

RELIABILITY ASSESSMENT FRAMEWORK FOR RENEWABLE OFF-GRID POWER SYSTEMS

S. Numminen, P. D. Lund. Evaluation of the reliability of solar microgrids in emerging markets – issues and solutions. Energy for Sustainable Development, 48, 34–42, doi:10.1016/j.esd.2018.10.006, 1 February 2019.

RELIABILITY ASPECT	NOTE	UNIT
<p>ENERGY SERVICE DESCRIPTION (COMPANY PROMISE)</p> <ul style="list-style-type: none"> • Supply schedule • Power and energy levels • Maintenance schedule • Load prioritization functions 	<ul style="list-style-type: none"> • Start and end of power supply in daily cycle per customer group • Power amount per customer group • Schedule of no-supply hours due to regular maintenance • Priorities set between customer groups during energy insufficiency or technical failure 	<ul style="list-style-type: none"> • Daily schedule (hours and minutes) • Watts (W) or Watt-peak (Wp) • Dates or weekdays and schedule (hours and minutes) • (Descriptive)
<p>ENERGY RELIABILITY</p> <ul style="list-style-type: none"> • Loss Of Load Hours (LOLH) • Number of lost customers • Schedule of low supply seasons • System autonomy 	<ul style="list-style-type: none"> • Number of hours of no supply due to energy insufficiency divided by the number of hours promised • Percentage of customers disconnected during low power • Seasonal periods when renewable supply does not meet the load • Storage ability to supply in periods of low power 	<ul style="list-style-type: none"> • % • % • Dates, share of no-supply days per year (%) • Number of hours
<p>TECHNICAL RELIABILITY</p> <ul style="list-style-type: none"> • Mean downtime (MDT) • Mean time to start repairing (MTSR) • Mean time to repair (MTTR) • Maximum time to repair (MTR) • Protection measures 	<ul style="list-style-type: none"> • Total time of no supply due to component breakup, repair or system maintenance divided by the total time promised • Speed of repair personnel to arrive after first notice (also first-aid service rapidity) • Speed of repair operations • Replacement or repair time of components with lowest availabilities • Anti-theft and other measures implemented against illegal behaviour and exceptional external events 	<ul style="list-style-type: none"> • % • Number of hours • Number of hours • Number of hours • (Descriptive)
<p>COMPONENT DEGRADATION AND SYSTEM LIFETIME</p> <ul style="list-style-type: none"> • Battery lifetime (nominal and real) • Vulnerable components 	<ul style="list-style-type: none"> • Nominal and an estimation of the real lifetime in the actual use environment • Description of vulnerable blocks in the energy system installed 	<ul style="list-style-type: none"> • Number of hours • (Descriptive)
<p>TOTAL RELIABILITY</p> <ul style="list-style-type: none"> • Total estimated system downtime 	<ul style="list-style-type: none"> • Approximate annual time of no power out of the scheduled supply = LOLH + MDT 	<ul style="list-style-type: none"> • %