

Importance and limitation of LCA in Circular Economy

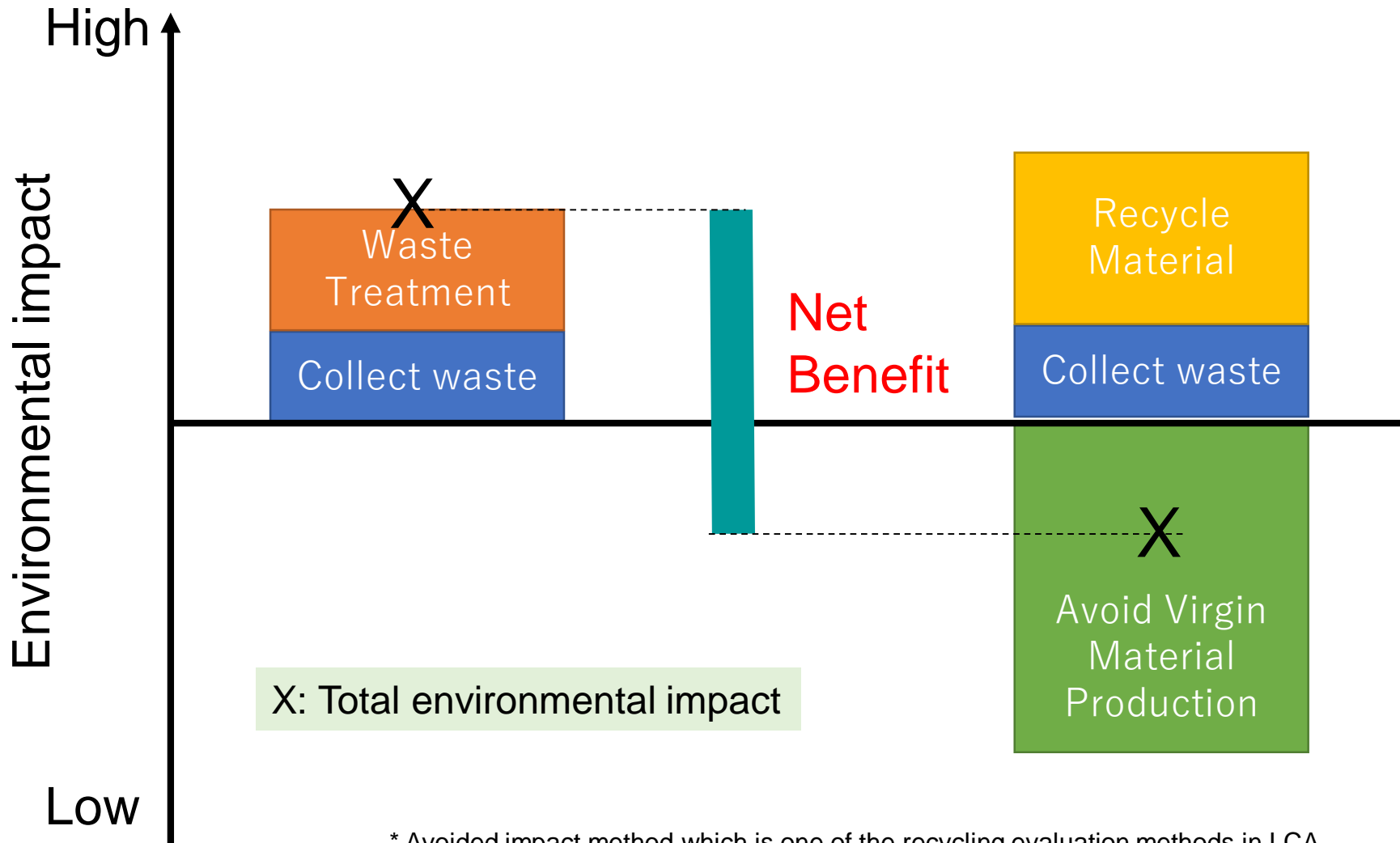
Kiyotaka TAHARA (Dr.)

Director, Research Laboratory for IDEA

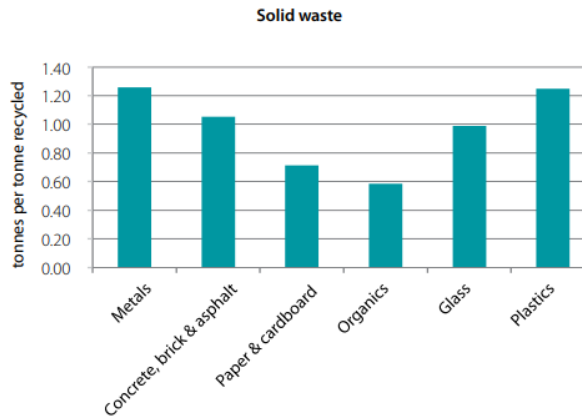
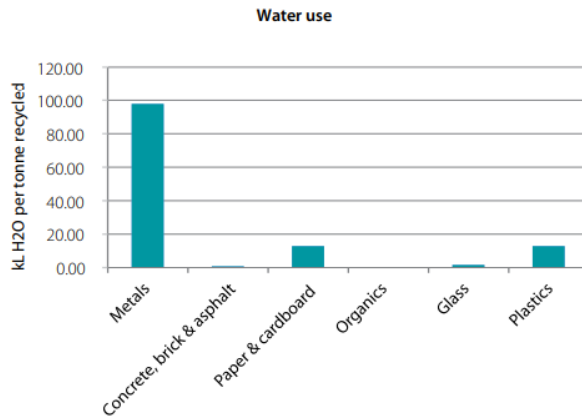
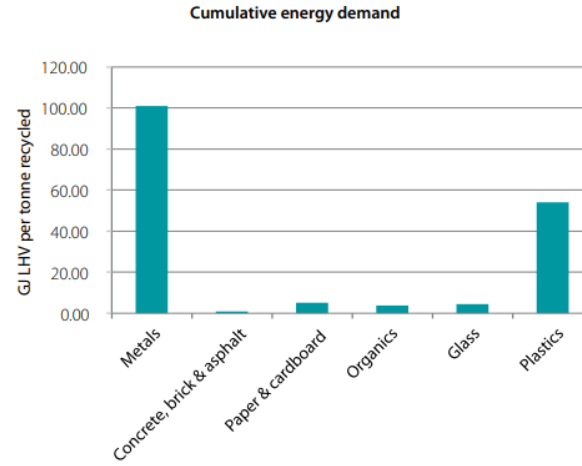
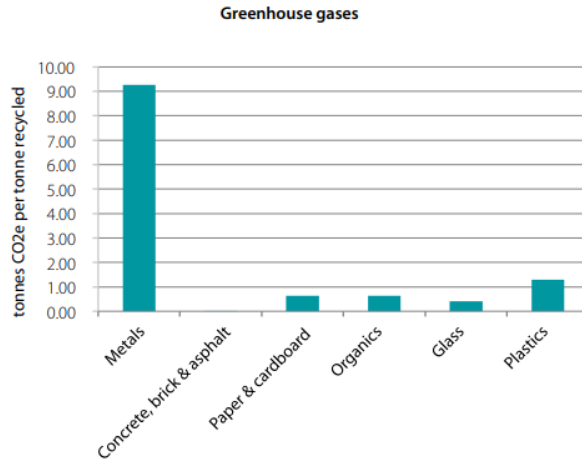
Research Institute of Science for Safety and Sustainability

National Institute of Advanced Industrial Science and Technology
(AIST)

Basic model of Recycling in LCA



Recycling Examples



Average net benefit of recycling 1 tonne of waste by material category

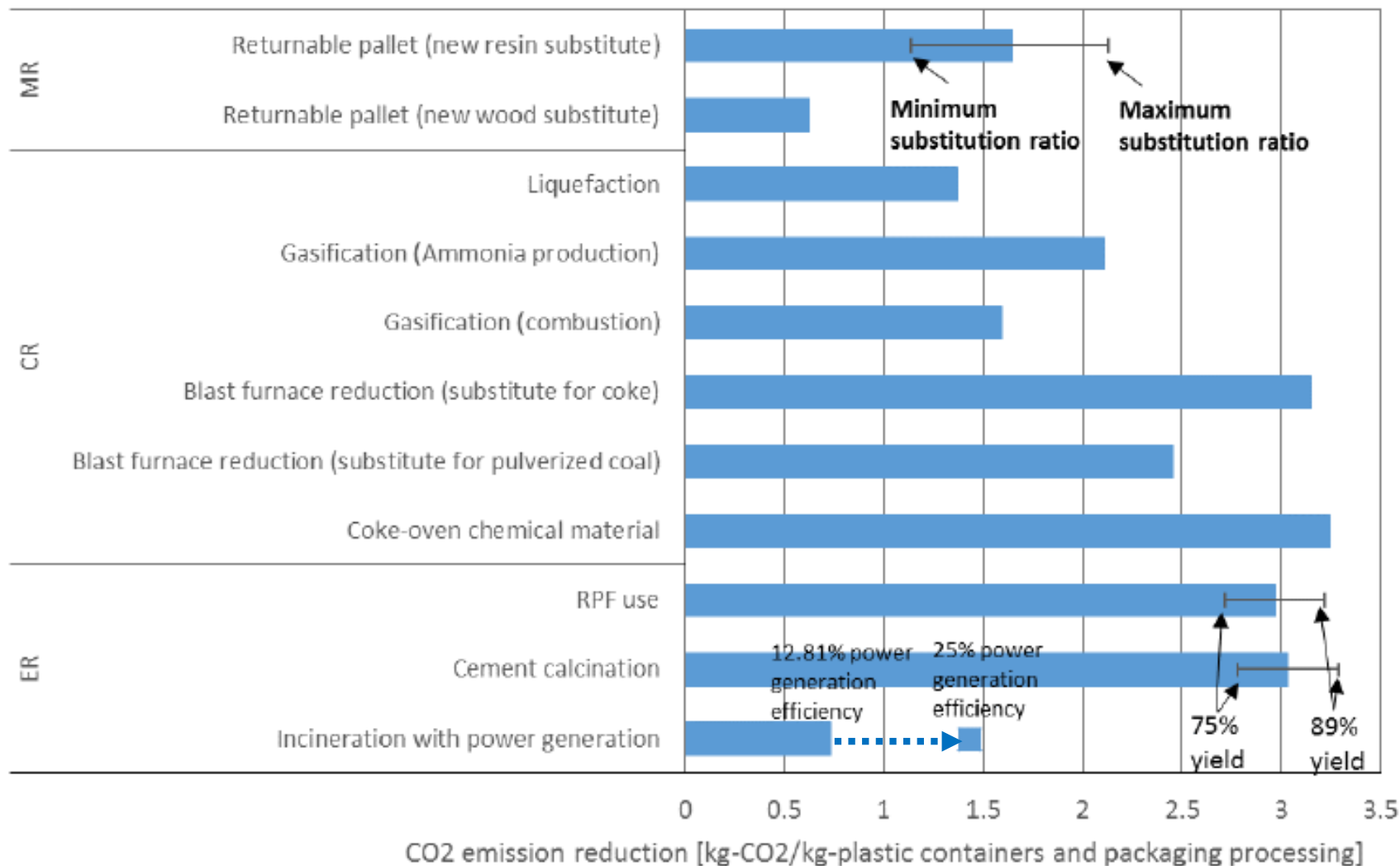
Source: <https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/warrlocal/100058-benefits-of-recycling.pdf>

Remanufacturing Examples

Author	Study type	Product Focus	Change in resource extraction	Change in energy consumption	Change in GHG emissions	Waste disposal
Kerr and Ryan (2001[21])	LCA	Photocopiers	-19% to -25%	-27%	-23%	-35%
		Photocopiers (modular)	-39% to -48%	-68%	-65%	-47%
Smith and Keoleian (2004[22])	LCA	Engines	-26% to -90%	-68% to -83%	-73% to -87%	-65% to -88%
Steinhilper (1998[23])	?	Various	-	-85%	-	-
Neto and Bloemhof (2009[24])	LCA	Personal computers	-	-80%	-	-
Kara (2010[25])	LCA	Printer cartridges	-	-	-33%	-
Gutowski et al. (2011[26])	Meta-review	Furniture	-	-100%	-	-
		Clothing	-	-64%	-	-
		Computers	-	-57%	-	-
		Electric motors	-	3%	-	-
		Tires	-	9%	-	-
		Appliances	-	75%	-	-
		Engines	-	-4%	-	-
Toner cartridges	-	-6%	-	-		
Warsen et al. (2011[27])	LCA	Gearbox	>50%	-33%	-	-
Biswas and Rosano (2011[28])	LCA	Compressors	-	-	-90%	-
Liu et al. (2014[29])	LCA	Engines	-95%	-66%	-67%	-
Wilson et al. (2014[30])	LCA	Turbine blades	-	-36%	-45%	-

Source: <https://www.oecd-ilibrary.org/sites/88b10248-en/index.html?itemId=/content/component/88b10248-en>

LCA of various plastic recycling methods



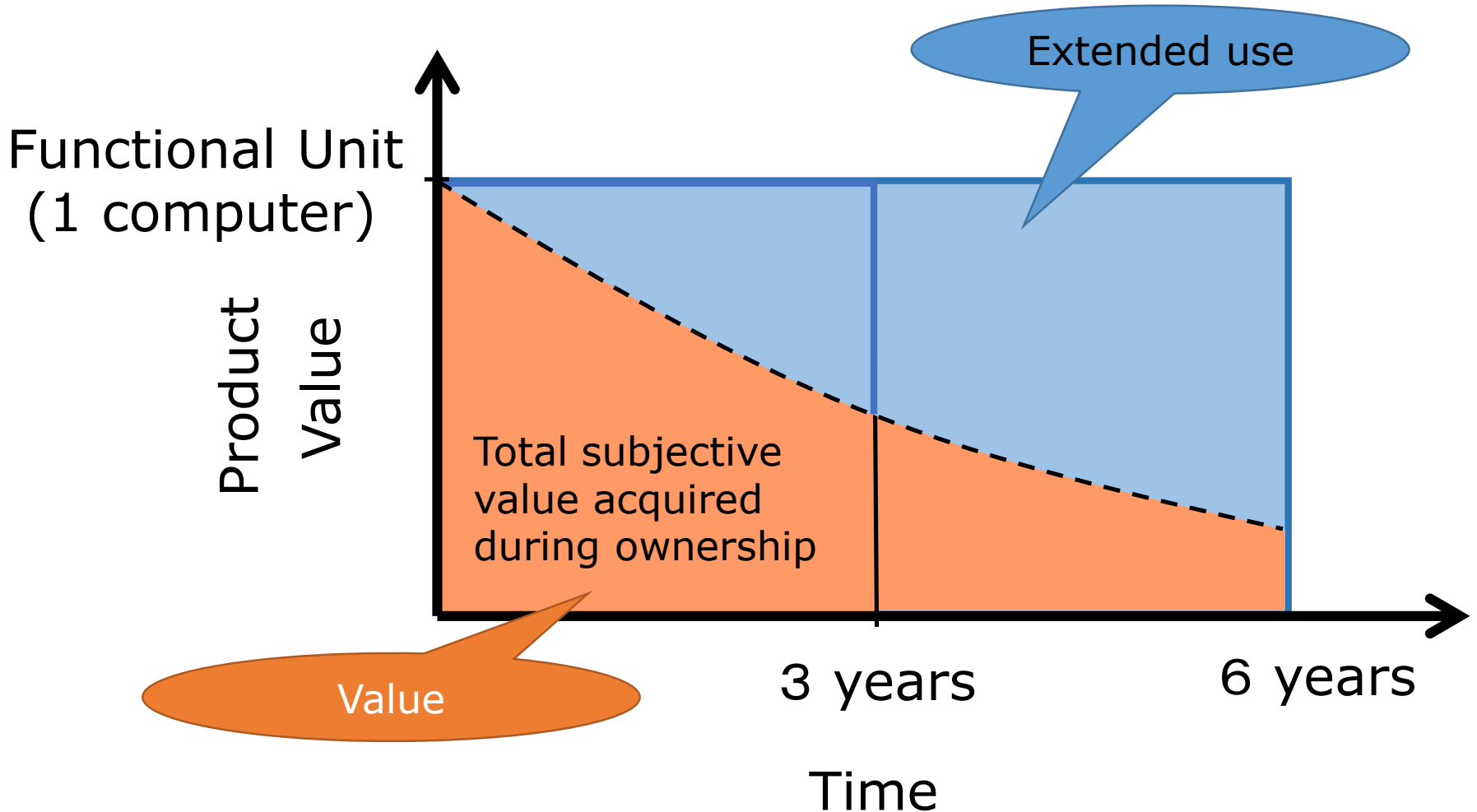
CO2 reduction effects of various recycling methods

Source: https://www.nikkakyo.org/sites/default/files/JaIME_LCA.pdf

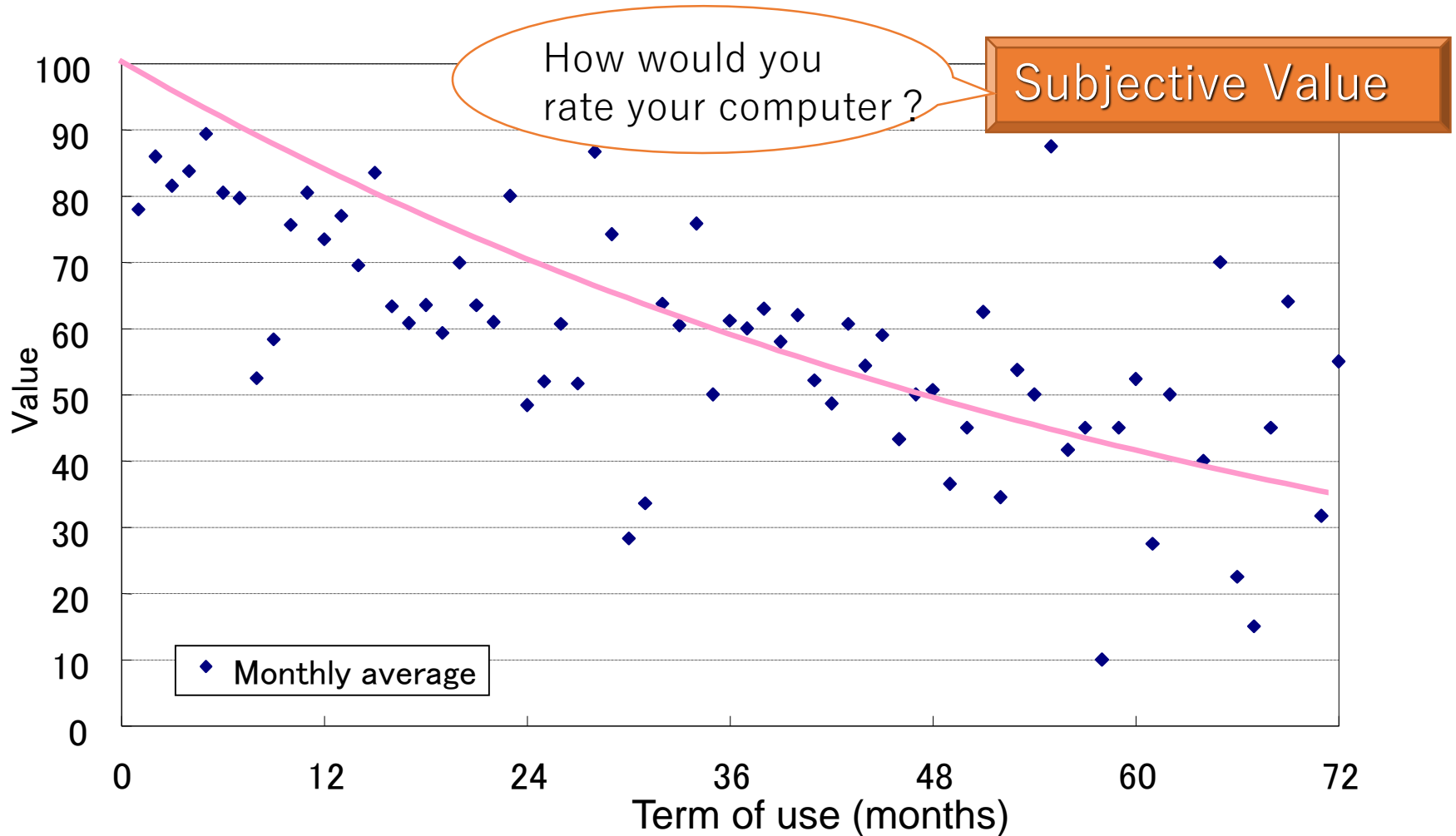
Challenges of LCA

- Functional unit and value issue
- Indirect effects
- Efficiency of energy using products
- Future modeling of LCA databases (Time extended)

Functional unit and value issue (1)

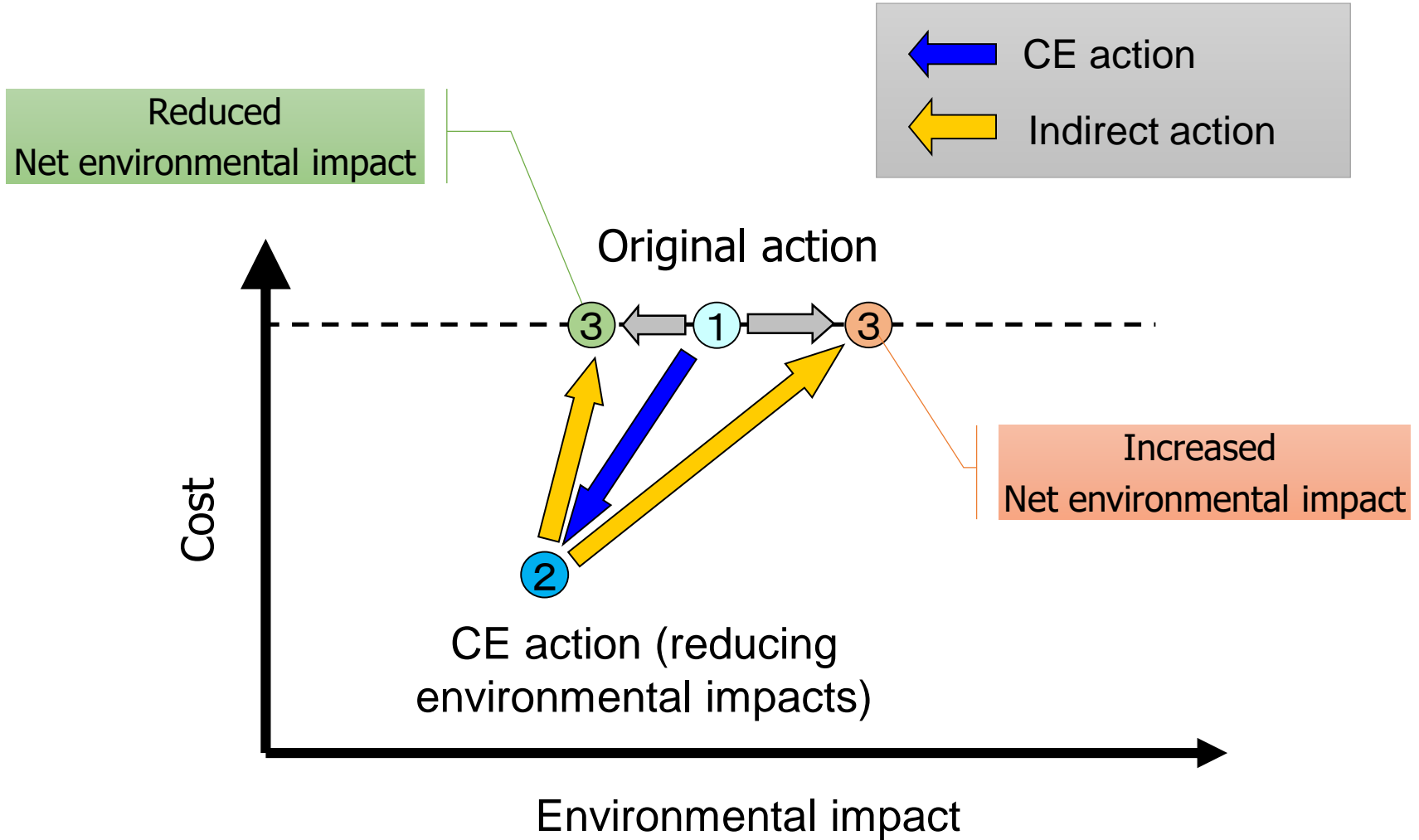


Functional unit and value issue (2)



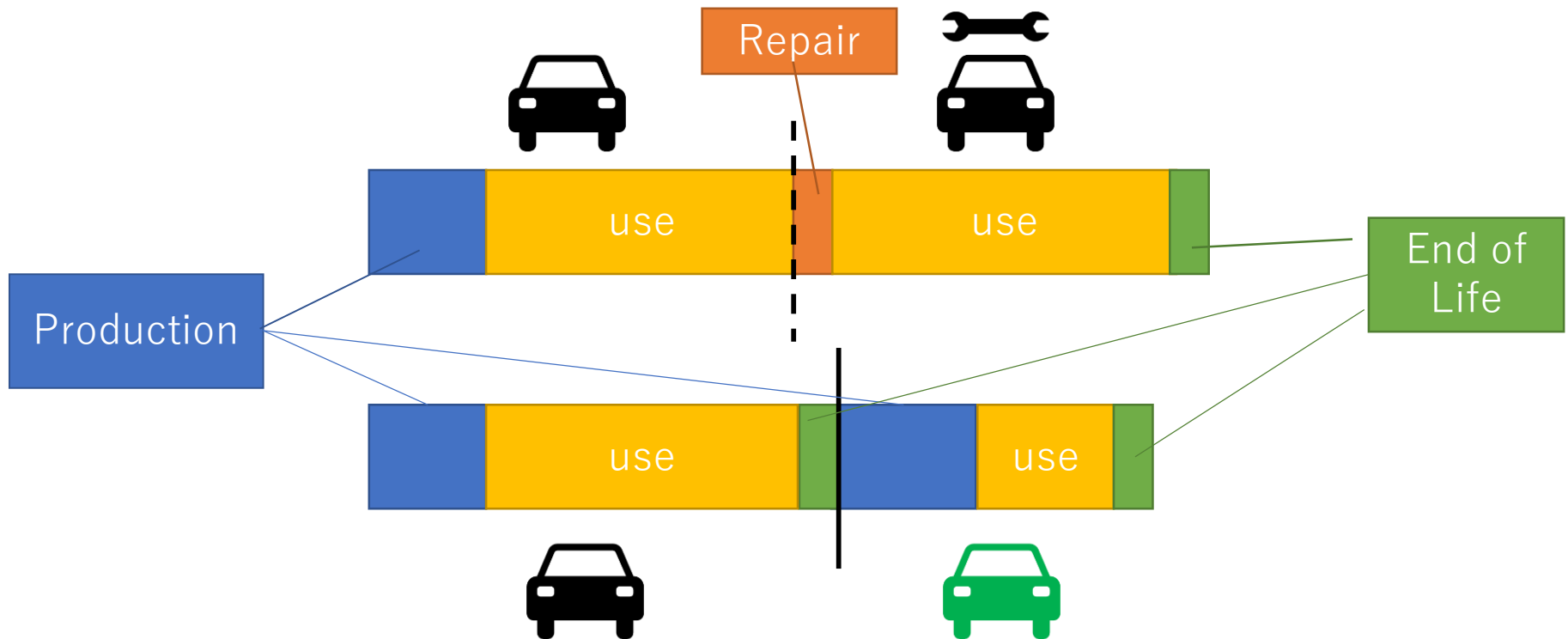
Source: Hiromi Takahashi, Yoji Uchiyama, Toshisuke Ozawa, Kiyotaka TAHARA, Astushi Inaba: Evaluation of Reusing House-Originated Personal Computers by Using Eco-Efficiency, EcoBalance Proceedings, pp.587-590, 2004

Indirect effects



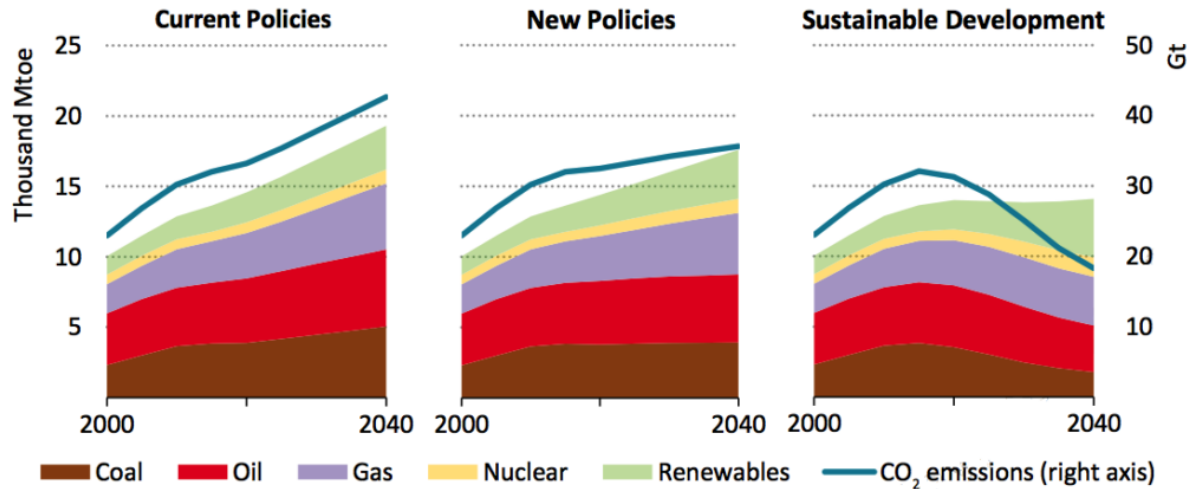
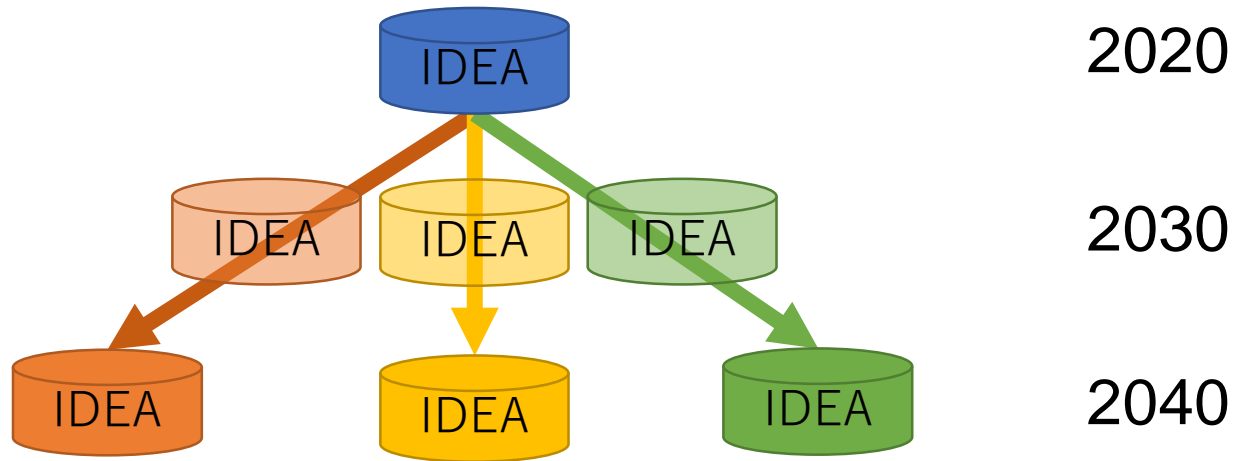
Efficiency of energy using products

The efficiency improvements of energy using products (e.g. automobiles and refrigerators) can reverse the results.



Modeling future scenarios into LCA databases

IDEA:
Inventory Database
For Environmental
Analysis
(LCA Database)



Source: IEA (2017) World Energy Outlook, Figure 2.9

Summary

- Many LCA case studies of CE already exist and there are mixed results
- It is important to conduct robust evaluations
- Extending the boundary of current evaluations is also important
 - Including indirect effects, value, efficiency improvements, time axis etc.