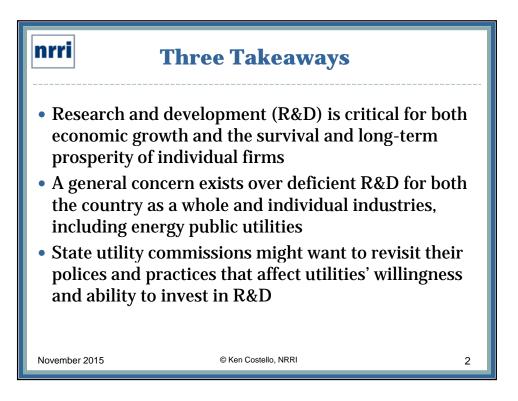


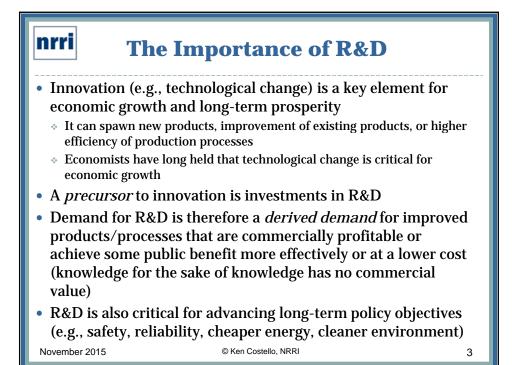
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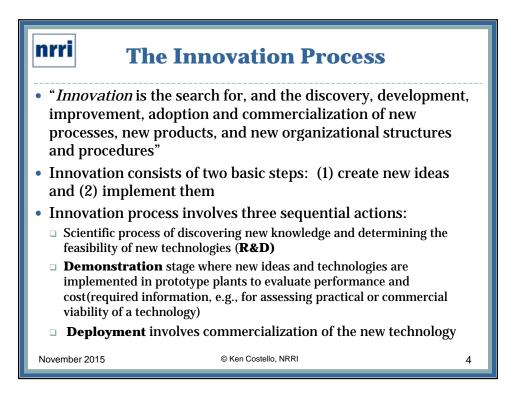
Ken Costello

Principal Researcher – Energy and Environment National Regulatory Research Institute kcostello@nrri.org

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National Trends in R&D

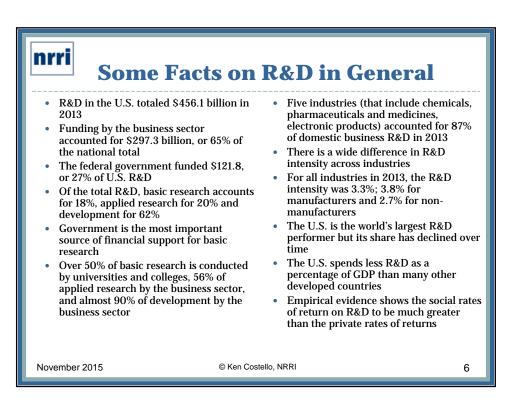
- Shift toward short-term R&D projects with quick payback
- Decline over time in the level of R&D funding (in constant \$) by the federal government
- Total spending on R&D (public plus private) has been relatively stable over the past three decades at roughly 2.5% of GDP
- But the share of private R&D has increased while the share of public R&D has fallen
- After 1980, small firms rivaled and even surpassed large firms in terms of R&D intensity
- Because of the federal budget situation, we can expect lower R&D financial support from the federal government in the future

- There is concern over the downward trend in basic research affecting future innovation
- There is also concern over the low level of R&D in the energy industry
- R&D is vulnerable to budget cuts, by both the government and business sector, since its contributions are long term in nature and difficult to quantify
- During 1953-1987, the real annual growth rate in federal R&D spending was 4.9%, during 1987-2008 it grew at just 0.3%, and during 2008-2013 it declined by 1%
- The federal government funded most of R&D before the 1980s; share of business sector funded R&D rose relative to federal-funded R&D since the mid-1960s

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Some Facts on Energy R&D

- Utilities, which include power generation, transmission, and distribution, natural gas distribution, water supply and sewerage treatment, spent just 0.1% of revenues on R&D
- Federal government energy R&D as a percentage of GDP has dropped since the 1970s
- The federal commitment to energy R&D is less than 0.5% of the annual nationwide energy bill
- While U.S. expenditures for energy R&D has risen in recent years, they are only about one-half the level in real dollars of R&D in late 1970s during the oil crisis
- Federal R&D expenditures have shifted toward "clean air" programs, such as energy efficiency, renewable energy, and modernization of the electric grid
- DOE receives about 7% of the total federal budget for R&D (Defense gets 50% with Health and Human Services receiving 25%)
- DOE has different R&D arrangements: contracts with industry, work at its labs, and grants to universities and industry consortia
- As discussed later, we have seen R&D drastically curtailed in the natural gas sector

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The Economics of R&D: Challenges Abound

• Expensive

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- Initiated by technology-push or demand-pull incentives
- Expenditures can incur several years before the firm reaps additional revenues or other benefits
- Inherently risky ("dry holes" are common) – costs and success are difficult to predict, and benefits are often distant
- In a dynamic world, R&D for one technology can quickly become obsolete with the introduction of newer, more promising technologies
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- Benefits can be appropriated by others, competing firms in the industry or the public at large ("free riders")
- The above comments imply that firms are unlikely to innovate unless the payoff from successful innovation is large, which is usually the case
- The market may also underallocate resources to R&D, for example because of public benefits
- Innovation usually begins with R&D, but not always

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