

# Firefly Algorithm-based Photovoltaic Array Reconfiguration for Maximum Power Extraction During Mismatch Conditions

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Below are the tables representing the different shade conditions which are considered for the study and its switching states to achieve maximum power from the PV array during partial shading conditions.

**Table S1:** Best of Switching Variables, VAR<sub>Best</sub> under each PSC tested for the proposed REA technique.

Conditions	Best of Switching Variable, VAR <sub>Best</sub>								
	VAR1	VAR2	VAR3	VAR4	VAR5	VAR6	VAR7	VAR8	VAR9
Downward Ladder	1	2	3	1	1	3	2	3	2
L Shape	3	1	2	2	3	1	1	2	3
Quadra Corner	1	2	3	2	3	1	3	2	3
Random A	3	1	2	2	3	1	1	2	3
Tetris Shape	1	2	3	1	1	3	2	3	2
Triangle Shape	3	1	2	2	3	1	1	2	3
Two Side Corner	2	2	2	3	3	2	2	1	3

U Shape	2	2	2	3	3	2	2	1	3
X Shape	3	1	2	2	3	1	1	2	3
X (500) Shape	1	2	2	2	3	3	1	2	2

Table S2: State of Relays for each PSC.

Relay Number	State of Relays									
	Downward Ladder	L Shape	Quadra Corner	Random A	Tetris Shape	Triangle Shape	Two Side Corner	U Shape	X Shape	X (500) Shape
R1	NC	NO	NC	NO	NC	NO	NO	NO	NO	NC
R2	NO	NO	NO	NO	NO	NO	NC	NC	NO	NO
R3	NO	NC	NO	NC	NO	NC	NO	NO	NC	NO
R4	NC	NO	NO	NO	NC	NO	NO	NO	NO	NO
R5	NO	NC	NC	NC	NO	NC	NO	NO	NC	NC
R6	NO	NO	NO	NO	NO	NO	NC	NC	NO	NO
R7	NO	NC	NO	NC	NO	NC	NO	NO	NC	NC
R8	NC	NO	NO	NO	NC	NO	NC	NC	NO	NO
R9	NO	NO	NC	NO	NO	NO	NO	NO	NO	NO
R10	NO	NC	NO	NC	NO	NC	NO	NO	NC	NO
R11	NC	NO	NC	NO	NC	NO	NC	NC	NO	NC
R12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R13	NC	NO	NO	NO	NC	NO	NO	NO	NO	NO
R14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R15	NO	NC	NC	NC	NO	NC	NC	NC	NC	NC
R16	NO	NO	NO	NO	NO	NO	NC	NC	NO	NO
R17	NO	NC	NC	NC	NO	NC	NO	NO	NC	NC
R18	NC	NO	NO	NO	NC	NO	NO	NO	NO	NO
R19	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R20	NO	NC	NO	NC	NO	NC	NC	NC	NC	NC
R21	NC	NO	NC	NO	NC	NO	NO	NO	NO	NO
R22	NO	NC	NC	NC	NO	NC	NO	NO	NC	NO
R23	NO	NO	NO	NO	NO	NO	NC	NC	NO	NO
R24	NC	NO	NO	NO	NC	NO	NO	NO	NO	NC
R25	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
R26	NC	NO	NO	NO	NC	NO	NO	NO	NO	NC
R27	NO	NC	NC	NC	NO	NC	NC	NC	NC	NO

**Table S3:** Best of Switching Variables, VARBest under each PSC tested for the 5×5 array size of the proposed REA technique.

Switching Variable, VAR	Conditions				
	Downward Ladder	L Shape	Short and Long	Triangle Shape	X (500) Shape
VAR1	2	2	5	4	2
VAR2	1	4	2	2	2
VAR3	2	2	5	1	2
VAR4	2	3	3	3	1
VAR5	4	4	2	3	5
VAR6	4	4	4	2	4
VAR7	2	2	5	2	4
VAR8	4	5	3	3	2
VAR9	1	2	5	2	3
VAR10	2	4	5	1	2
VAR11	4	2	3	5	3
VAR12	4	1	2	4	3
VAR13	1	3	4	5	1
VAR14	3	1	1	5	5
VAR15	2	4	4	2	2
VAR16	5	3	2	2	3
VAR17	4	2	4	1	3
VAR18	3	3	1	4	1
VAR19	1	3	5	4	3
VAR20	2	2	5	3	5
VAR21	4	2	4	1	4
VAR22	1	3	4	2	2
VAR23	4	2	3	1	2
VAR24	4	4	5	2	5
VAR25	2	1	2	4	1

Table S4: State of relays for 5×5 array size of REA method under each PSC.

State of Relays						
VAR	Relays Number	Conditions				
		Downward Ladder	L Shape	Short and Long	Triangle Shape	X (500) Shape
VAR1	R1	NO	NO	NO	NO	NO
	R2	NC	NC	NO	NO	NC
	R3	NO	NO	NO	NO	NO
	R4	NO	NO	NO	NC	NO
	R5	NO	NO	NC	NO	NO
VAR2	R6	NC	NO	NO	NO	NO
	R7	NO	NO	NC	NC	NC
	R8	NO	NO	NO	NO	NO
	R9	NO	NC	NO	NO	NO
	R10	NO	NO	NO	NO	NO
VAR3	R11	NO	NO	NO	NC	NO
	R12	NC	NC	NO	NO	NC
	R13	NO	NO	NO	NO	NO
	R14	NO	NO	NO	NO	NO
	R15	NO	NO	NC	NO	NO
VAR4	R16	NO	NO	NO	NO	NC
	R17	NC	NO	NO	NO	NO
	R18	NO	NC	NC	NC	NO
	R19	NO	NO	NO	NO	NO
	R20	NO	NO	NO	NO	NO
VAR5	R21	NO	NO	NO	NO	NO
	R22	NO	NO	NC	NO	NO
	R23	NO	NO	NO	NC	NO
	R24	NC	NC	NO	NO	NO
	R25	NO	NO	NO	NO	NC
VAR6	R26	NO	NO	NO	NO	NO
	R27	NO	NO	NO	NC	NO
	R28	NO	NO	NO	NO	NO
	R29	NC	NC	NC	NO	NC
	R30	NO	NO	NO	NO	NO
VAR7	R31	NO	NO	NO	NO	NO
	R32	NC	NC	NO	NC	NO
	R33	NO	NO	NO	NO	NO
	R34	NO	NO	NO	NO	NC
	R35	NO	NO	NC	NO	NO

VAR8	R36	NO	NO	NO	NO	NO
	R37	NO	NO	NO	NO	NC
	R38	NO	NO	NC	NC	NO
	R39	NC	NO	NO	NO	NO
	R40	NO	NC	NO	NO	NO
VAR9	R41	NC	NO	NO	NO	NO
	R42	NO	NC	NO	NC	NO
	R43	NO	NO	NO	NO	NC
	R44	NO	NO	NO	NO	NO
	R45	NO	NO	NC	NO	NO
VAR10	R46	NO	NO	NO	NC	NO
	R47	NC	NO	NO	NO	NC
	R48	NO	NO	NO	NO	NO
	R49	NO	NC	NO	NO	NO
	R50	NO	NO	NC	NO	NO
VAR11	R51	NO	NO	NO	NO	NO
	R52	NO	NC	NO	NO	NO
	R53	NO	NO	NC	NO	NC
	R54	NC	NO	NO	NO	NO
	R55	NO	NO	NO	NC	NO
VAR12	R56	NO	NC	NO	NO	NO
	R57	NO	NO	NC	NO	NO
	R58	NO	NO	NO	NO	NC
	R59	NC	NO	NO	NC	NO
	R60	NO	NO	NO	NO	NO
VAR13	R61	NC	NO	NO	NO	NC
	R62	NO	NO	NO	NO	NO
	R63	NO	NC	NO	NO	NO
	R64	NO	NO	NC	NO	NO
	R65	NO	NO	NO	NC	NO
VAR14	R66	NO	NC	NC	NO	NO
	R67	NO	NO	NO	NO	NO
	R68	NC	NO	NO	NO	NO
	R69	NO	NO	NO	NO	NO
	R70	NO	NO	NO	NC	NC
VAR15	R71	NO	NO	NO	NO	NO
	R72	NC	NO	NO	NC	NC
	R73	NO	NO	NO	NO	NO
	R74	NO	NC	NC	NO	NO
	R75	NO	NO	NO	NO	NO
VAR16	R76	NO	NO	NO	NO	NO
	R77	NO	NO	NC	NC	NO
	R78	NO	NC	NO	NO	NC
	R79	NO	NO	NO	NO	NO

	R80	NC	NO	NO	NO	NO
VAR17	R81	NO	NO	NO	NC	NC
	R82	NO	NC	NO	NO	NO
	R83	NO	NO	NO	NO	NO
	R84	NC	NO	NC	NO	NO
	R85	NO	NO	NO	NO	NO
VAR18	R86	NO	NO	NC	NO	NO
	R87	NO	NO	NO	NO	NO
	R88	NC	NC	NO	NO	NC
	R89	NO	NO	NO	NC	NO
	R90	NO	NO	NO	NO	NO
VAR19	R91	NC	NO	NO	NO	NO
	R92	NO	NO	NO	NO	NO
	R93	NO	NC	NO	NO	NO
	R94	NO	NO	NO	NC	NO
	R95	NO	NO	NC	NO	NC
VAR20	R96	NO	NO	NO	NO	NO
	R97	NC	NC	NO	NO	NO
	R98	NO	NO	NO	NC	NO
	R99	NO	NO	NO	NO	NC
	R100	NO	NO	NC	NO	NO
VAR21	R101	NO	NO	NO	NC	NO
	R102	NO	NC	NO	NO	NC
	R103	NO	NO	NO	NO	NO
	R104	NC	NO	NC	NO	NO
	R105	NO	NO	NO	NO	NO
VAR22	R106	NC	NO	NO	NO	NO
	R107	NO	NO	NO	NC	NC
	R108	NO	NC	NO	NO	NO
	R109	NO	NO	NC	NO	NO
	R110	NO	NO	NO	NO	NO
VAR23	R111	NO	NO	NO	NC	NO
	R112	NO	NC	NO	NO	NO
	R113	NO	NO	NC	NO	NO
	R114	NC	NO	NO	NO	NO
	R115	NO	NO	NO	NO	NC
VAR24	R116	NO	NO	NO	NO	NO
	R117	NO	NO	NO	NC	NC
	R118	NO	NO	NO	NO	NO
	R119	NC	NC	NO	NO	NO
	R120	NO	NO	NC	NO	NO
VAR25	R121	NO	NC	NO	NO	NC
	R122	NC	NO	NC	NO	NO
	R123	NO	NO	NO	NO	NO

<b>R124</b>	NO	NO	NO	NC	NO
<b>R125</b>	NO	NO	NO	NO	NO