FINANCING THE FUTURE OF NUCLEAR

CEEPR & EPRG Intl Energy Policy Conf.
Strategies for 2050 Carbon Neutrality in East Asia
Seoul, June 27-28, 2022

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A Diverse Field of Nuclear

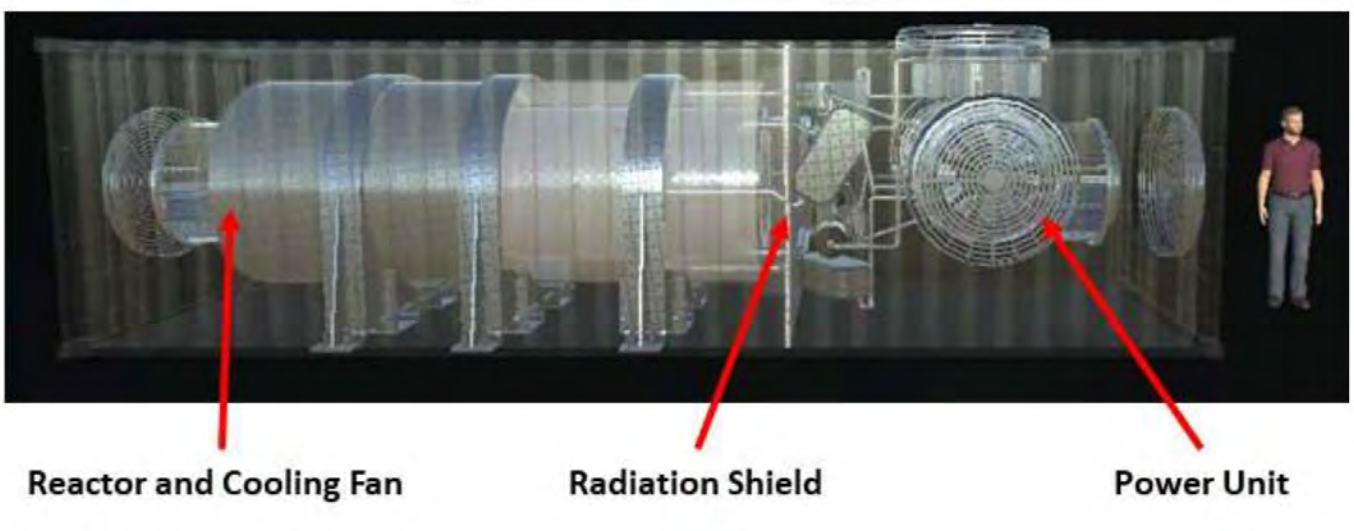
- **Existing LWRs – financing life extensions.**
  - Generally, a cost-efficient sources of low-carbon energy.
  - The economics are clear, the politics are tough.
  - Electricity market details obscure the value.
- **New builds of traditional, large LWRs.**
  - High costs must be reduced. MIT study identified options.
  - Financing difficulties can be a scapegoat.
  - The UK has been a laboratory for alternative financing models.

A Diverse Field of Nuclear (2)

- **SMRs.**
  - How different from LWRs?
- **Advanced Reactors – Gen IV.**
  - Offer improved safety paradigm with important implications.
  - Lower cost is hoped for, but not yet demonstrated.
  - Significant RD&D costs remain.
- **Microreactors**

New Deployment Paradigm for Nuclear Fission

- **Small, 1-20 MW heat/elect**
- **Factory built**
- **Transportable**
- **Plug-and-play**
- **Semi-autonomous operation**
- **Fuel handling offsite only.**



Siting Flexibility

factories and chemical plants

EV charging

district heating

New Business Model

- **Work of a current student, Santiago Andrade (LGO)**
- **Product is dramatically different from historical nuclear.**
    - Customer is industrial and commercial businesses.
    - Quality is valued by customer.
    - Volume in equipment and customers.
- **2 Questions:**
    - What must change from existing nuclear?
    - What can be ported from ‘distributed fossil’ business model?
- **The energy consumer becomes the customer.**
- **Selling energy service vs. selling equipment.**
- **How does financing change?**

PUBLIC GOVERNANCE AND PRIVATE FINANCING OF NUCLEAR POWER

Focus Questions

- **Can nuclear new build be financed by private investors?**
- **How does wholesale electricity market design affect investor decisions?**
- **Should governments support nuclear investments and how?**

Experimentation in the UK

- **The foundation.**
  - A strong national commitment to decarbonization.
  - A long-range strategic perspective.
  - A decision that new nuclear is one part of the solution.

- **Hinkley Point C employed a Contract-for-Differences (CfD) to provide a hedge to investor against market risk.**
  - Construction risk remains with the investor.

- **Sizewell C may use the Regulated Asset Base (RAB) model.**
  - The government will share construction risk.

Conventional Wisdom in the US

- **New build nuclear is not possible in regions with competitive wholesale power markets.**
  - Only conceivable in regions with traditional rate-of-return regulated utilities.
  - Blunders at Vogtle and Summer cast a shadow even there.

- **In recent years there have been complaints that structural features of wholesale electricity markets are unfair to nuclear.**

Point #1: Cost is Key

- **Recent new build projects in the U.S. and western Europe have had lengthy construction delays and large cost overruns.**
- **No amount of creative finance is going to erase high costs. New financial models are not a substitute for reducing actual construction costs.**

Point #2. Blaming the Market is Misdirection

- **Short memories.**
  - In the 2000s, owners of U.S. nuclear plants added nearly 6 GW of nuclear capacity in the form of uprates. Research shows owners of merchant nuclear plants operating in competitive wholesale market regions were more likely to make these investments--Lei, Tsai and Kleit (2017).
  - In the early 2000s, amidst speculation of a nuclear renaissance, many prospective new builds were located in regions with competitive wholesale markets.

- **Changing prospects in the US driven in part by**
  - increased capex cost for nuclear,
  - dramatic drop in the cost of natural gas,
  - lack of a strong carbon premium for nuclear, and
  - political support for and falling cost of renewables

Markets are Embedded in Larger Political Framework

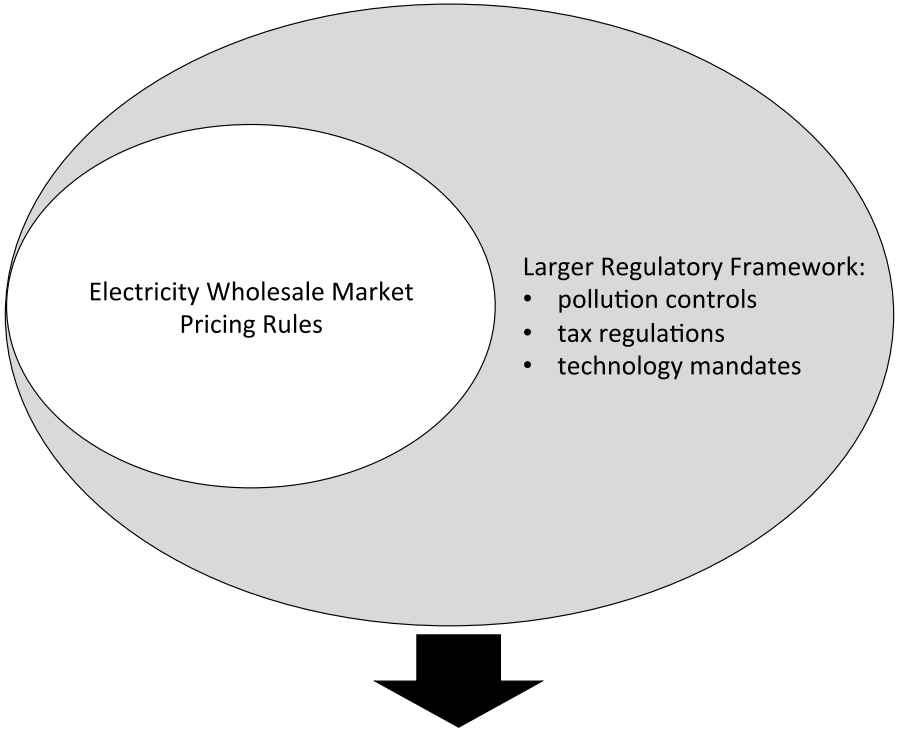


Figure 4.2, MIT Future of Nuclear Energy in a Carbon Constrained World.

Markets are Embedded in Larger Political Framework (2)

- **Outright bans on nuclear.**
- **Punitive taxes and regulations.**
- **Out-of-market payments to competing technologies.**
    - Tax subsidies for renewables. Portfolio mandates for renewables.
    - Significant share of electricity revenues are channeled outside the wholesale market.
    - Lowers the average wholesale market price

The Need is for Public Commitment

- **Currently, regardless of the details of wholesale market structure, an investor in a new nuclear plant will be circumspect about whether they will be allowed to harvest whatever profit may be due on the investment.**

- **Zero Emissions Credits for existing nuclear plants have worked!**

- **Public contract with Hinkley Point C has worked.**
  - The hedge of market price risk via the contract-for-difference is irrelevant.
  - Key are the provisions which specifically target public actions to seize profits.

The Need is for Public Commitment (2)

- **The UK RAB model is a trickier problem.**
  - Public commitment is good.
  - How much of the construction risk for a large LWR should be absorbed by the public? We have no tool to decide this.
  - Quoted figures do not account for the cost of risk shifted onto the public.

- **Demonstration of advanced nuclear designs also warrants a public investment, per MIT Future of Nuclear Energy study.**
  - Political will has not yet been tested.

Net Zero Goals Deepen the Challenge

- **The generation profile is changing rapidly, driven by evolving policies and developing political forces.**
  - Market design is also changing.
- **The future industry and market structure is hugely uncertain.**
  - Mix of politics and technological uncertainty.
- **Incentivizing large investments in fixed assets will require social/political commitment.**
  - Wholesale market prices may channel an ever smaller share of industry revenue.
- **Schmalensee (2019) Strengths and Weaknesses of Traditional Arrangements for Electricity Supply**
  - http://ceepr.mit.edu/publications/working-papers/710
  - Ch. 2 in Handbook on the Economics of Electricity (J.M. Glachant, P.L. Joskow, and M. Pollitt, eds.)

THANK YOU