# Portfolio-Based Planning: Enhancing Energy Security and Reducing Generating Cost

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***Parallel Session***

**Integrating Renewables in Energy Planning**
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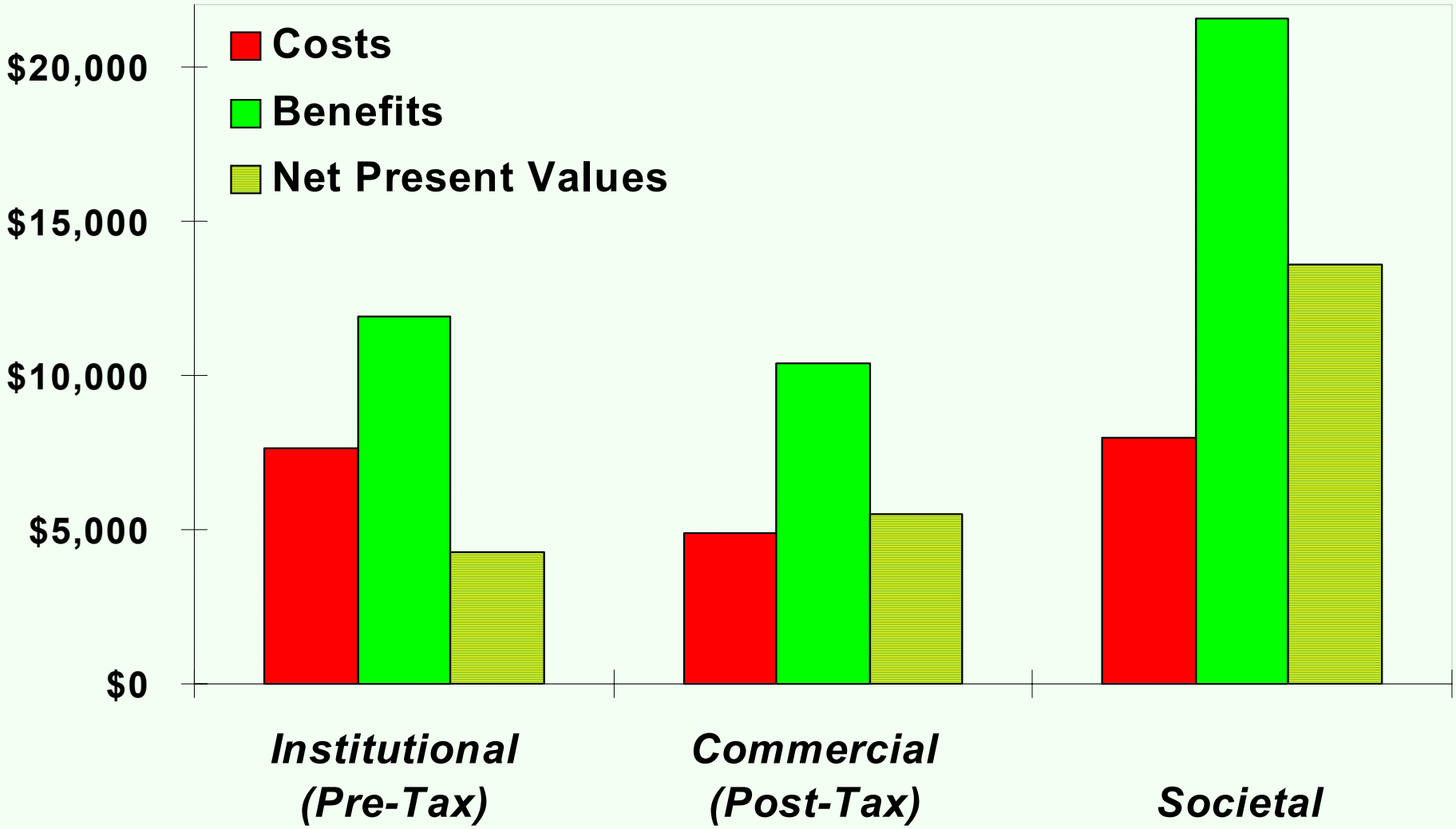
# Shifting The Grounds for Debate: 18 Years of Research in 1 Minute

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

# REFLECTING MARKET RISK

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

# Present Value Costs and Benefits per kW of PV-Augmented Uninterruptable Power Supply



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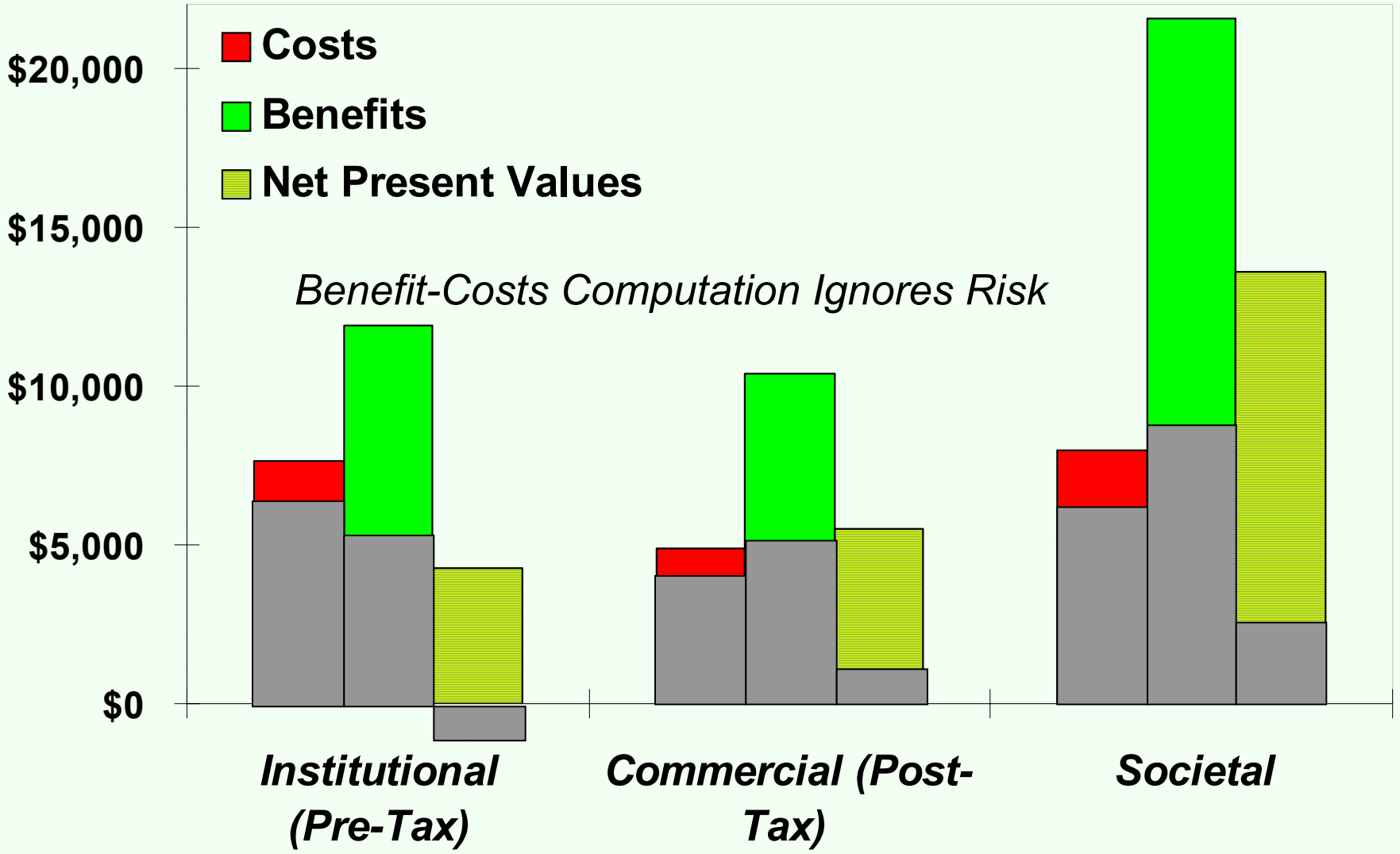


# Arbitrary Discounting Produces Arbitrary Results

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

| | Junk Bond | Government Bond |
|---|---|---|
| | Tenet Hlth Care<br>7-3/8% due 2013 | US Treasury<br>3-7/8% due 2013 |
| | **Yearly Proceeds** | |
| 2005 | $73.75 | $38.75 |
| 2006 | $73.75 | $38.75 |
| 2007 | $73.75 | $38.75 |
| ⋮ | ⋮ | ⋮ |
| 2013 | $1,073.75 | $1,038.75 |
| **Present Value** | **But US-Treasury is Worth More!** | |
| **@ 5% Discount** | $1,154 | $927 |

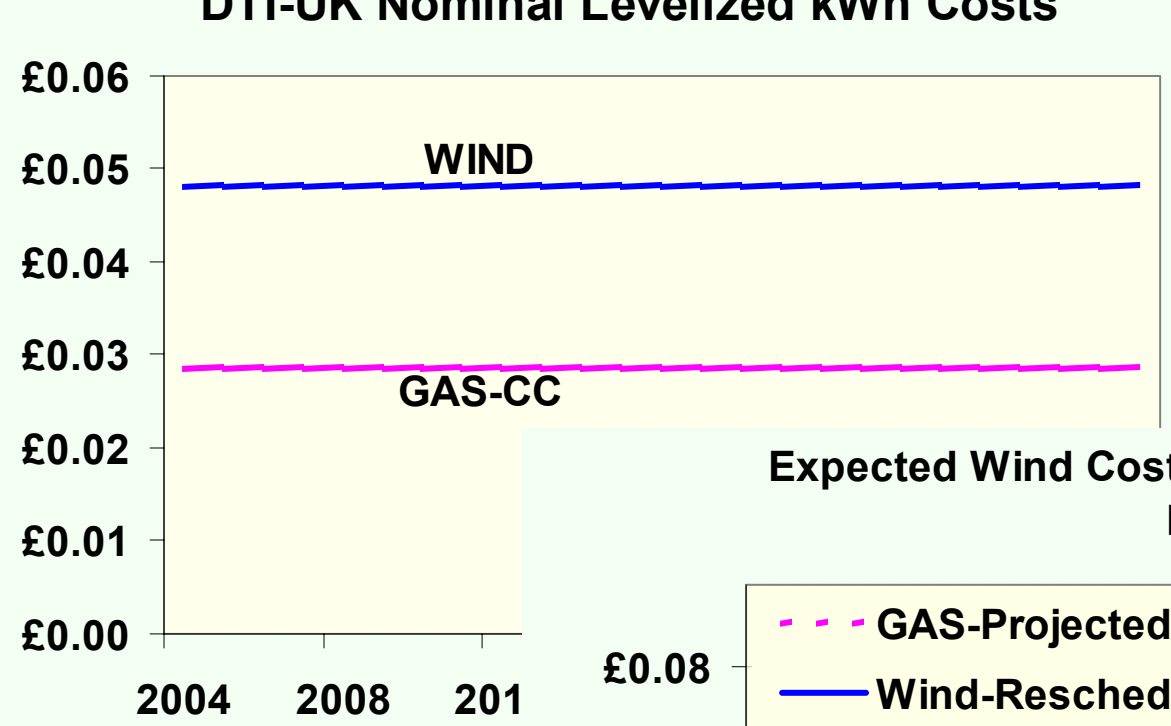
# Ignoring Risk-Differentials: Sensitivity Analysis Makes it Worse

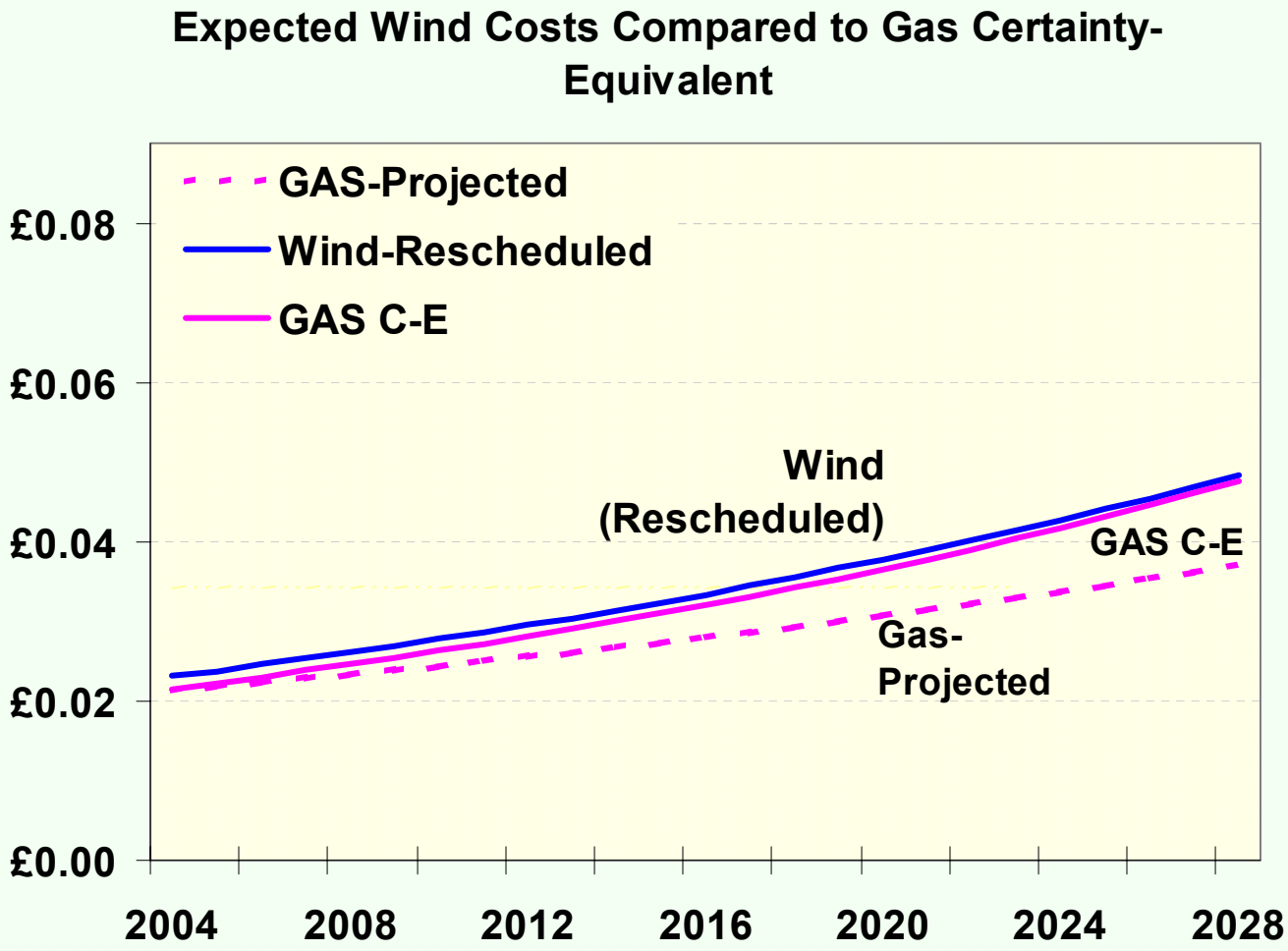
**Sensitivity Analysis for Bond Investments With a Single Arbitrary Discount**

| | Junk Bond | | Government Bond | |
|---|---|---|---|---|
| | Tenet Hlth Care 7-3/8% due 2013 | | US Treasury 3-7/8% due 2013 | |
| **Sensitivity Range** | 1.0 | 0.9 | 1.0 | 0.9 |
| | **Yearly Proceeds** | | **Yearly Proceeds** | |
| 2005 | ($1,000) | ($1,000) | ($1,000) | ($1,000) |
| 2006 | $74 | $74 | $39 | $39 |
| 2007 | $74 | $74 | $39 | $39 |
| 2008 | $74 | $74 | $39 | $39 |
| 2009 | $74 | $74 | $39 | $39 |
| 2010 | $74 | $74 | $39 | $39 |
| 2011 | $74 | $74 | $39 | $39 |
| 2012 | $74 | $74 | $39 | $39 |
| 2013 | $1,074 | $966 | $1,039 | $935 |
| **Net Present Value @5% Discount** | **$146** | **$77** | **($69)** | **($136)** |
| **Percent Change** | **0%** | **-47.3%** | **0%** | **-96.7%** |

# What is *Levelized Cost* anyhow? What does it measure?

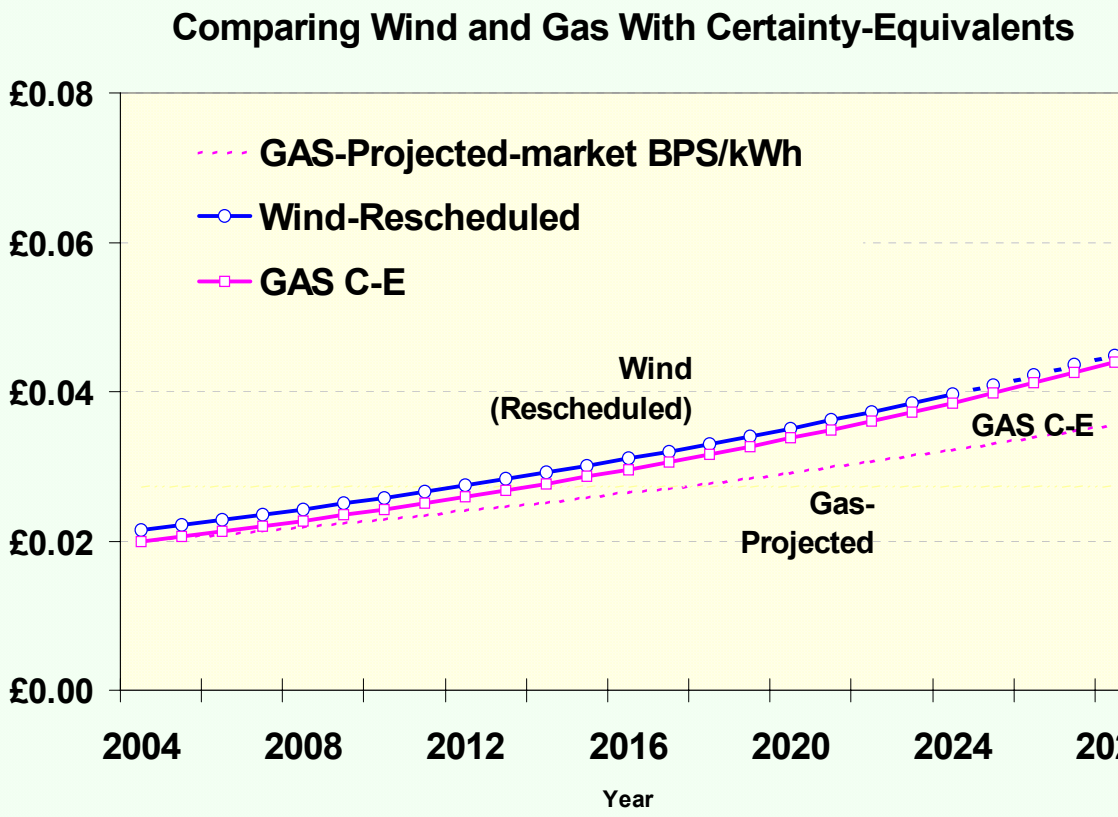
- An *Imaginary Construct*
- Cannot be compared to observed market prices
- Biases against capital-intensive alternatives especially with inflation
- Represents a *Time-Weighted-Average* of projected annual costs



# Renewables Can Change the Legacy We Leave for Future Generations

- Fossil usage saddles future cohorts with rising fuel & environmental costs
- Back-loaded capital recovery for wind/PV may be a no-regrets means of hedging climate change risk



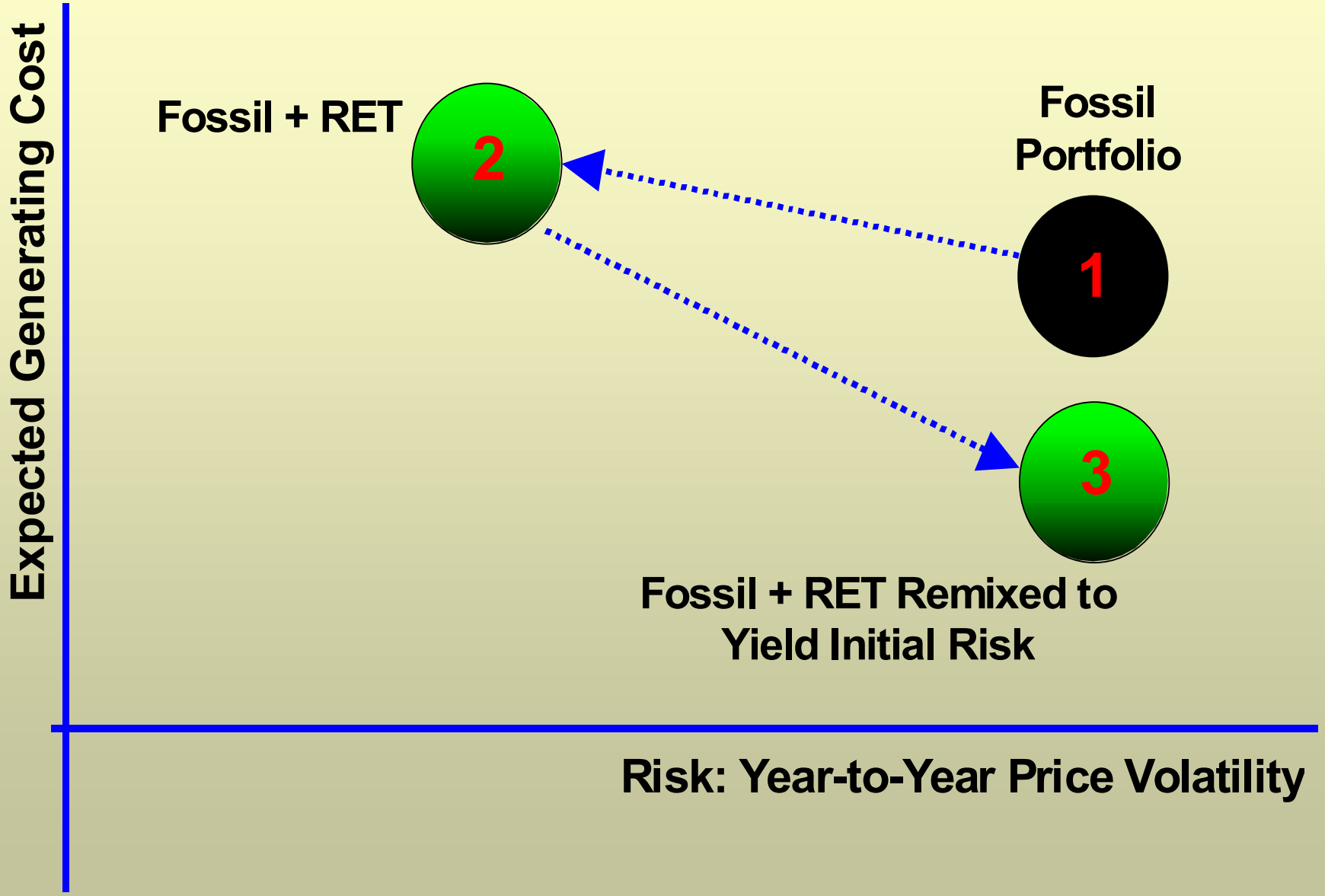

**Should We Alter Our Compact With Future Generations?**

# Nobel Laureate Harry Markowitz Taught the World About Portfolios

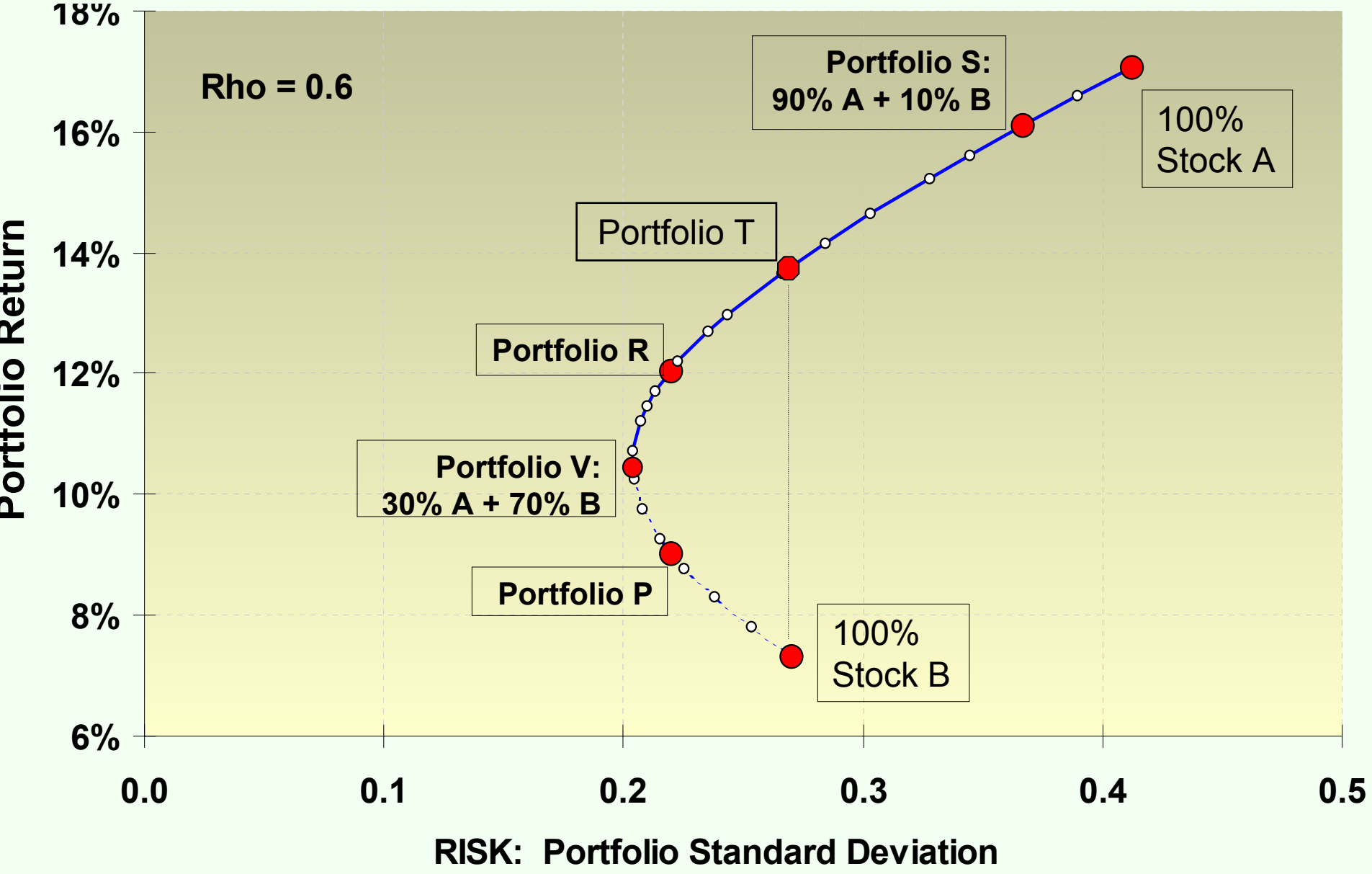
- Portfolio of risky equity stocks expected yield 10%
- Add risk-free government bonds with expected yield 3%
- Resulting Overall Yield? ??

- Resulting yield will be >10% at any given level of portfolio risk

# Renewable Technologies Help the Generating Mix
## Risk and Cost of Generating Portfolios



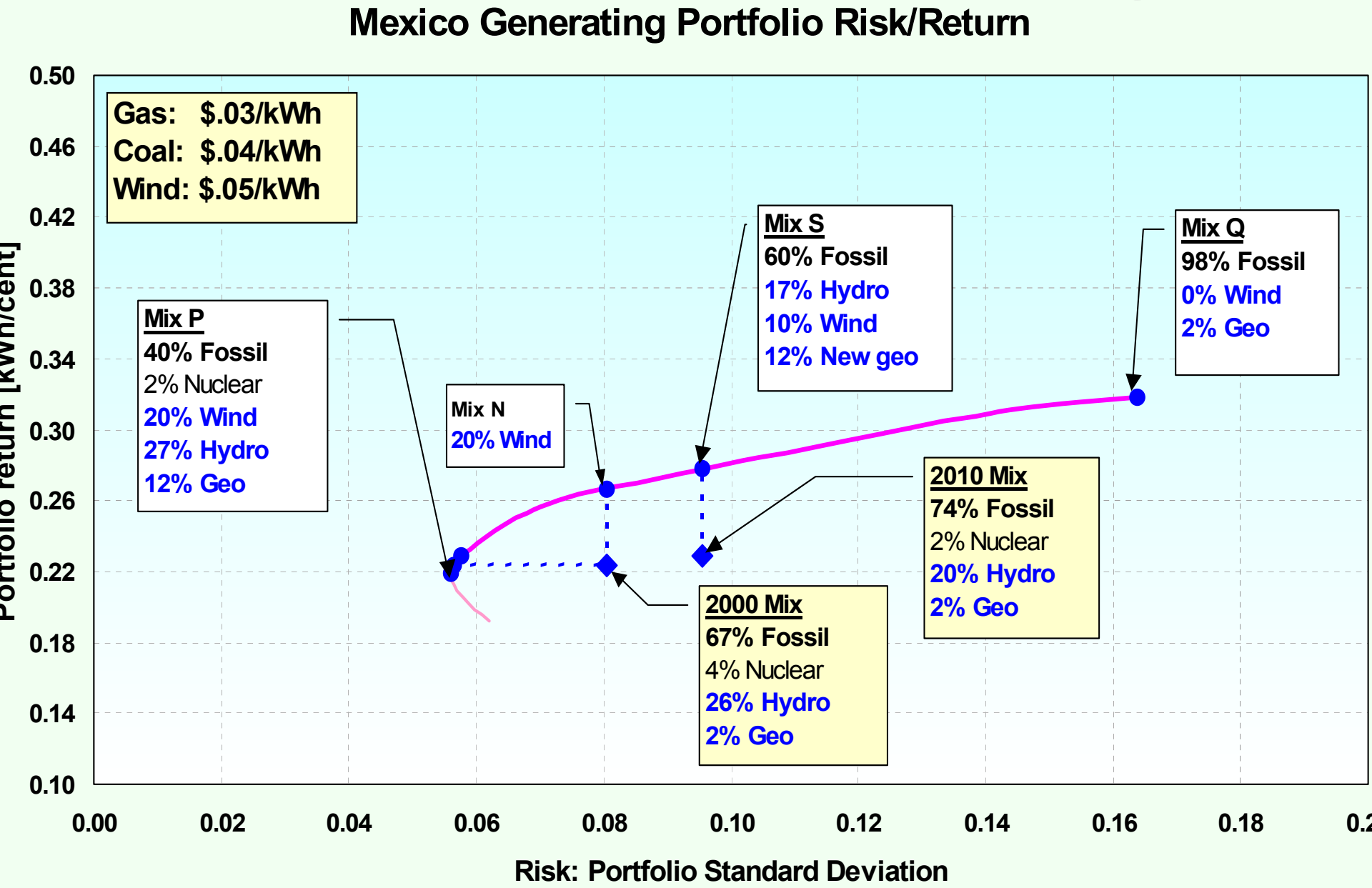
# Risk and Return for A Portfolio of Risky Assets





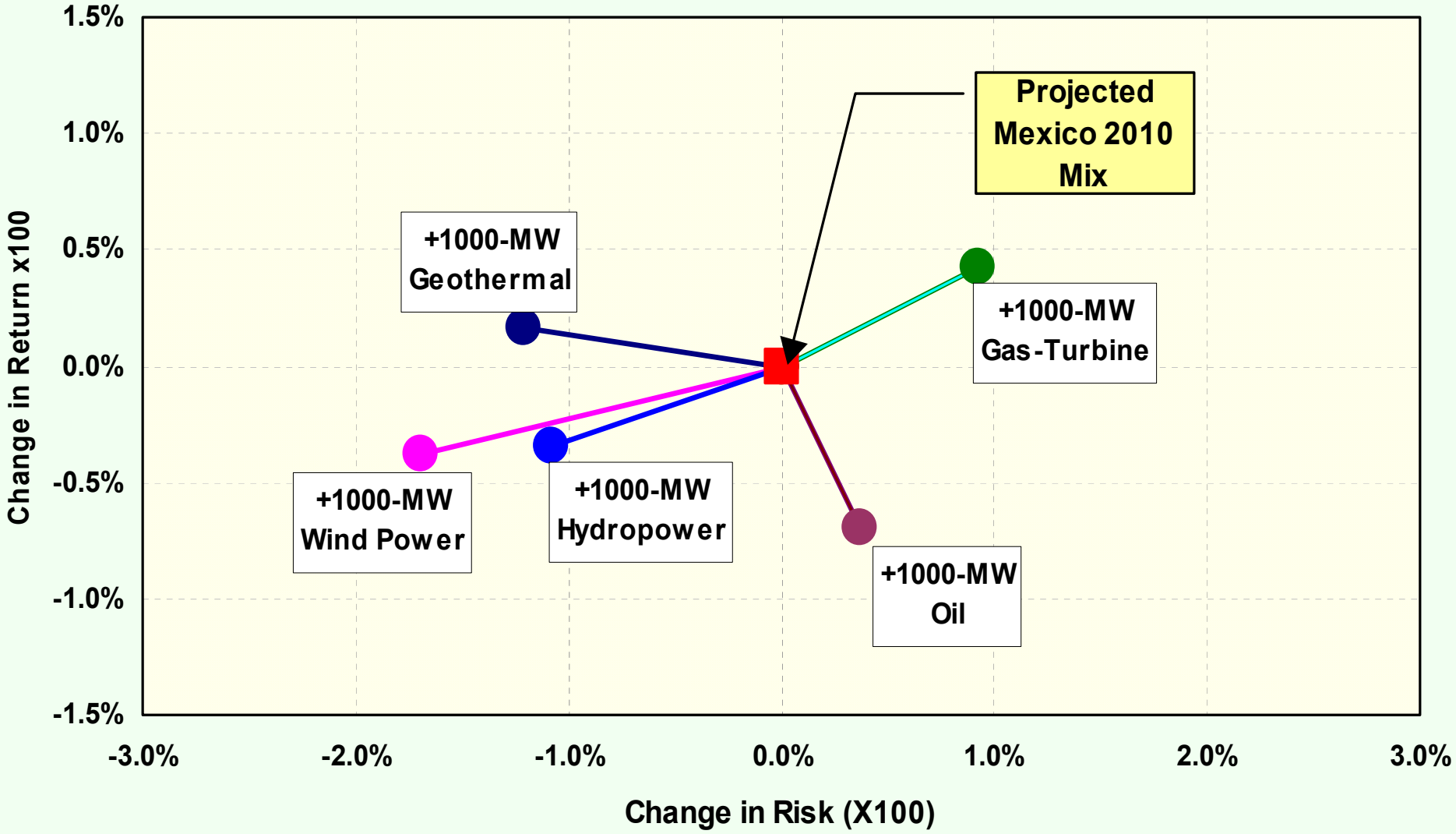

ewables Portfolio Standard." PUF. 2-15-2000.

# Wind/RE Lowers Mexico Generating Cost

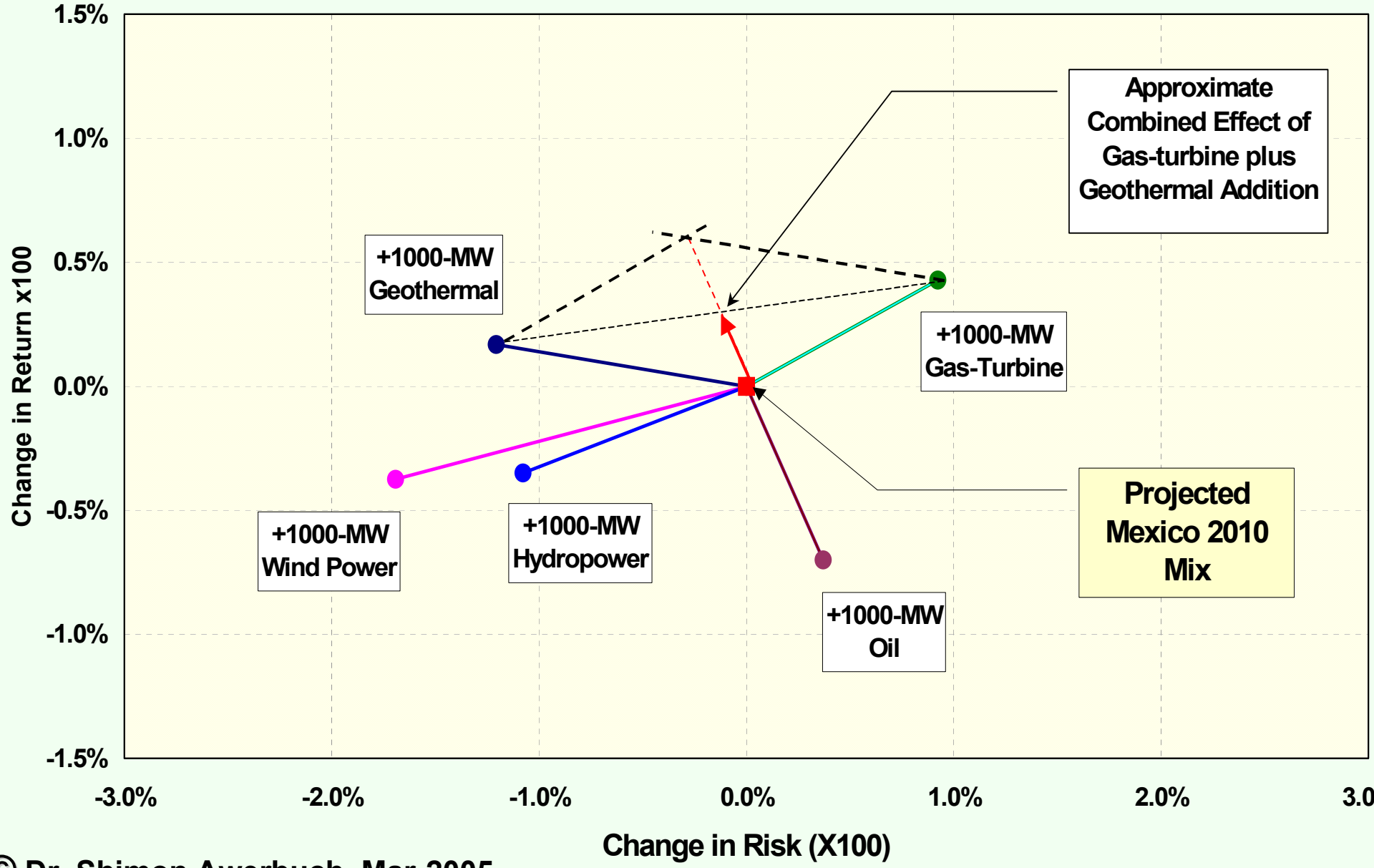


# One-Step Analysis for Planners

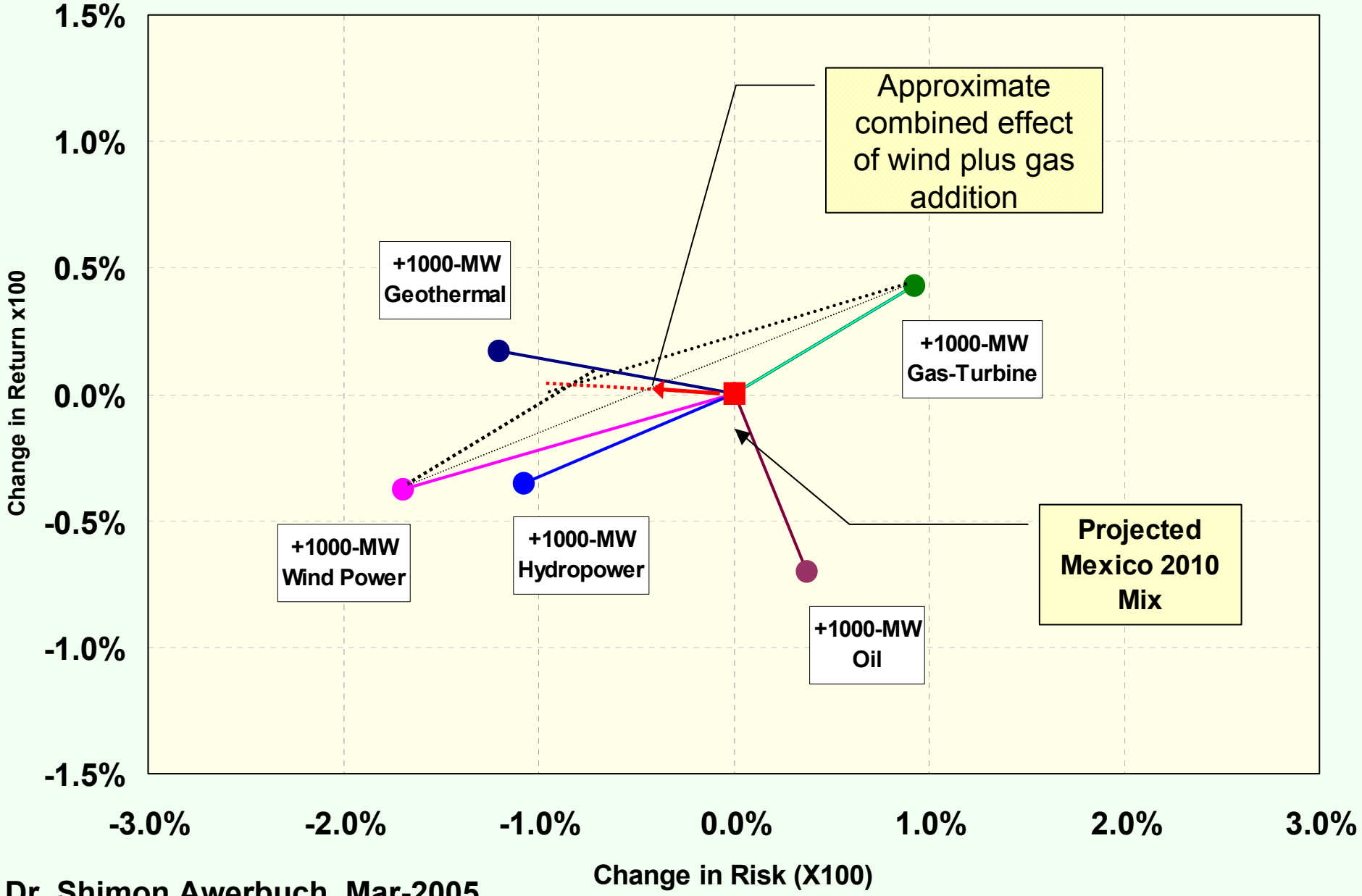
**Mexico: Risk-Return Sensitivity of Projected Mexico 2010 Mix to 1000-MW Additions of Various Technologies**



# Graphic One-Step Vector Diagram: Risk-Cost Addition for Multiple Small Project Additions

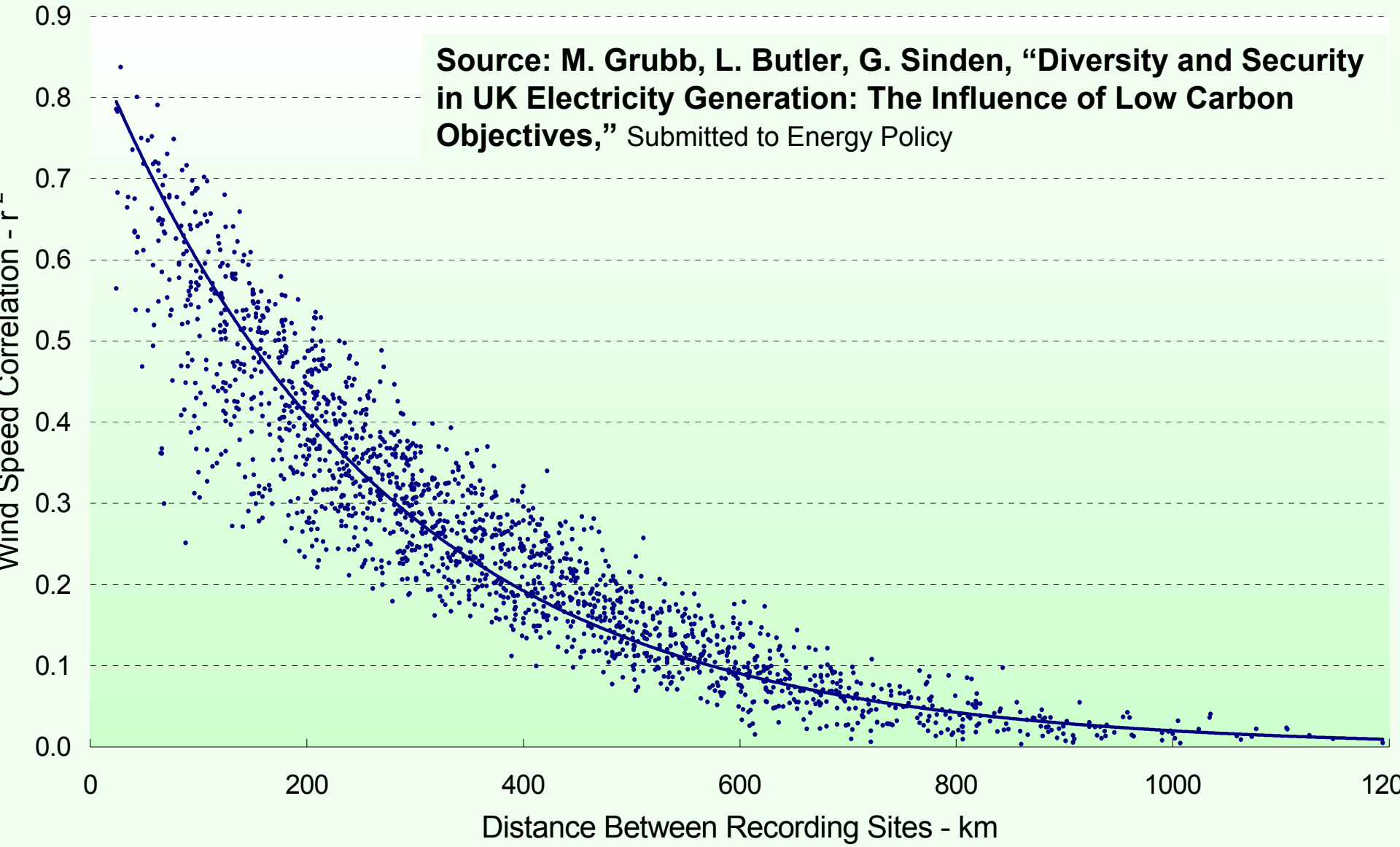


# Graphic One-Step Diagram: Risk-Cost Change for Wind-Gas Additions

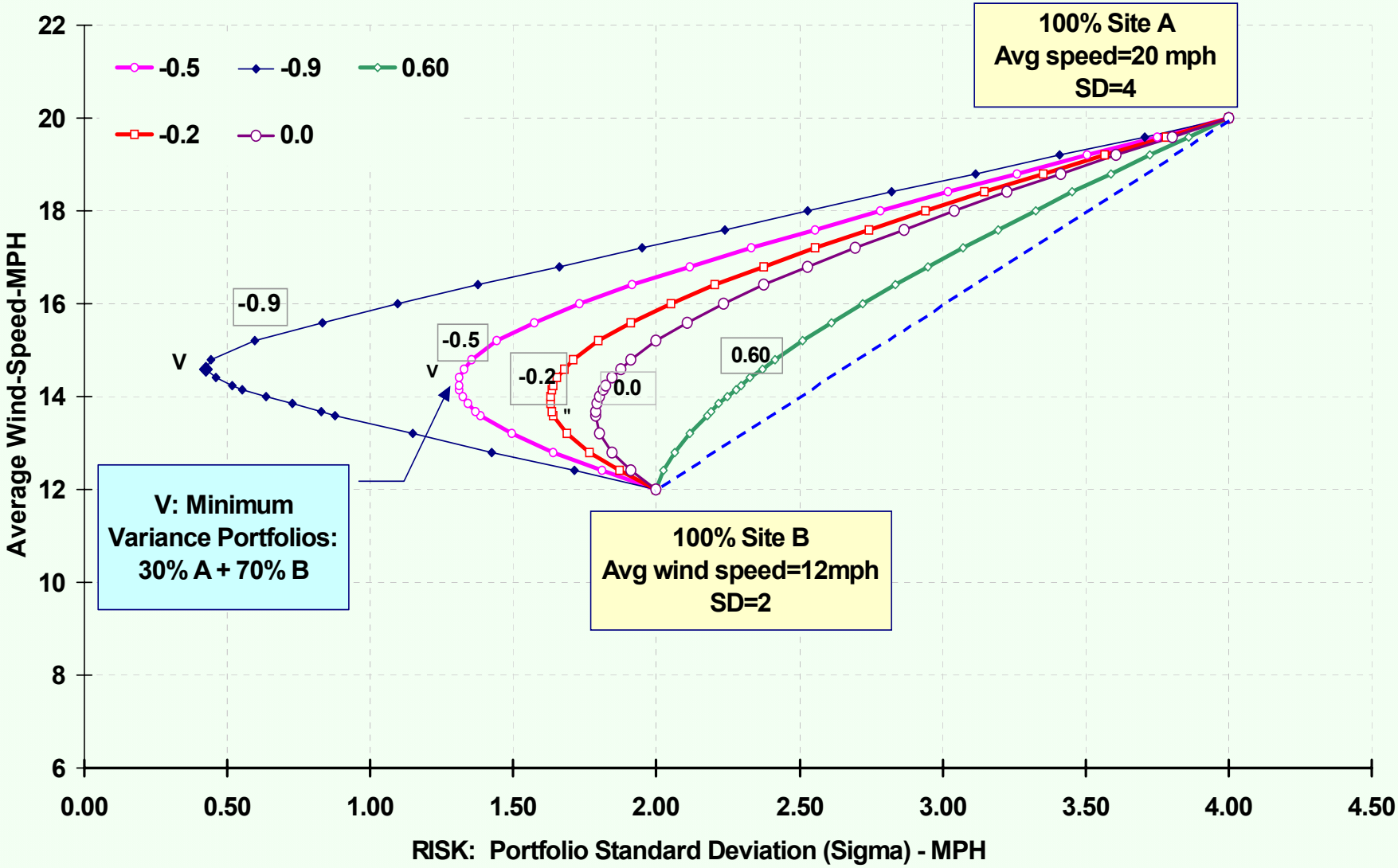


# Onshore Wind Speed Correlation by Distance - UK

1,770 pairs of wind speed recording sites - surface wind speed - typically ~30 years data per pair



# Wind Capacity Credits: Expected Variability for Two-Site Wind Portfolio



# Networks of the Future: *Informated*, *Decentralized* and *Market-Driven*

- ***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**

# Current RE Deployment in its Infancy

- **Renewables "Shoe-horned" into Existing Network Operations & Architecture**

  -- Inherit inappropriate dispatch, pricing and other rules

- Network cannot fully exploit their value

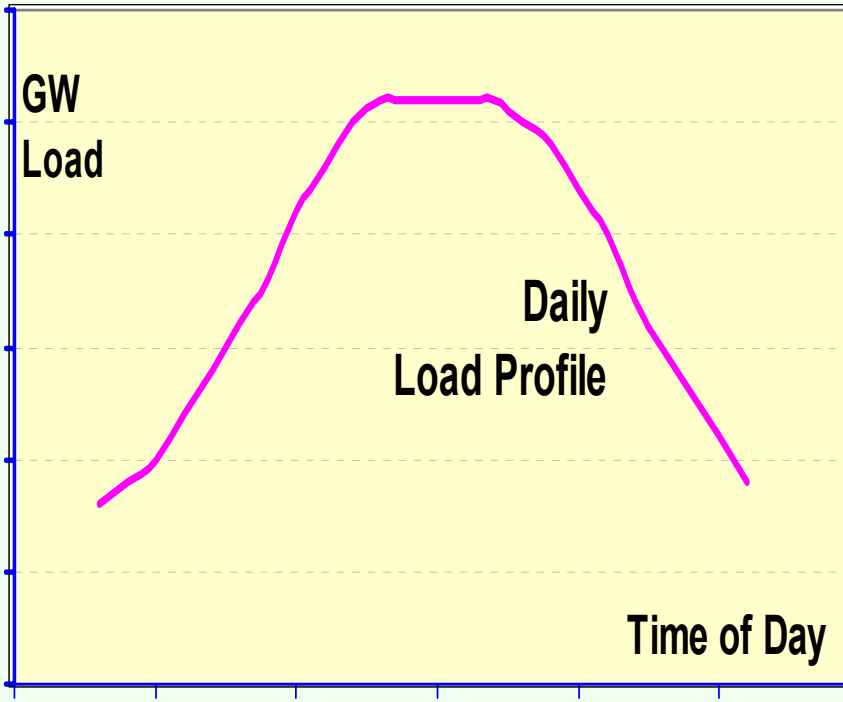
  -- Like Word Processors and Bessemer Steel

**Effective 21st Century Electricity Production/Delivery Systems Require *Mass Customization, Generation Diversity…***

**and infra-structures that support it**

# Mass-Production vs. Mass-Customization

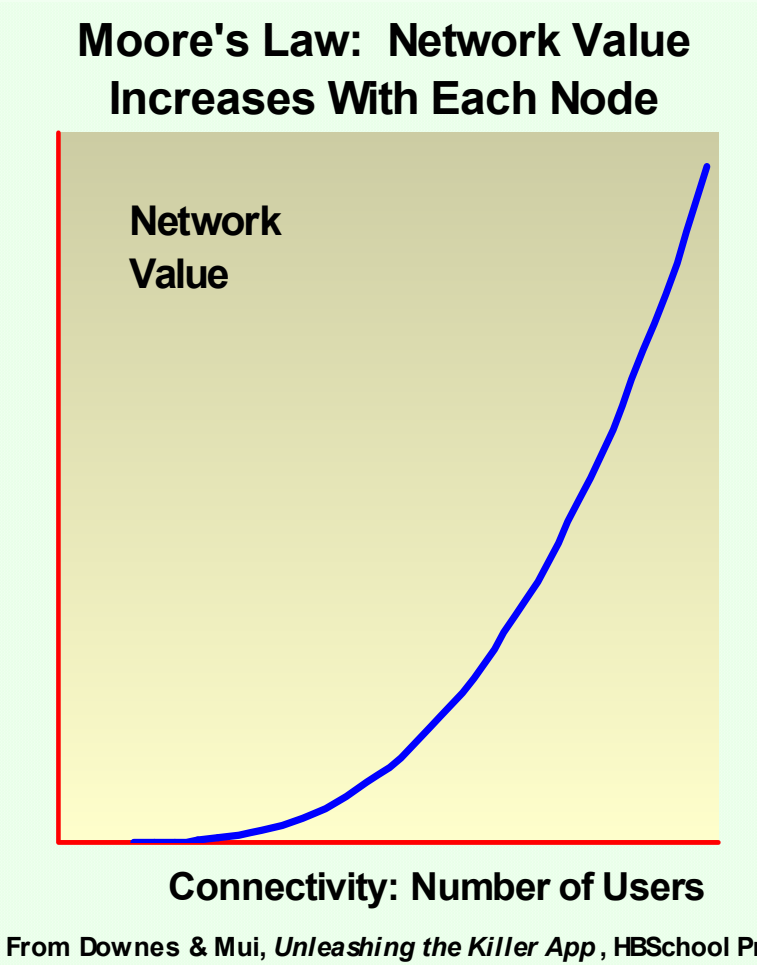
- *Any color as long as it's black* (Ford) vs. *Have it your way* (Dell)
- Electricity is mass-produced using "dispatchable" sources to meet aggregated network load




- Masks underlying dynamics of millions of transactions, each with a different valuation
- Inhibits integration of "intermittent" sources

# Modern Decentralized Grids Exploit Network Economics: They are Electricity Market-enablers

- **Each new node provides external benefits- Moore's Law**
  - Increasing number & diversity of connected suppliers enhances competition & reduces market power
  - Important role for RE
- **Market Enabler: At any moment, there exist differences in the value of power among different loads and different geographic areas**
  - Network enables arbitrage – important market-making role



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