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From: "Amory B. Lovins" [ablovins@rmi.org]
Sent: 01/29/2004 08:26 PM
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Subject: Solar Water Heating Roadmap Meeting

I regrettably can't attend this worthy event -- I book 4-6 months ahead and am under big deadlines -- but I hope the participants will receive and consider a few simple ideas:

- End-use efficiency first: RMI's 1991 The State of the Art: Water Heating, a 412-page synthesis for Competitek, precursor of E Source (www.esource.com, which unfortunately did not reissue this volume in its Technology Atlas series as it did with four others), found a ~1991 technical potential to save 61-65% of water-heating energy at <0.7¢/kWh average cost (1986 $ levelized at 5%/y real discount rate) -- equivalent to about a one-year simple payback at a 6¢/kWh tariff. Nearly all the savings had a marginal cost below 1.5¢/kWh. Saving almost all the rest of water-heating energy through alternative water-heating devices would cost ~2-4¢/kWh depending on local conditions. Hence saving almost all of the ~150 TWh/y (and a lot of gas) then used for US water heating would cost probably ~1.1-2.0¢/kWh. The efficiency improvements are retrofittable by integrated packages designed for convenient delivery and implementation. RMI's synthesis included end-use (fixture-level) efficiency, reduced tank and pipe losses, and optimal aquastat settings, taking account of their complex interactions and scoping uncertainties in the data. Obviously, very efficient end-uses makes solar water heating systems smaller, increases their solar fraction, and improves overall system performance and economics, so solar and efficiency should be

bundled.

(By the way, I think DOE should commission E Source [www.esource.com] to update, reformat, and publish this unique 1991 assessment. It found much bigger and cheaper savings than other studies because it's far more thorough and integrated. It's an underexploited gold-mine. Many analysts today don't even know it exists, and there are not many copies around.)

- Quasi-seasonal storage: As UWisc/Madison researchers showed in the 1970s, conventionally sized storage optimization for a day or two is a local, not a global, minimum in the curve relating total system cost of water-heating to storage. The broad global minimum, at considerably lower cost, is at a storage time of weeks to months. With efficient end-use, this normally entails roughly 0.3-0.7 m^3 of storage per m^2 of collector. Our 1983 99%-solar DHW system at 7100' in the Rockies used 0.5; the Lyngby house in Denmark used 0.7. The reason the storage isn't much larger is that as the temperature drops in the stratified storage tank (5 m^3 in our case), the first-law efficiency of the collector improves because it has a better load to work into. Many people didn't know or have forgotten the literature on this whole-system optimization concept because it's >20 years old, so nearly all solar water heating system uses only short-term storage and therefore supplies much costlier hot water than it should.

- Supply integration: Solar water heating can be a nice coproduct of low-concentration (e.g. nontracking Winston collector) photovoltaics at a residential scale...also improving PV efficiency if using crystalline rather than amorphous Si (because of its temp coefficient).

- Remember passive downpumpers. The brilliant

Copper Cricket and Bronze Lizard designs by Eldon Haines and Bob Block are apparently now in the public domain, generously posted on the Web after their Oregon (?) company crashed due to a random business misfortune, despite the excellence of the concept and products. Our Bronze Lizard produced ~40šC on cloudy days and ~70šC on cloudy days in a 4900-Cš-d/y climate going occasionally to -44šC. The advantages of these Geyser Pump ("slurp-and-burp") collectors include zero parasitic energy, collector sited above load, and high reliability, provided the joints in the vacuum circuit are brazed with good workmanship.

- Remember to use risk-adjusted discount rates. Because solar energy has no fuel-adjustment clause, it avoids the fuel-price volatility of gas and of fossil-fueled electricity. This typically increases solar's economic value by ~1¢/kWh or by a doubling of the present value of the directly-used-natural-gas cost stream. See Small Is Profitable (www.smallisprofitable.org) for details. Not doing this right (as any first-year MBA student knows how to do) sells short one of solar's major economic advantages.

Best wishes -- ABL

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