to meet societal needs?
 - Can we find an effective way to improve the diversity of our workforce?
- Is it necessary to the health of our field to attack the public perception of the word 'nuclear'?
 - Can we make nuclear science exciting to the general public, or K-12 students and teachers?
 - Can we convey its value to society?

Snapshot of NS Pipeline - 2006



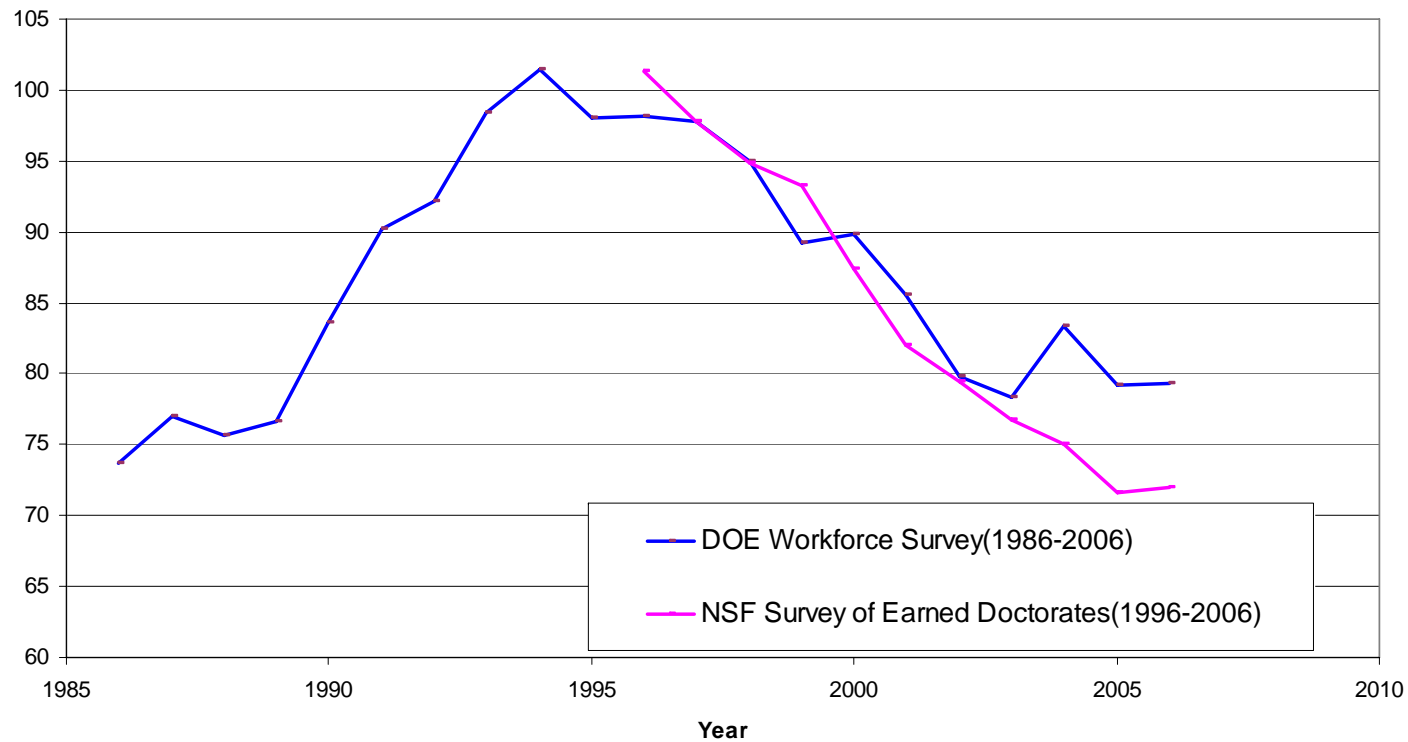
Workforce trends

Nuclear workforce supported by DOE and NSF NP grants (headcount)

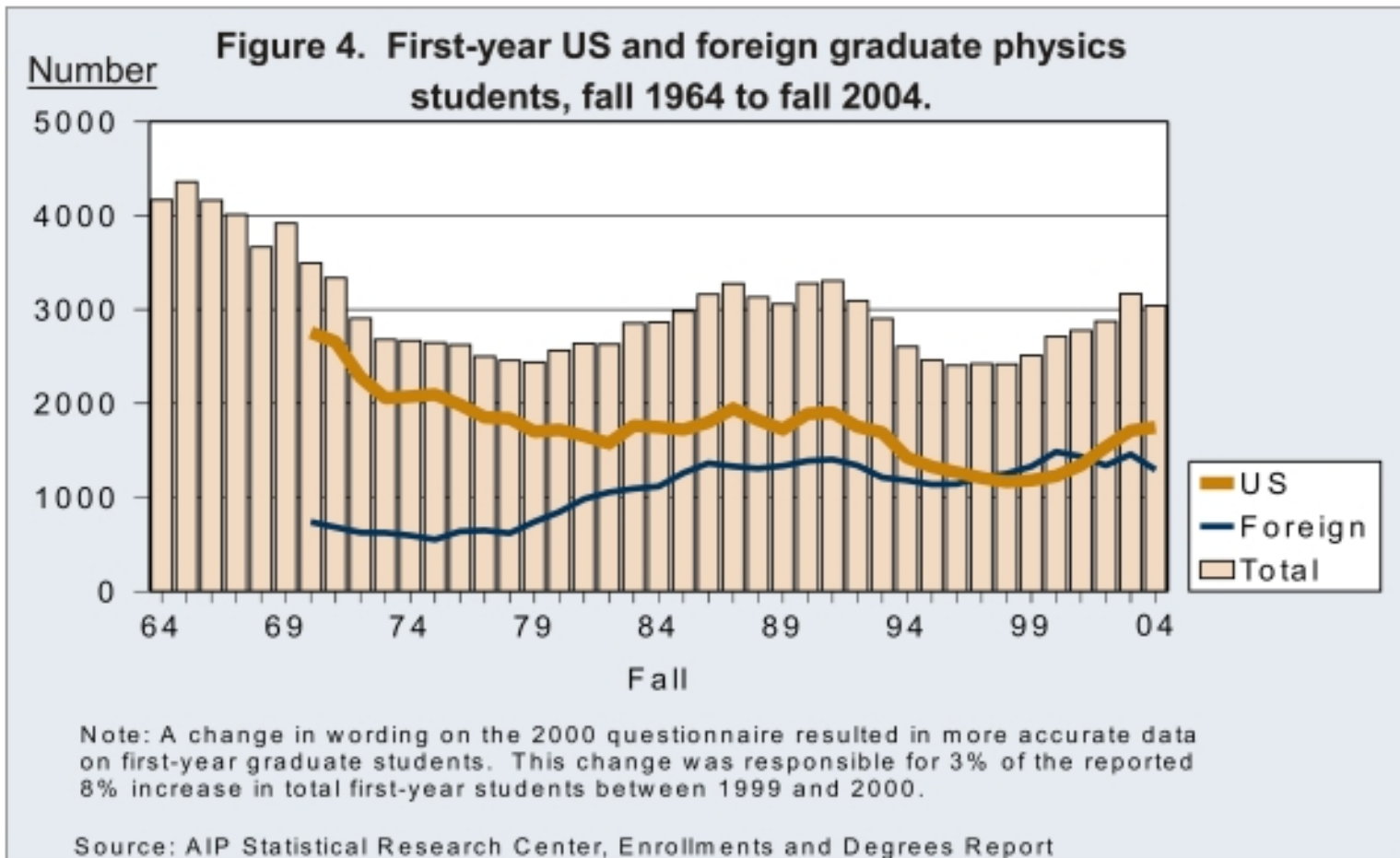


Nuclear Science PhDs

PhD's Awarded (running 5-year average)



Physics graduate students



Have we improved in attracting diversity?

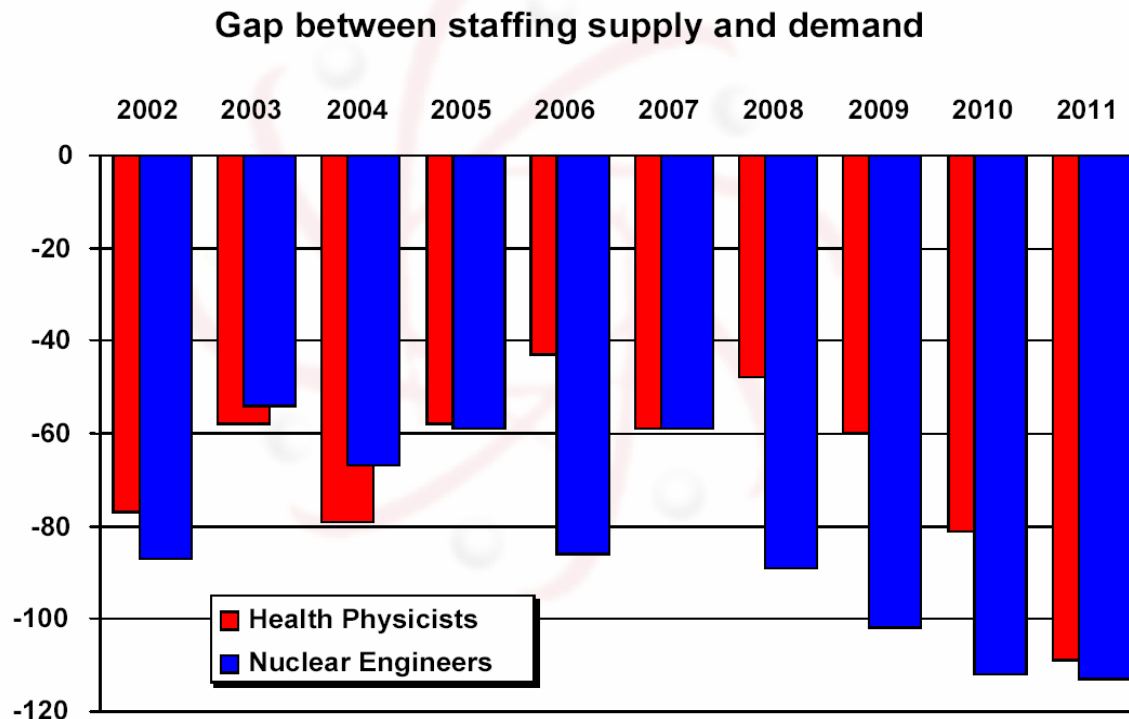
Source	DOE 2006 Workforce Survey*		NSAC Education Report, PhDs 5-10 years out
Gender	U.S citizen	Non-US citizens	U.S Citizens
Male	81%	88%	88%
Female	19%	12%	12%
Race			
Caucasian	90%	69%	90%
Asian or Asian American	5%	30%	1.2%
Black or African American	1%	0%	1.2%
American Indian or Alaskan native	0%	N.A.	1.2%
Hispanic	4%	1%	0.6%
Mixed race or ethnicity	-	-	6.2%

Report to NSAC, P. McMahan, 3/8/2007

* Based on 169 PhD graduates in 2005/2006

Nuclear energy and health physics

Actual staffing gap rises to more than 100 HPs
and 100 nuclear engineers by 2011



Significant efforts
have been made to
increase
undergraduate
nuclear engineering
enrollments.

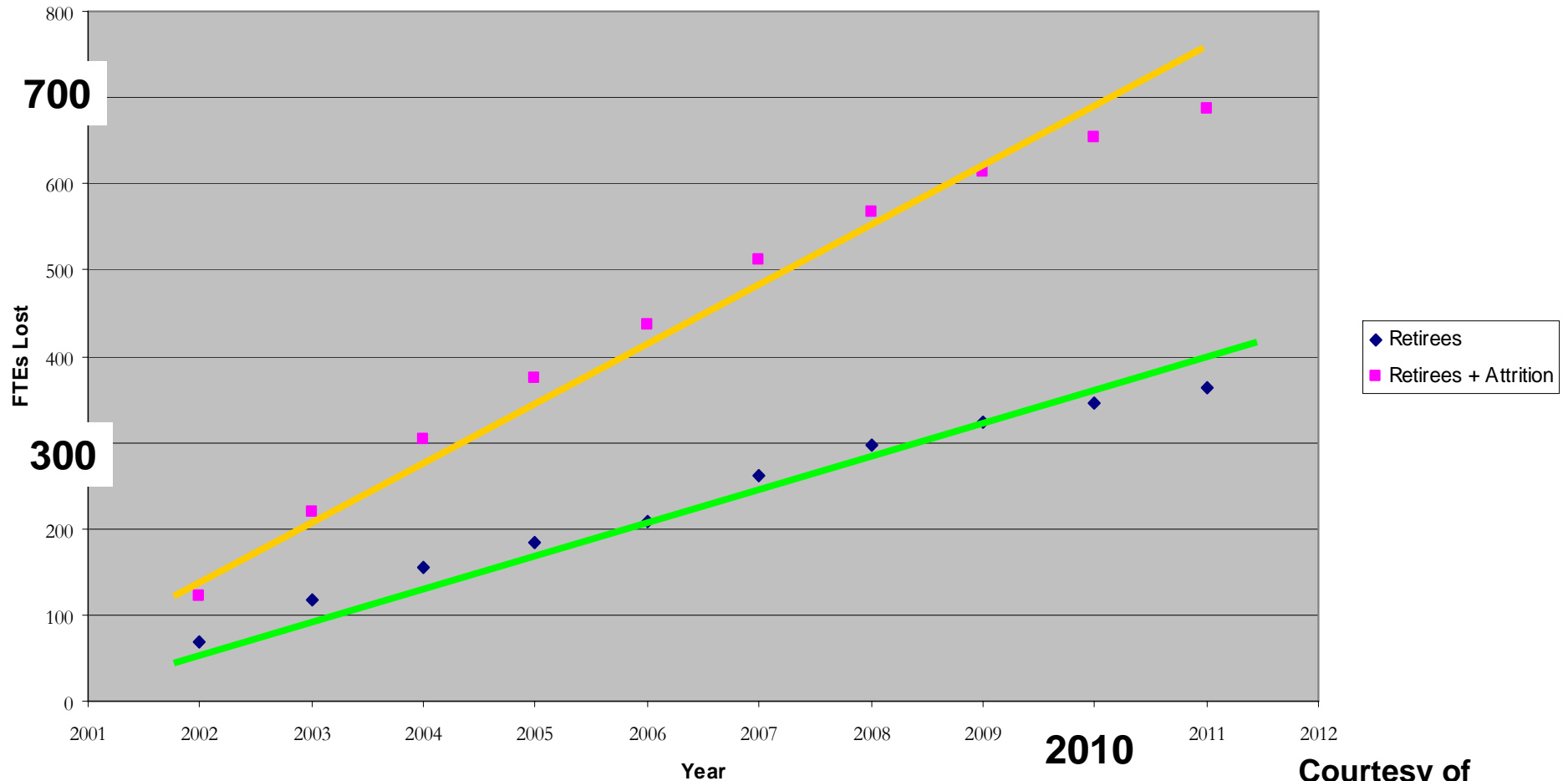
40 M\$/y for a 10 to
20% increase in
undergrads

*Source: ANS Task Force on
Nuclear Workforce*

Nuclear Energy Institute estimates that over the next 10 years in order to maintain the current nuclear capabilities the nuclear industry will have to hire 11% of all mechanical engineers (compared to the current 3%).

DOE Nuclear Workforce

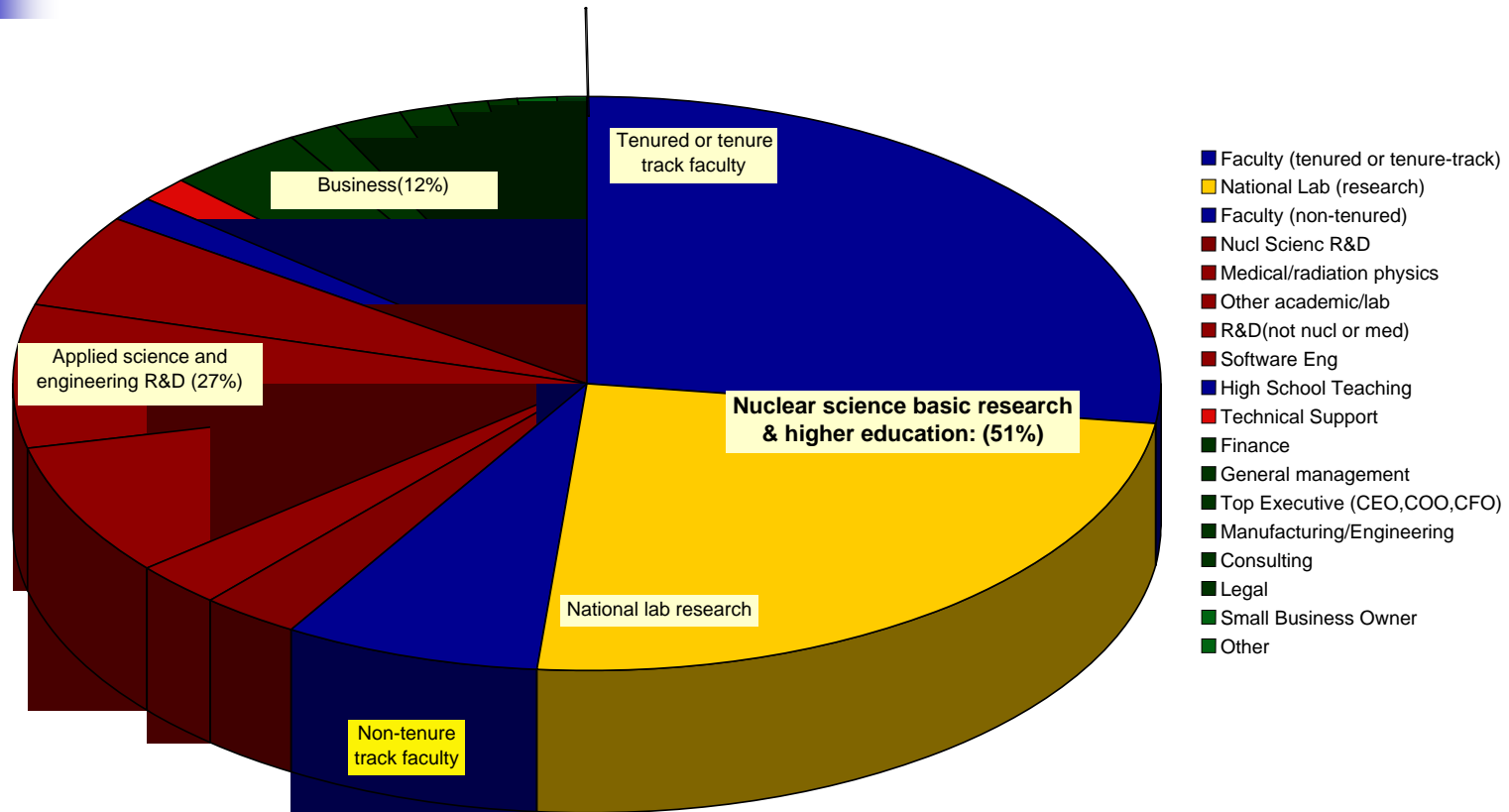
PNNL: Loss of Nuclear Workforce (2002-2010)



2007 Nuclear Science Long Range Plan: A Vision for Education and Outreach
Report to NSAC, P. McMahan, 3/8/2007

Courtesy of
Prof. Sue B. Clark

How does Nuclear Science Contribute?



2004 PhD +5-10 Survey, NSAC Education Report

2007 Nuclear Science Long Range Plan: A Vision for Education and Outreach
 Report to NSAC, P. McMahan, 3/8/2007



Summary

- NSAC Education report recommended an increase in # of PhDs in nuclear science over the next decade
 - In order to maintain the health of the field
 - In order to contribute to projected needs in nuclear energy, medicine and national security
- However the number of nuclear science PhDs has been declining
- The workshop participants agreed that the trend needs to be reversed



Recommendation 1

- **Increase the involvement & visibility in undergraduate education & research**
 - Outcome: Increased number of PhDs in nuclear science
 - Outcome: Increased number of scientists and engineers exposed to nuclear science
 - Outcome: Increased number of physics teachers exposed to nuclear science



Strategy

From NSAC Education report Graduate Student Survey:

- Only 28% of graduate students had an advanced undergraduate course in nuclear physics or chemistry.
- 87% of US males and 92% of US females had an undergraduate research experience.

Strategy to increase the involvement & visibility in undergraduate education & research:

- Expand the undergraduate **research** experience
- In **education**, ensure that undergraduate physics majors are exposed to nuclear physics early and often
- Make nuclear science **visible** to as many undergraduates as possible

Best practices and future implementation strategies

- Research
 - Present best practices
 - Undergraduate research at Tennessee Tech - 11 TTU Graduates have attained PhDs or are in graduate school in nuclear physics
 - Conference Experience for Undergraduates
 - Future strategies
 - Pre-research summer school for rising juniors
 - Integrated mentoring
- Education
 - Future strategies
 - Workshop on undergraduate curriculum
- Visibility
 - Future strategies
 - Distinguished lecturers - to visit small schools with no nuclear faculty



*2006 PECASE awardee,
Daniel Bardeen, ORNL*

Strategies will include a coordinated nationwide effort to aggressively recruit under-represented groups into all present and future programs



Beyond undergraduate

- Although we focus on undergraduate education in this recommendation,
- We endorse the recommendations of the NSAC Education report in the areas of graduate and postdoctoral education for:
 - shortening the median time to the Ph.D. degree
 - prestigious DOE graduate student fellowships
 - new training grant opportunities in nuclear science
 - Prestigious postdoctoral fellowships



Why outreach is important

- 'Nuclear' is an unreasonably scary word to many people
- We need nuclear science to be understood and appreciated as
 - Exciting and modern
 - Value-added to society
 - Worth supporting



Recommendation 2

- **Develop and disseminate materials and hands-on activities that illustrate and demonstrate core nuclear science principles to a broad array of audiences**
 - Outcome: Enhanced public understanding and appreciation of nuclear science and its value to society



Strategy for Outreach

- Undergraduate
 - Extend visibility throughout campus, to educate our future leaders, teachers & citizens
- Pre-service and inservice teachers
 - Knowledge of nuclear science concepts
 - Access to nuclear scientists as a resource
 - Tools for introducing nuclear science into the classroom
- High school students
 - Research-related activities
- Middle-school students
 - Spark a curiosity and interest in science
- General public
 - Move beyond fear of word 'nuclear' to an appreciation and understanding of nuclear science and its value

Outreach: Best practices and future implementation strategies

- Undergraduate
 - Present best practices
 - Clark University WMD course -general science credit
- High school teachers and students
 - Present best practices: PAN, Quarknet, Plasma camp
 - Future strategies
 - An expanded summer camp (at national labs?) for high school teachers and students which takes best of above models
- Public outreach
 - Future strategies:
 - National public speakers' bureau access to library of material
- All stakeholders future strategies
 - Nationally coordinated website
 - Partner within the community and with other organizations (e.g. DOE-NE, ANS) to develop material and activities
 - Seek recognition for outreach as a valued activity of all scientists





Summary

- The community is doing a lot of great things now at all levels
 - See activity booklet
- Two biggest problems we see:
 - Increase number of PhDs in nuclear science to meet national needs in basic research and applications
 - Improve public perception of nuclear science
- Our Strategies
 - Undergraduate research and education
 - Coordinated outreach effort