Memorandum Regarding
Technological Development Assumptions

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The purpose of this memorandum is to propose a final scheme for harmonizing the rate of technological developments in the MA modeling exercise. Figure 1 shows the technological efficiency with time (a modified form of the earlier figure), while Figures 2 and 3 show the rates of change of technological efficiency. As parameters that have to be harmonized we have identified:

- Rate of technological development
- Rate of environmental technological development
- Irrigation efficiency
- Yield improvement
- Improvement of water use efficiency
- Improvement of energy efficiency

These parameters have been described during the San Jose - Costa Rica scenarios workshop as shown in table 1.

Figures 1 to 3 take into account the following comments of Detlef van Vuuren and Mark Rosegrant on the earlier scheme:

- Should have less convergence between Economic Optimism and Techno Garden (done)
- Local Learning and Fortress World should have earlier breakpoint (breakpoint now 2015)

Here are some other points I would like to make as a result of their comments:

- Modelers should use Figures 1 to 3 only as orientation.
- These figures are meant only to indicate global trends, and it is expected that regional trends will in some (all?) cases depart from the global trends. In this scheme no time shifts are included.
- Figures 2 and 3 imply that assumptions about the rate of change remain constant over fixed periods. I hope that the different groups can comply with this since it would help us to harmonize our assumptions.
- In principle, Figures 1 to 3 represent both exogenous and endogenous trends of technological development in the models. I realize that it is difficult to control the endogenous technological trends simulated by the models (e.g. the net rate of energy efficiency improvements simulated by IMAGE) but we should at least try to avoid contradictions.
- Figures 1 to 3 refer to general technology development, but at the Costa Rica meeting we distinguished between "technology development" and "*environmental* technology development" and agreed that they would differ in some cases (see Table 1 and additional line for environmental technological development in figure 1). The first step is to decide which technology factors belong in which categories. I would not put technology factors related to agriculture or water use in the "environmental" category because I believe that the motivation behind development in these sectors is not primarily environmental. Instead, I would suggest that only factors having directly to do with water pollution, air pollution, or soil pollution, or biodiversity conservation should be put in the "environmental technology" category. These could include, e.g., assumptions for end-of-pipe reduction of NOx and SO2 emissions, or perhaps factors having to do with preference for low carbon fuels.

Updated Assumptions

EconOpt

- High economic growth with lower trade barriers means high rate of technological development. Conversely, a high rate of technological development is consistent with high economic growth (2000 to 2025)
- High rates slow down after 25 years (turning pt 2025)
- Further slowing of rates when economic growth rate slows (turning pt 2050)

TechnoGarden

- Lower economic growth rates mean lower rate of technological development than EconOpt, but still maintains current rate. (2000 to 2050).
- REVISED > Steadily increasing economic growth rate means that technological development begins to catch up to EconOpt after 2050 (turning pt 2050) *but does not converge.*

Local Learning

- Regionalization and higher barriers slow down economic growth and dispersion of technologies and slows down overall technological development (2000 to 2025).
- Increased decentralized learning (as indicated in curve of "education spending") increases rate of technological development (turning pt 2025)
- Continued educational spending and increasing economic growth rate after 2050 leads to further increase in rate of technological development (turning pt 2050).
- *NEW > Departs from Fortress scenario fairly early in scenario period (2015)*

Fortress

- Same dynamics as Local Learning in first period (2000-2025).
- Economic growth rate continues to decrease, education spending begins to decrease, leading to still lower rate of technological development (turning pt 2025).

Action points

- The technological parameters used in the models should be harmonized according to figures 1 to 3. Please follow the time steps and breakpoints shown in the figures.
- Regional differences can be incorporated using different starting point conditions or different trends.
- Please send us the harmonized values for each parameter used in the single model in order to provide this information for the entire group as soon as possible.

Table 1: Assumptions for technological parameters according to discussions in Costa Rica

	EconOpt	**Technogarden**	**Fortress**	**Local Learning**	**Responsible expert**
Technology	*Medium = current rates of technology improvement.*				
Rate of technology development	Medium-High	Medium moves to higher	Kind of lowish	Medium-low to medium (increasing)	Van Vuuren Alcamo Märker
Rate of env. technology development	Medium	High	Low but high for high income countries local env. problems	Medium	Van Vuuren Alcamo Märker
Irrigation efficiency	Medium-High	Medium moves to higher	I: low D : low could become medium in long-term	Starts medium-low, increasingly medium	Rosegrant
Yield improvement	Medium-High	I: organic farming .... thus low D: Medium to high	I: low D : low	I: Medium goes lower (organic farming) D: Starts medium-low, increasingly medium	Rosegrant?, Nelson?
Impr. of water use efficiency	Medium	High	Low but high for high income countries local env. problems	Medium (2015 divergence from)	Alcamo Märker Rosegrant
Impr. energy efficiency	Medium	High	Low	Medium	Van Vuuren
	EconOpt	**Technogarden**	**Fortress**	**Local Learning**	**Responsible expert**

Figure 1

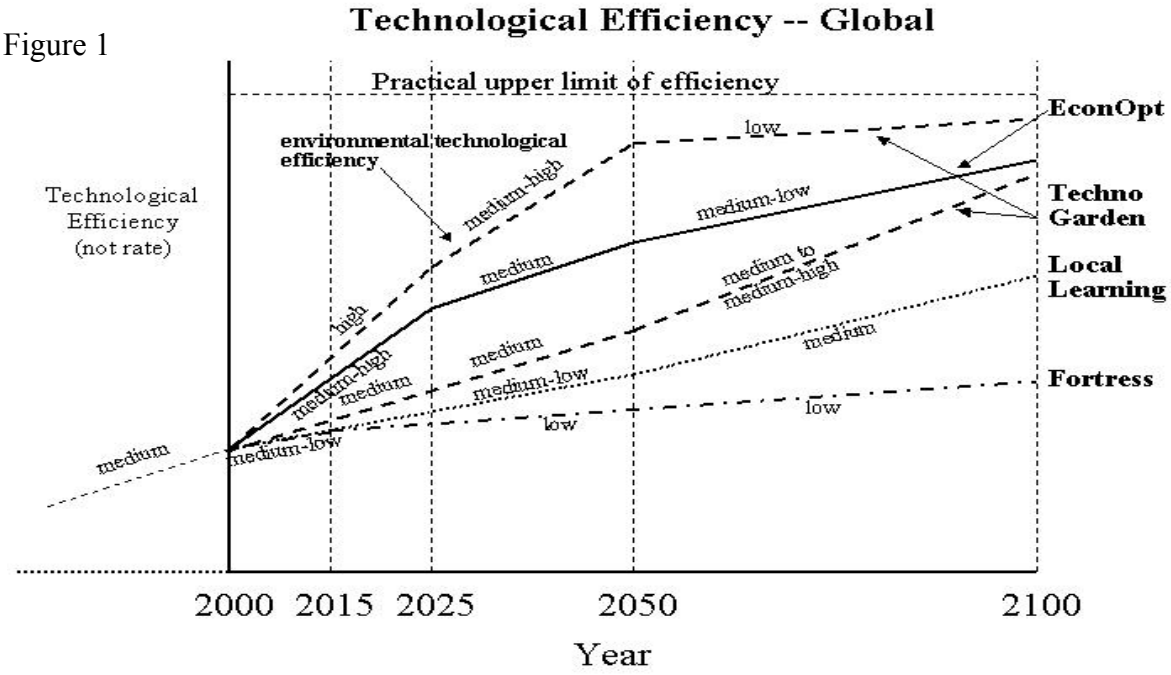

Figure 2

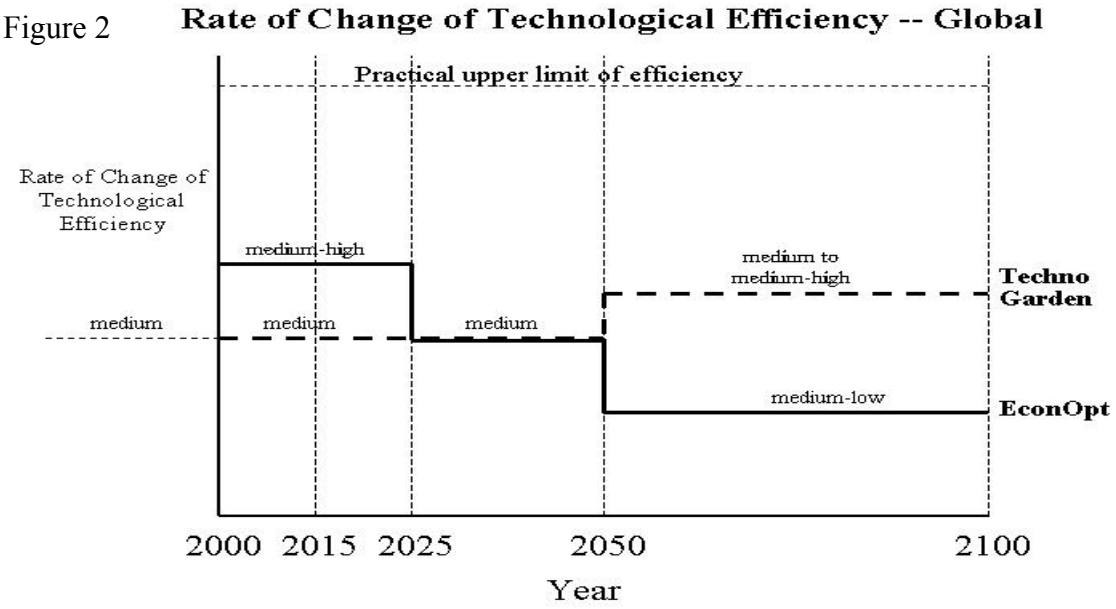

Figure 3