“Virtual rebound effects” with emphasis on long-term infrastructure investments, and their interaction with absolute (ordinary) rebound effects

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Basic idea of “virtual rebound”:

Defined in relation to an alternative energy consumption or use, where utilization of given infrastructure investments would or should be reduced, but inefficiently low energy prices dictate that it instead remains constant, in (too) many states of the world.

Main idea:

The virtual and the absolute (or standard) rebound effects are often mutually reinforcing. By this it meant that, *when the "virtual rebound" is greater, this can in itself lead to a greater absolute rebound*.

Examples of infrastructure investments that can give rise to “virtual rebounds”:

- Urban structure
- More general infrastructure
- Transportation system
- Energy production systems (such as power plants)

Effect relevant in various contexts:

- When energy is subsidized outright, in the country in question
- When infrastructure users are not charged the full (global) externality costs of energy use, including climate-related costs
- When there is an expectation that full costs will not be charged in the future

Concrete case studied here:

- Infrastructure investments giving rise to high long-term emissions when not modified
- When energy prices are “right”, they will be modified (“retrofitted”) in response to these prices, leading to reductions in fossil energy consumption and carbon emissions
- When energy prices are too low, retrofits are not taking place; this leads to the “virtual rebound” (relative to the optimal situation)

“Virtual” and “regular” rebound interactions:

- When retrofits do not take place, this can lead to an additional, “regular”, rebound due to low energy prices.
- Example: High energy prices ought to lead to switch from private to public transport; but low energy prices prevents this. This lack of “retrofits” leads to a greater rebound in terms of private transport volume, when fuel prices are kept low.

Example in the following, providing a magnitude of “virtual rebounds” (abstracting from normal rebounds)

Example where infrastructure will be retrofitted ex post given that retrofit cost is below energy cost; and energy cost is kept at a “too low” level. Both energy and retrofit costs are, in the example, log-normally distributed and independent.

"Virtual rebound": Excessive ex ante expected energy consumption and/or carbon emissions due to "too low" expected energy prices (= 2 in the example), instead of "correct" (higher) expected energy prices ex post. Percentage increment relative to base energy consumption in optimal solution.

"True" expected energy price	Low variance for future energy price	Medium variance for future energy price	High variance for future energy price
2.5	20	18	17
3	58	41	36
4	255	125	98

Source: Adopted from Strand, Miller and Siddiqui (2011), Table 1

The example shows:

- The “virtual rebound” effect can be very significant; at least this is indicated in (arguably realistic) simulations.
- Note that a “normal” rebound effect may come on top of the “virtual rebound” effect (the “normal” rebound may increase almost in proportion to the “virtual” counterpart).