



On the Sustainability of Eco-efficiency

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Sustainability is nowadays accepted by all stakeholders as a guiding principle for both public policy making and corporate strategies, but.....

- the biggest challenge for most organisations remains in the real and substantial **implementation** of the sustainability concept.
- At the core of the implementation challenge lies the question, **how sustainability can be measured**, especially for products and processes.
- As long as this question is not answered, there will be no consistent development towards sustainability and the use of the term remains **arbitrary**.

Eco-efficiency is seen by many as a good proxy for sustainability...

- Eco-efficiency analysis relates two pillars of sustainability, the economic and the environmental one (Huppes 2007).
- Quantified eco-efficiency analysis for sustainability (Unilever 2006).

→ Is eco-efficiency defined more precisely than sustainability?

→ Is the eco-efficiency concept used in a sustainable way?

Eco-efficiency definitions

There is a wide variety of terminology developing referring to eco-efficiency, e.g.:

E/E = production value / unit of environmental impact or
cost / unit of environmental improvement or
environmental impact/ unit of production value or
environmental improvement / unit of cost

(Huppes & Ishikawa 2006)

Summary of current eco-efficiency definitions:

„Something environmental

divided by

something economic

or

vice versa.“

Eco-efficiency definition for case study

$$eco - efficiency = \frac{value (convenience)}{environmental load}$$

(Adachi 2004)

Illustrative eco-efficiency case study



Smart vs. Prius vs. S-Class



Eco-efficiency case study

For this example:

environmental load: life cycle CO₂ emissions

value: purchase price

data sources: following slides

Eco-efficiency case study – Purchase Price

The screenshot shows the Mercedes-Benz website interface for the 2009 S550 Sedan. The left sidebar contains a navigation menu with options like Home, Overview, Exterior, Interior, Packages, Safety, Performance, Specs, Photos And Videos, and a circled 'Build This Vehicle' button. The main content area displays the car's name, a detailed description, and key features like the 5.5-liter V-8 engine and COMAND System. The MSRP of \$87,825 is highlighted with a red circle.

Mercedes-Benz

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MSRP \$87,825

Build This Vehicle

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The 2009 S550 Sedan

Even before you step inside, the S550 mesmerizes from the V-shaped trunk lid, to flared wheel arches and LED side marker lamps, to the iconic hood ornament. And throughout the cabin, furnishings like ambient lighting and Burl Walnut wood trim set an enchanting tone. But it's under the hood where the S550 truly dazzles.

- 5.5 liter 382 -horsepower 32-valve V-8 engine
- 7-speed automatic transmission with Touch Shift

Want all-wheel-drive? Explore the S550 4MATIC Sedan

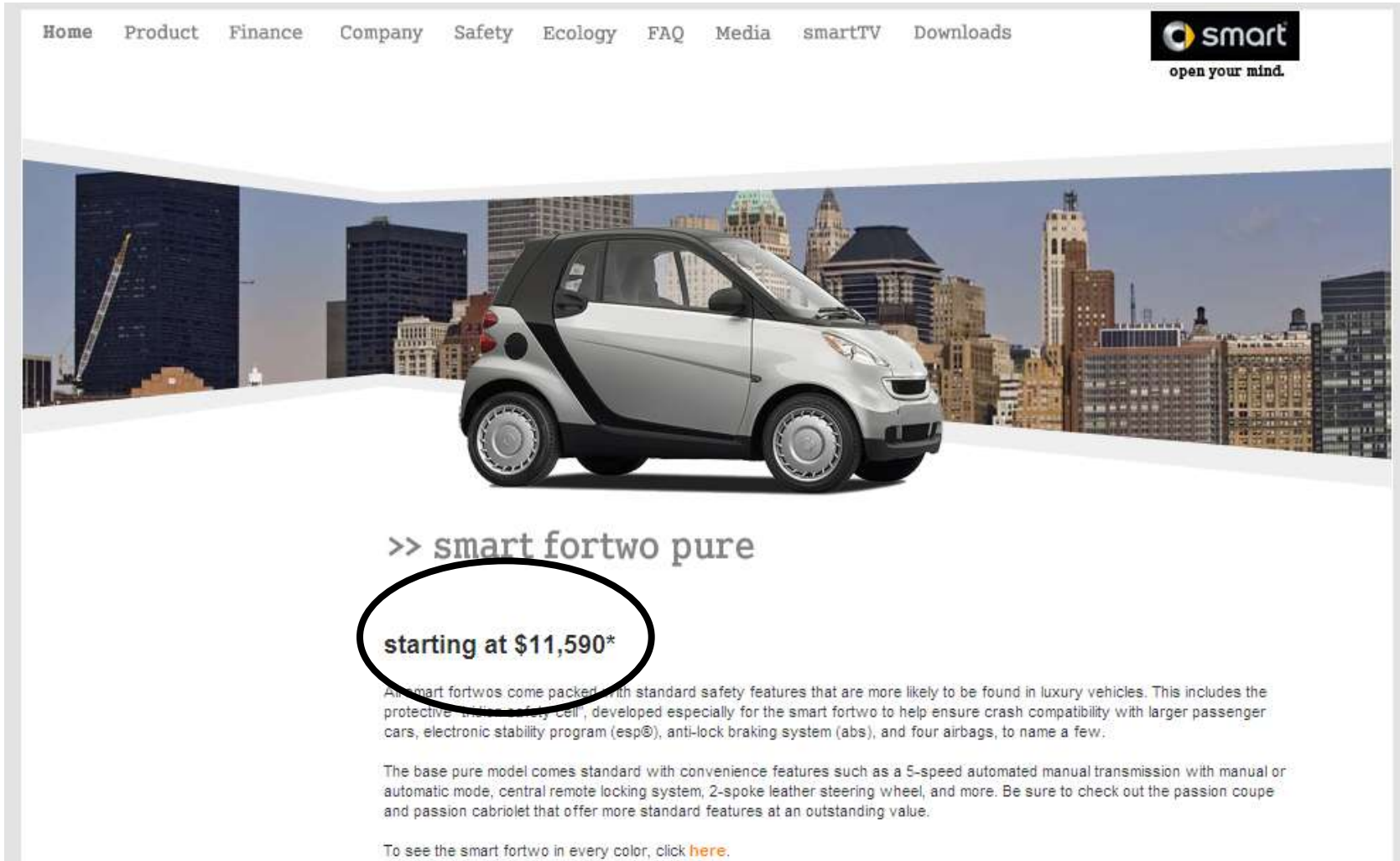
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COMAND System
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5.5-liter V-8 engine
Exemplary 382-horsepower performance

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Eco-efficiency case study – Purchase Price



The screenshot shows the top navigation bar of the Smart car website with links: Home, Product, Finance, Company, Safety, Ecology, FAQ, Media, smartTV, Downloads. The Smart logo with the tagline "open your mind." is in the top right. Below the navigation is a large image of a silver smart fortwo pure car parked on a rooftop with a city skyline in the background.

>> smart fortwo pure

starting at \$11,590*

All smart fortwos come packed with standard safety features that are more likely to be found in luxury vehicles. This includes the protective driver safety cell, developed especially for the smart fortwo to help ensure crash compatibility with larger passenger cars, electronic stability program (esp®), anti-lock braking system (abs), and four airbags, to name a few.

The base pure model comes standard with convenience features such as a 5-speed automated manual transmission with manual or automatic mode, central remote locking system, 2-spoke leather steering wheel, and more. Be sure to check out the passion coupe and passion cabriolet that offer more standard features at an outstanding value.

To see the smart fortwo in every color, click [here](#).

Eco-efficiency case study – Purchase Price

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eco-efficiency case study – life cycle CO₂ data

S-Class: Environmental Certificate

Prius: production scaled by curb weight

(S-Class 4465 lbs, Prius 2932 lbs)

use phase scaled by fuel economy values

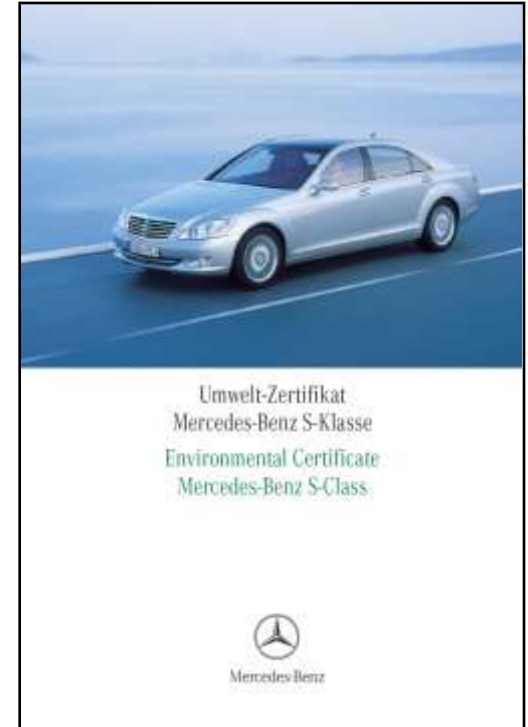
(S-Class 18 mpg, Prius 46 mpg)

smart: production scaled by curb weight

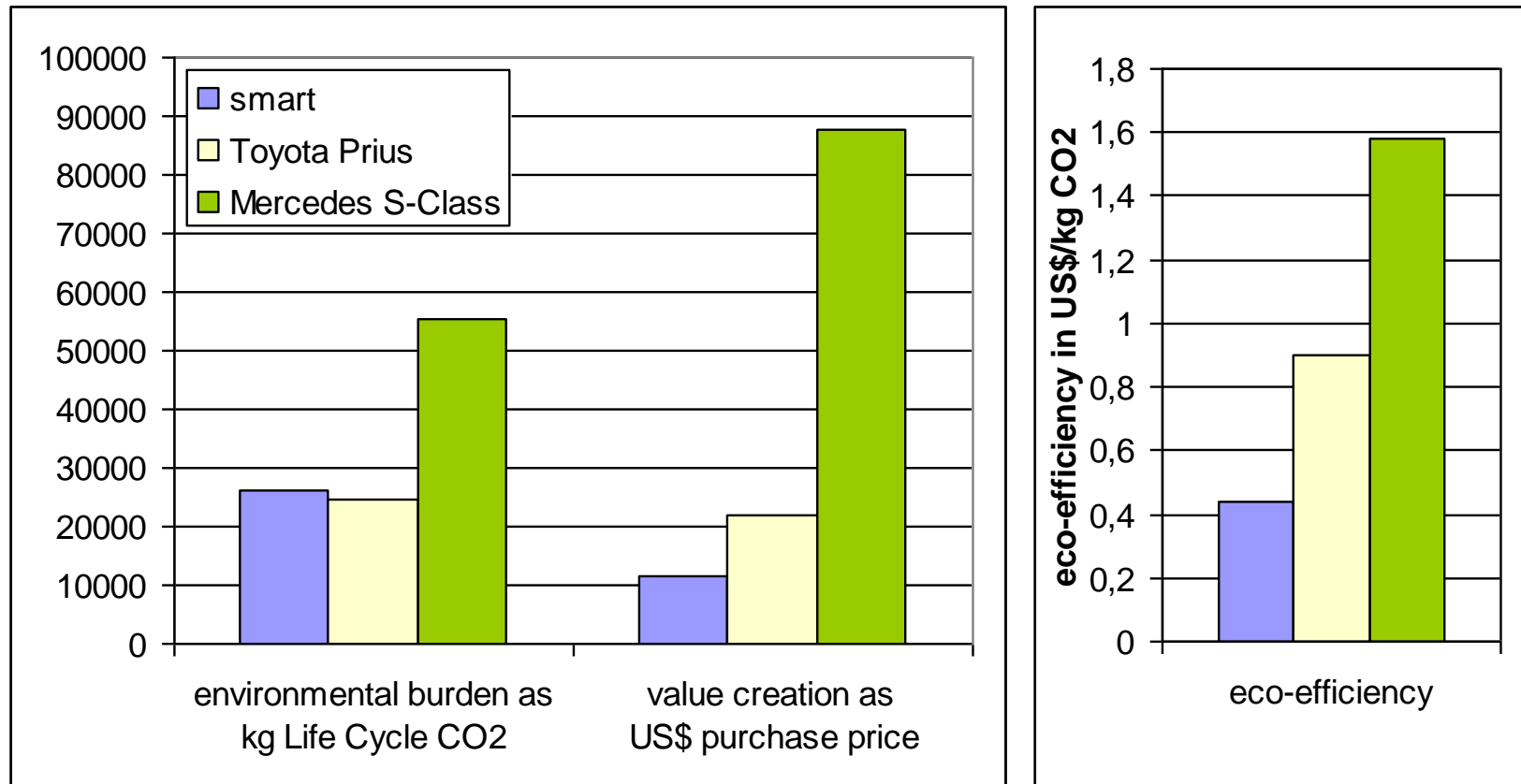
(S-Class 4465 lbs, smart 1808 lbs)

use phase scaled by fuel economy values

(S-Class 18 mpg, smart 37 mpg)

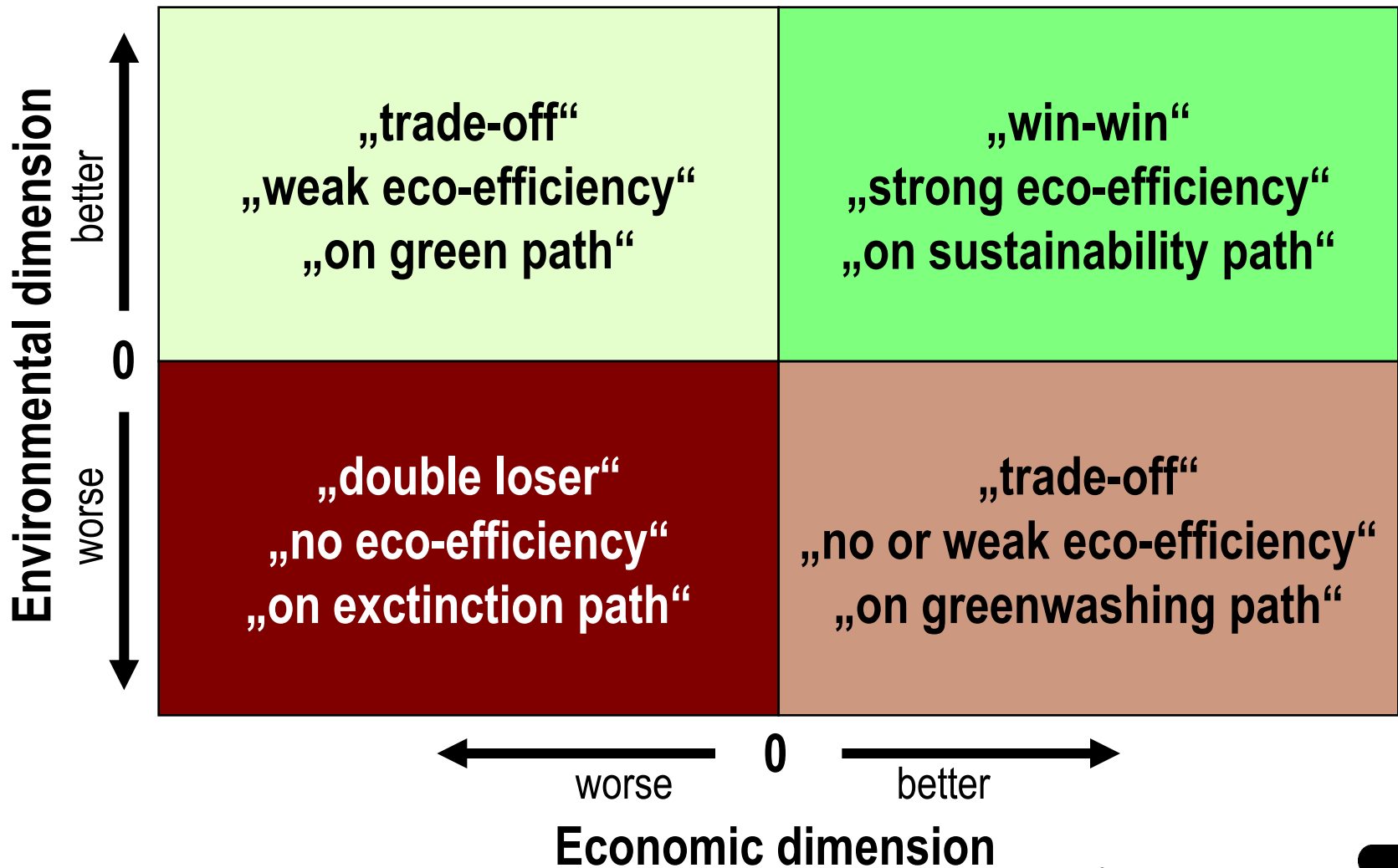


Illustrative eco-efficiency case study result for a running life of 100.000 miles



S-Class (1,6 \$/kg CO₂) is roughly twice as „eco-efficient“ as the Prius (0,9 \$/kg CO₂) and roughly three times as „eco-efficient“ as a smart (0,5 \$/kg CO₂)

Eco-efficiency Portfolio



Eco-efficiency is not sustainable per se...only under certain conditions

Sustainability = $f(E_1, E_2)$

E_1 = environmental, if E_2 = economical

E_1 = economical, if E_2 = environmental

improvement is defined as $f(x)$, $E_x > 0$

The three sustainability cases of ecoefficiency:

			sustainability
I.	$E_1, E_2 > 0$	$\rightarrow f(E_1, E_2) > 0 \rightarrow$	☺
II.	$E_1, E_2 < 0$	$\rightarrow f(E_1, E_2) < 0 \rightarrow$	☹
III.	$E_1 > 0, E_2 < 0$ $E_1 < 0, E_2 > 0$	$\rightarrow f(E_1, E_2) = ? \rightarrow$	☹

→ Condition for environmental effectiveness is necessary.

The systems or life cycle perspective have to be applied for sustainability assessments in order to achieve reliable and robust results.

$$\mathbf{LCSA = LCA + LCC + SLCA}$$

LCSA = Life Cycle Sustainability Assessment

LCA = Environmental Life Cycle Assessment

LCC = LCA-type Life Cycle Costing

SLCA = Societal Life Cycle Assessment

formula based on Klöpffer [LCM 2007]

E/E as part of LCSA

$$\mathbf{E/E = LCA + LCC}$$

$$\mathbf{LCSA = E/E + SLCA}$$

LCSA	=	Life Cycle Sustainability Assessment
LCA	=	Environmental Life Cycle Assessment
LCC	=	LCA-type Life Cycle Costing
SLCA	=	Societal Life Cycle Assessment

formula based on Klöpffer [LCM 2007]

Conclusions

- **Eco-efficiency has no direct link to sustainability per se.**
- **There is still a need for a consistent definition of the term.**
- **A „strong“ eco-efficiency definition implies improvement in both dimensions – environment and economy.**
- **If this condition is not met, eco-efficiency is open to „green-washing“ by offsetting environmental with economic performance. In the worst case, environmentally unfavourable products are sold as eco-efficient because they are more profitable.**
- **To avoid misuse, a legitimate eco-efficiency concept needs a constraint, which prevents the deterioration of the environmental dimension.**