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Author: Mohammad-Hossein Shariatkhah Mahmoud-Reza Haghifam Mohesn Parsa-Moghaddam Pierluigi Siano

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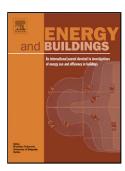
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### Modeling the reliability of multi-carrier energy systems considering

## dynamic behavior of thermal loads

- 3 Mohammad-Hossein Shariatkhah<sup>a,\*</sup>, Mahmoud-Reza Haghifam<sup>a</sup>, Mohesn Parsa-Moghaddam<sup>a</sup>, Pierluigi Siano<sup>b</sup>
- <sup>a</sup> Faculty of Electrical and Computer Engineering, Tarbiat Modares University, Tehran, PO Box 14115-111, Iran
- <sup>b</sup> Department of Industrial Engineering, University of Salerno, Fisciano, Italy.
- 6 Abstract— Technological advances in the field of energy conversion have led to the development
- of multi-carrier energy systems (MCESs). The ability of MCESs to manage different forms of energy
- 8 can improve the efficiency and reliability of power systems. This paper attempts to address the
- 9 dynamic behavior of loads in reliability evaluation of MCESs. A Markov-Chain Monte-Carlo
- approach is employed to model the dynamic behavior of thermal loads. The proposed model also
- investigates the mutual dependence between different forms of energy and its influence on
- availability of supply. Numerical simulations of an energy hub are provided to demonstrate the
- validity of the proposed approach.
- Keywords— Reliability; Monte-Carlo; Markov Chain; Multi-Carrier Energy Systems (MCESs);
- 15 Load Dynamics.

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- 17 Nomenclature
- 18 Water Heater Parameters
- 19 c tank thermal capacity (kWh/°C)
- 20 T<sub>a</sub> ambient temperature (°C)
- 21  $T_T(t)$  water temperature at time t ( ${}^{\circ}C$ )
- 22 T<sub>d</sub> desired temperature for outlet water (°C)
- 23  $T_{in}$  inlet water temperature ( ${}^{\circ}C$ )
- 24 a thermal resistance of tank walls (kW/°C)

<sup>\*</sup> Corresponding author. Tel./fax: +98 21 82884347.

E-mail address: m.shariatkhah@modares.ac.ir (M.H. Shariatkhah), haghifam@modares.ac.ir (M.R. Haghifam), parsa@modares.ac.ir (M.P. Moghaddam), psiano@unisa.it (P. Siano).

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