

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

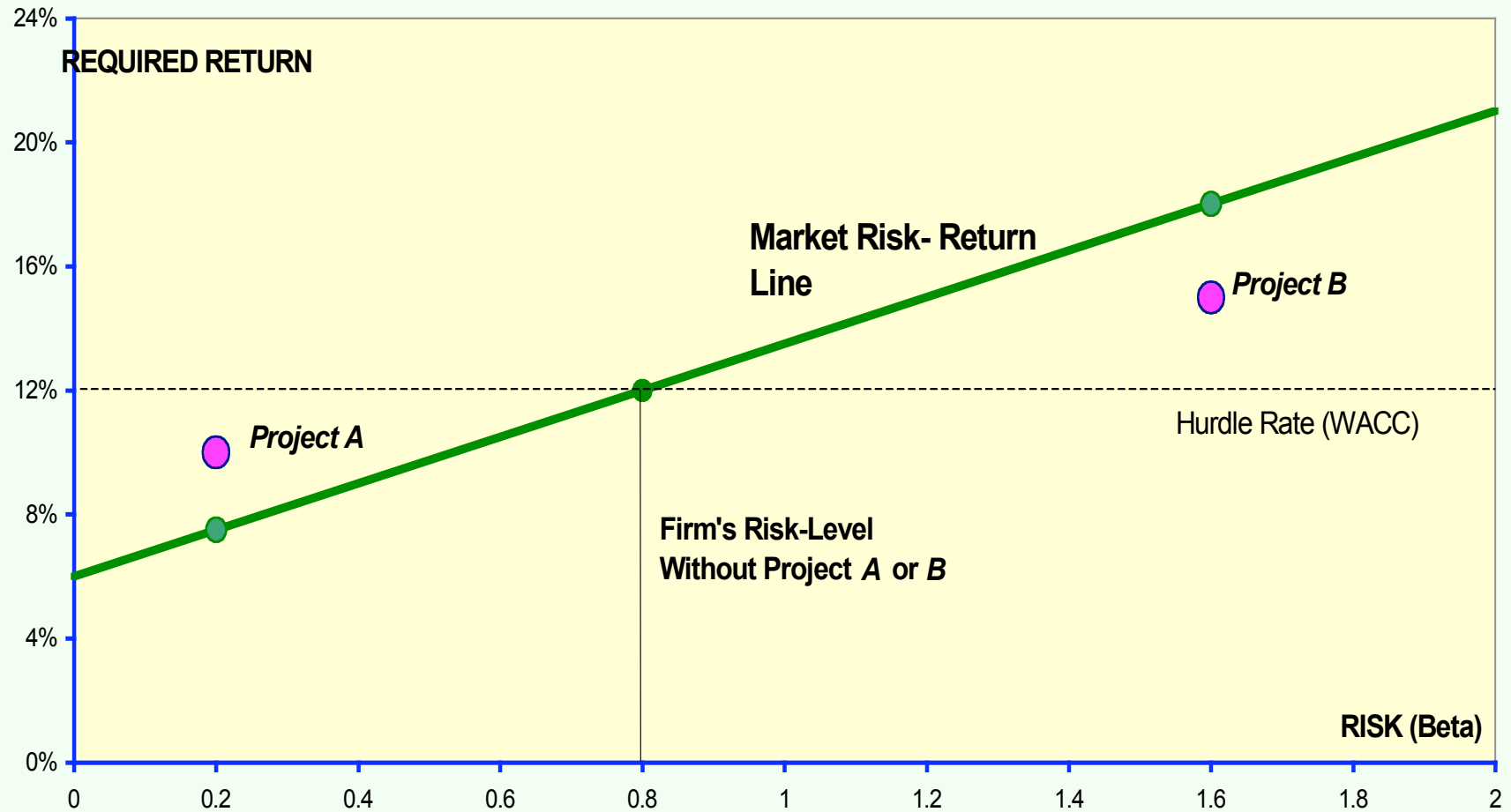
Arbitrary Discounting Produces Arbitrary Results

Valuing Two Bond Investments Using a Single Arbitrary Discount Rate

Assumed Discount = 6%

	10% Junk Bond	4% Government Bond
YEAR	Yearly Proceeds	
1	\$100	\$40
2	\$100	\$40
3	\$100	\$40
4	\$100	\$40
Present Value of Proceeds	\$347	\$139

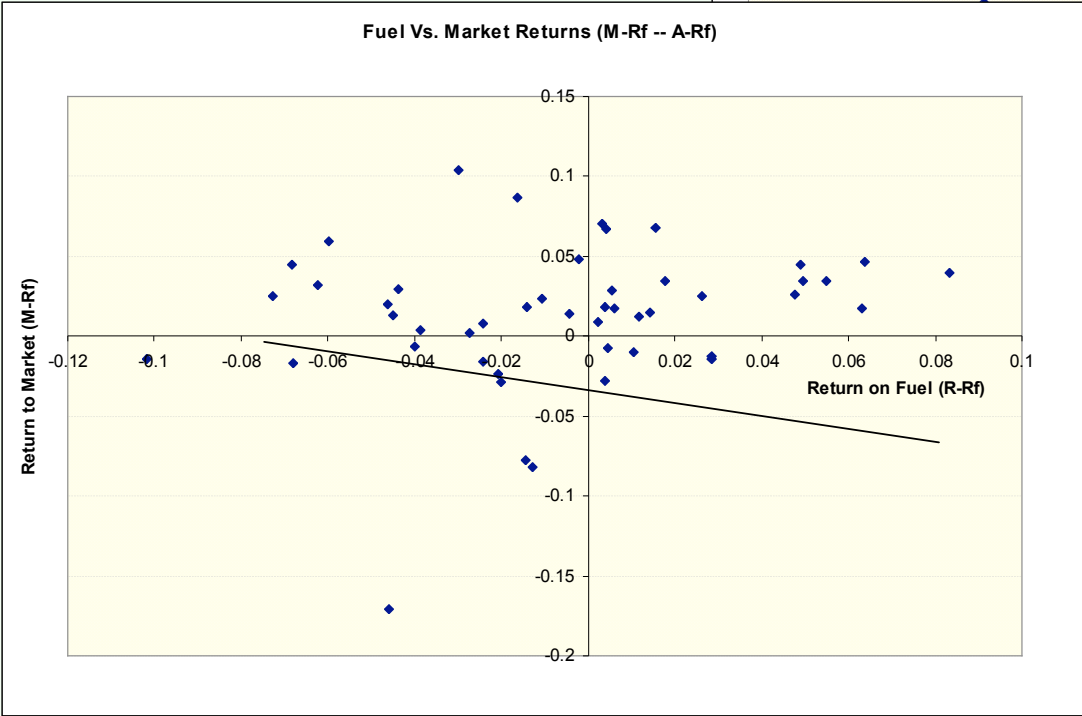
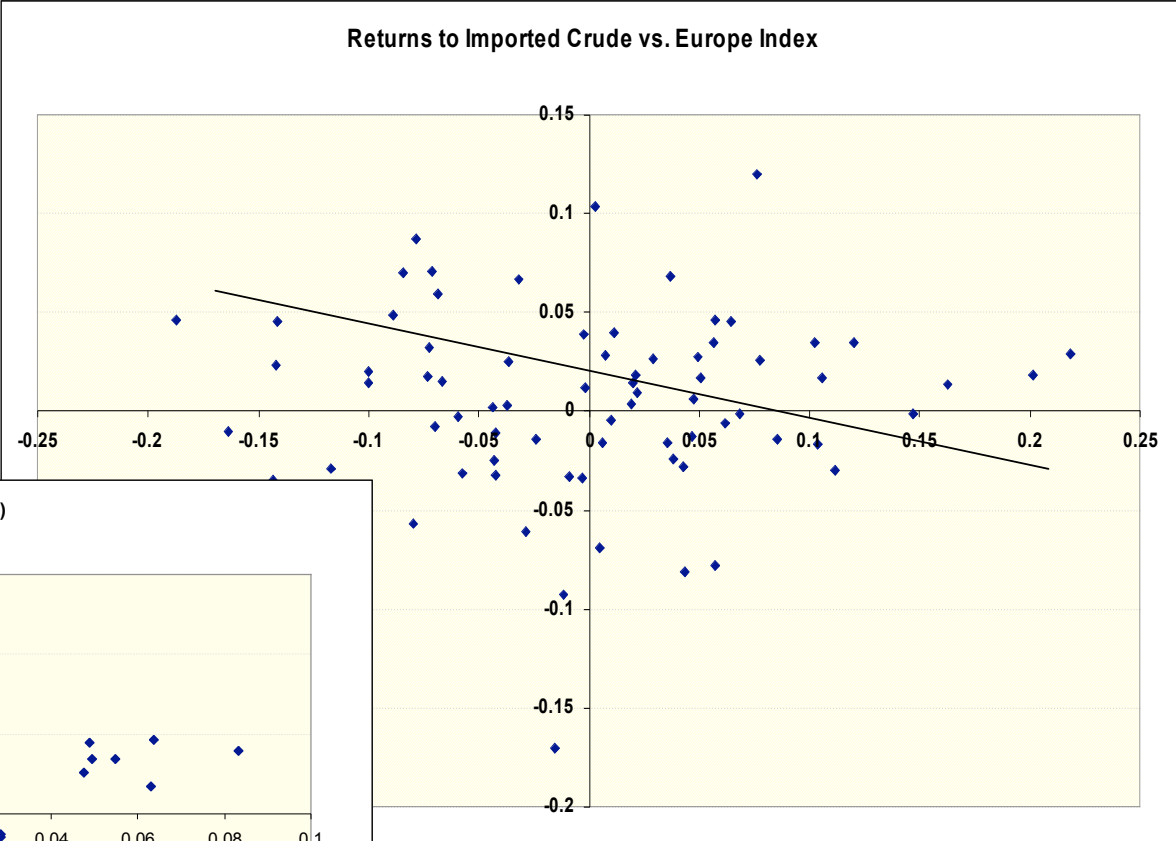
Project Selection When Risk Varies WACC Leads to Poor Results



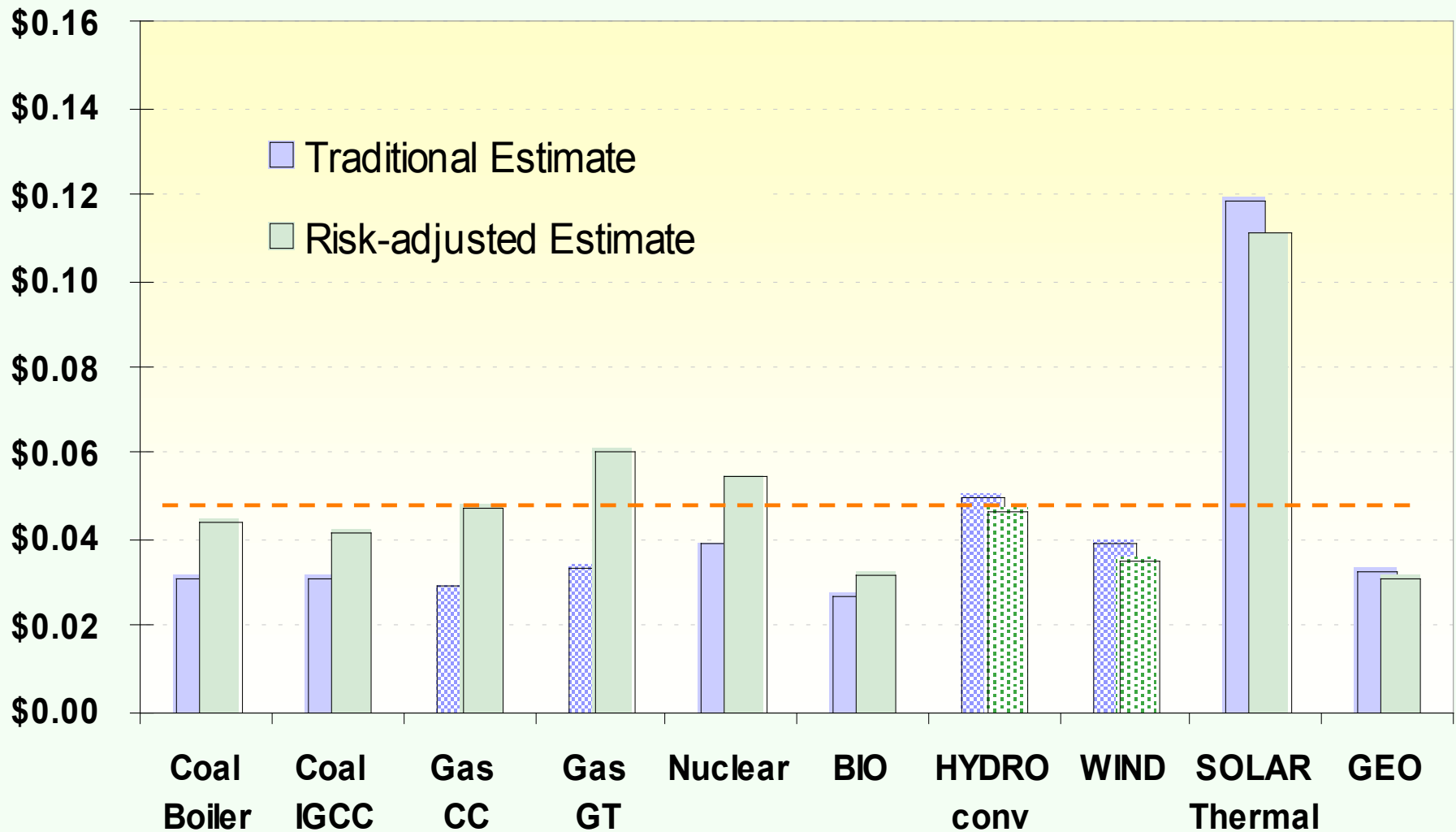
Project A Raises Share Price, Project B Lowers It!
Low-Risk / Low-Return Assets Need Not Hurt Shareholder Value

Oil and Gas Are Systematically Risky

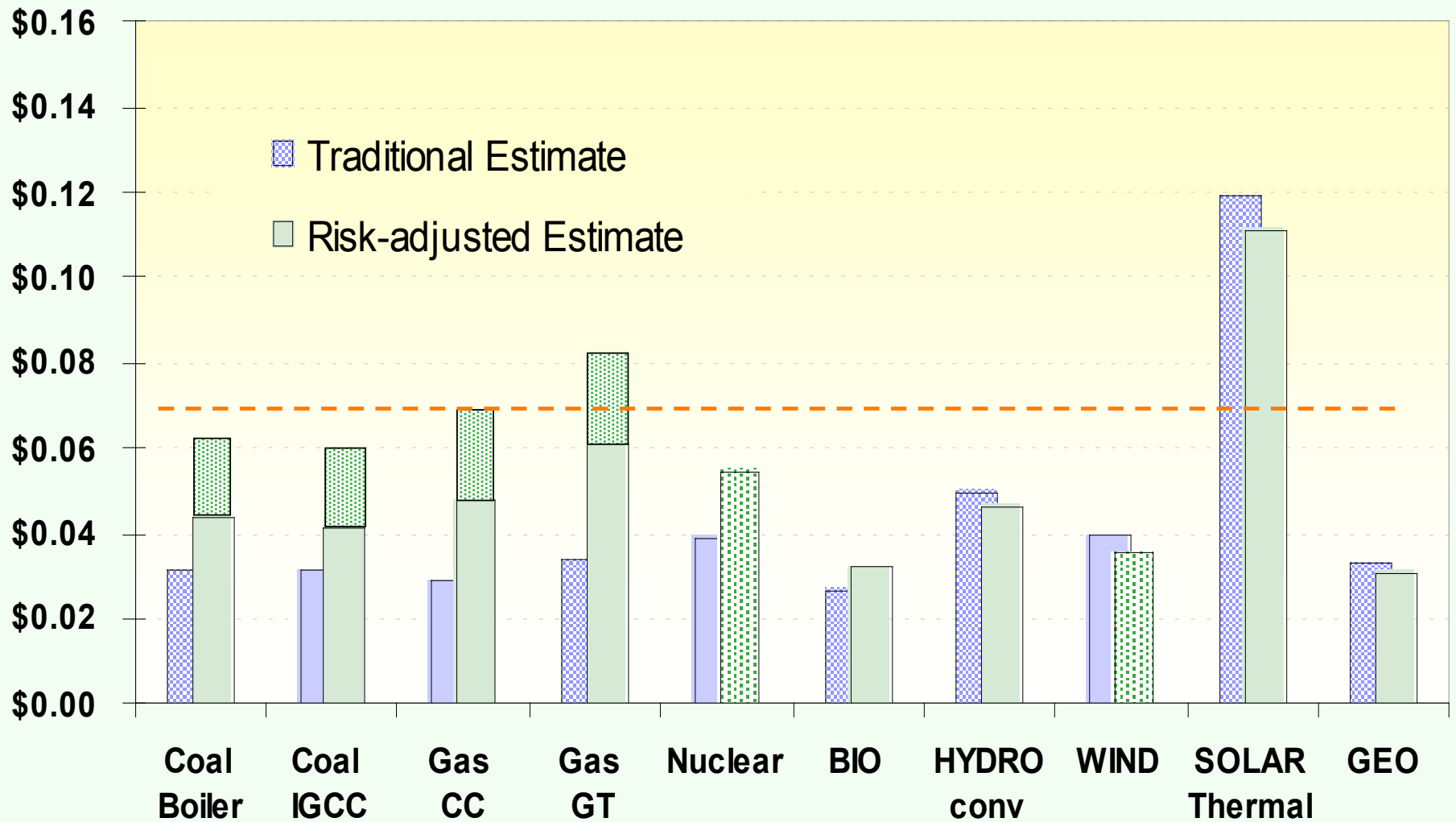
Crude Oil
Beta = -0.05



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



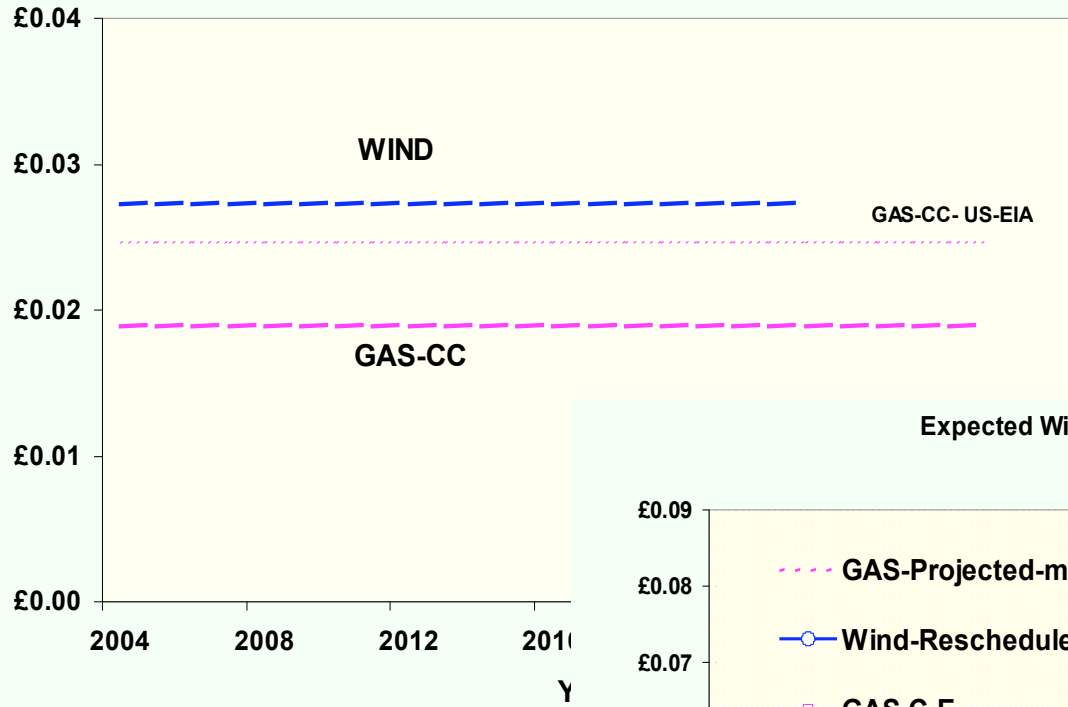
What is *Levelized Cost* anyhow?

What does it measure?

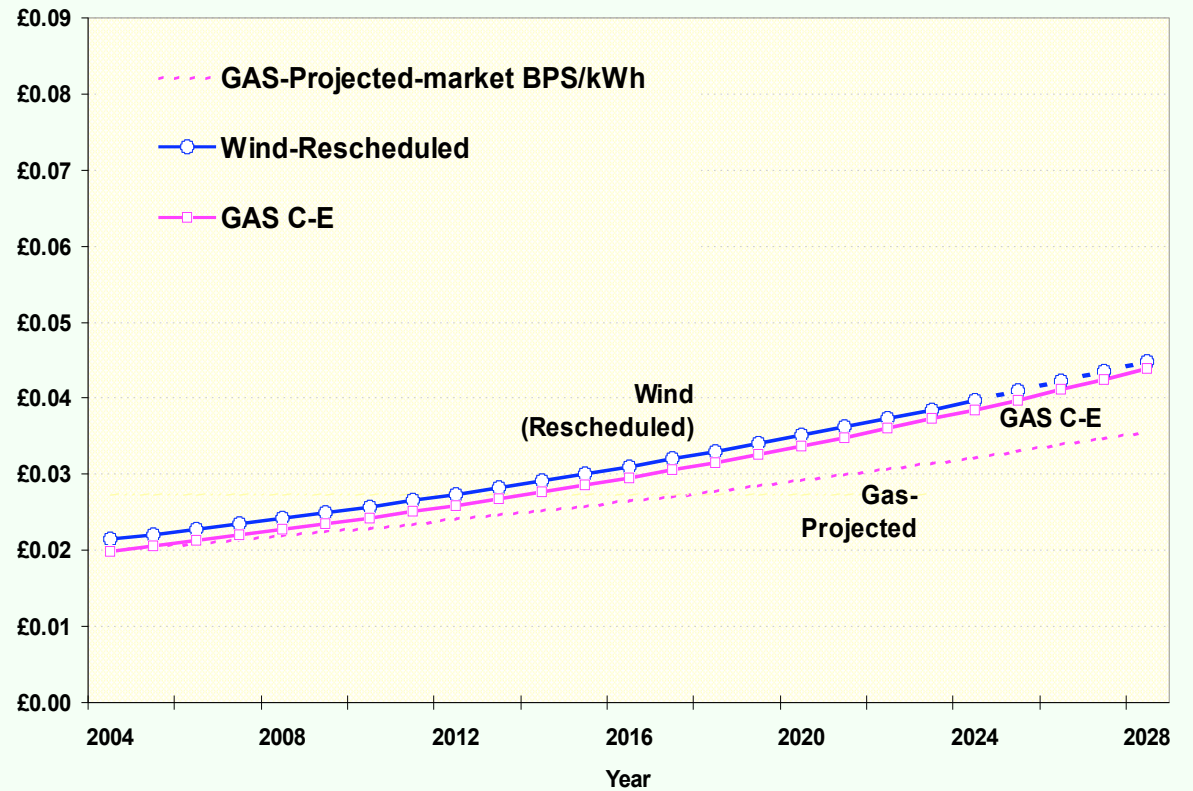
- **An *Imaginary Construct***
- **Cannot be compared to observed market prices**
- **Represents a *Time-Weighted-Average* of projected annual costs**

DTI Levelized kWh Cost Estimates

k = 10%



Expected Wind Costs Compared to Gas Certainty-Equivalents



Portfolio Effect: The Only Free Lunch in Economics!

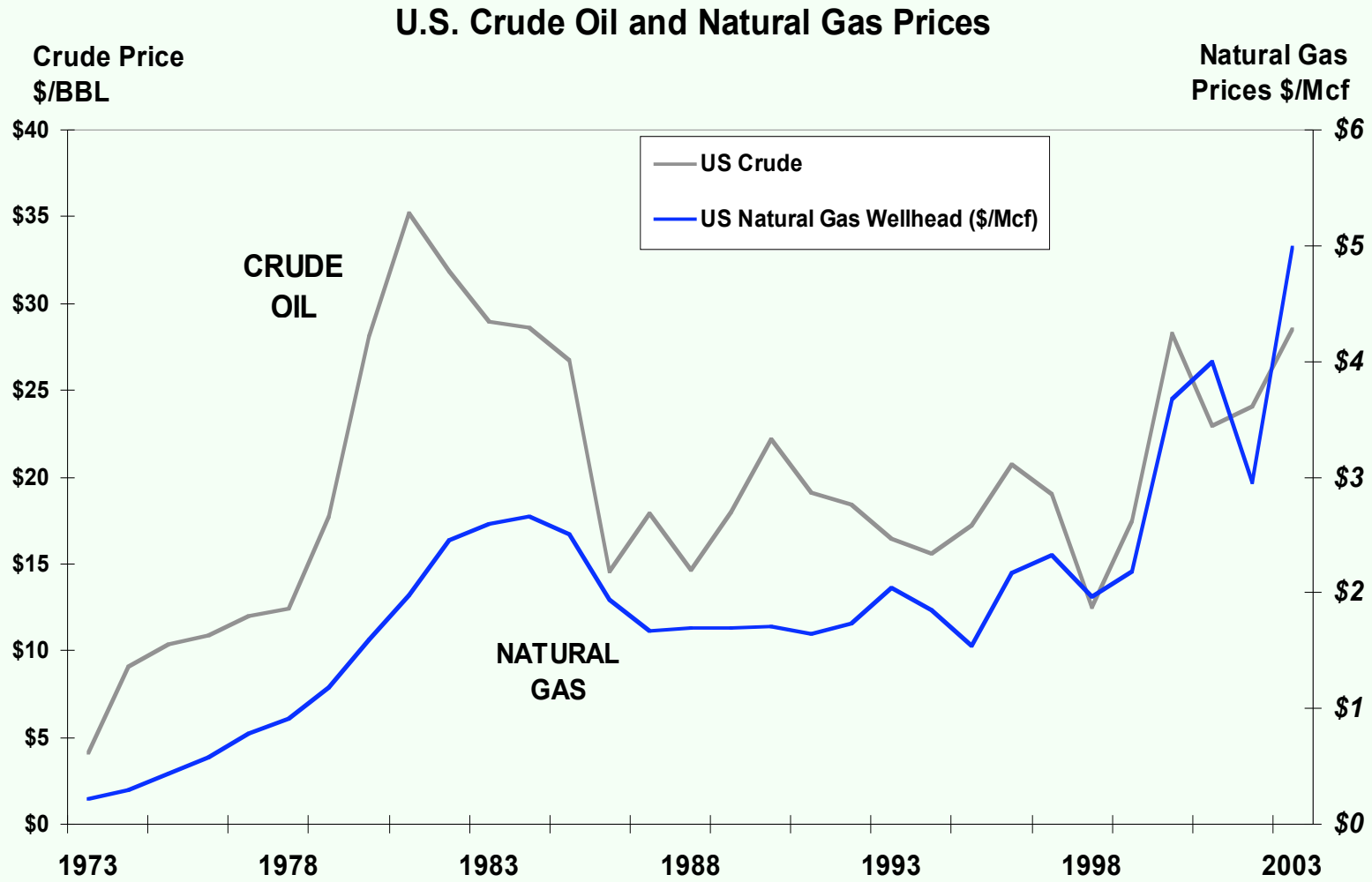
**Astute Asset Combinations Reduce Cost
at any Given Level of Risk**

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

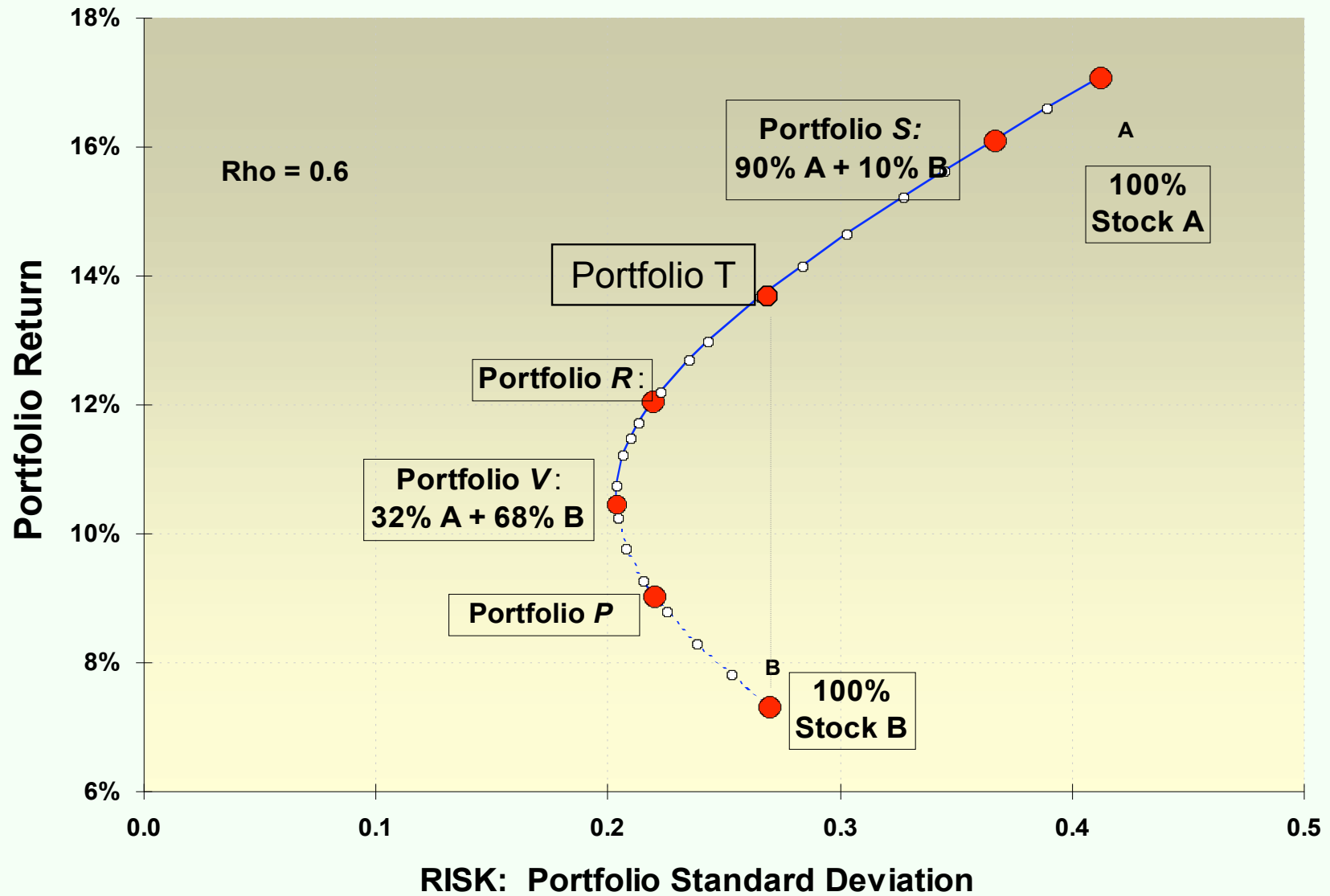


Fixed-Cost Renewable Technologies Help Diversify Portfolios

- 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



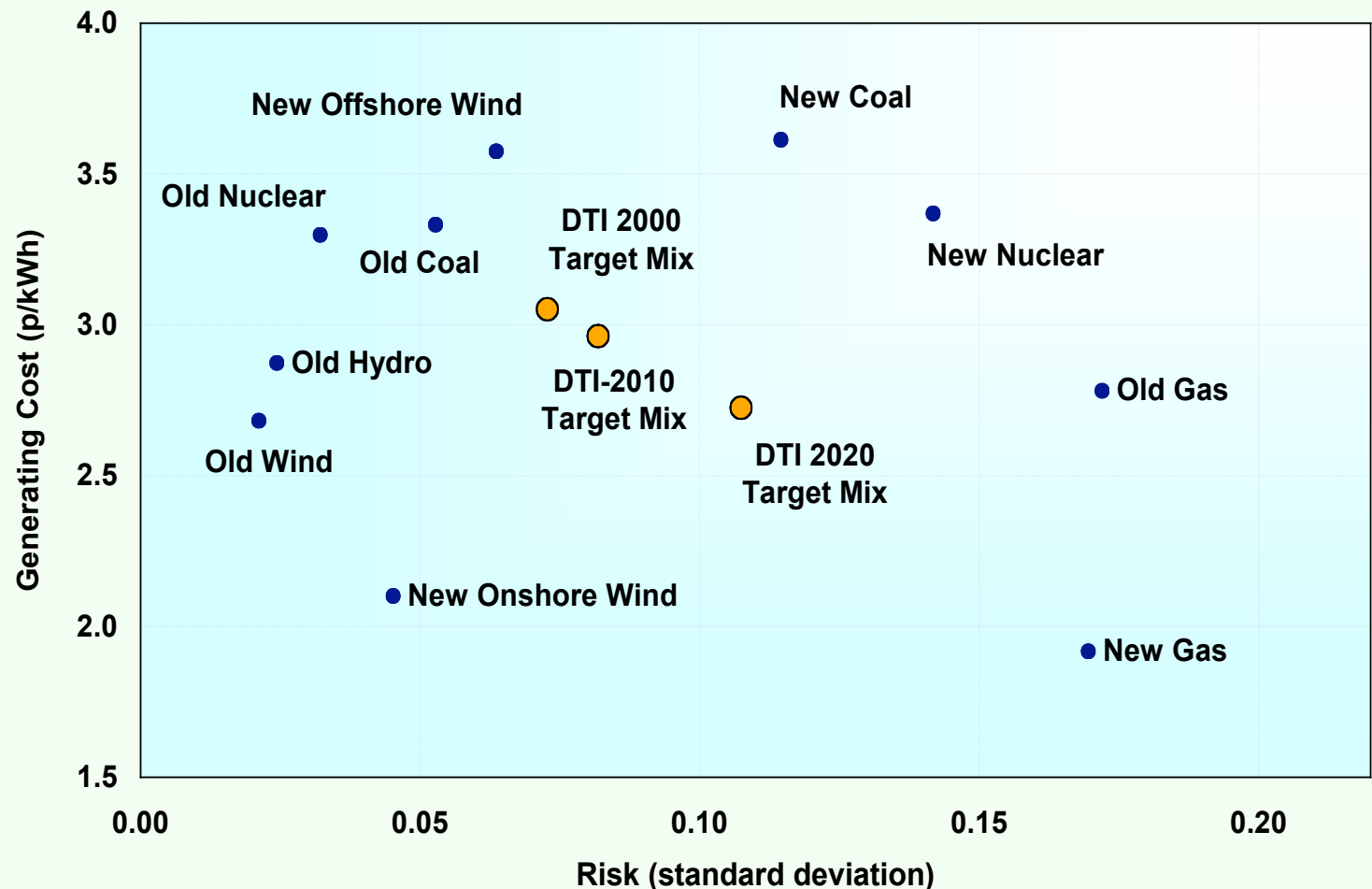
S. Awerbuch, "Getting It Right: The Real Cost Impacts of a Renewables Portfolio Standard," PUF, 2-15-2000.

UK Trends in Generating Cost-Risk

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

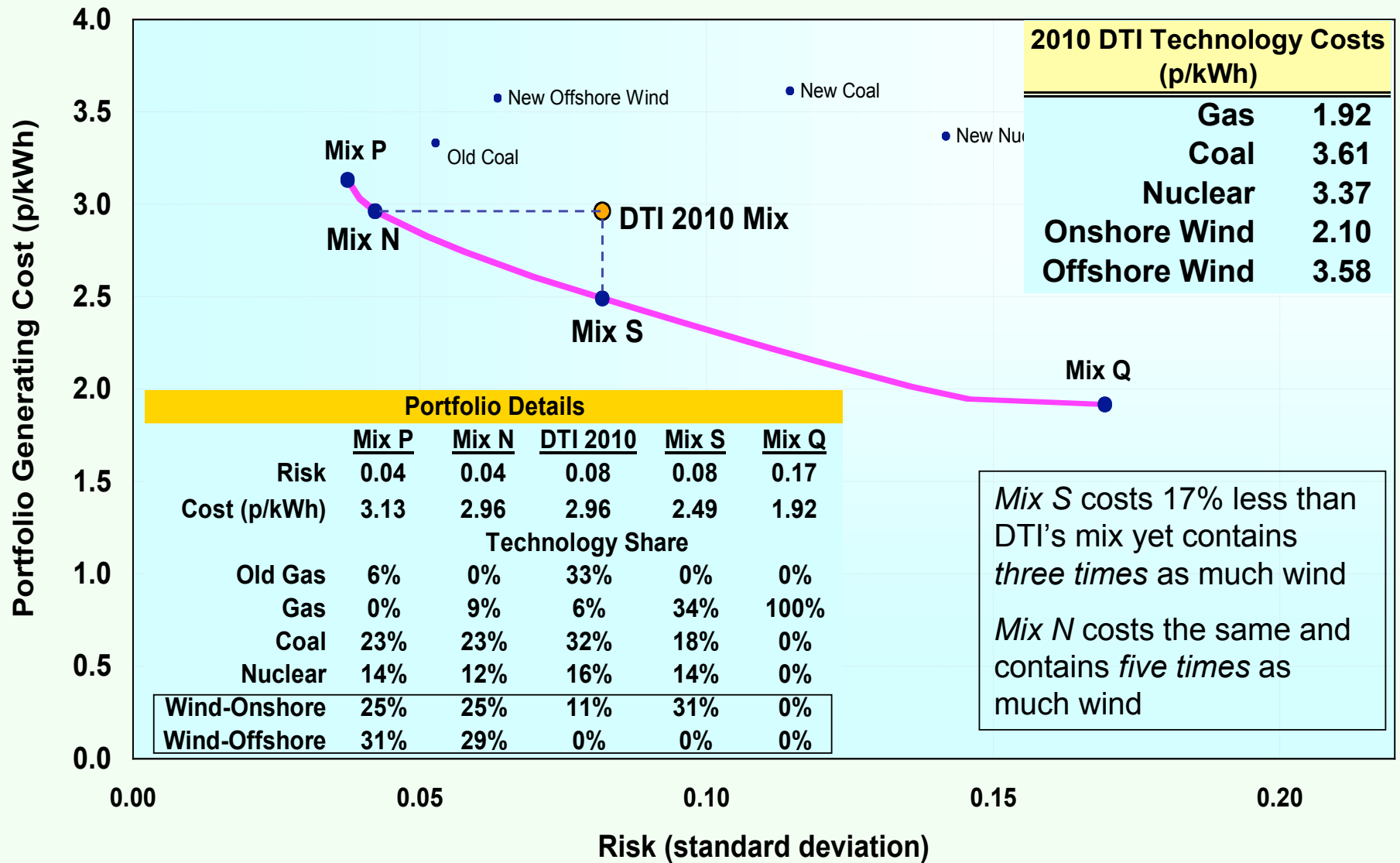
- **Reduces Energy Diversity/ Security**
- **Wind/ Renewables ideally positioned to diversify generating mix and reduce cost/risk**

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***

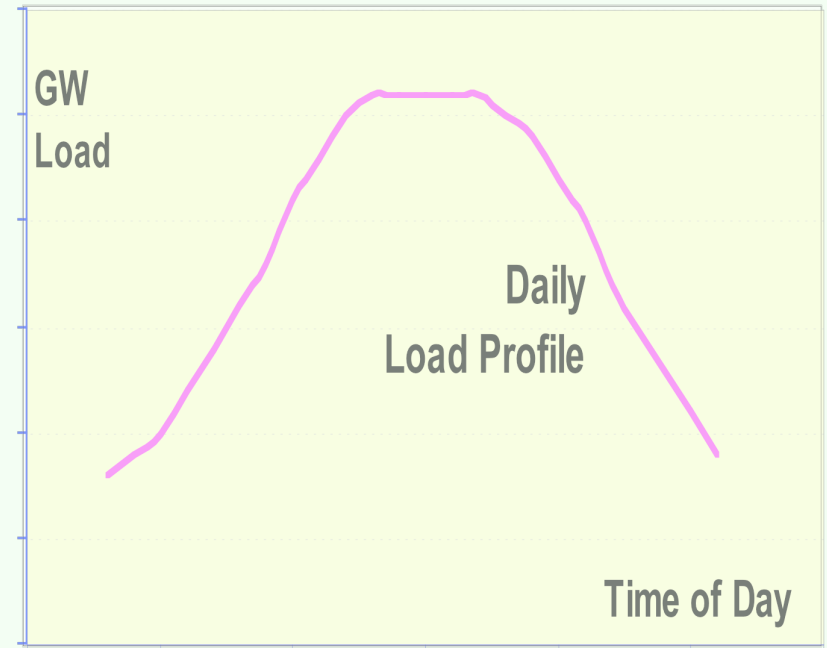
Networks of the Future Must Focus on Markets, Not Electricity Transmission

- **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**