Emissions Trading and Incentives for Technology Development

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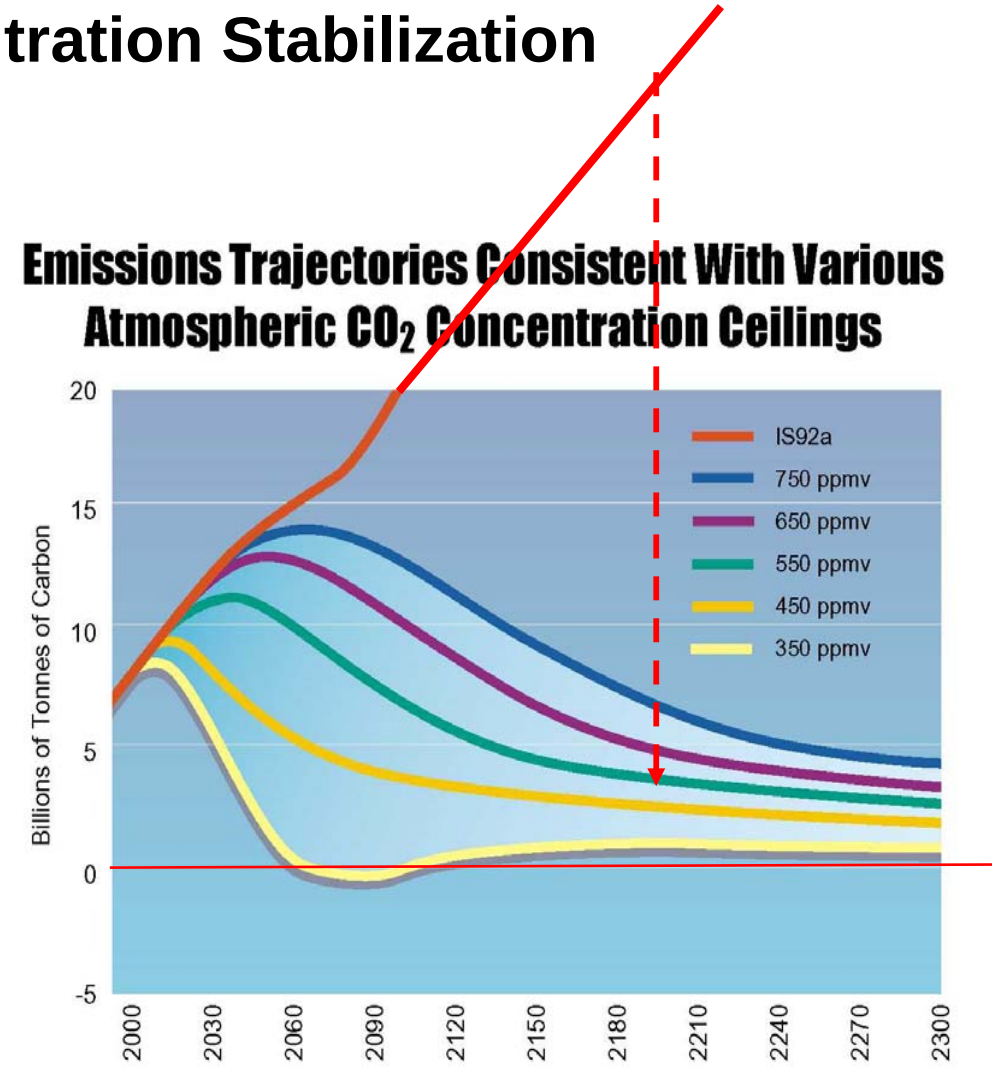
Enormous Technology Shifts Are Required to Achieve Policy Goal of GHG Concentration Stabilization

- **Policy goals**
  - Stabilize global temperature
  - Stabilize GHG *concentration*
- **Implications for emissions**
  - Ultimately, net global greenhouse gas emissions must fall by nearly 100% from their projected "business as usual" levels
- **To gain agreement on policies, energy must remain affordable, especially for poorer countries**
  - Current technology and evolutionary improvements cannot plausibly reduce global emissions to zero at acceptable cost
- **R&D to provide breakthrough technologies is needed**



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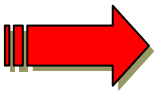
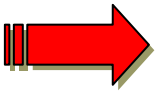
Important Conditions for Motivating R&D and New Technology Deployment

- **For both R&D *and* technology deployment decisions:**
  - Expectation that policy will remain in place over long time period
  - Firm understanding of CO_2 price levels into future (if policy is market-based)



IMPERMANENCE AND UNCERTAINTY ARE ANATHEMA

- **Also important for R&D:**
  - Certainty that investor will obtain/retain intellectual property rights
  - Expectation that carbon prices will remain high enough to repay the investment in R&D as well as motivate technology adoption



AND EMISSIONS MARKETS ALONE ARE INSUFFICIENT

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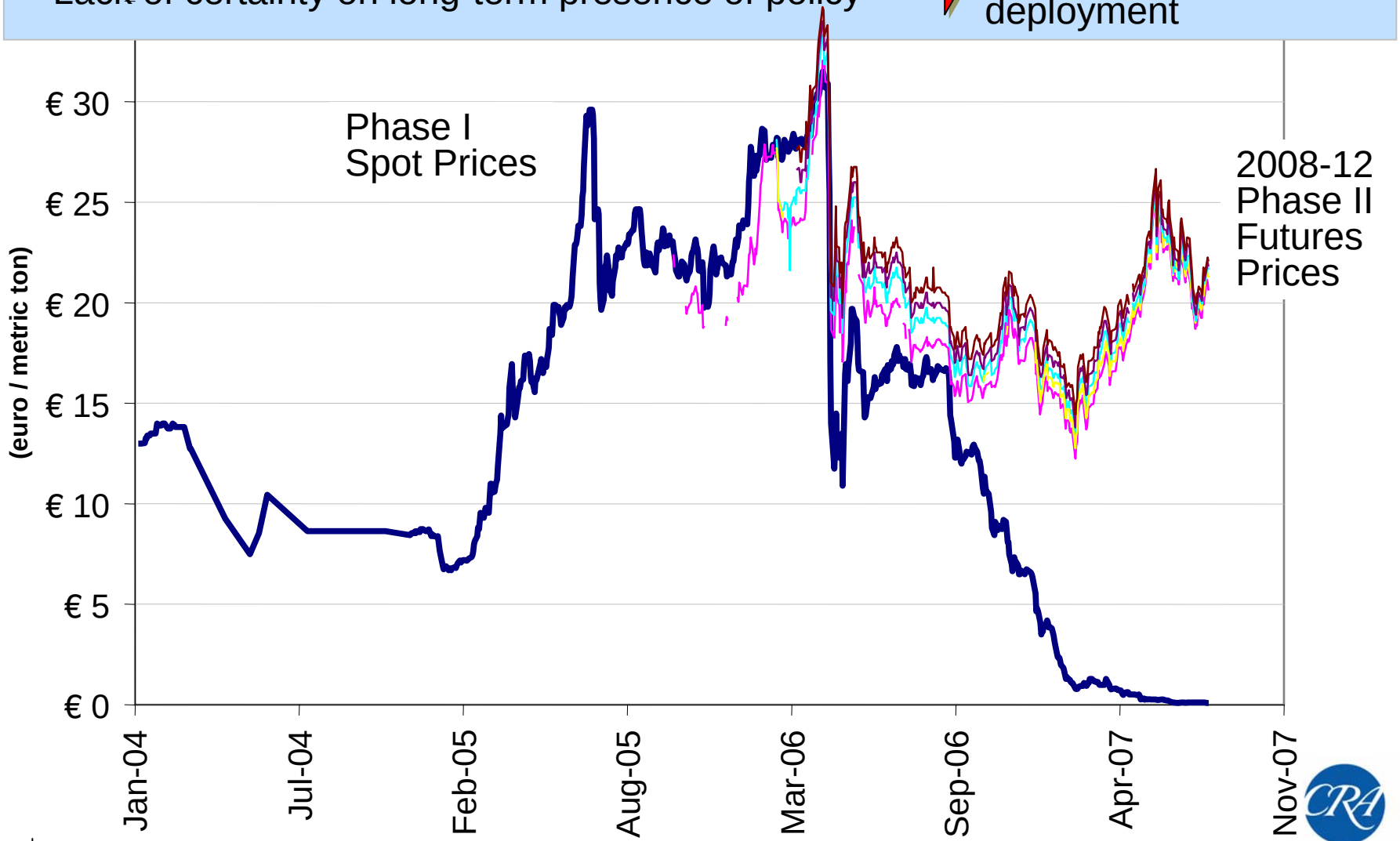
EU's ETS: A Case Study in Poor Deployment Incentives

- Lack of certainty on CO_2 market prices
- Lack of certainty on long-term presence of policy

→ High prices but minimal advanced technology deployment



Source: Bloomberg EU ETS Prices

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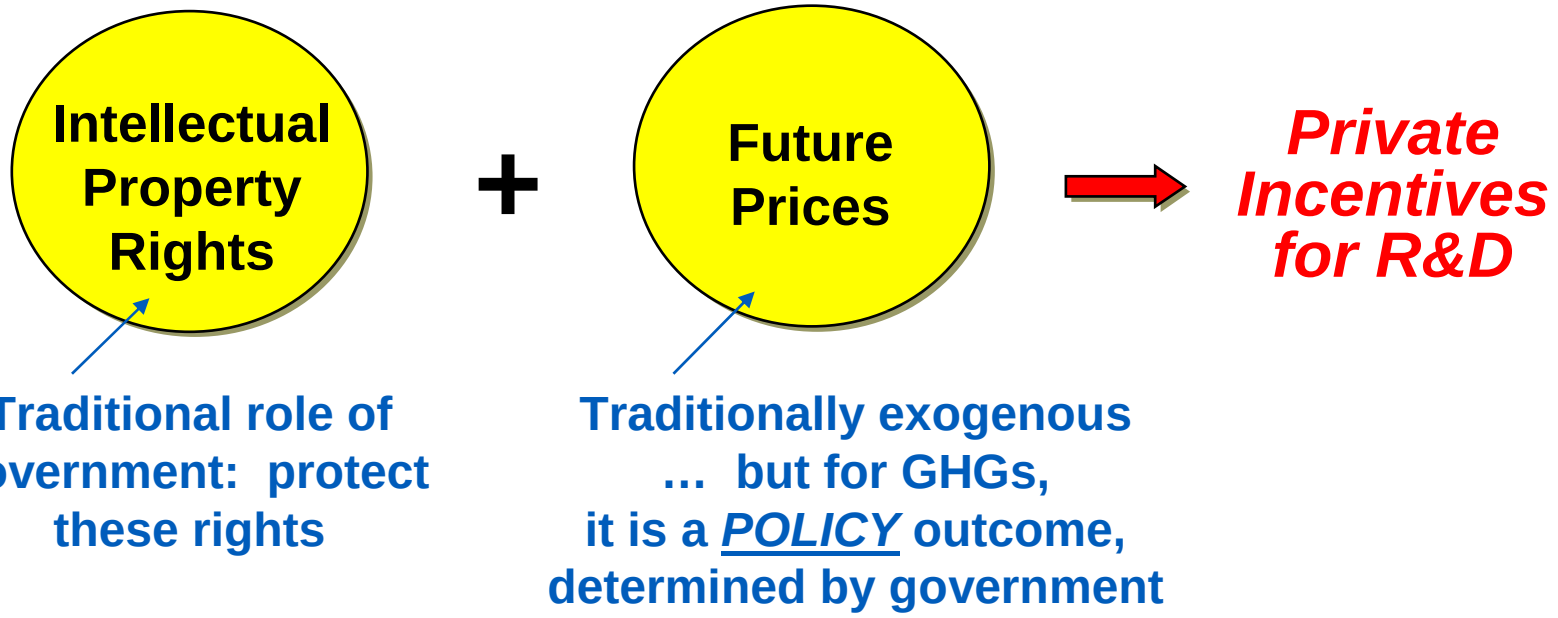
The Problem Is More General -- No Carbon Pricing System Can Provide Credible Incentives for Long-Term R&D

- **"Safety valve" and other approaches that directly target and manage the future course of CO_2 prices:**
  - Greatly reduce day to day price volatility
  - Greatly increase certainty on long-term evolution of CO_2 prices
  - Enable an emissions policy with greater political permanence
- **The above attributes would be very beneficial to decisions to deploy new technologies**
- **But these attributes probably do not provide sufficient incentives for the necessary types of R&D that will make near-zero CO_2 emissions an affordable outcome for the global economy**

GHG R&D Faces "Twice" the Incentive Challenges of Traditional R&D

- **Private sector R&D is motivated by profits to be earned from successful innovation, which has 2 components:**



- **Rights to intellectual property are not rights to a specific price level**

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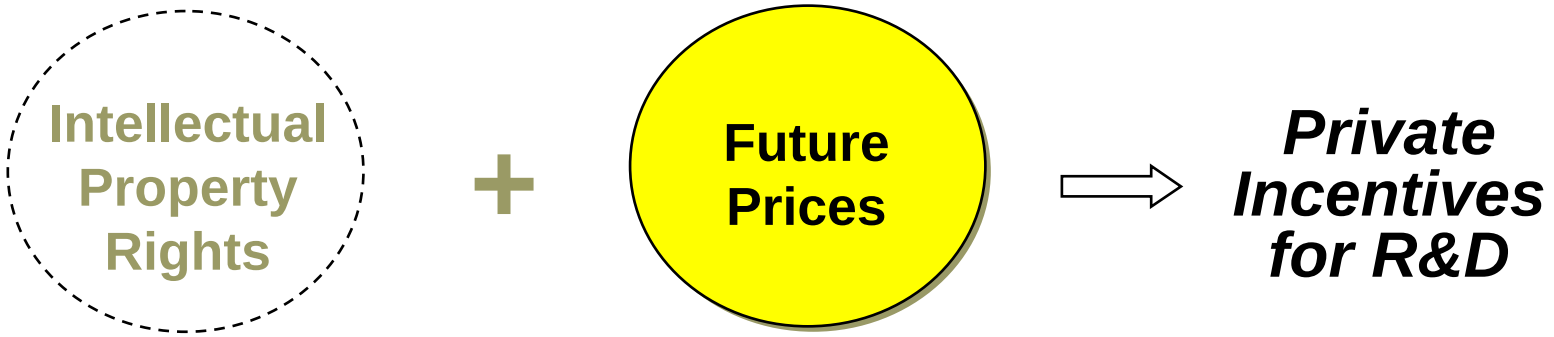
Why Price Incentives Work Poorly for GHG-Related R&D



- **For GHGs, price reflects a *policy choice*, not a physical scarcity**
  - Announced carbon price must be high enough that the investor expects to profit from *developing* the technology
  - Once the technology is developed, the carbon price only needs to cover costs of *using* the technology to bring about adoption
  - Since high carbon prices have other undesirable economic impacts, the optimal choice is to surprise the inventor by *reducing* the announced price *after* the technology is available
- **Therefore, a future carbon price sufficient to make R&D on climate technologies profitable is inherently *not credible***

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GHGs Pose Challenges to the Intellectual Property Rights Part of the R&D Incentives Equation Too

- **Impossibility of patenting the kinds of scientific advances required**
- **Integration of many incremental innovations**
  ("cumulative innovation")
- **Very long time frames for potential payback**
  (may exceed period of patents or credible licensing terms)
- **Need for global deployment**
  (transfer to all countries without reducing intellectual property rights protection will be difficult)

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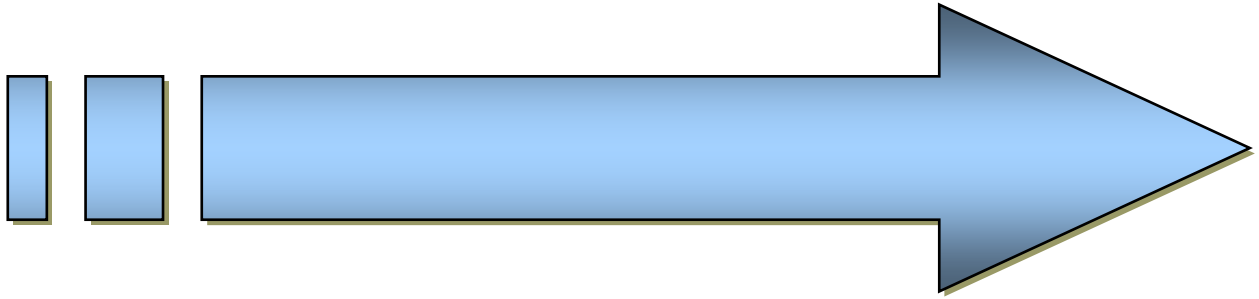
CO_2 Pricing Is a Poor Device to Motivate the Kind of R&D that Is Needed to Stabilize GHG Concentrations



Research Basic Applied | **Development** | **Demonstration** (Prototype Testing) | **Deployment** (Commercialization or Diffusion)

Carbon prices not effective at putting new technologies *ONTO* the shelf

Carbon pricing can get technologies *OFF* the shelf

The US SO_2 cap only produced deployment-stage "innovations"

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A Painful Conclusion

- **The great merit of market systems is getting government out of decisions about how to reduce GHG emissions**
- **Now we have to put government back into the business of R&D**
- **Challenge is to do so in a way that**
  - Builds on the ability of carbon pricing to stimulate the adoption of new technologies
  - Does not turn into an excuse for subsidizing *deployment* of new technologies – which the market can sort out perfectly well when there is a price on carbon
  - Enables the private sector to make the choices, bears the risks, and gain the rewards from R&D

Governments Should Concentrate On Providing Credible and Irreversible Incentives for Private Sector R&D

- **Traditional incentives subsidize cost of research *inputs***
  - Tax credits for R&D
  - Research grants or contracts to businesses and universities
  - Direct funding for government laboratories and other research facilities
- **Alternatives emulate what emission pricing cannot do – reward *outputs* of research based on their contribution to reducing emissions**
  - Have a number of advantages over traditional incentives
  - Can take different forms
- **Prizes are the clearest example of a reward for outputs -- success in R&D**
  - Prizes put the incentives, decisions, and risks in the right place
  - How can that be done across the board for R&D?

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Other Issues In Designing R&D Policy Compatible With Reliance on Carbon Prices for Technology Deployment

- **Alternatives to IP to reward innovation**
  (e.g., prizes, contests ?)
- **Role models for successful government funding of basic research**
  (e.g., Defense Advanced Research Projects Agency ?)
- **Incentive-compatible schemes for public-private partnerships**
  (e.g., matching funds ? -- but not subsidies)
- **Global spillover problems for publicly-funded R&D**
  (e.g., international R&D collaboration ?)
- **Incentives for global deployment/ technology transfer**
  (…?)

Little is understood; little has been discussed

We urgently need answers to these questions – we don't avoid them by creating an emission trading system

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