

Table 3. Energy ratio of output to input for various energy sources.

| <u>Energy source</u>  | <u>Energy ratio</u> |
|---|---------------------|
| <i>Nonrenewable fossil fuels</i> <sup>vi</sup>              |                     |
| Oil & natural gas (US wellhead)                             |                     |
| Discoveries – 1940s   | >100                |
| – 1970s   | 8                   |
| Production of earlier discoveries – 1970s                   | 20                  |
| – 1980s   | 10                  |
| Coal – 1950 (US mine)                                       | 80                  |
| – 1970 (US mine or strip)                                   | 30                  |
| <i>Renewable fuels</i>                                      |                     |
| Ethanol (grain, sugarcane, crop residues) <sup>vi</sup>     | 0.7-1.8             |
| Methanol (tree plantation) <sup>vi</sup>                    | 2.6                 |
| Vegetable oil (precursor to biodiesel) <sup>vii</sup>       | 1.8-4.6             |
| Biomass tree crops (fertilized) <sup>viii</sup>             | 6-13                |
| Biomass herbaceous crops (fertilized) <sup>ix</sup>         | 11-12               |
| Biomass crop, then gasification <sup>viii,x</sup>           | 2-5                 |
| Anaerobic digester biogas (8 countries) <sup>xi</sup>       | 1.5-3.1             |
| Solar flat-plate collectors (heat) <sup>xii</sup>           | 2-5                 |
| <i>Non-solar electricity production</i> <sup>vi</sup>       |                     |
| Coal-fired, US average                                      | 9                   |
| Western surface coal – no scrubbers                         | 6                   |
| – scrubbers   | 2.5                 |
| Natural gas-fired <sup>xii</sup>                            | 2.3                 |
| Nuclear light-water reactor                                 | 4                   |
| <i>Solar-related electricity production</i>                 |                     |
| Photovoltaic arrays <sup>vi</sup>                           | 1.7-10              |
| Parabolic-thermal collectors <sup>xiii</sup>                | 3-8                 |
| Wind turbines <sup>xiv,xv</sup>                             | 3-18                |
| Conventional or small hydroelectric <sup>xvi</sup>          | 10-12               |
| Biomass-fired (plus crop production) <sup>viii,x,xvii</sup> | 3.3-3.7             |
| With advanced cogeneration <sup>viii,xviii</sup>            | 8-9                 |
| <i>Energy conservation</i>                                  |                     |
| Double-pane windows <sup>xix</sup>                          | 136                 |
| Ceiling insulation <sup>xix</sup>                           | 61                  |
| Passive solar housing <sup>xii</sup>                        | 10-25               |

## Notes for Tables 1-3.

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- <sup>vii</sup> C.E. Goering and M.J. Daughtery. 1982. Energy accounting for eleven vegetable oil fuels. *Transactions of the American Society of Agricultural Engineers* 25:1209-1215.
- <sup>viii</sup> R. Herendeen and S. Brown. 1987. A comparative analysis of net energy from woody biomass. *Energy* 12:75-84.
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- <sup>xvi</sup> M.W. Gilliland, J.M. Klopatek and S.G. Hildebrand. 1981. Net energy: Results for small-scale hydroelectric power and summary of existing analyses. *Energy* 6:1029-1040.
- <sup>xvii</sup> D.M. Gates. 1985. *Energy and Ecology*. Sinauer Associates, Sunderland, MA.
- <sup>xviii</sup> R.H. Williams and E.D. Larson. 1993. Advanced gasification-based biomass power generation. Pp. 729-785 in: T.B. Johansson, H. Kelly, A.K.N. Reddy and R.H. Williams (eds.). *Renewable Energy: Sources for Fuels and Electricity*. Island Press, Washington, DC.
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