

# Technology Workshop Wrap-Up

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# A research community

## ◆ Common:

- Analytical framework (causal factors / cost components matrix)
- Operational concepts (Learning, LC...)
- Research goals (assess the costs of constrained energy scenarios)
- Taking care of the R&D costs and benefits (public and private) and of the corresponding asymmetry
- ...
- Recognition of the multiplicity/complexity of the variables to be taken into account; problem of disentangling
- Difficulties in gathering relevant and reliable data



# Old and new questions arising

- ◆ New specifications:
  - Moore, Wright and Goddard or S-shaped ?
  - What future for TFLCs or different types of TFLCs ?
  - Learning and non-learning cost components, floor cost ?
- ◆ What boundaries: €/kWe, €/kWh, system costs ?
- ◆ Are the explicit LCs and the expert elicitation approaches substitutes or complementary ?
- ◆ Patent approaches: how to eliminate biases, take into account the industries' patent culture ?
- ◆ How to measure the *alignment* of an innovation system ?



# What's a modeller to do ?

1. Gather **and maintain** dedicated data sets on cost components and factors impacting (cumulative capacities, GERD and BERD, patents, cost of raw materials, incentives)
2. Know the questions to be answered:
  1. Impact of TC on the cost of mitigation (carbon value)
  2. Benefits of R&D (implies an R&D => technology performance connection)
3. Find compromises, adjusted to each model, in the “explaining and forecasting” trade-off
4. Organize the transparency in hypotheses and results (advances in AMPERE but still more advances needed in ADVANCE)



# Keep in touch...

- ◆ Further explore the potential of connecting expert elicitation exercises for a quantification of the R&D productivity
- ◆ Keep in touch with all analytical research that will better explain:
  - Diffusion dynamics and industry cycles
  - Impacts/productivity of R&D with uncertainty
  - Industry innovation strategies
  - Consumer adoption behaviour
  - Impacts of incentives
  - Institutional alignment
  - ...



# Synthesis of micro-brainstorming

- ◆ We still have to better understand the causalities behind the learning curves:
  - But the complexity of the factors impacting technology performance/diffusion cannot be fully reproduced in the models
  - => a clear distinction should be made between explaining and forecasting
- ◆ About models:
  - There is no General Purpose Model and models should be designed to answer a given set of questions
  - Models should take into account the proper conditions of technology development where it will mostly take place (i.e. in emerging countries)
- ◆ To be considered/implemented in ADVANCE:
  - Decomposing learning and non-learning components (floor costs)
  - Develop some causality link between R&D and technology performance probably in hybrid approaches
  - Test the consistency of depth-speed diffusion profiles for demand and supply, energy and non-energy options
  - Systematic and transparent reporting on data - results, models - methods



# *Annex*



# Feedbacks-1

- ◆ John Weyant (Stanford): The relevance of hybrid approaches
  - Attention should indeed be paid to the combination of top-down (econometric) and bottom-up (expert-based) approaches
  - Experience from a study on industry energy demand in the US, with 2 econometric models and 2 BU studies showed that phenomenon such as technology adoption by industry leaders do not appear in econometric studies
- ◆ Elmar Kriegler (PIK): ADVANCE as a platform for further work
  - The matrix of factors and impacts on cost component is far too complex to be integrated as such in models
  - He feels scepticism on the conventional Two Factor Learning Curves...
  - because the sequence of government and industry R&D should be considered
  - Modellers should probably go to critical component learning
- ◆ Nico Bauer (PIK): Insights from depth/speed of diffusion studies
  - The models should allow to introduce more flexible barriers to diffusion, based on economic grounds
  - Attention should also be paid to learning for non-supply and non-energy options





# Feedbacks-2

- ◆ Keywan Riahi (IIASA): Putting the emphasis on understanding
  - There already exist detailed analyses and database for component learning (e.g. At ECN)
  - The issue is rather on the conceptual side, trying to understand what are the factors that explain the observation through the learning concept
- ◆ Elena Verdolini (FEEM): Cleaning-up the Learning Curve
  - The role of GERD should not be overemphasized in particular when industries such as the automobile industry are considered
  - LCs should also be cleaned from the impacts of the many incentives that impact costs and diffusion
- ◆ Jae Edmonds (PNNL): Also emphasising the question of causality
  - Association of two variables doesn't indicate causality: e.g. GCAM, with exogenous time dependant technology costs and exponential growth reproduces fairly smooth ex-post learning curves
  - In that case cost produces a consistent diffusion profile
  - The question is thus: how much is attributable to learning, how much to system behaviour



# Feedbacks-3

- ◆ **Valentina Bossetti (FEEM):** Need to have specialized models
    - There is a temptation to develop bigger and bigger models but the question is “what is the reward ?” given the limits of big models
    - Very probably there should be different specialized models to answer to different questions
  - ◆ **PR Shukla (IIM):** Take into account specific conditions of technology development in emerging countries
    - Technology representation should take into account that most development will take place in rapidly growing emerging economies
    - With particular patterns of diffusion and even different technological objects (e.g. electric two-wheelers)
    - What is the meaning of a strong public/private R&D distinction in China ?
  - ◆ **Matthieu Glachant (CERNA):** Need to distinguish two stages in IAM development (explaining and forecasting)
    - LC are purely observational and should not replace approaches of technology costs functions based on economic grounds
    - Then there is another question that is: what should we introduce in the models
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