Challenging the Energy Mix: How Renewables Really Impact Cost and Energy Security

Shimon Awerbuch, Ph.D.

Energy-Regulatory Economics and Finance

www.awerbuch.com

SPRU Energy Group
University of Sussex

Energy Ireland 2005

Dublin: June 13-14

RETs Provide Important Portfolio Benefits Without Increasing Cost.... But Investors Cannot Capture These

Benefit	Policymaker Awareness
Å **Environmental Benefits** - Widely understood–undervalued by regulators	**HIGH**
Å **Help Mitigate Market Power** - *Unlock* Benefits of Liberalization by Enhancing Competition - Requires NO restructuring & incentives	**MOD**
Å **Security: *Mitigate/Diversify* Fossil Risk** - *Reduce* electricity generating costs - *Minimize macroeconomic fossil risk*	**LOW**

Most significant aspect of energy security today

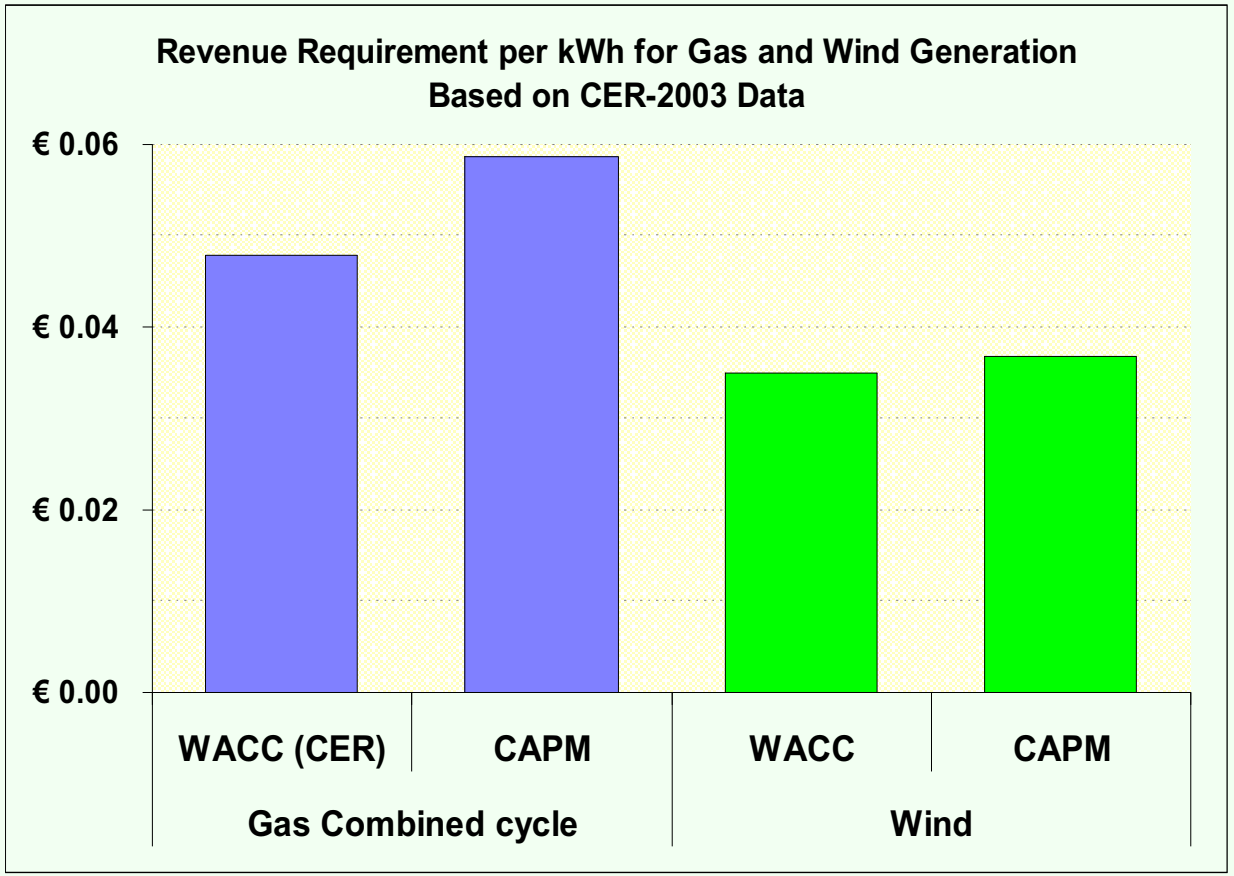
The Macroeconomic Consequences of Fossil Price Risk: A major external cost

- **Fossil volatility hurts employment & GDP growth in consuming and producing nations**
- **Macroeconomic cost of 2000-04 oil spikes in EU: €400 Billion**
  - Offsets *entire* 2020/20% RET investment needs estimated by EWEA / EREC
- **Gas also plays a role (US): (LBNL, 2005)**
  - 1% nat-gas demand reduction → 0.8% - 2% price reductions
  - Every MWH of renewables saves consumers $7.50 - $20 through lower gas prices

Where is the Policy Disconnect?

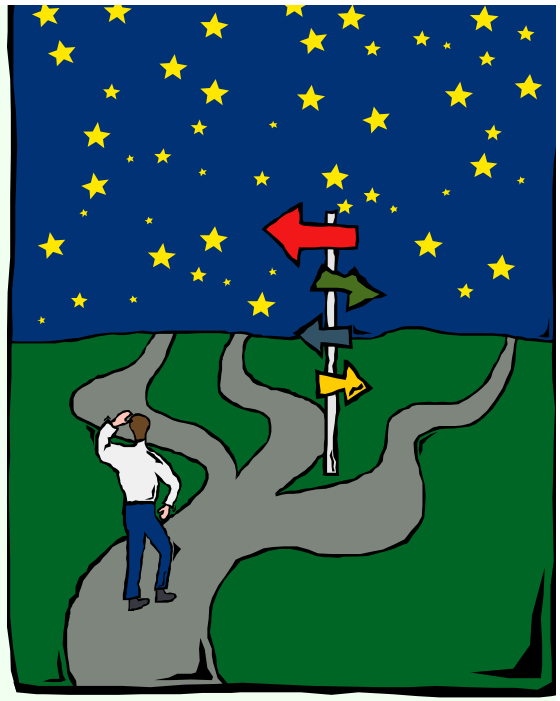
Risk Affects KWH Cost Estimates

- Risk affects *value* and economic *expectations*
- Engineering cost estimates- arbitrary discounting
  - No economic interpretation



Selecting *Least-Cost* Alternative:
Like asking for 20-year stock forecasts

Portfolio Based Valuation

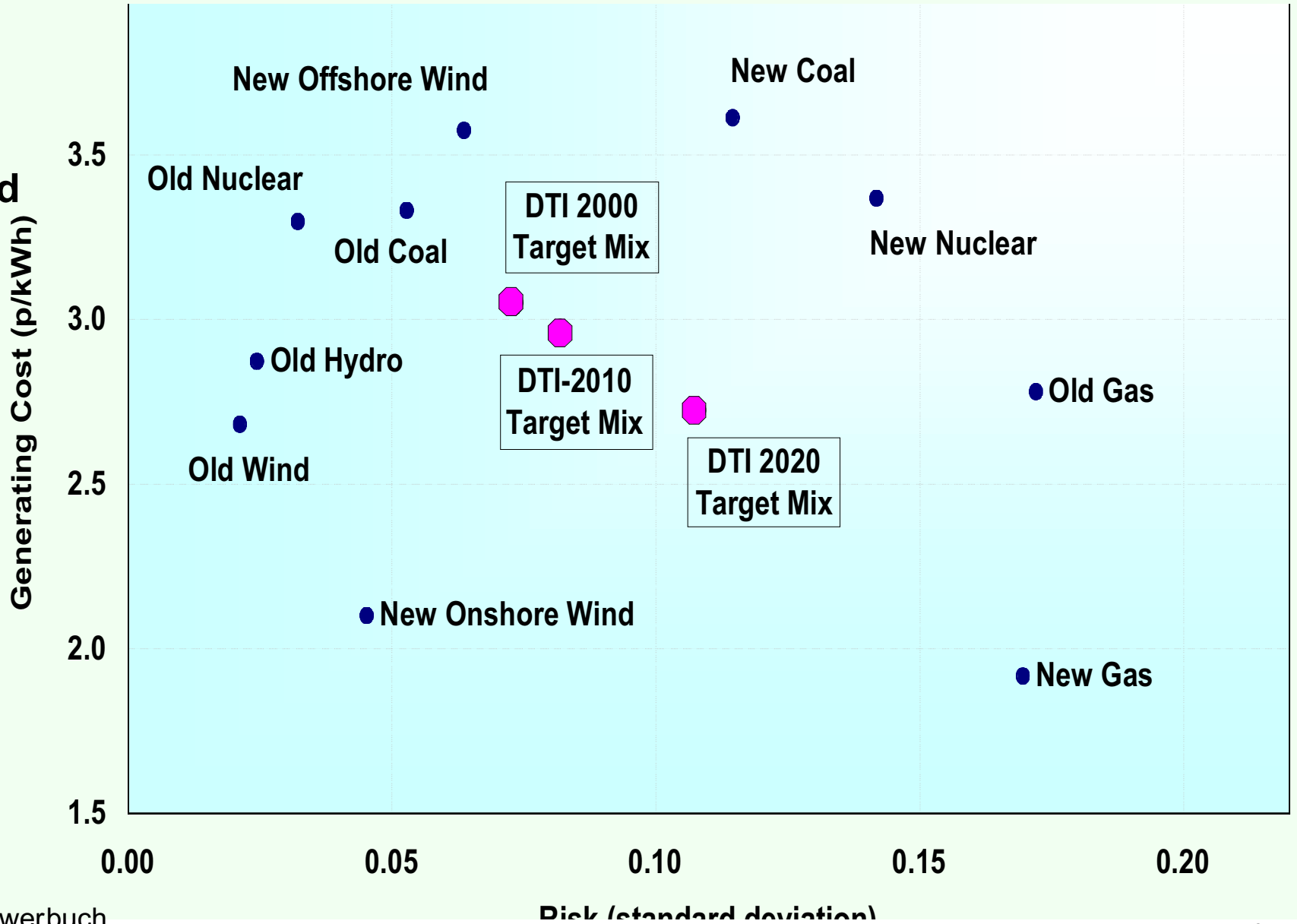


- **A Generating Alternative's *Stand-Alone* Cost Not Very Meaningful**
- **Must consider its contribution to portfolio *cost* relative to its contribution to portfolio *risk***
- ***Textbook Portfolio Theory Predicts:***
  - Adding Fixed-Cost Renewables to Generating Mix *Reduces* Overall Generating Cost at any Level of Risk..... Even if *stand-alone* costs are *higher*

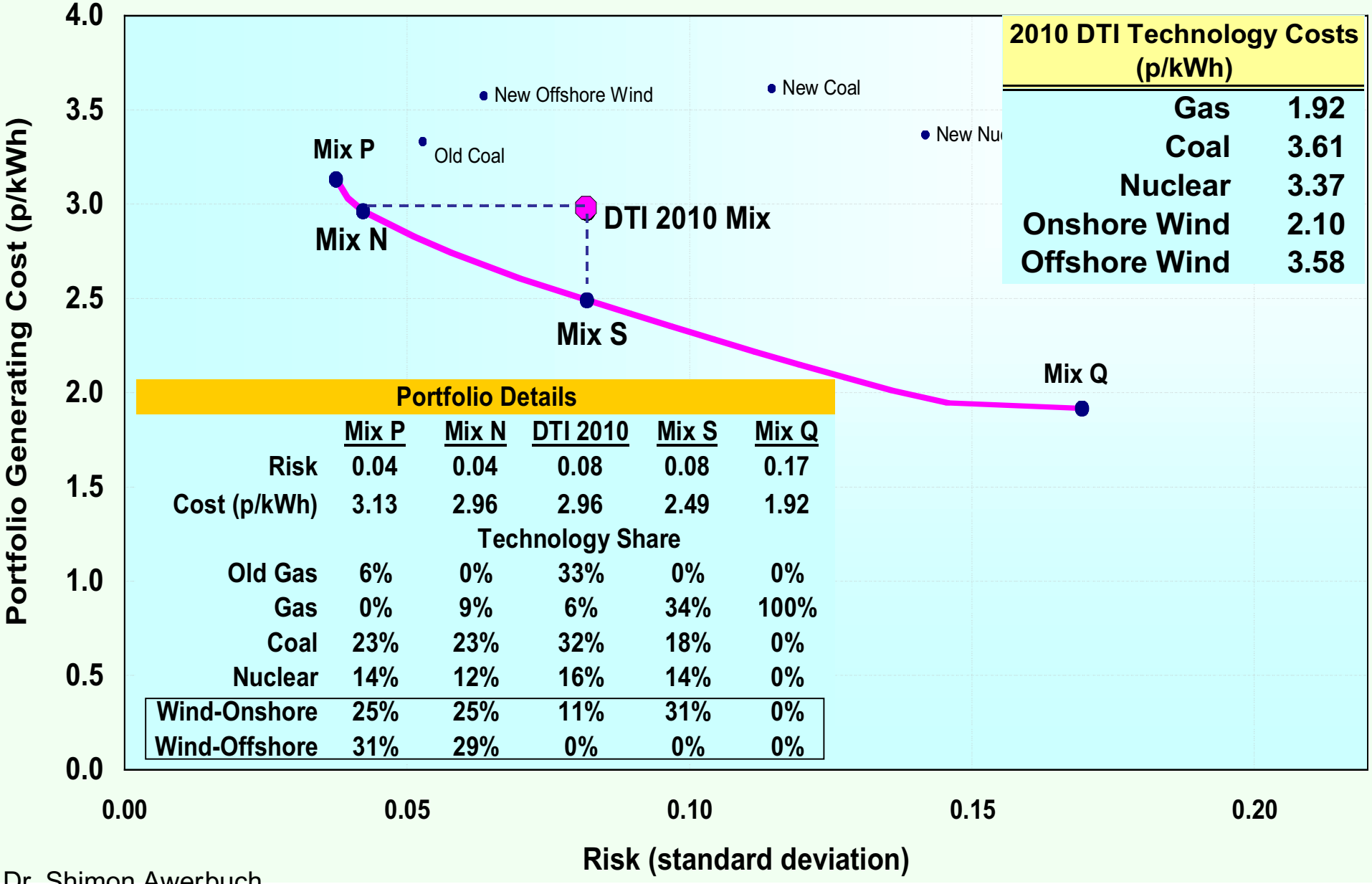
Enhancing Energy Security
Does Not Have to Raise Cost

DTI's UK Generating Mix: Cost–Risk Trends

- **Larger gas shares reduce portfolio Diversity-Security**
- **Wind ideally positioned to diversify mix and reduce cost/risk**



2010 UK Portfolio Optimization
– DTI Technology Costs –



2010 DTI Technology Costs (p/kWh)

Gas	1.92
Coal	3.61
Nuclear	3.37
Onshore Wind	2.10
Offshore Wind	3.58

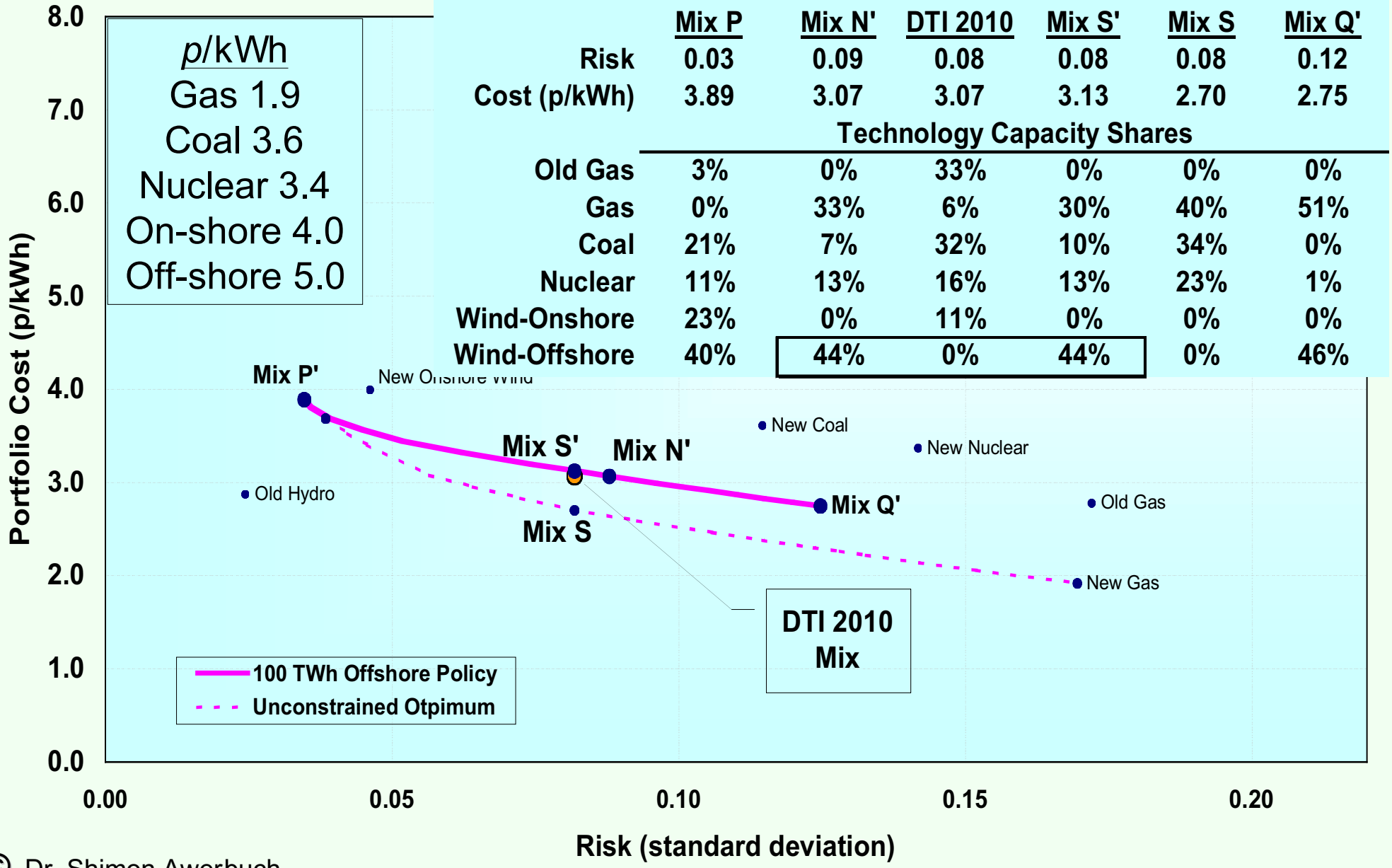
Portfolio Details

	Mix P	Mix N	DTI 2010	Mix S	Mix Q
Risk	0.04	0.04	0.08	0.08	0.17
Cost (p/kWh)	3.13	2.96	2.96	2.49	1.92
Technology Share					
Old Gas	6%	0%	33%	0%	0%
Gas	0%	9%	6%	34%	100%
Coal	23%	23%	32%	18%	0%
Nuclear	14%	12%	16%	14%	0%
Wind-Onshore	25%	25%	11%	31%	0%
Wind-Offshore	31%	29%	0%	0%	0%

Cost of UK Accelerated Wind Deployment Policy High Wind Cost Scenario – 2010 (2003–_)

	Mix P	Mix N'	DTI 2010	Mix S'	Mix S	Mix Q'
Risk	0.03	0.09	0.08	0.08	0.08	0.12
Cost (p/kWh)	3.89	3.07	3.07	3.13	2.70	2.75
Technology Capacity Shares						
Old Gas	3%	0%	33%	0%	0%	0%
Gas	0%	33%	6%	30%	40%	51%
Coal	21%	7%	32%	10%	34%	0%
Nuclear	11%	13%	16%	13%	23%	1%
Wind-Onshore	23%	0%	11%	0%	0%	0%
Wind-Offshore	40%	44%	0%	44%	0%	46%

p/kWh
Gas 1.9
Coal 3.6
Nuclear 3.4
On-shore 4.0
Off-shore 5.0



Renewable Energy and the Power Grid:

RE Can Help Reconceptualize Electricity Production & Delivery Paradigms

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 support re-conceptualized *just-in-time, mass-customized*

electricity production/delivery paradigms

Baby Steps– Learning to Integrate Wind – people talk about capacity factors

- ***Capacity-Factor-*** **Fraction of *theoretically* feasible output a given asset produces in a year**
  - Ireland Wind *Capapcity Factor* = 35% → high
  - Is wind non-productive 65% of the time?
    - Exploiting resource is economic and sustainable
- **No grid asset operates 100% of the time**
  - In the US: Power grid itself operates at 15%-20% capacity-factor.

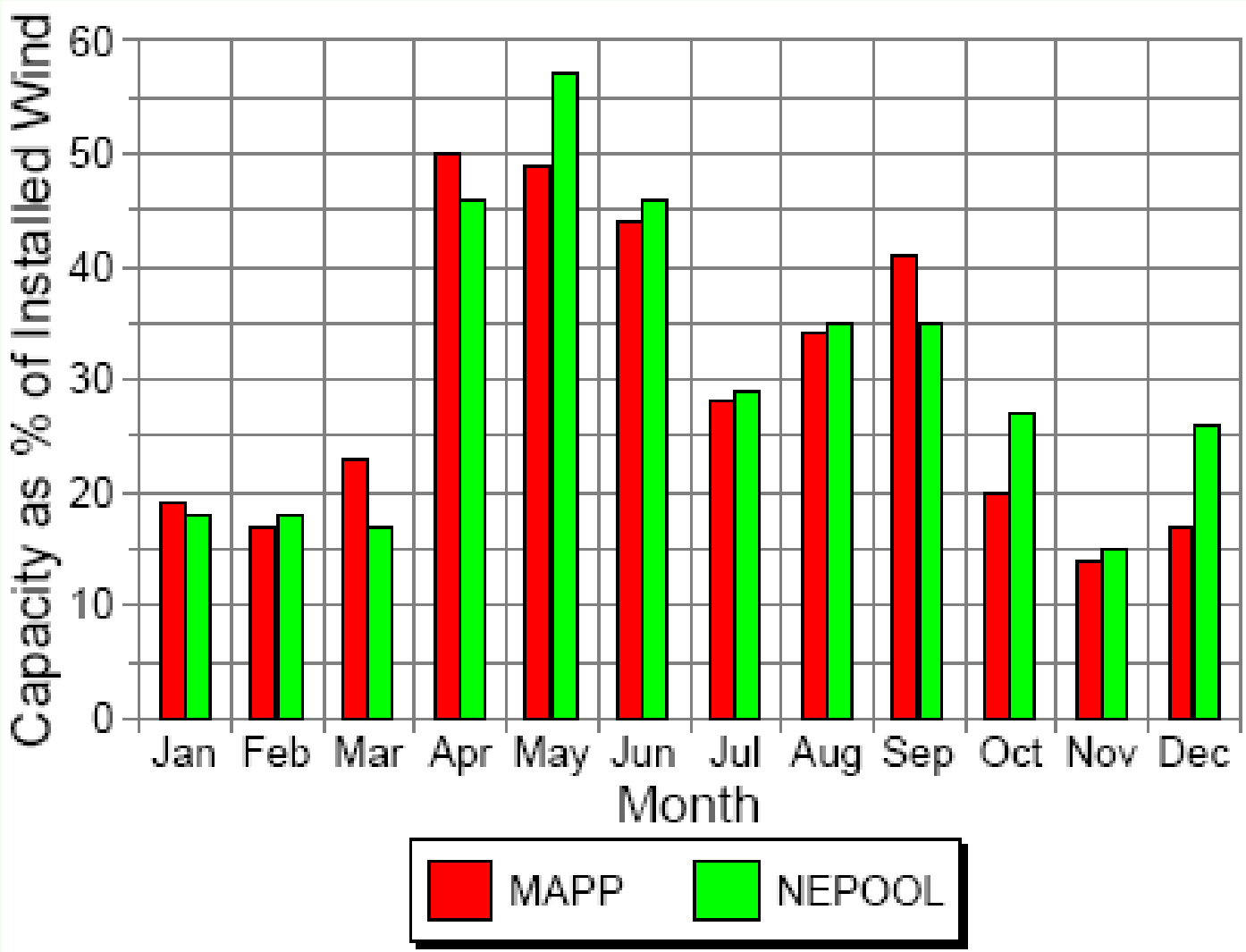
Wind Intermittency: People worry about backup – Capacity–*Credit (ELCC)*

- **Amount of conventional generation (KW) that can be replaced with wind**
  - *ƒ*{capacity-factor & coincidence with system peak}
- **Every grid asset requires backup**
  - e.g. 500-MW fossil plant with 15% forced outage rate
    - →Capacity-credit might be 78% (Milligan, NREL, 2002)
    - → At 77% plant availability?
- **Backup issue complex**

Wind Backup Needs– Complex & Controversial:
Estimated Wind Capacity–Credits

- ESB ≈ 35%
- R. Perez: (Martinique) approaches 50%
- A. Lovins:
  - 43% for PEI
  - Altamont Pass: 40%;
  - Solano: 74%

Simulated wind capacity credit: 10-year actual wind and load data (Source: Milligan, NREL 2002)



Wind Integration Costs

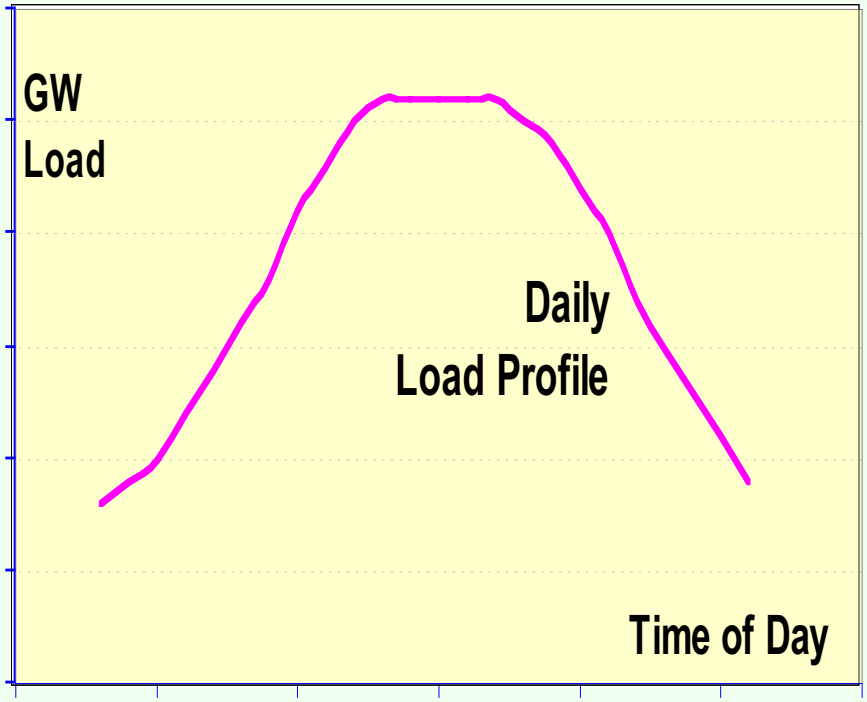
- **Recent studies suggest wind deployment imposes very small system costs**
  - e.g. kWh Cost of 20% wind penetration:

    0.5p in the UK / 0.4 Euro-cent in Germany

    (Sources: Dale, Milborrow, *et. al.*, National Grid Transco & UMIST (2004), and German *DENA Grid Study* (2005)
- **Important – helps us understand wind integration**
  - But are conceived in the context of today's grid protocols & architecture
- **Ignore power of *organizational learning & market incentives***

Mass–Production vs. Mass–Customization in Electricity Production/Delivery

- ***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**
  - High Value Vs. Interruptible loads
- **Inhibits integration of "intermittent" sources**

Intermittent Resources: Mass-customization & Discrete Load Matching™

- **Interruptible loads may = 5% - 17% of peak demand**
  - May not need backup for hours
  - Value backup less than price central-dispatch pays
- **Mass-Customization Demonstration**
  - Feasibility of intermittent wind for UK hotel chain with 12 MW load / _2.5 million p.a.
  - Goal: intermittent wind *exclusively* serves 50% of hotel chain's load
    - Will manage intermittency without relying on system power

The power of market incentives

- **Monopoly system operators cite costs of cycling fossil generators to compensate for wind intermittency**
  - Heard in the monopoly days in the US, but now vanished with restructuring
- **Market incentives induced fossil operators to learn new ways of tweaking and operating equipment**
  - Coal plants cycled to meet market needs
- **Demonstrates power of financial incentives over engineering standards that have never met a market test**

How to efficiently integrate wind into the Irish system

- **Provide system operator with financial incentives to add wind under *price-cap* regulation**

- **Allow organizational learning and incentives to work**

THANK YOU

Shimon Awerbuch