

# **The Real Cost of Electricity Generating Alternatives: A Portfolio Approach**

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# 18 Years of Research in 2 Minutes

- ***Standard, risk-adjusted financial cost models say:***  
**The kWh-cost for most RETs is less than gas-fired electricity**
- ***Modern Portfolio Theory says:***  
**Even if you believe RETs cost more..... Adding them to a risky fossil generating mix *reduces* overall kWh cost at any level of risk**
- ***Exploiting new 'broadly-applicable' technologies:***
  - **Requires changes in accounting measures, organizations & supporting systems/infra-structures**
  - **Produce benefits not easily pre-conceived**

# **Macroeconomic Consequences of Fossil Price Risk: A major external cost**

- **Fossil volatility hurts employment & GDP growth in oil consuming *and* producing nations**
- **Macroeconomic cost of 2000-04 oil spikes in EU = Approximately €700 Billion**
- **This exceeds total EWEA/EREC estimated renewables investment needed to meet 2020/20% EU targets**

# What's the "Catch?"

- **Adding Wind/RE Enhances Energy Security**
  - Helps avoid sizeable GDP losses
- **But Doesn't it Raise Generating Cost?**
- ***Adjusting for market risk*, the stand-alone levelized cost of many renewables is lower than gas**

# **REFLECTING MARKET RISK**

**Valuing Energy Technologies  
Necessarily Involves  
an Assessment of Financial Risk**

# Traditional Engineering-Based Cost Models No Longer Work

- They produce “rule-of-thumb” valuations that ignore taxes and risk differentials
- But, fossil prices vary *systematically* – non-diversifiable risk
  - Costs of passive/capital-intensive renewables are systematically riskless
  - Financial properties mimic US Treasury obligations

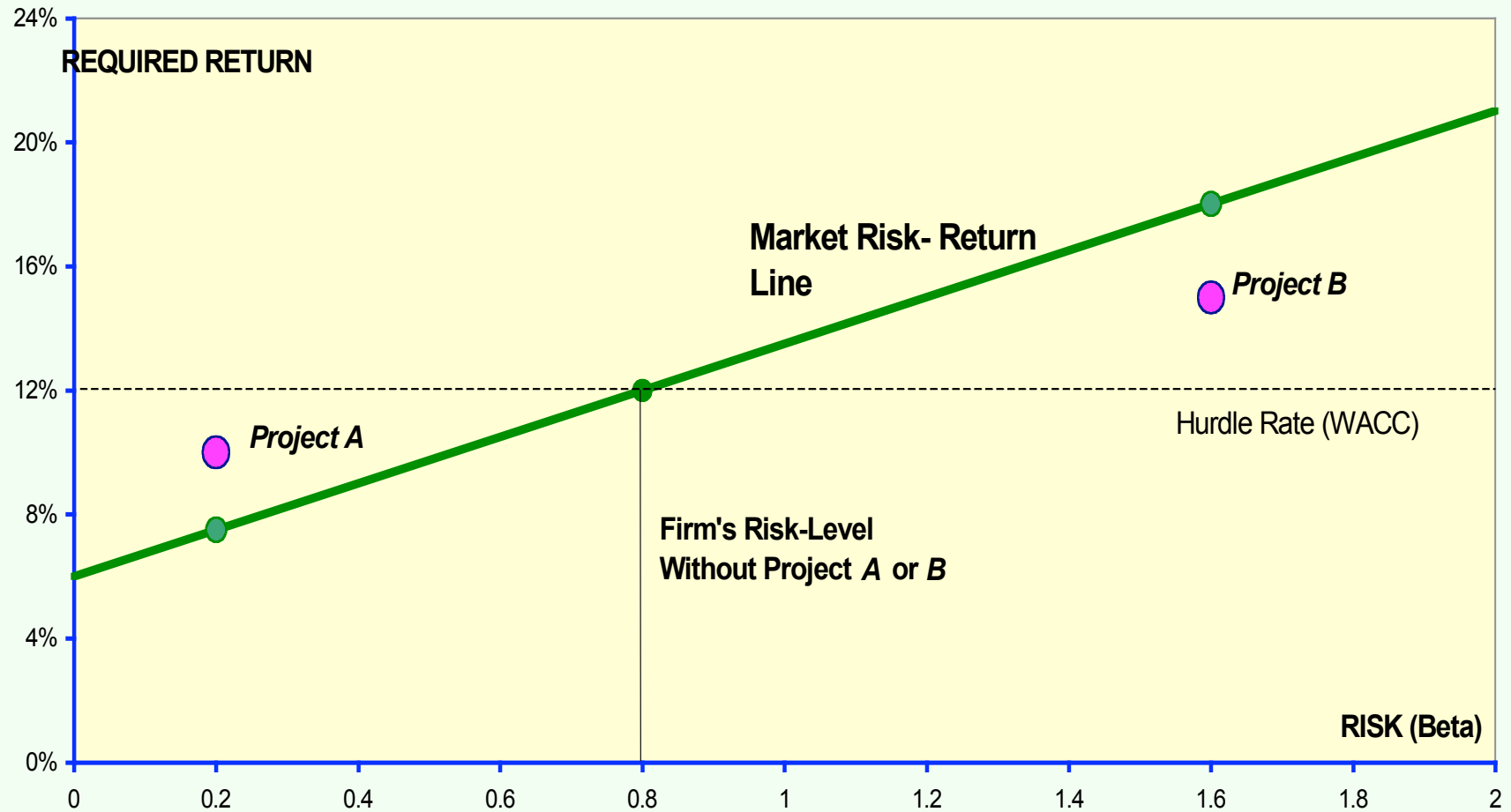
# Arbitrary Discounting Produces Arbitrary Results

## Valuing Two Bond Investments Using a Single Arbitrary Discount Rate

Assumed Discount = 6%

|                                      | 10%<br>Junk Bond | 4%<br>Government Bond |
|--------------------------------------|------------------|-----------------------|
| YEAR                                 | Yearly Proceeds  |                       |
| 1                                    | \$100            | \$40                  |
| 2                                    | \$100            | \$40                  |
| 3                                    | \$100            | \$40                  |
| 4                                    | \$100            | \$40                  |
| <b>Present Value<br/>of Proceeds</b> | <b>\$347</b>     | <b>\$139</b>          |

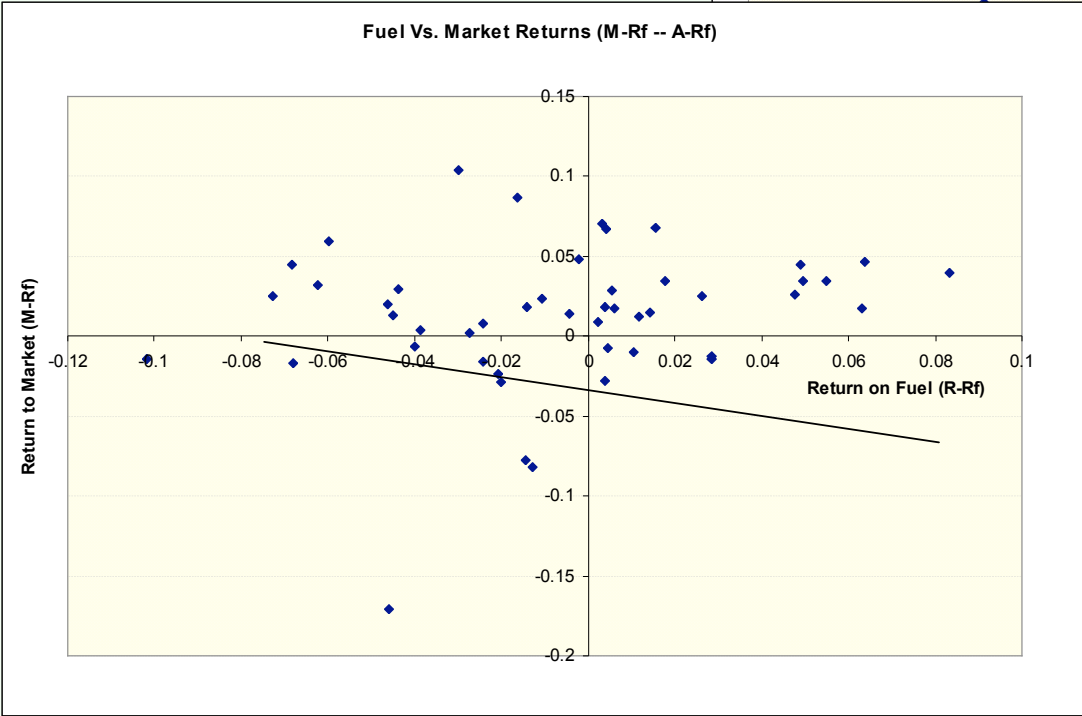
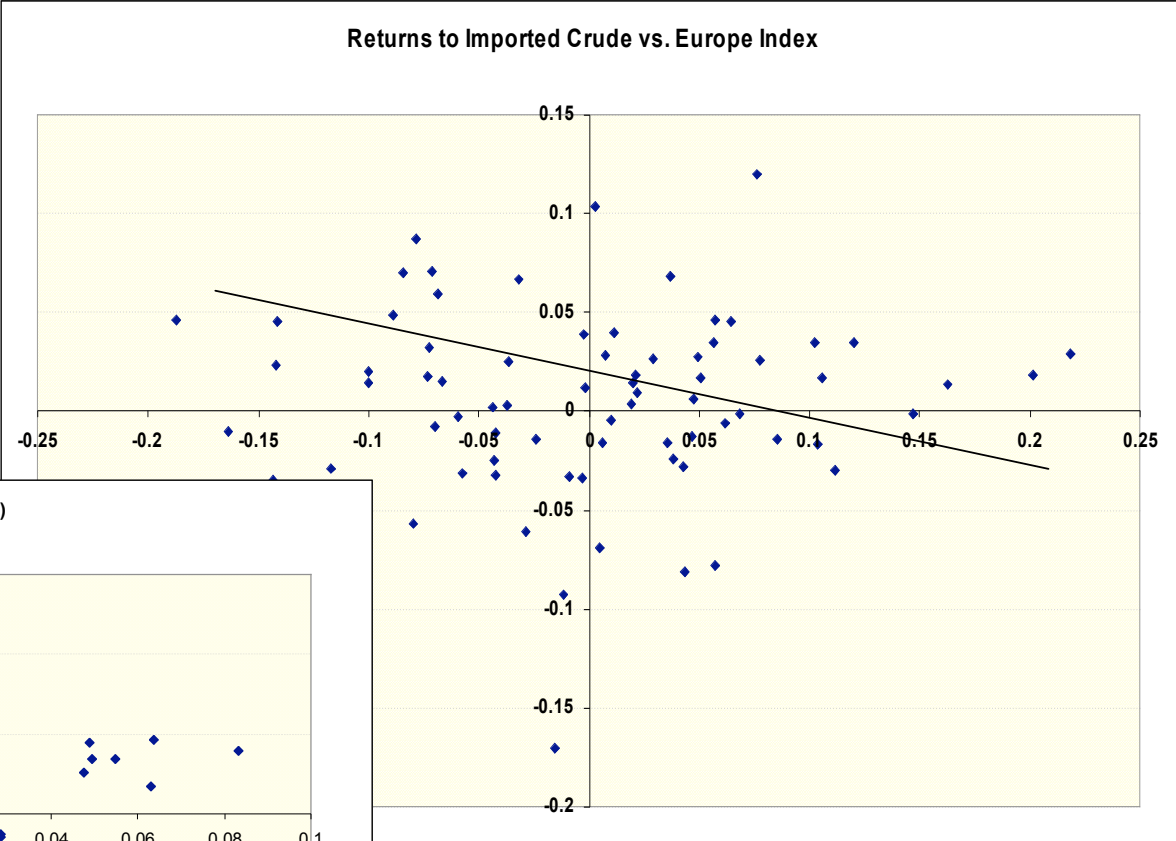
## Project Selection When Risk Varies WACC Leads to Poor Results



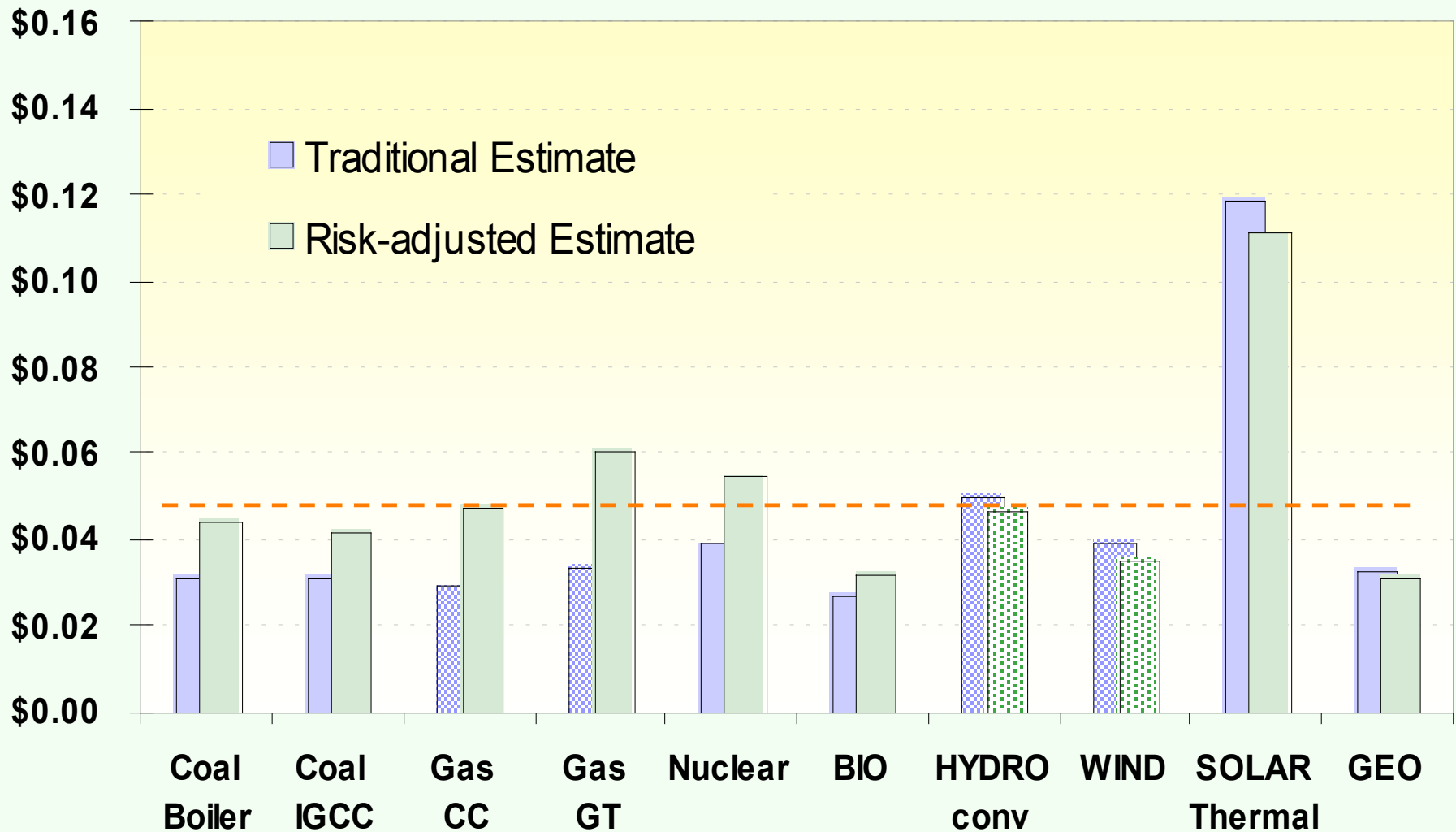
***Project A Raises Share Price, Project B Lowers It!***  
***Low-Risk / Low-Return Assets Need Not Hurt Shareholder Value***

# Oil and Gas Are Systematically Risky

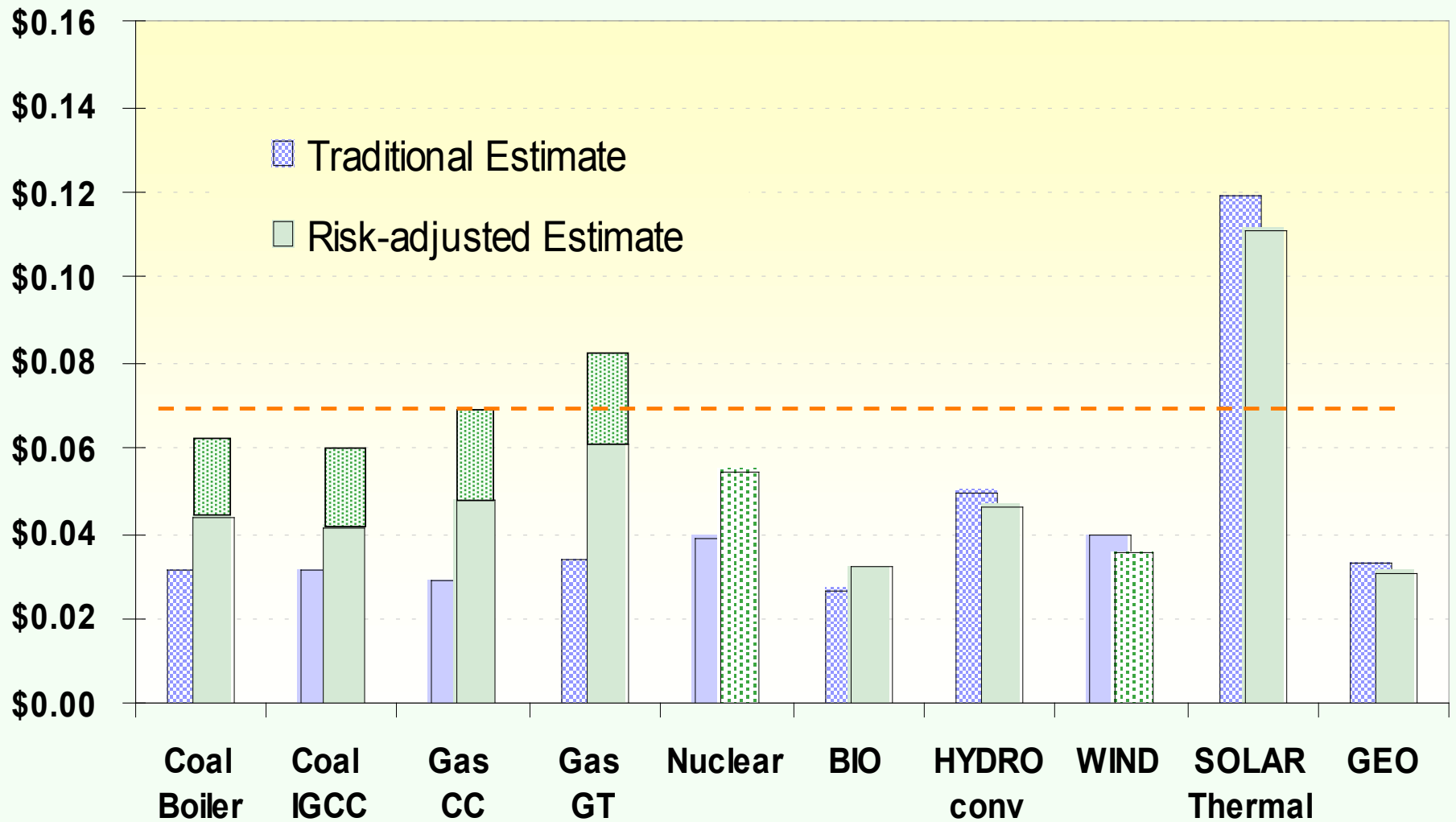
Crude Oil  
Beta = -0.05



# Traditional vs. Risk-Adjusted Levelized Cost-of-Electricity Estimates 30-Year Contract-Fuel Assumption



# Traditional vs. Risk-Adjusted Levelized Cost-of-Electricity Estimates Historic Fossil Price Risk



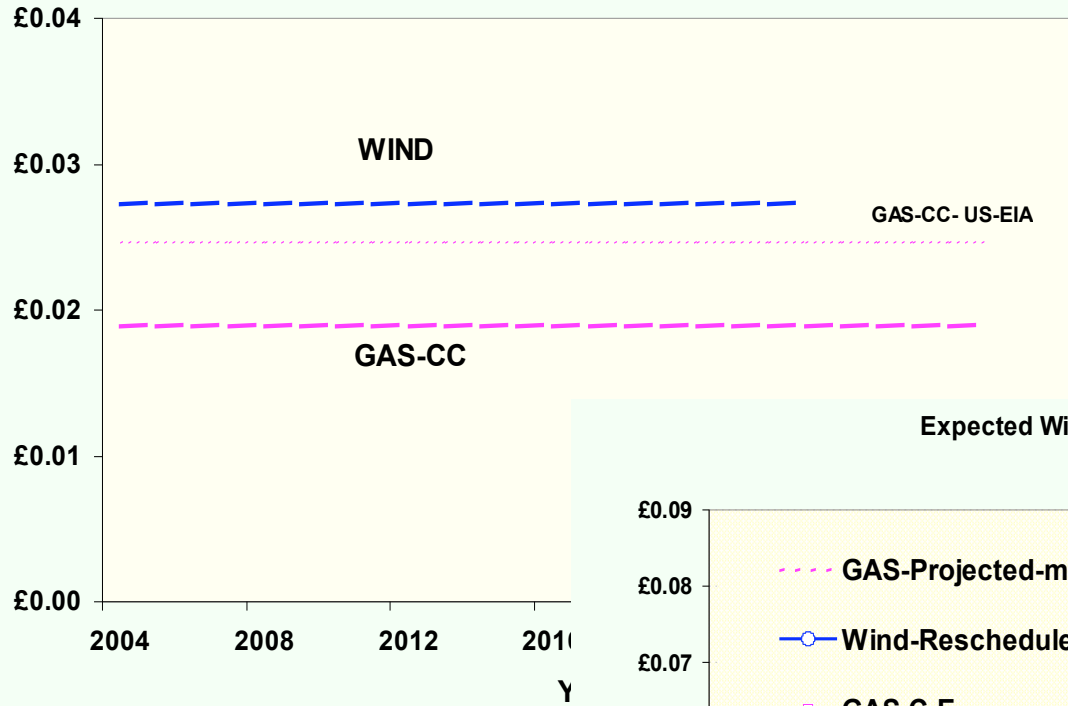
# **What is *Levelized Cost* anyhow?**

## **What does it measure?**

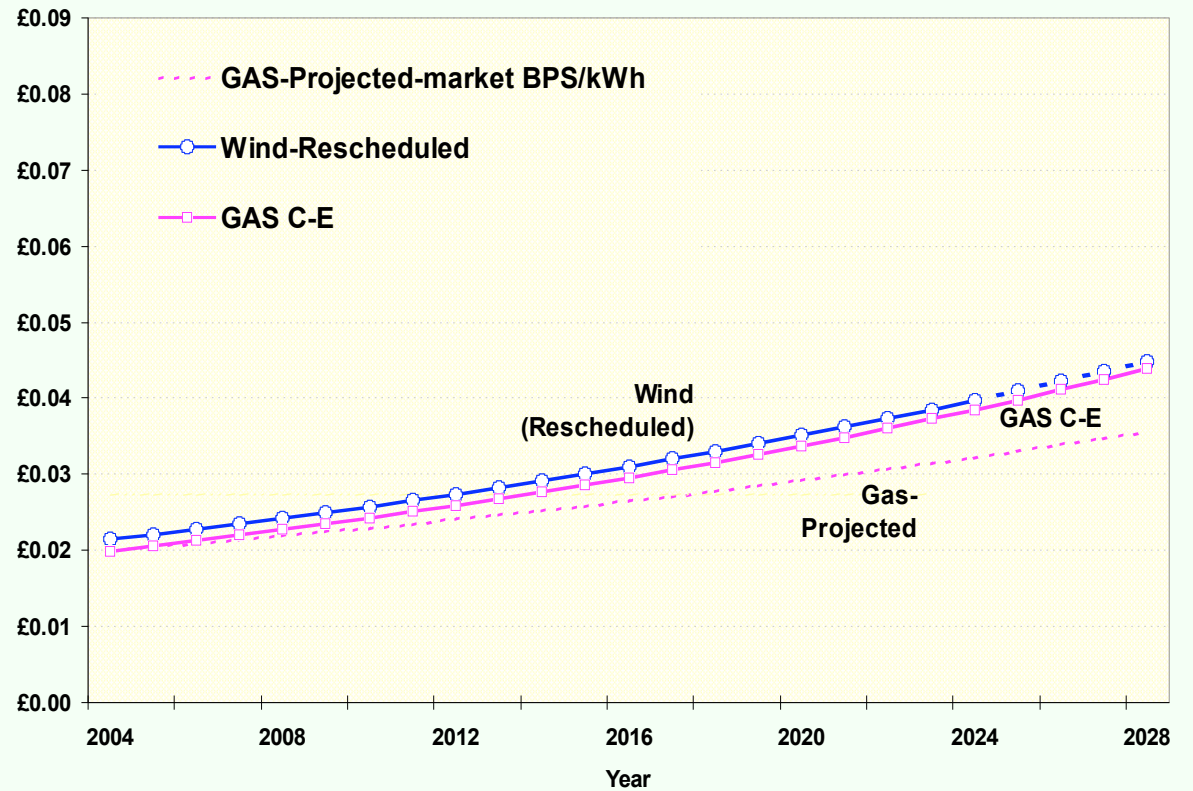
- **An *Imaginary Construct***
- **Cannot be compared to observed market prices**
- **Represents a *Time-Weighted-Average* of projected annual costs**

# DTI Levelized kWh Cost Estimates

k = 10%



Expected Wind Costs Compared to Gas Certainty-Equivalents



**Portfolio Effect:  
The Only Free Lunch in  
Economics!**

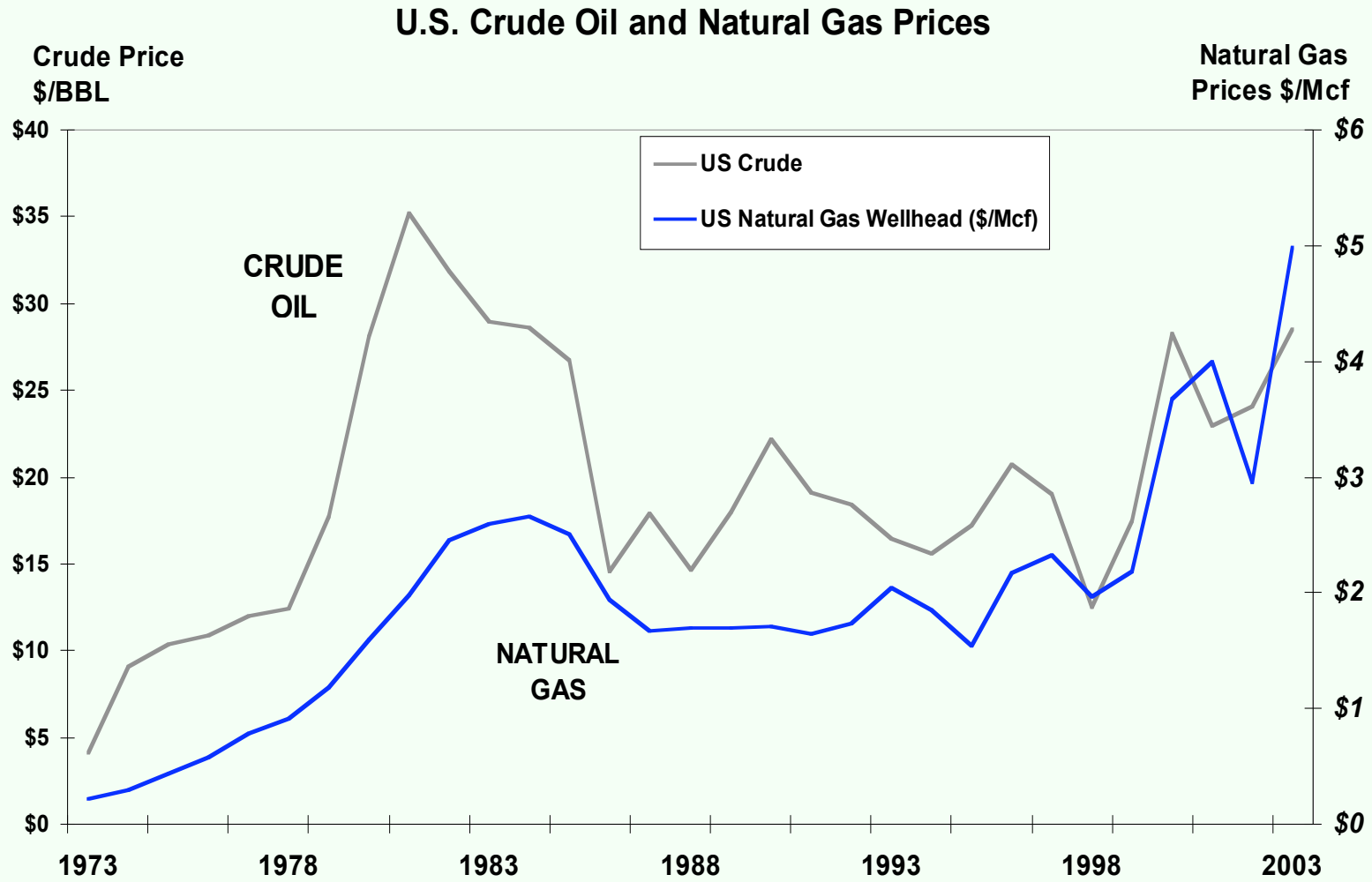
**Astute Asset Combinations Reduce Cost  
at any Given Level of Risk**

# **A Generating Alternative's *Stand-Alone* Cost is Not Very Meaningful**

- ***Finding 30-Year least-cost resource not feasible***
- **Must consider its contribution to portfolio *cost relative to* its contribution to portfolio *risk***
- **Adding Fixed-Cost RETs *Reduces* Cost at any Level of Risk.....**
  - Even if *stand-alone* costs are *higher*

**Selecting *Least-Cost* Alternative:  
Like asking for 30-year stock forecasts**

# Fossil Prices are Highly Correlated

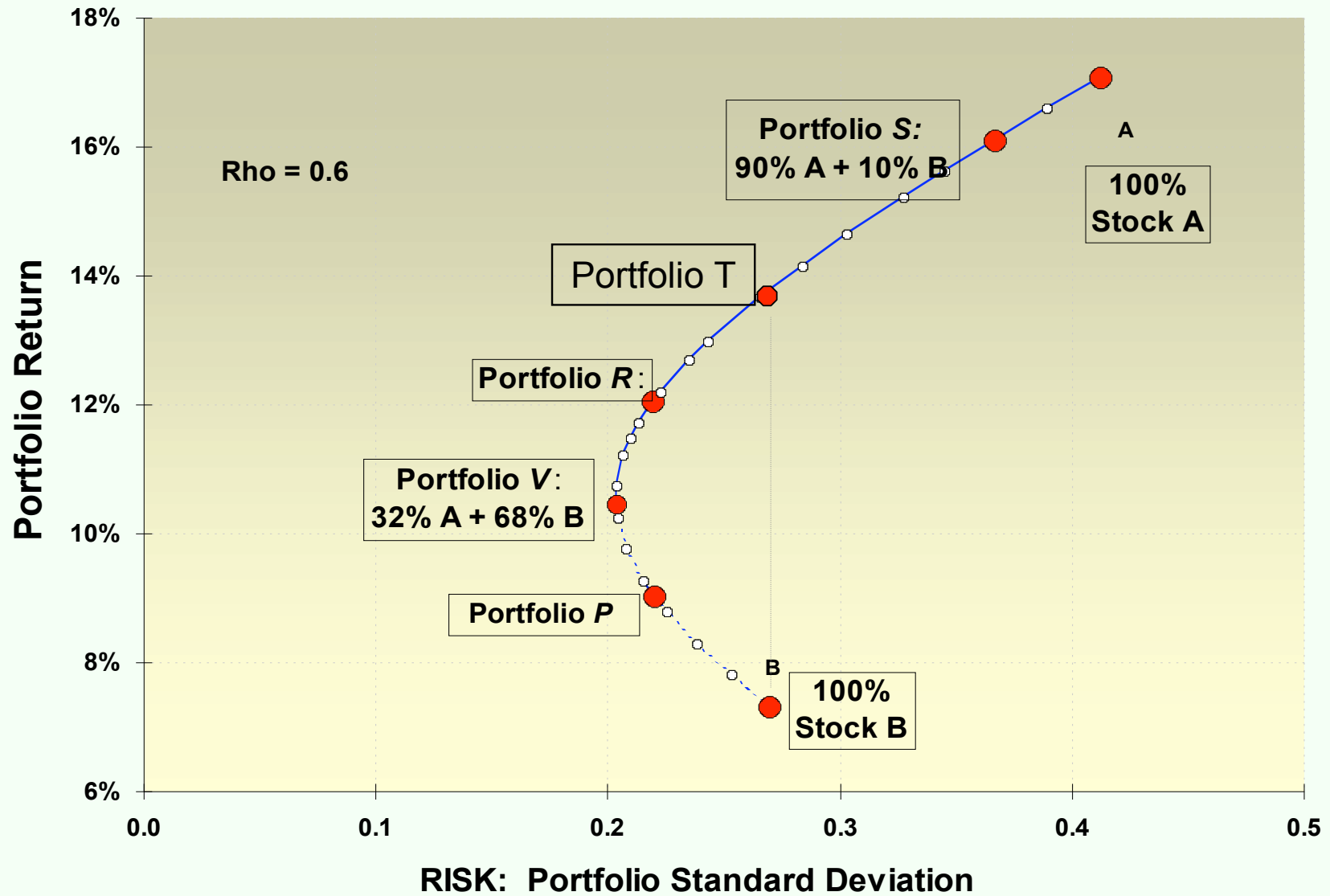


# Fixed-Cost Renewable Technologies Help Diversify Portfolios

- Mitigate fossil price volatility - intuitive
- The benefits are *Counter-cyclical*
  - a form of “national insurance”
  - (R. C. Lind & Nobel Laureate J. Kenneth Arrow, 1984)
- Payoff occurs when economy is doing poorly

**Inefficient portfolios that are needlessly exposed to fossil risk reduce energy security and diversity**

# Risk and Return for Portfolios of Risky Assets



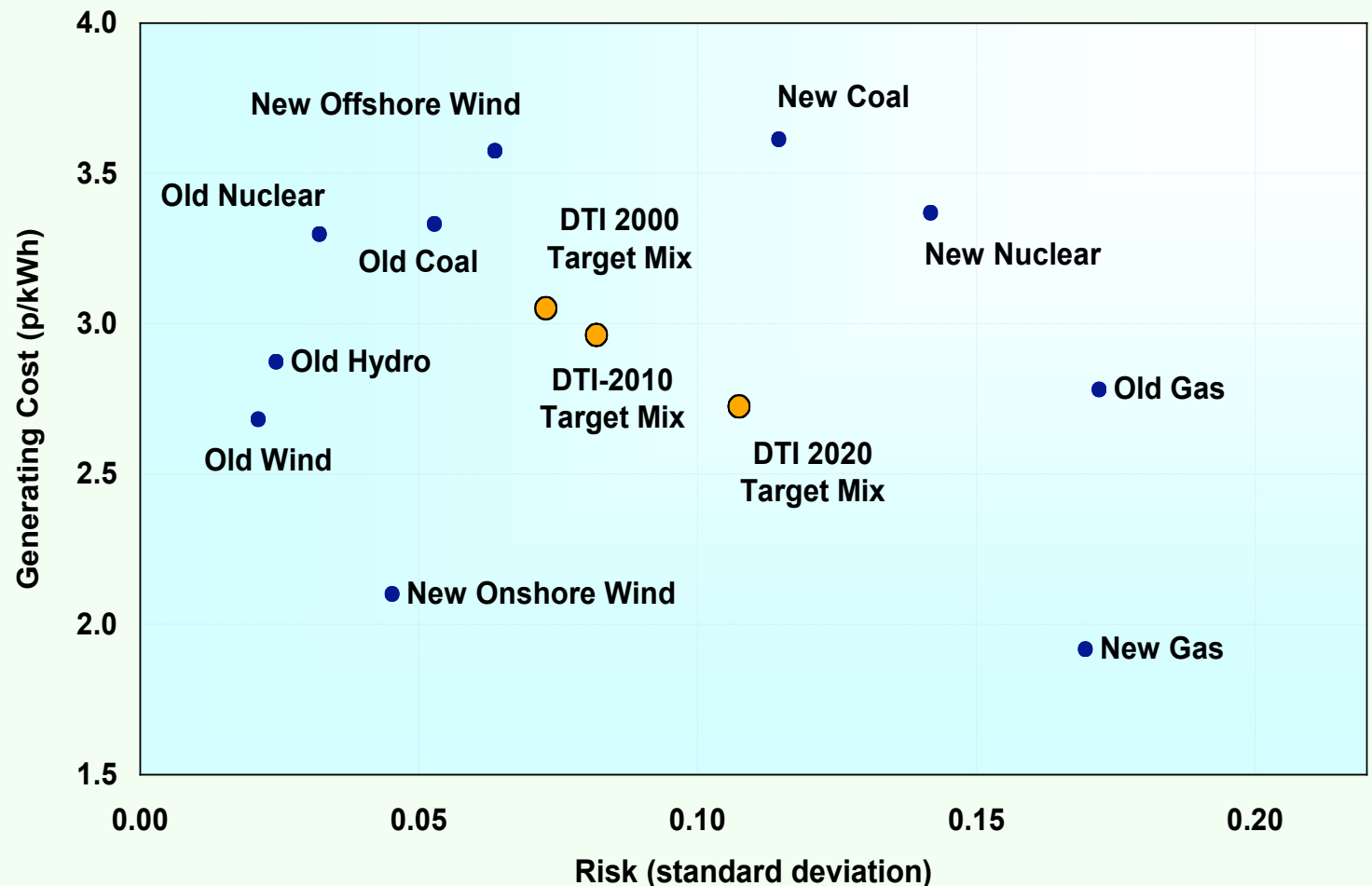
S. Awerbuch, "Getting It Right: The Real Cost Impacts of a Renewables Portfolio Standard," PUF, 2-15-2000.

# UK Trends in Generating Cost-Risk

- **Move to larger gas share increases portfolio risk**
  - Increases year-to-year expected generating cost volatility

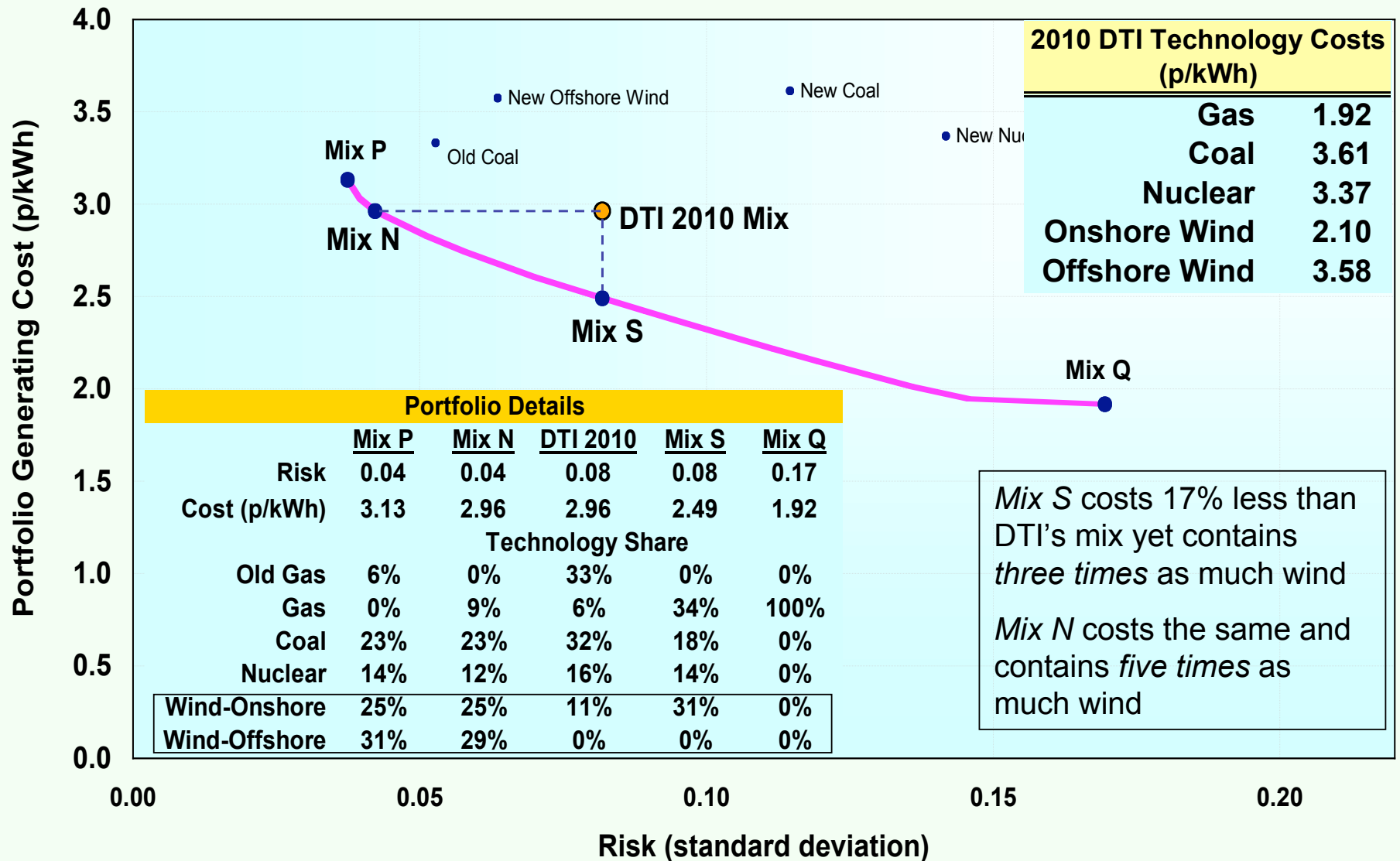
- **Reduces Energy Diversity/ Security**
- **Wind/ Renewables ideally positioned to diversify generating mix and reduce cost/risk**

UK 2010 Technology Costs and Estimated Risk  
DTI Projected 2010 and 2020 Target Mixes



# 2010 Portfolio Optimization

## DTI Technology Costs



***Renewable Energy and the  
Power Grid:***

***RE Can Help Reconceptualize  
Electricity  
Production & Delivery  
Paradigms***

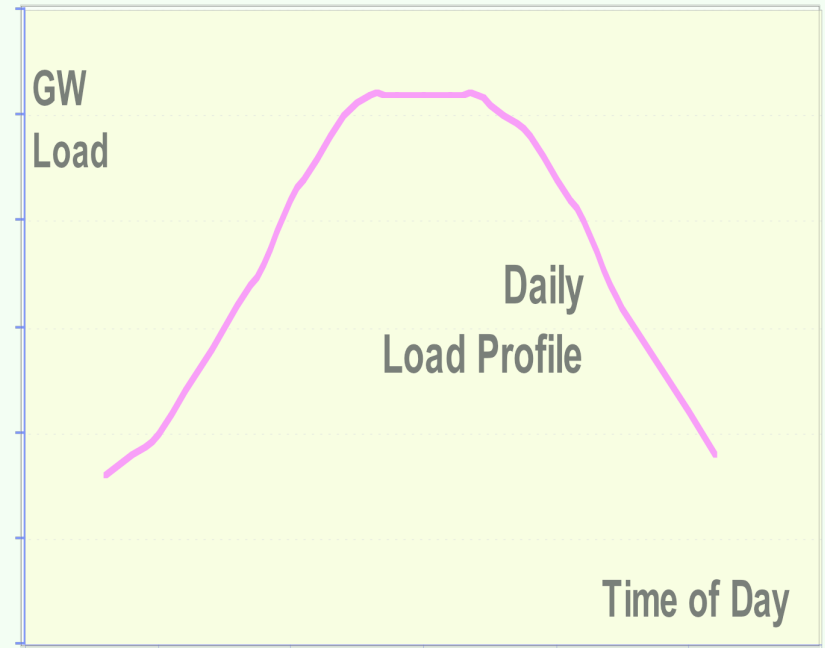
# Networks of the Future Must Focus on Markets, Not Electricity Transmission

- **Facilitate Markets & Deliver Market-driven products**
  - Not just transporting commodity electrons
- **Exploit technology attributes: match to load's need**
  - *Do not* force all sources to resemble gas turbines
- **Promote diversity-- create opportunities for all new resources**

**Future networks must enable re-conceptualized *just-in-time, mass-customized* electricity production/delivery paradigms**

# Mass-Production vs. Mass-Customization

- *Any color as long as it's black (Ford) vs. Have it your way (Dell)*
- Electricity is mass-produced using “dispatchable” sources to meet aggregated network load
- Masks underlying dynamics of millions of transactions, each with a different valuation
- Inhibits integration of “intermittent” sources



# Why Integrate Renewables into the Power Network?

- **Create Sizeable Portfolio Benefits**
  - *Reduce* overall generating cost and risk
- **Enhance energy security/diversity**
- **Reduce Market Power:**
  - Help open markets & *unlock* the potential benefits of liberalization

**The Grid Can Play an Important Role  
in Implementing These Crucial  
Objectives**