Macro-engineering for Climate-change: Retrospectives of a Financial Economist

Shimon Awerbuch, Ph.D.

Energy-Regulatory Economics and Finance

Tyndall Centre Visiting Fellow
SPRU- University of Sussex
s.awerbuch@sussex.ac.uk

Macro-Engineering Options for Climate Change Management & Mitigation

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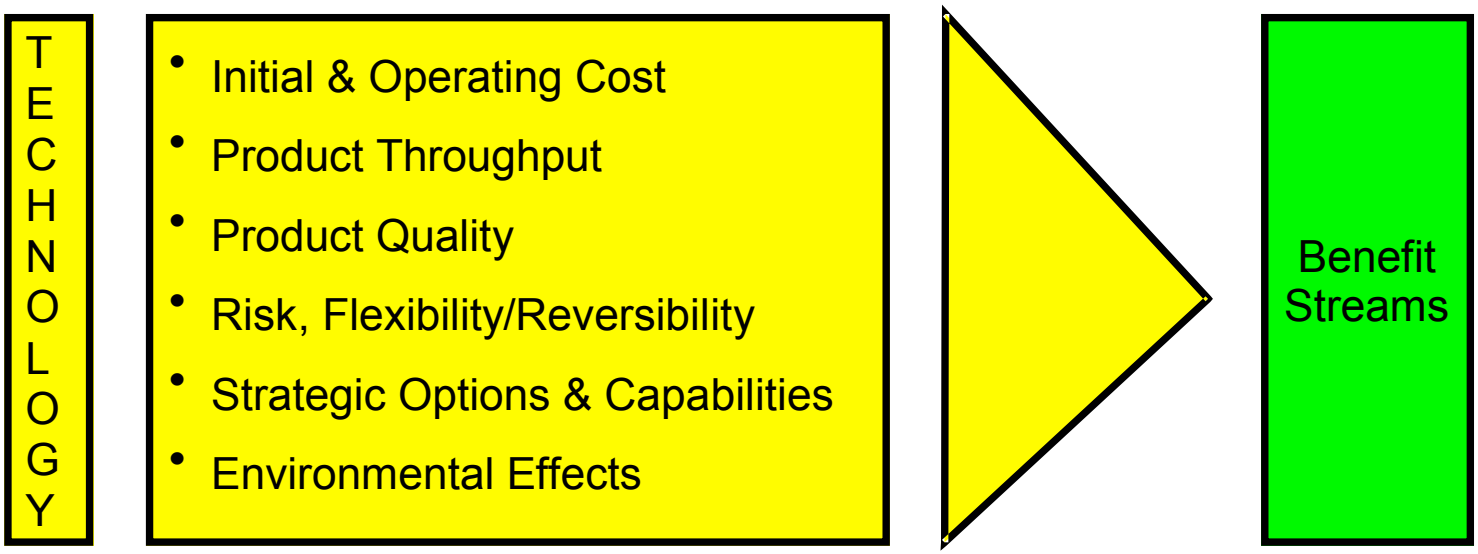
EVALUATING NEW TECHNOLOGY

Technologies Provide a Bundle of Benefit-Cost Attributes



Most Attributes Have No Direct Accounting Measure

(Source: Awerbuch, 1999)

Many mind-expanding ideas and potential solutions for climate change management

- ***End-of-pipe (*kluge) *or downstream* solutions (David Keith)**
- **Create clear cost consequences compared to other solutions**
  - Lack of 'process elegance'
  - e.g.: manufacturing defective products which then need rework
- ***Activity-Based Costing* (e.g. Robert Kaplan) tells us this often creates *non-value adding* activities & processes;**
  - lack of process quality *increases* cost
  - Radical change from previous paradigm- "some level of kluge fixes is optimal"
- **Do these contemporary production cost paradigms apply to carbon mitigation processes/strategies?**
  - can concepts that worked in manufacturing, financial services and health care be transferred to thermodynamically–based processes and solutions?

"Rebound Effect:" Economic Supply & Demand Laws at Work in Energy Consumption

- **1870's – British Government worries about depleting coal**
  - asks Stanley Jevons to evaluate enhanced efficiency options
- **Jevons argued you can not slow down consumption of coal (or any other commodity) by making its use cheaper and easier**
- **Indeed Tech-progress has steadily increased per/capita or per/GDP$ fossil consumption**
- **Plenty of evidence for *Rebound Effect*: efficient appliances and autos *increase* long-run energy consumption**
  - **Example: US – 1950's-1990's: home furnace efficiencies double….. as does size of new houses!**

Implication: *Passive* Geo-engineering Technologies Will *Lower* Carbon Emitting Cost and Hence *Increase* Use of Such Processes

- **Passive Technologies: high sunk costs & near-zero marginal costs** (graph next page)
- **Sunk costs make consumption more attractive**
  - No mileage car hires – drive more
  - Buffet lunches - hard to skip third desert
  - PV arrays of a given size
- **But, added CO2 is also a great free-lunch!** (Ken Calderira)
- **Some Passive geo-engineering options have public project characteristics per Lind-Arrow**
  - Benefits have public good characteristics that cannot be efficiently rationed using market mechanisms

Outcome Efficiency =
f (technology + pricing & taxation mechanisms)

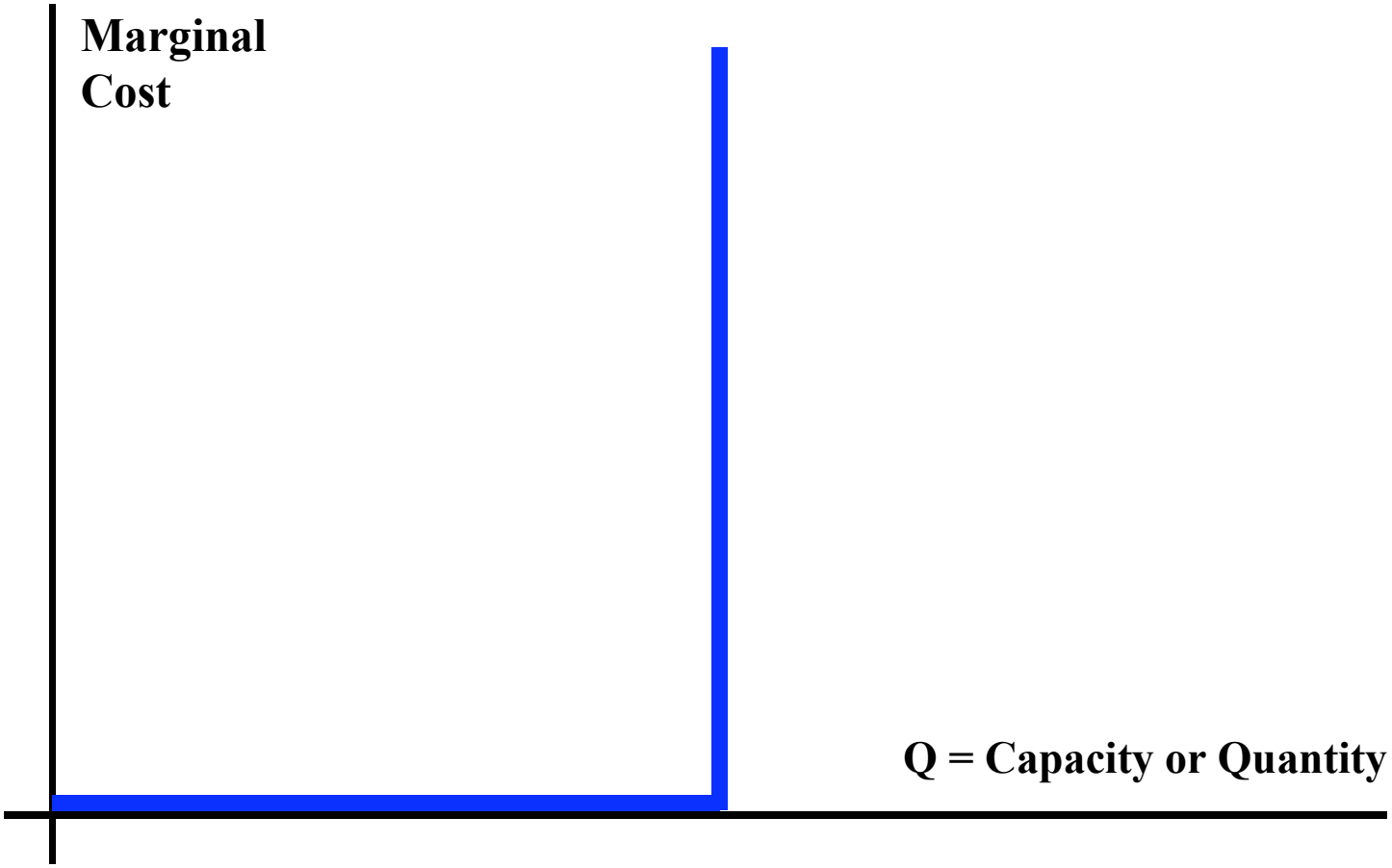
There are many basic relationships we do not fully understand…. in science *and* in cost-accounting

- **Science: We may not fully understand carbon solubility kinetics/limits in H_2O….. (Julio Friedmann)**

- **Cost Accounting: often do not know accounting production costs**
  - Especially involving long-lived assets
  - Depend on conceptualizations of how we recover capital
  - Hard to infer from "reported costs" for given plants

- **Implication: Report cost results with same precaution and circumspection as scientific results**
  - They are often equally or even more ambiguous
  - Not-objective: based on cost models and cost conceptualizations

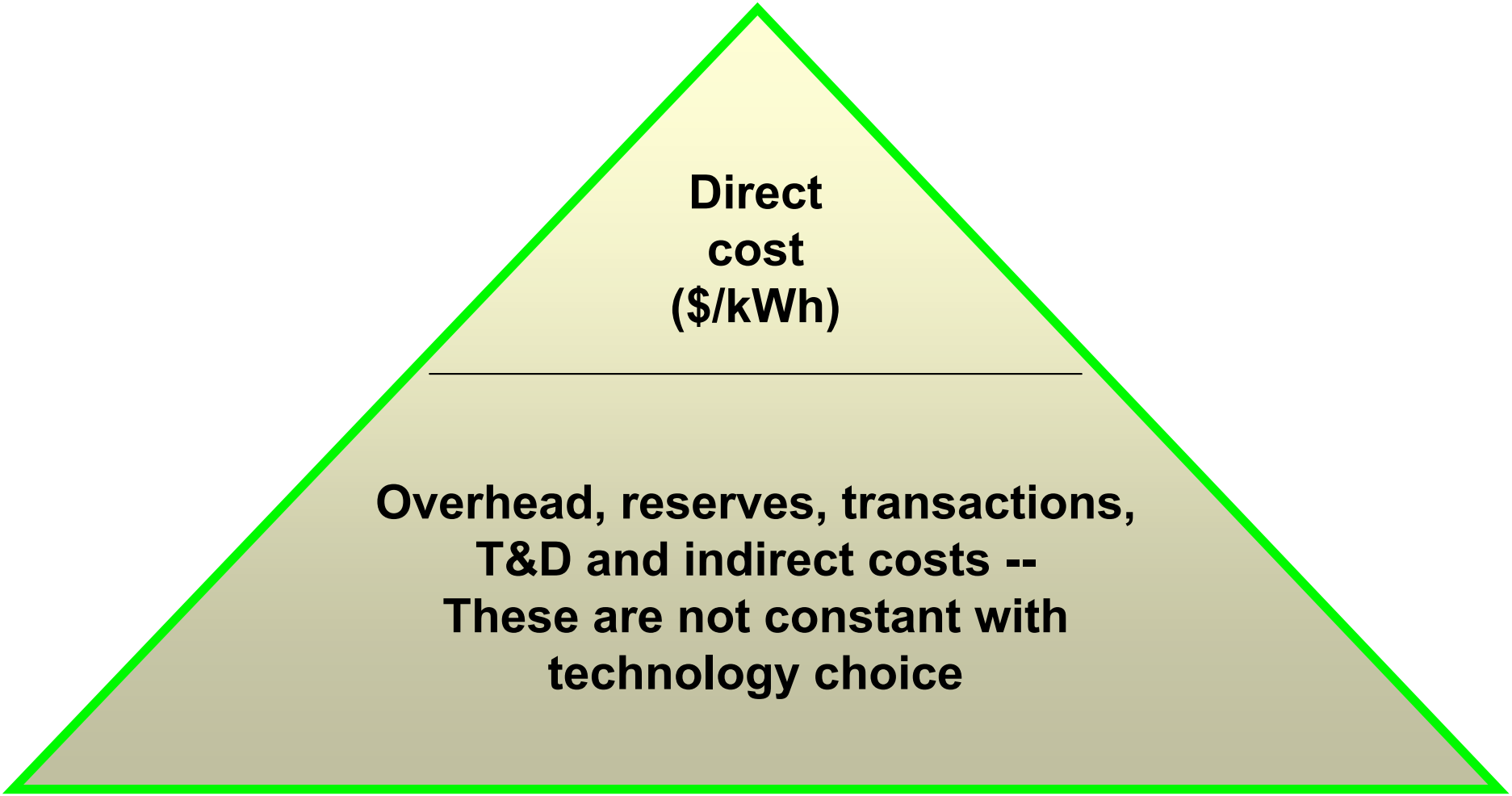
Marginal Cost of Capital Intensive Technology
(George Stigler, 1949)



Some of what we do know about project cost drivers

- **Project Flexibility/Reversibility/Strategic Options reduces cost**
  - Modular PV and Wind power
  - Steel Mini-mils – higher average costs "on paper" but greater profitability
  - "Strategic options" embedded in technology: offer ways of dealing with uncertainty
  - Create opportunities for subsequent re-direction/re-deployment as conditions change
- **Learning cuts costs: *many small ones* better than *one big one***
  - Then again – major technology R&D produces intermediate outputs & capabilities
- **30-year immovable central generators may not make sense in increasingly dynamic electricity markets**
  - Can carbon sequestration alter this paradigm?
- **Exclusive Focus on direct costs (e.g. £/tonne) is misleading**
  - *Fordist-era* efficiency measures often no longer useful
  - *Indirect* costs often exceed

Direct (Unit) Cost Measures Focus on the Tip of the Cost Iceberg



Technology Valuation- Three Ideas

- **<u>Discount Rates:</u> Technology assessments necessarily involve inferences about future cost streams and their systematic risk**
  - This forms the basis for market-based and societal discount rates
  - Theoretically precise, subject to empirical error.
- **<u>Human Processes:</u> Tech valuation also requires an understanding of how new technology changes *human processes* – this is what ultimately changes cost**
- ***Stand-alone* technology costs often not meaningful**
  - Portfolio Effect– create portfolio of strategies with uncorrelated cost, risk and outcome streams – can alter technology valuation
  - Some mitigation schemes may be properly valued as *public projects (per* Lind-Arrow) – their contribution to the risk of the public portfolio will be minimal and their benefits widely dispersed