Nuclear Power + Learning Curves = Frustration$^{(squared)}$

Modeling Technological Innovation
Santa Fe, NM, USA • 15 August 2008

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IAEA
International Atomic Energy Agency

IAEA interest in learning & innovation

1. Future cost and performance assumptions for modeling assistance to Member States

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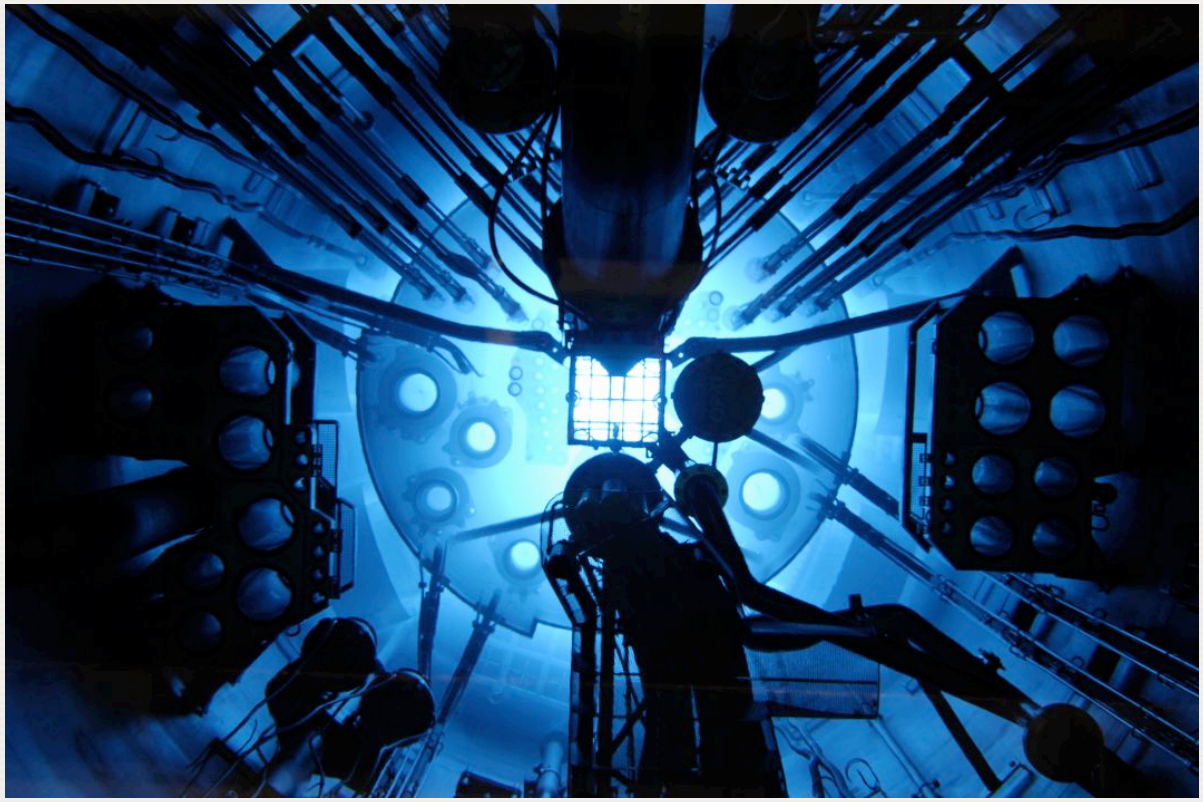
IAEA interest in learning & innovation

2. Catalyze Innovation: International Project on Innovative Nuclear Reactors and Fuel Cycles



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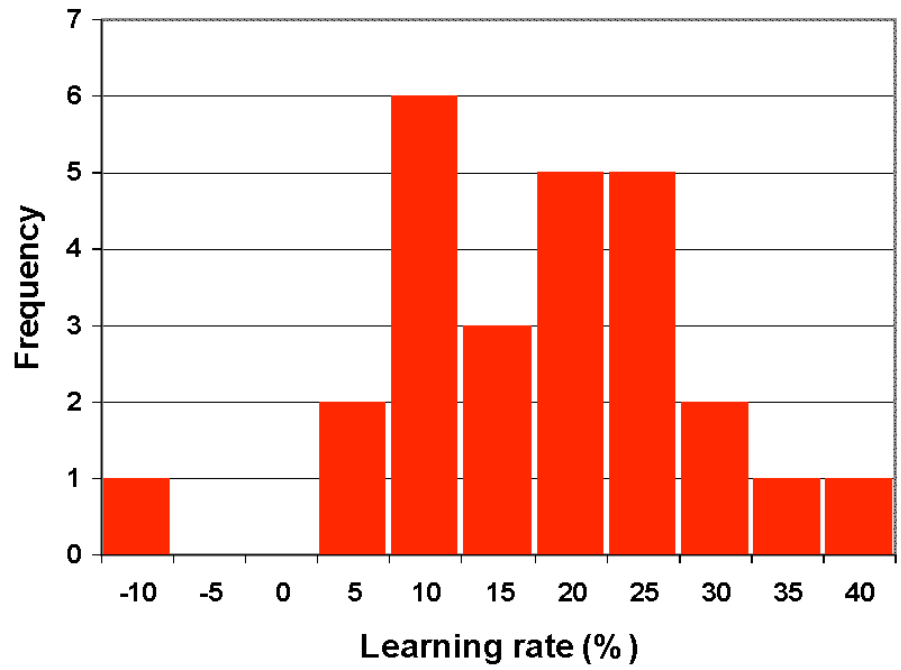
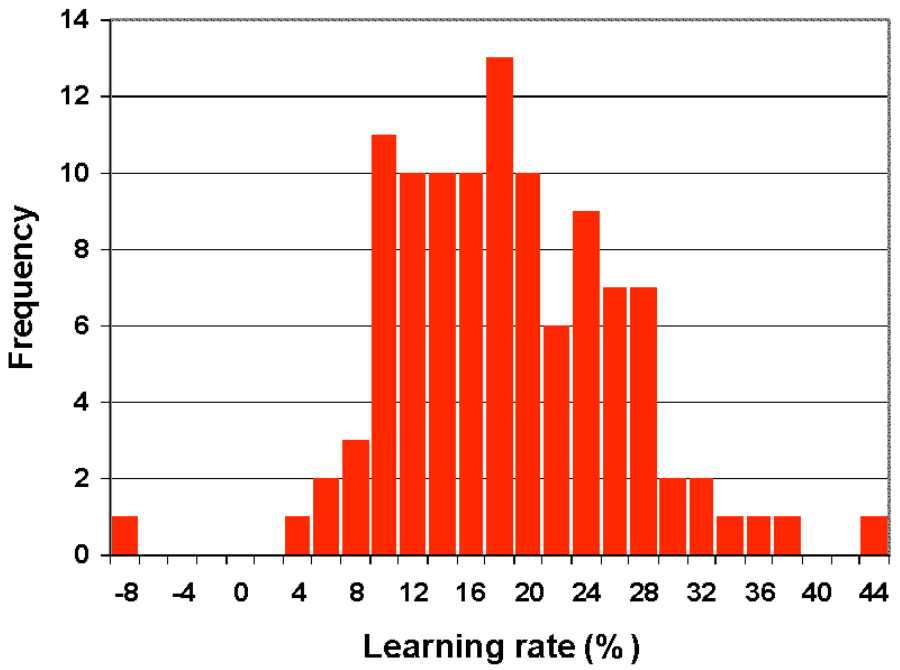
Observed learning rates





Energy Technologies

(McDonald & Schrattenholzer, 2001)

General Industry

(Dutton & Thomas, 1984)

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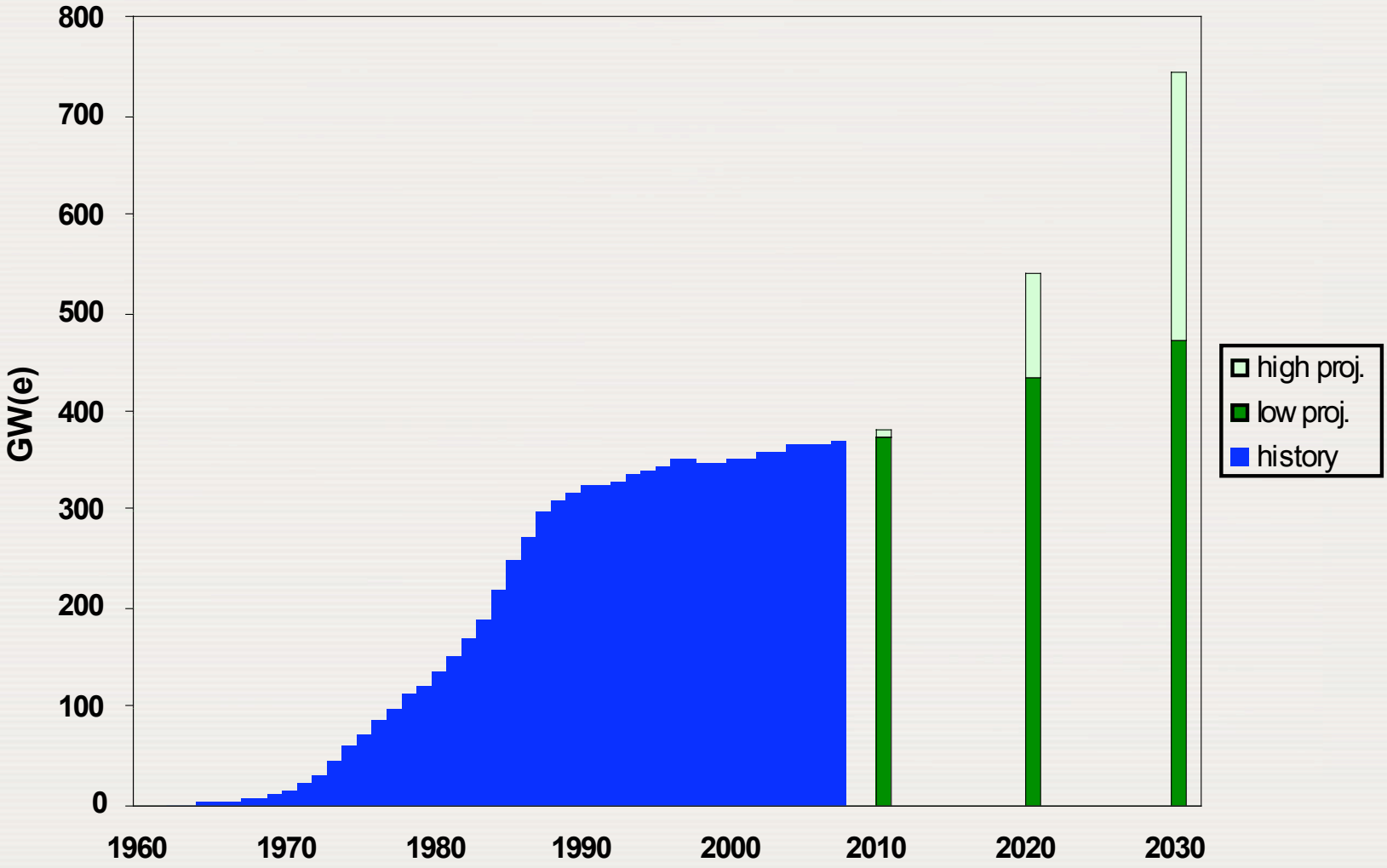
Global nuclear power capacity growth



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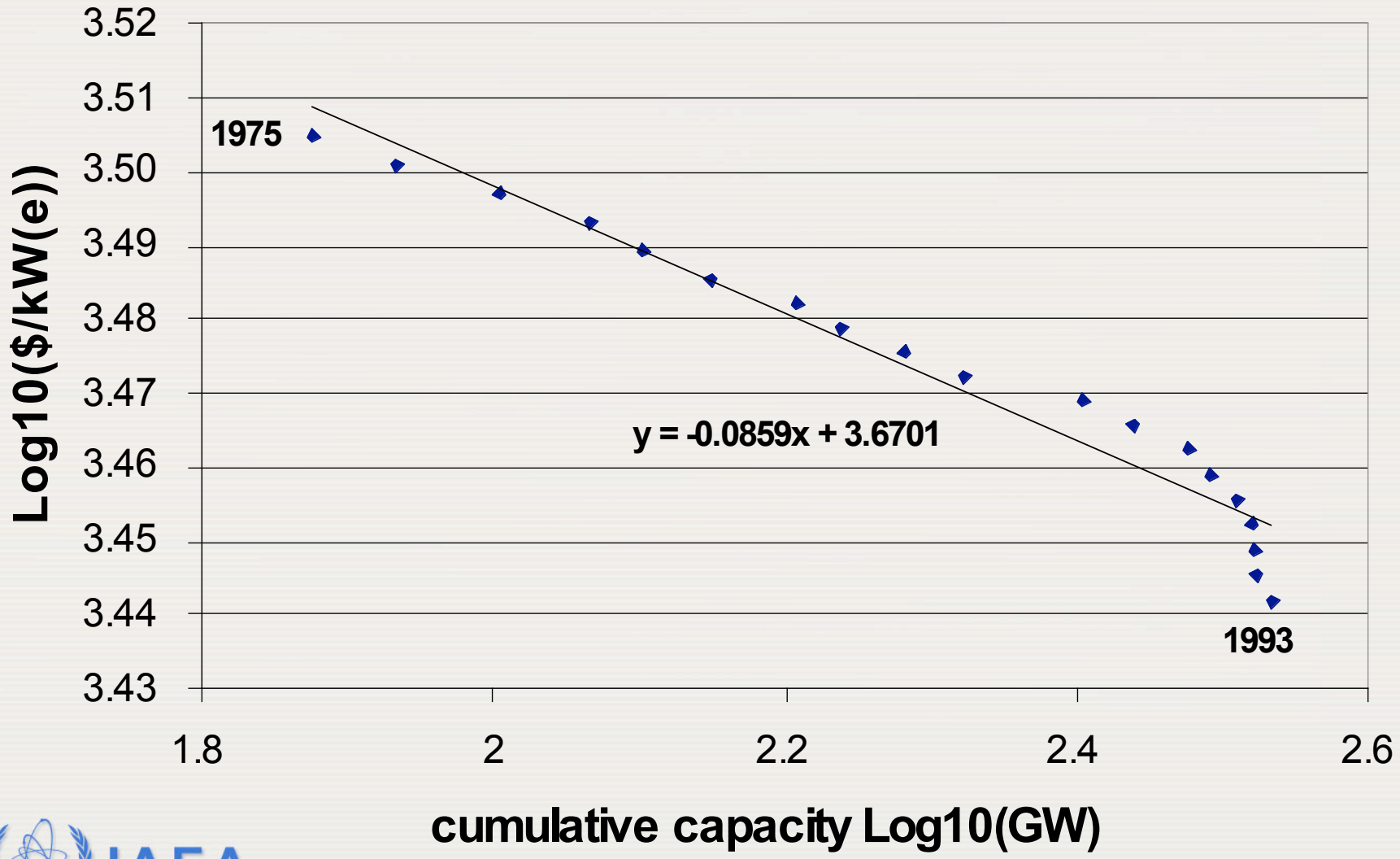
Nuclear Learning 1975-1993 (1/2)



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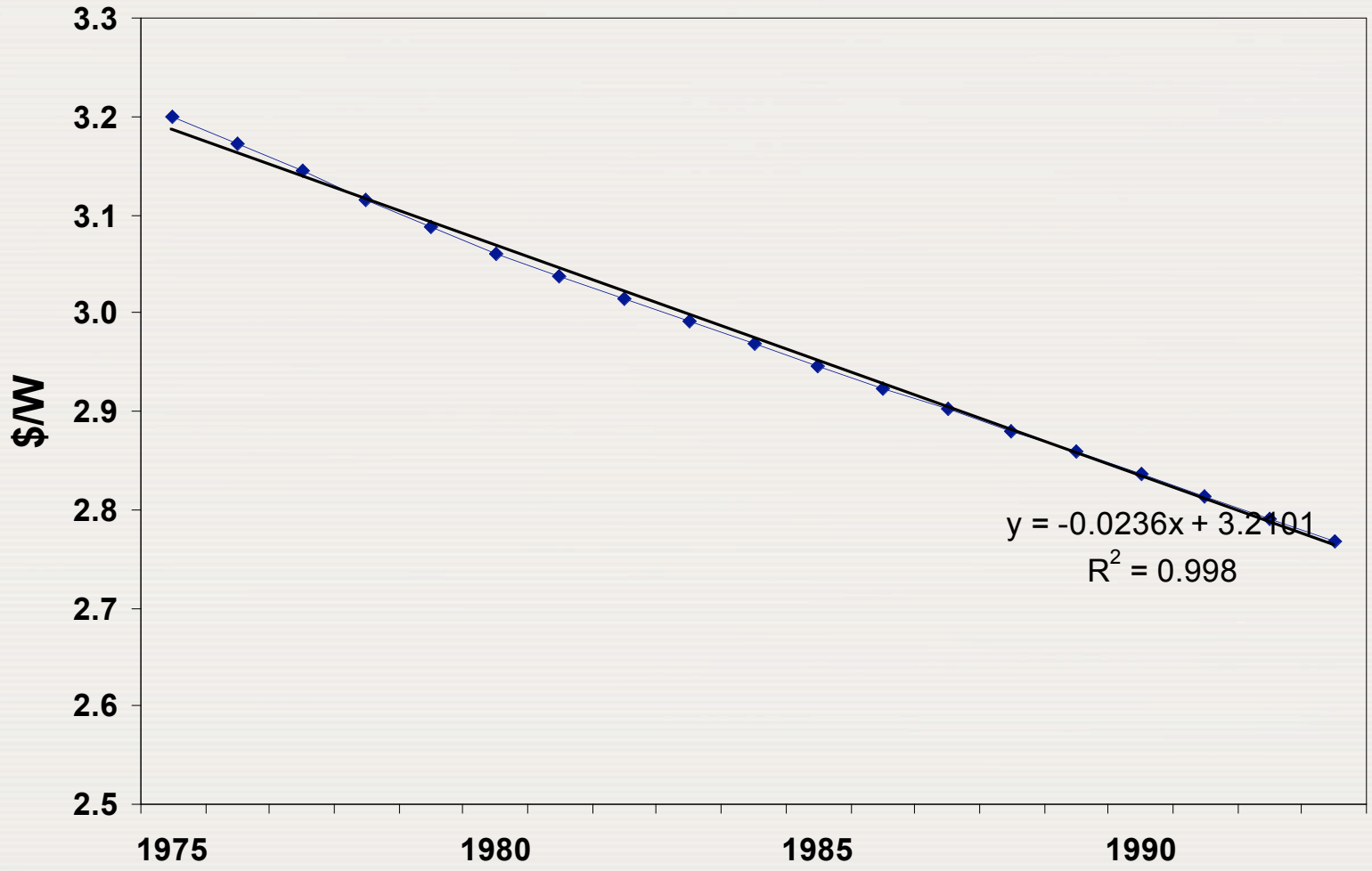
Nuclear Learning 1975-1993 (2/2)



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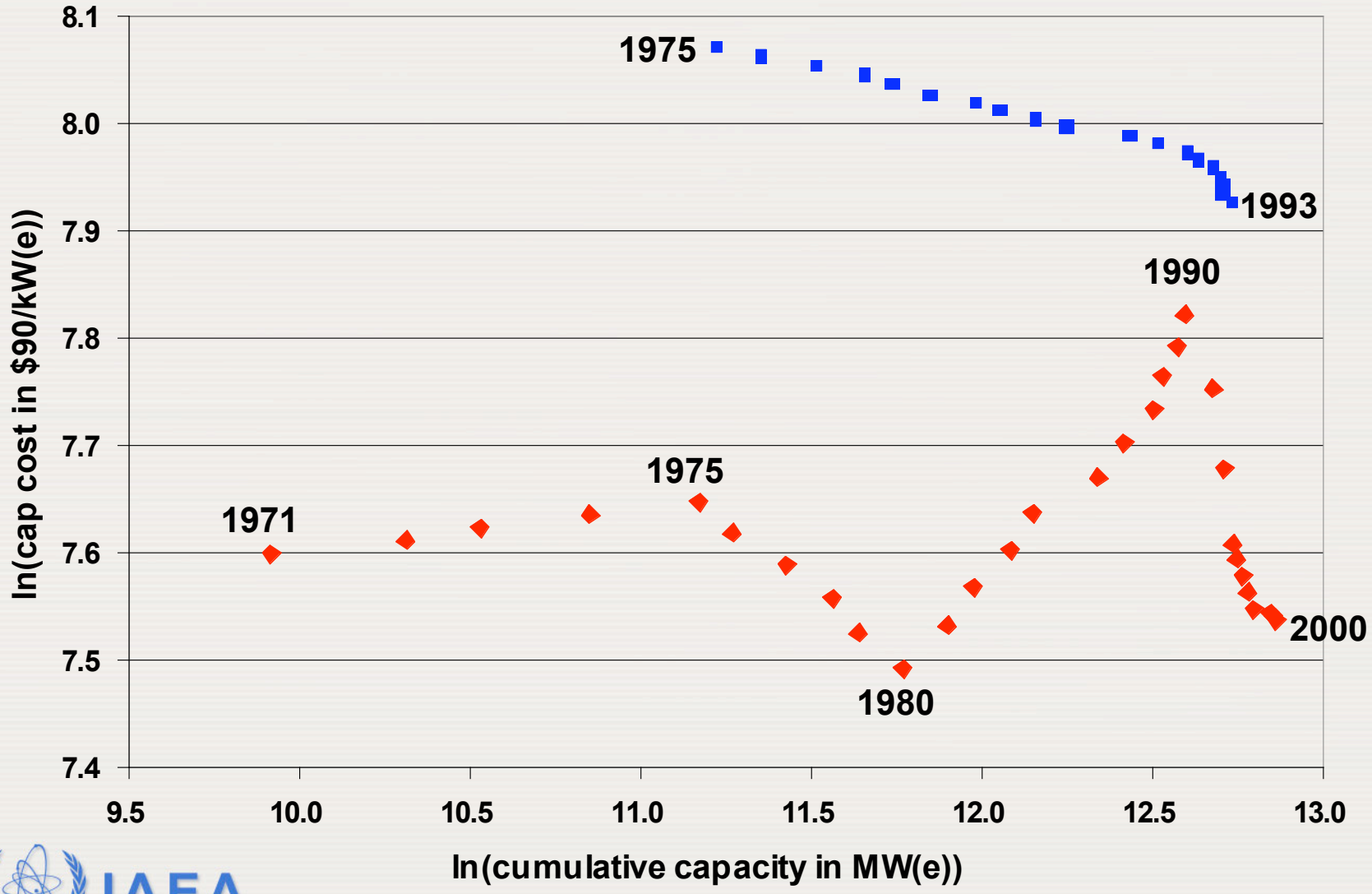
Two nuclear learning series



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Confounding factors (1/2)

- Cost data are hard to come by
- Only 563 units in history
- Product changes, regulatory conservatism
- Economies of scale
- Greenfield vs. additional units
- Escalating input costs (& exchange rates)
- Positive exogenous change (materials science, computing, physics…)

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Confounding factors (2/2)

- "The failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history. For all their common technical, social, and political environment, the costs of these plants differ widely, from a commendable $932 a kilowatt for Duke Power's McGuire 2 station to a grotesque $5,192 a kilowatt for Long Island Lighting's Shoreham plant… The disparities in cost are so great as to make a prima facie case for mismanagement in the first degree." *(Forbes magazine, 1985)*

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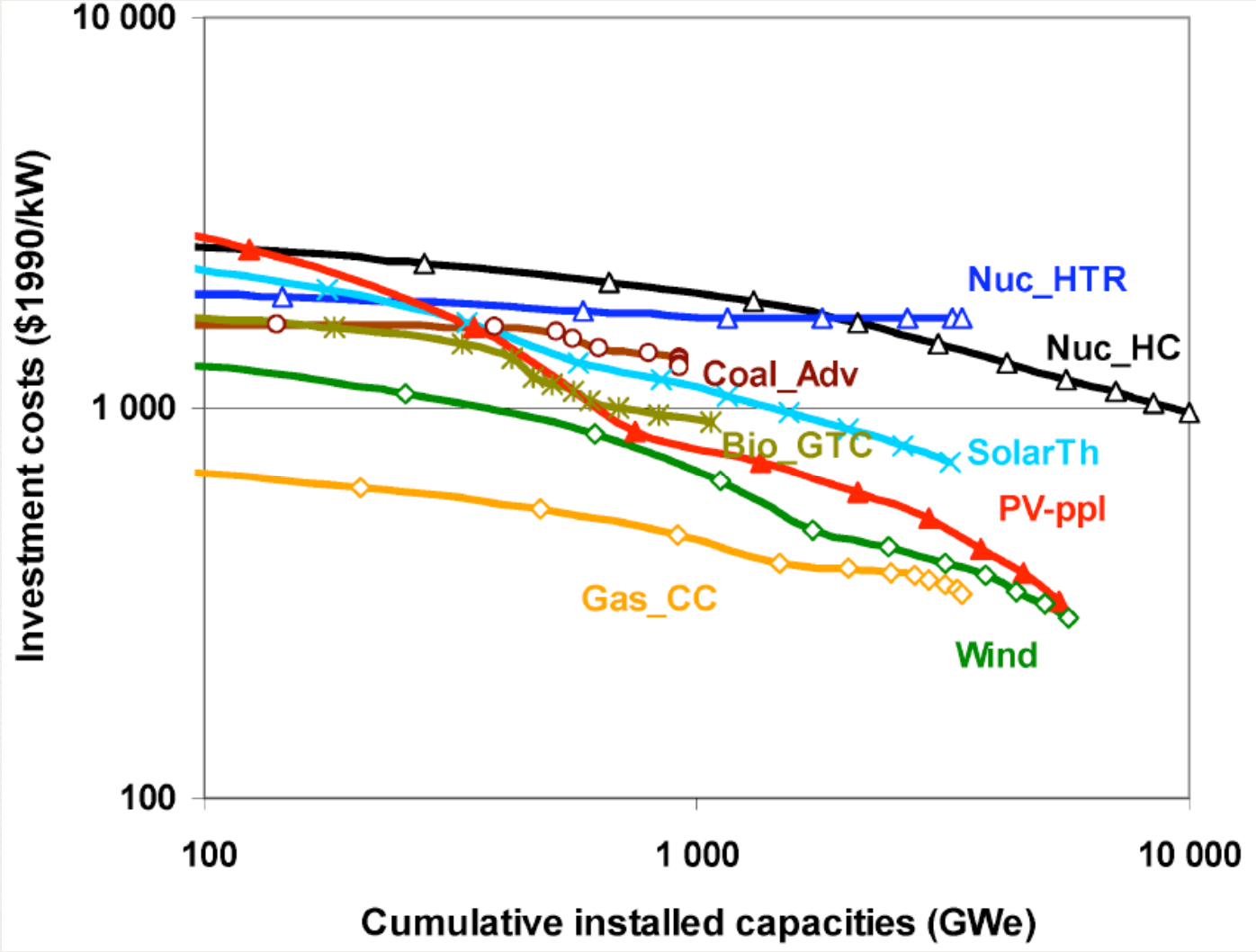
Implied learning in SRES A1T



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Steps for INPRO

- Started with 4 SRES scenarios
- Postulated aggressive nuclear variants
- Endogenized learning into the model
- Estimated required increase in learning rates to match aggressive nuclear variants

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Learning rate targets for nuclear

Scenario	Implicit learning rate in the original SRES scenario(%)	Learning rate to match aggressive nuclear variant (%)
A1T	4-5	10
A2	0-1	6
B1	3-4	10
B2	0-1	8

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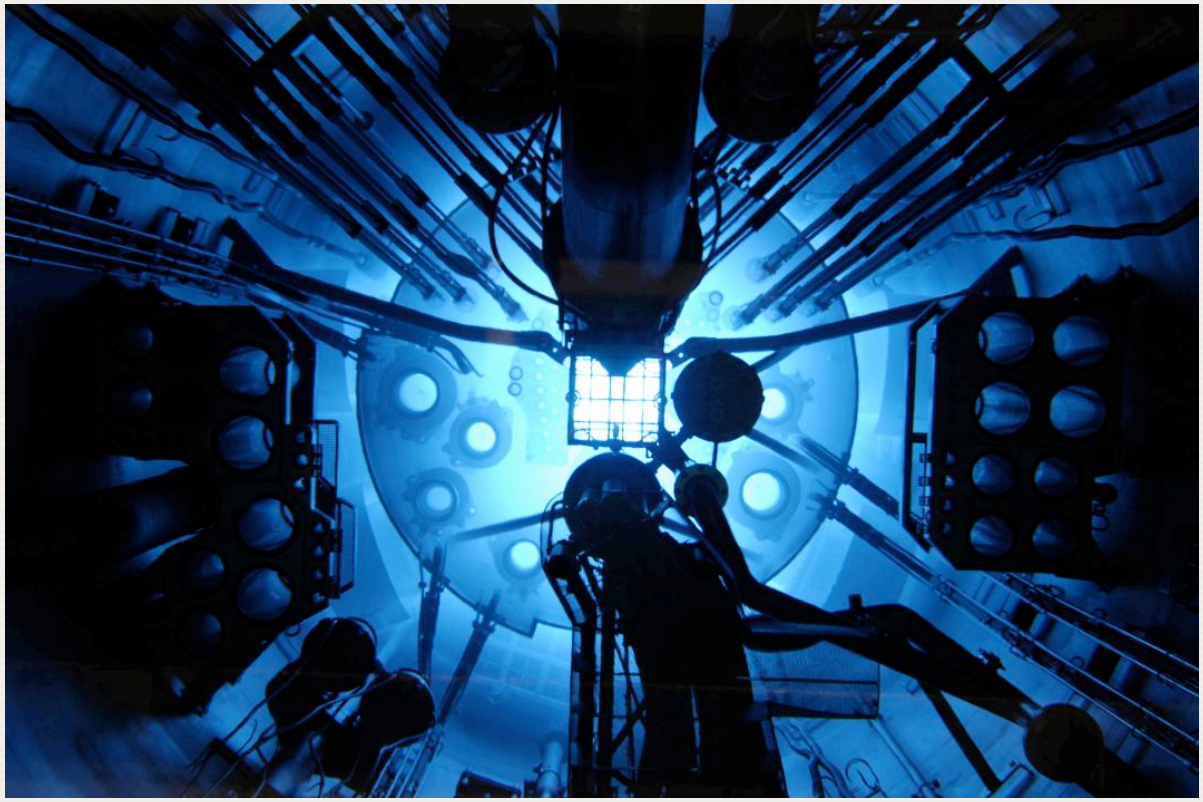
INPRO

- International Project on Innovative Nuclear Reactors and Fuel Cycles



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Draft take-aways

- No answers yet to 2 IAEA interests
- Nuclear data we should examine carefully
- Big challenges remain
  - how to unpack and structure
  - which ‘clocks’ to use
  - social factors
  - strategic issues (blood on the floor)

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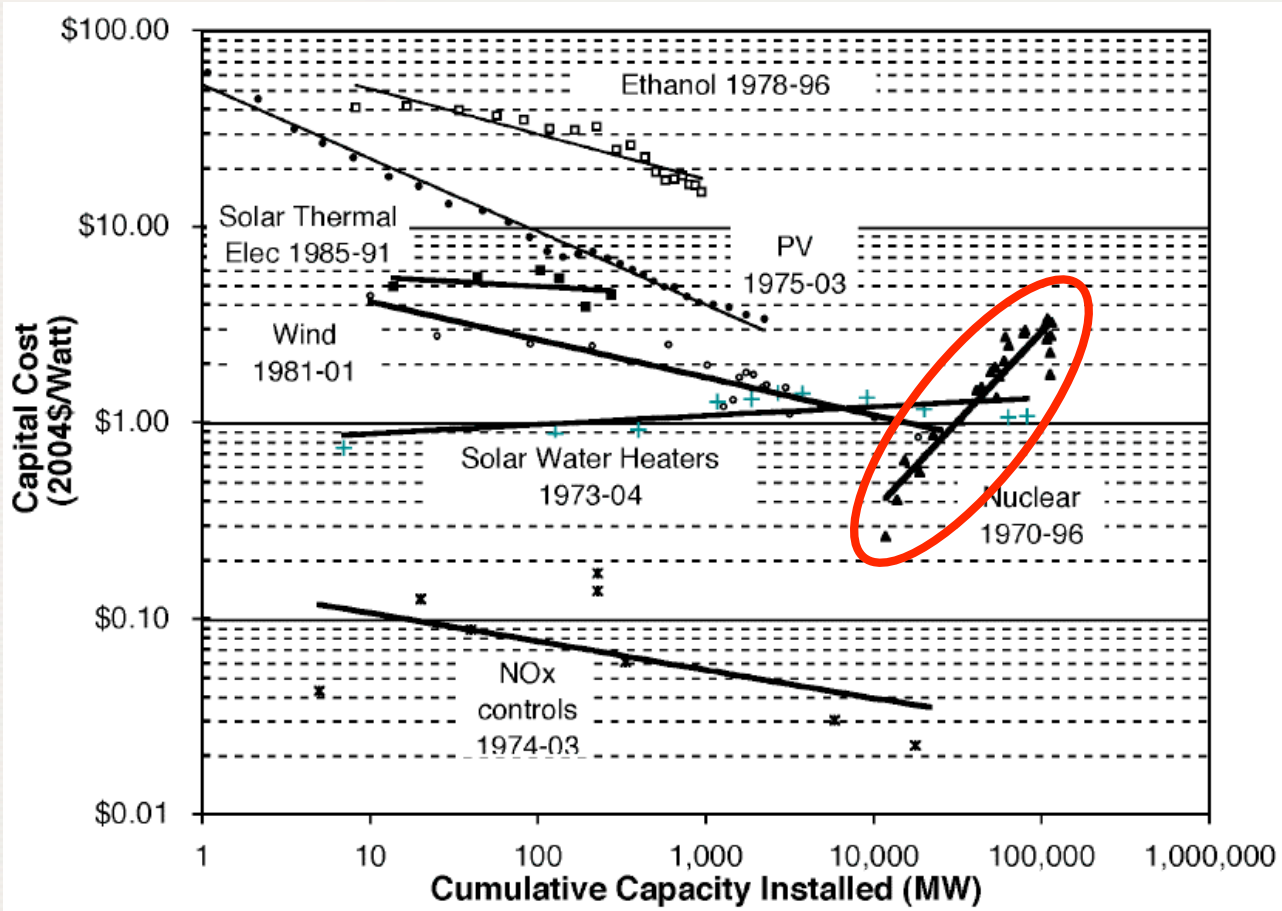
If…

- Understanding best accelerates through studying outliers,
- then nuclear is a prime contender



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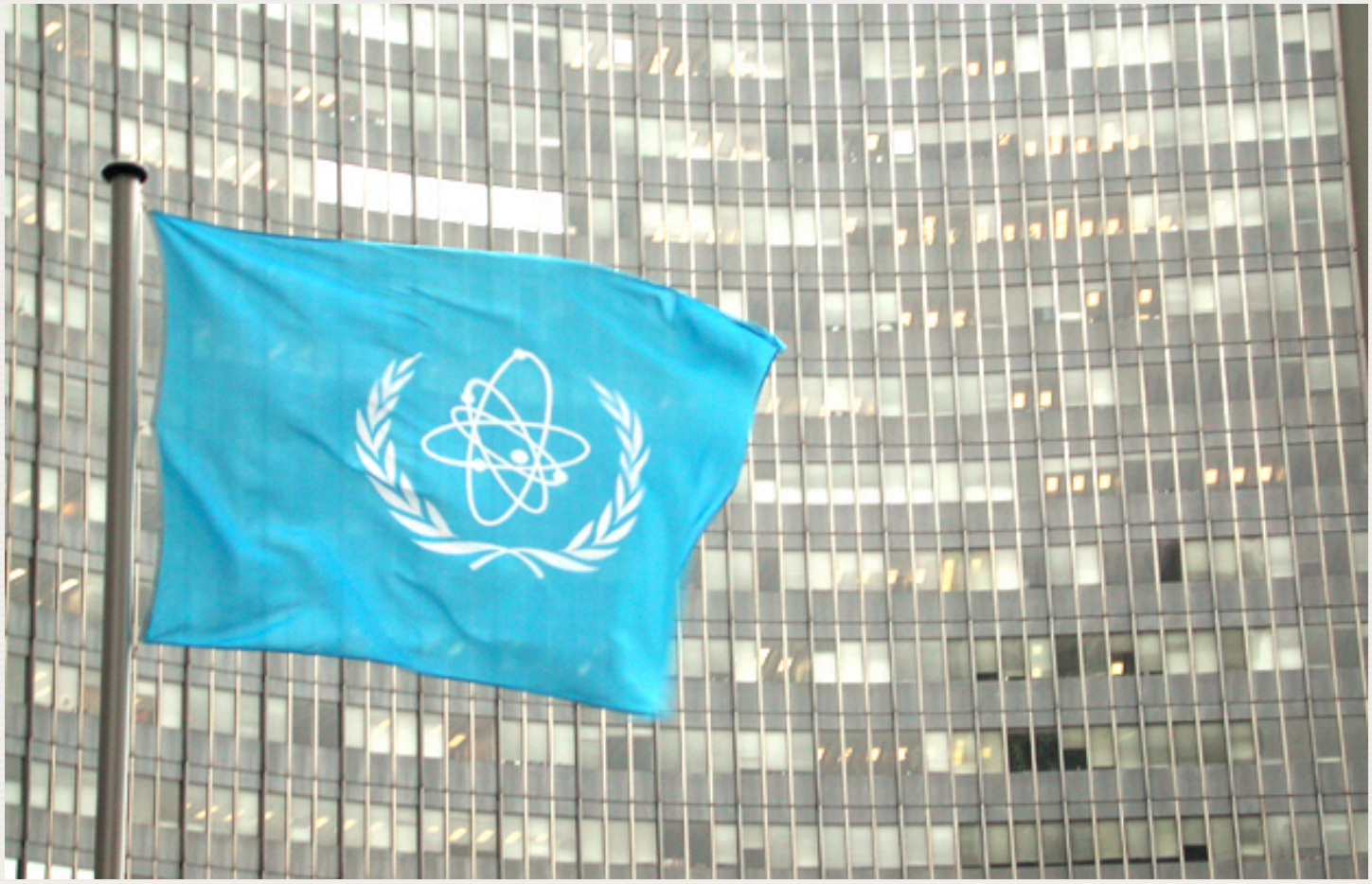

…atoms for peace.

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