

**S1. Criteria Judgmental Matrix in variant decision scenarios for socio-political indices ( $S_{SP}$ )**

TABLE S1.1 COMPARISON MATRIX (CRITERION X CRITERION ) FOR  $S_{SP1}$

	<i>PC</i>	<i>PH</i>	<i>EO</i>	<i>EL</i>	<i>CM</i>	<i>ADB</i>	<i>CI</i>	<i>PSR</i>	<i>TB</i>	<i>FIC</i>
<i>PC</i>	1.00	1.00	1.00	1.00	1.00	1.00	3.00	1.00	2.00	2.00
<i>PH</i>	1.00	1.00	2.00	2.00	1.00	1.00	1.00	0.20	2.00	3.00
<i>EO</i>	1.00	0.50	1.00	1.00	1.00	1.00	1.00	0.33	3.00	1.00
<i>EL</i>	1.00	0.50	1.00	1.00	1.00	3.00	1.00	0.33	1.00	3.00
<i>CM</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00
<i>ADB</i>	1.00	1.00	1.00	0.33	1.00	1.00	1.00	0.33	2.00	3.00
<i>CI</i>	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
<i>PSR</i>	1.00	5.00	3.00	3.00	1.00	1.00	1.00	1.00	3.00	3.00
<i>TB</i>	0.50	0.50	0.33	1.00	0.33	3.00	1.00	1.00	1.00	1.00
<i>FIC</i>	0.50	0.33	1.00	0.33	0.50	0.50	1.00	0.33	1.00	1.00

TABLE S1.2 COMPARISON MATRIX (CRITERION X CRITERION ) FOR  $S_{SP2}$

	<i>PC</i>	<i>PH</i>	<i>EO</i>	<i>EL</i>	<i>CM</i>	<i>ADB</i>	<i>CI</i>	<i>PSR</i>	<i>TB</i>	<i>FIC</i>
<i>PC</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00
<i>PH</i>	1.00	1.00	2.00	2.00	1.00	1.00	1.00	0.20	2.00	3.00
<i>EO</i>	1.00	0.50	1.00	1.00	1.00	1.00	1.00	0.33	3.00	1.00
<i>EL</i>	1.00	0.50	1.00	1.00	1.00	3.00	1.00	0.33	1.00	3.00
<i>CM</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00
<i>ADB</i>	1.00	1.00	1.00	0.33	1.00	1.00	1.00	0.33	2.00	3.00
<i>CI</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
<i>PSR</i>	1.00	5.00	3.00	3.00	1.00	1.00	1.00	1.00	3.00	3.00
<i>TB</i>	0.50	0.50	0.33	1.00	0.33	3.00	1.00	1.00	1.00	1.00
<i>FIC</i>	0.50	0.33	1.00	0.33	0.50	0.50	1.00	0.33	1.00	1.00

TABLE S1.3 COMPARISON MATRIX (CRITERION X CRITERION ) FOR  $S_{SP3}$

	<i>PC</i>	<i>PH</i>	<i>EO</i>	<i>EL</i>	<i>CM</i>	<i>ADB</i>	<i>CI</i>	<i>PSR</i>	<i>TB</i>	<i>FIC</i>
<i>PC</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00
<i>PH</i>	1.00	1.00	2.00	2.00	1.00	1.00	1.00	0.20	2.00	3.00
<i>EO</i>	1.00	0.50	1.00	1.00	1.00	1.00	1.00	0.33	3.00	1.00
<i>EL</i>	1.00	0.50	1.00	1.00	1.00	3.00	1.00	0.33	1.00	3.00
<i>CM</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00
<i>ADB</i>	1.00	1.00	1.00	0.33	1.00	1.00	1.00	0.33	2.00	3.00
<i>CI</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
<i>PSR</i>	1.00	5.00	3.00	3.00	1.00	1.00	1.00	1.00	3.00	3.00
<i>TB</i>	0.33	0.50	0.33	1.00	0.33	3.00	1.00	1.00	1.00	1.00
<i>FIC</i>	0.50	0.33	1.00	0.33	0.50	0.50	1.00	0.33	1.00	1.00

TABLE S1.4 COMPARISON MATRIX (CRITERION X CRITERION ) FOR  $S_{SP4}$

	<i>PC</i>	<i>PH</i>	<i>EO</i>	<i>EL</i>	<i>CM</i>	<i>ADB</i>	<i>CI</i>	<i>PSR</i>	<i>TB</i>	<i>FIC</i>
<i>PC</i>	1.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	3.00	1.00
<i>PH</i>	0.50	1.00	2.00	2.00	1.00	1.00	1.00	0.20	2.00	3.00
<i>EO</i>	0.50	0.50	1.00	1.00	1.00	1.00	1.00	0.33	3.00	1.00
<i>EL</i>	1.00	0.50	1.00	1.00	1.00	3.00	1.00	0.33	1.00	3.00
<i>CM</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	2.00
<i>ADB</i>	1.00	1.00	1.00	0.33	1.00	1.00	1.00	0.33	2.00	3.00
<i>CI</i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
<i>PSR</i>	1.00	5.00	3.00	3.00	1.00	1.00	1.00	1.00	3.00	3.00
<i>TB</i>	0.33	0.50	0.33	1.00	0.33	3.00	1.00	1.00	1.00	1.00
<i>FIC</i>	1.00	0.33	1.00	0.33	0.50	0.50	1.00	0.33	1.00	1.00

## S2. Alternative Judgmental Matrix for evaluation on socio-political indices

TABLE S2.1 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *PC*

	$\mu_{HKES}$	$\mu_{WTES}$	<i>SPVEs</i>	<i>SW<sub>HHEs</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HESs</sub></i>
$\mu_{HKES}$	1.000	5.000	1.000	7.000	5.000	3.000	1.000	1.000
$\mu_{WTES}$	1.000	1.000	0.500	1.000	1.000	0.500	1.000	1.000
<i>S<sub>PVEs</sub></i>	1.000	2.000	1.000	5.000	3.000	3.000	1.000	1.000
<i>SW<sub>HHEs</sub></i>	0.143	1.000	0.200	1.000	1.000	0.333	0.500	1.000
<i>S<sub>HES</sub></i>	0.200	1.000	0.333	1.000	1.000	1.000	0.333	0.500
<i>DFGen</i>	0.333	2.000	0.333	3.000	1.000	1.000	1.000	1.000
<i>B<sub>ESS</sub></i>	1.000	1.000	1.000	2.000	3.000	1.000	1.000	1.000
<i>P<sub>HESs</sub></i>	1.000	1.000	1.000	1.000	2.000	1.000	1.000	1.000

TABLE S2.2 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *PH*

	$\mu_{HKES}$	$\mu_{WTES}$	<i>SPVEs</i>	<i>SW<sub>HHEs</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HESs</sub></i>
$\mu_{HKES}$	1.00	3.00	1.00	3.00	3.00	3.00	1.00	1.00
$\mu_{WTES}$	1.00	1.00	0.33	1.00	1.00	1.00	1.00	1.00
<i>S<sub>PVEs</sub></i>	1.00	3.00	1.00	5.00	5.00	1.00	1.00	1.00
<i>SW<sub>HHEs</sub></i>	0.33	1.00	0.20	1.00	1.00	1.00	0.33	1.00
<i>S<sub>HES</sub></i>	0.33	1.00	0.20	1.00	1.00	1.00	0.50	1.00
<i>DFGen</i>	0.33	1.00	1.00	1.00	1.00	1.00	0.33	0.50
<i>B<sub>ESS</sub></i>	1.00	1.00	1.00	3.00	2.00	1.00	1.00	1.00
<i>P<sub>HESs</sub></i>	1.00	1.00	1.00	1.00	1.00	3.00	1.00	1.00

TABLE S2.3 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *EO*

	$\mu_{HKES}$	$\mu_{WTES}$	<i>SPVEs</i>	<i>SW<sub>HHEs</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HESs</sub></i>
$\mu_{HKES}$	1.00	3.00	1.00	5.00	5.00	1.00	1.00	1.00
$\mu_{WTES}$	1.00	1.00	0.50	1.00	1.00	1.00	1.00	1.00
<i>S<sub>PVEs</sub></i>	1.00	2.00	1.00	5.00	5.00	1.00	1.00	1.00
<i>SW<sub>HHEs</sub></i>	0.20	1.00	0.20	1.00	1.00	0.33	0.33	0.33
<i>S<sub>HES</sub></i>	0.20	1.00	0.20	1.00	1.00	0.25	0.20	0.25
<i>DFGen</i>	1.00	1.00	1.00	3.00	4.00	1.00	1.00	1.00
<i>B<sub>ESS</sub></i>	1.00	1.00	1.00	3.00	5.00	1.00	1.00	1.00
<i>P<sub>HESs</sub></i>	1.00	1.00	1.00	3.00	4.00	1.00	1.00	1.00

TABLE S2.4 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *EL*

	$\mu_{HKES}$	$\mu_{WTES}$	<i>SPVEs</i>	<i>SW<sub>HHEs</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HESs</sub></i>
$\mu_{HKES}$	1.00	1.00	1.00	2.00	2.00	1.00	1.00	1.00
$\mu_{WTES}$	1.00	1.00	0.50	1.00	1.00	1.00	1.00	1.00
<i>S<sub>PVEs</sub></i>	1.00	2.00	1.00	3.00	3.00	1.00	1.00	1.00
<i>SW<sub>HHEs</sub></i>	0.50	1.00	0.33	1.00	1.00	0.33	0.50	1.00
<i>S<sub>HES</sub></i>	0.50	1.00	0.33	1.00	1.00	0.33	0.33	1.00
<i>DFGen</i>	1.00	1.00	1.00	3.00	3.00	1.00	1.00	1.00
<i>B<sub>ESS</sub></i>	1.00	1.00	1.00	2.00	3.00	1.00	1.00	1.00
<i>P<sub>HESs</sub></i>	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

TABLE S2.5 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *CM*

	$\mu_{HKES}$	$\mu_{WTES}$	<i>SPVEs</i>	<i>SW<sub>HHEs</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HESs</sub></i>
$\mu_{HKES}$	1.00	7.00	1.00	5.00	5.00	1.00	1.00	1.00
$\mu_{WTES}$	1.00	1.00	0.50	1.00	1.00	0.33	0.20	0.33
<i>S<sub>PVEs</sub></i>	1.00	2.00	1.00	5.00	3.00	1.00	1.00	1.00
<i>SW<sub>HHEs</sub></i>	0.20	1.00	0.20	1.00	1.00	0.20	0.33	0.33
<i>S<sub>HES</sub></i>	0.20	1.00	0.33	1.00	1.00	0.25	0.33	0.25
<i>DFGen</i>	1.00	3.00	1.00	5.00	4.00	1.00	3.00	1.00
<i>B<sub>ESS</sub></i>	1.00	5.00	1.00	3.00	3.00	1.00	1.00	1.00
<i>P<sub>HESs</sub></i>	1.00	3.00	1.00	3.00	4.00	0.33	1.00	1.00

TABLE S2.6 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *ADB*

	$\mu HKES$	$\mu WTES$	<i>SPVEs</i>	<i>SW<sub>HES</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HES</sub></i>
$\mu HKES$	1.00	4.00	1.00	5.00	5.00	1.00	1.00	1.00
$\mu WTES$	1.00	1.00	0.20	1.00	1.00	0.20	0.20	0.33
<i>SPVEs</i>	1.00	5.00	1.00	7.00	5.00	1.00	1.00	3.00
<i>SW<sub>HES</sub></i>	0.20	1.00	0.14	1.00	1.00	0.20	0.20	0.33
<i>S<sub>HES</sub></i>	0.20	1.00	0.20	1.00	1.00	0.33	0.25	0.33
<i>DFGen</i>	1.00	5.00	1.00	5.00	3.00	1.00	1.00	2.00
<i>B<sub>ESS</sub></i>	1.00	5.00	1.00	5.00	4.00	1.00	1.00	2.00
<i>P<sub>HES</sub></i>	1.00	3.00	0.33	3.00	3.00	1.00	1.00	1.00

TABLE S2.7 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *CI*

	$\mu HKES$	$\mu WTES$	<i>SPVEs</i>	<i>SW<sub>HES</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HES</sub></i>
$\mu HKES$	1.000	1.000	1.000	3.000	5.000	1.000	2.000	1.000
$\mu WTES$	1.000	1.000	0.333	2.000	2.000	1.000	0.500	0.333
<i>SPVEs</i>	1.000	3.000	1.000	5.000	4.000	2.000	1.000	1.000
<i>SW<sub>HES</sub></i>	0.333	0.500	0.200	1.000	1.000	0.500	1.000	1.000
<i>S<sub>HES</sub></i>	0.200	0.500	0.250	1.000	1.000	0.333	1.000	1.000
<i>DFGen</i>	1.000	1.000	0.500	2.000	3.000	1.000	0.333	0.200
<i>B<sub>ESS</sub></i>	0.500	2.000	1.000	1.000	1.000	1.000	1.000	0.333
<i>P<sub>HES</sub></i>	1.000	3.000	1.000	1.000	1.000	3.000	1.000	1.000

TABLE S2.8 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *PSR*

	$\mu HKES$	$\mu WTES$	<i>SPVEs</i>	<i>SW<sub>HES</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HES</sub></i>
$\mu HKES$	1.00	1.00	1.00	4.00	3.00	2.00	1.00	1.00
$\mu WTES$	1.00	1.00	0.50	3.00	1.00	1.00	0.50	0.33
<i>SPVEs</i>	1.00	2.00	1.00	5.00	5.00	2.00	1.00	1.00
<i>SW<sub>HES</sub></i>	0.25	0.33	0.20	1.00	1.00	1.00	1.00	0.33
<i>S<sub>HES</sub></i>	0.33	1.00	0.20	1.00	1.00	1.00	0.33	0.25
<i>DFGen</i>	0.50	1.00	0.50	1.00	1.00	1.00	1.00	0.20
<i>B<sub>ESS</sub></i>	1.00	2.00	1.00	1.00	3.00	1.00	1.00	0.33
<i>P<sub>HES</sub></i>	1.00	3.00	1.00	3.00	4.00	1.00	1.00	1.00

TABLE S2.9 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *TB*

	$\mu HKES$	$\mu WTES$	<i>SPVEs</i>	<i>SW<sub>HES</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HES</sub></i>
$\mu HKES$	1.00	3.00	1.00	4.00	3.00	2.00	1.00	3.00
$\mu WTES$	1.00	1.00	0.25	1.00	1.00	2.00	0.33	0.33
<i>SPVEs</i>	1.00	4.00	1.00	6.00	5.00	2.00	1.00	3.00
<i>SW<sub>HES</sub></i>	0.25	1.00	0.17	1.00	1.00	2.00	0.20	0.33
<i>S<sub>HES</sub></i>	0.33	1.00	0.20	1.00	1.00	1.00	0.33	0.33
<i>DFGen</i>	0.50	0.50	0.50	0.50	1.00	1.00	0.25	0.33
<i>B<sub>ESS</sub></i>	1.00	3.00	1.00	5.00	3.00	1.00	1.00	1.00
<i>P<sub>HES</sub></i>	0.33	3.00	0.33	3.00	3.00	4.00	1.00	1.00

TABLE S2.10 COMPARISON MATRIX (ALTERNATIVE X ALTERNATIVE) ON *FIC*

	$\mu HKES$	$\mu WTES$	<i>SPVEs</i>	<i>SW<sub>HES</sub></i>	<i>S<sub>HES</sub></i>	<i>DFGen</i>	<i>B<sub>ESS</sub></i>	<i>P<sub>HES</sub></i>
$\mu HKES$	1.00	0.33	1.00	0.25	0.20	3.00	1.00	1.00
$\mu WTES$	1.00	1.00	0.33	0.20	0.14	1.00	0.33	1.00
<i>SPVEs</i>	1.00	3.00	1.00	1.00	0.50	3.00	1.00	1.00
<i>SW<sub>HES</sub></i>	4.00	5.00	1.00	1.00	1.00	2.00	1.00	2.00
<i>S<sub>HES</sub></i>	5.00	7.00	2.00	1.00	1.00	3.00	0.33	0.50
<i>DFGen</i>	0.33	1.00	0.33	0.50	0.33	1.00	0.20	0.50
<i>B<sub>ESS</sub></i>	1.00	3.00	1.00	1.00	3.00	1.00	1.00	1.00
<i>P<sub>HES</sub></i>	1.00	1.00	1.00	0.50	2.00	5.00	1.00	1.00

**S3. Various specifications of hydrokinetic turbines ( $\mu H_{KES}$ ), solar photovoltaic ( $S_{PVES}$ ) modules and battery ( $B_{ESS}$ ), Diesel Fuel Genset ( $D_{FGen}$ ) and converter based on manufacture datasheet**

Table S3. 1 Various key specification of different models of  $\mu H_{KES}$  [2-8]

Manufacturer	Smart Hydro Power		New Energy Corporations		Vortex Hydrokinetics	Idénergie Inc	Gruinard Energies
$\mu H_{KES}$ Alternatives	$\mu H_{KES1}$	$\mu H_{KES2}$	$\mu H_{KES3}$	$\mu H_{KES4}$	$\mu H_{KES5}$	$\mu H_{KES6}$	$\mu H_{KES7}$
Model	Monofloat [2]	Free stream [3]	EVG-005H [4]	EVG-025H [5]	SETUR-L [6]	Riverlution [7]	P-66 [8]
Rated Power (kW)	5	5	5	25	5	0.5	3.5
Rated water velocity (m/s)	3.1		3		4	3.5	3
Mounting	Floating / Fixed						
Required minimum river depth (m)	2	1.1	1.22	3	1	0.6	1.5
Environmental Impact	None		Low	Moderate	None	Low	Low
Scalable (Unit Addition Provisions)	Yes		Limited		Yes	Yes	Limited
Debris Protection	Yes		Limited		Limited	Yes	Yes
Rated AC Voltage (V)	3 $\phi$ , 0—400 V (region/site-based design provisions)		3 $\phi$ , 0—300 V (region/site-based design provisions)		1 $\phi$ , 120 / 240 V 3 $\phi$ , 120 / 208/400 V	3 $\phi$ , 0—300 V (region/site-based design provisions)	3 $\phi$ , 0—300 V (region/site-based design provisions)
Frequency (Hz)	50/60 Hz		50/60 Hz		50/60 Hz	50/60 Hz	50/60 Hz
Weight (Kg)	380	300	250	1500	300	131	90
Unit Cost (USD)	17774.04	15226.18	19505.12	26987.16	127545.20	9728.18	60953.50

Table S3.2 Specification of different models of  $S_{PVES}$  [9-13]

Manufacturer	Adani Solar [9]				EMMVEE PV Pvt. Ltd. [10]				Vikram Solar [11, 12]						Goldi Green [13]	
Panel Model	ETERNAL Series [9]				60-270	60-280	72-320	72-330	Somera Prime[11]			Somera Grand[12]			72-330	72-345
	72-335	72-340	72-345	72-350					60-285	60-300	60-310	72-345	72-360	72-370		
$S_{PVES}$ alternatives	$S_{PV1}$	$S_{PV2}$	$S_{PV3}$	$S_{PV4}$	$S_{PV5}$	$S_{PV6}$	$S_{PV7}$	$S_{PV8}$	$S_{PV9}$	$S_{PV10}$	$S_{PV11}$	$S_{PV12}$	$S_{PV13}$	$S_{PV14}$	$S_{PV15}$	$S_{PV16}$
Total number of cells/panel and type	Mono-crystalline, 72 cells				Mono-crystalline, 60 cells	Mono-crystalline, 72 cells	Mono-crystalline, 60 cells	Mono-crystalline, 72 cells	Mono-crystalline, 60 cells	Mono-crystalline, 72 cells	Mono-crystalline, 72 cells	Mono-crystalline, 72 cells	Mono-crystalline, 72 cells	Mono-crystalline, 72 cells	Mono-crystalline, 72 cells	Mono-crystalline, 72 cells
Normal operating cell temperature (NOCT) (°C)	44°C ± 2°C				48°C ± 2°C				45°C ± 2°C						45°C ± 2°C	
Temperature range (°C)	-40°C to + 85°C															
Panel dimension (mm)	Length =1976 Width = 992 Height= 35/40				Length =1640 Width = 990 Height= 35	Length =1970 Width = 990 Height= 35	Length =1640 Width = 992 Height= 36	Length =1956 Width = 992 Height= 36	Length =1955 Width = 990 Height= 42							
Panel weight (kg)	22 kg for 35 mm height 27 kg for 40 mm height				17.7	21	18	22	22							
Panel Rated Efficiency (%) @STC*	17.09	17.34	17.6	17.85	16.63	17.25	16.41	16.92	17.52	18.44	19.05	17.78	18.55	19.07	17.05	17.83
Power Output (W) @NOCT	244.9	248.6	253.2	256.1	195	202	234.2	246	213	222	229	251.5	262.4	269.7	237.6	248.4
Voltage at maximum power output (V) @NOCT	34.79	35.08	35.33	35.61	28.4	28.7	33	34.9	30.5	31.1	31.5	27.8	27.9	28	34.05	34.88
Current at maximum power output (A) @NOCT	7.04	7.09	7.17	7.19	6.87	7.04	7.11	7.04	6.95	7.20	7.35	8.27	8.58	8.79	6.98	7.12
Open-circuit voltage (V) @NOCT	42.98	43.19	43.4	43.64	35	35.3	41.41	43	38.4	38.9	39.3	37.8	38.2	38.4	42.86	43.41
Short-circuit current (A) @NOCT	7.64	7.71	7.76	7.84	7.44	7.63	7.41	7.49	7.46	7.68	7.86	8.82	9.20	9.45	7.32	7.56
Module Cost (USD)	179.3	181.9	184.6	187.3	140.4	145.6	166.4	171.6	136.5	143.7	150.9	165.2	172.4	177.2	180.6	188.9

Table S3.3 Key specification of different models of  $B_{ESS}$  [14-16]

Manufacturer		Discover Battery [14]	CROWN Battery [15]	Trojan Battery Company [16]					
Model		12VRE-3000TF	12CRV100 AGM	SAGM 12 135	SSIG 12 255	SSIG 12 230	J200-RE	SSIG 12 170	SSIG 12 120
$B_{ESS}$ alternatives		$B_{ESS1}$	$B_{ESS2}$	$B_{ESS3}$	$B_{ESS4}$	$B_{ESS4}$	$B_{ESS6}$	$B_{ESS7}$	$B_{ESS8}$
Nominal Voltage (v)		12							
Life Cycle	@20 % DOD	5000	1100	4500	3000	3000	4000	3000	1500
	@50% DOD	2500	600	1600	1250	1250	1600	1100	600
	@80% DOD	1500	325	1000	650	700	1000	700	400
Nominal Capacity (kWh)		3.11	1.22	1.62	3.06	2.76	2.64	2.04	1.44
Capacity in Ampere Hour (Ah)	@100 Hr	243	105	137	255	230	220	170	120
	@20 Hr	215	98	135	229	209	200	153	107
	@10 Hr	190	N/A	131	211	192	176	136	99
Internal Resistance (m $\Omega$ )		5+/-1.5	3.45	4.3	5.3	N/A	5.3	N/A	N/A
Short Circuit Current (A)		2150	3370	2920	2321	N/A	2321	N/A	N/A
Operating Temperature ( $^{\circ}$ C)		-35 $^{\circ}$ C to 50 $^{\circ}$ C	-20 $^{\circ}$ C to 49 $^{\circ}$ C	-20 $^{\circ}$ C to 50 $^{\circ}$ C	-20 $^{\circ}$ C to 45 $^{\circ}$ C				
Battery Dimensions (length x width x height in mm)		500 x 187 x 370	330 x 171 x 206	329 x 179 x 278	380 x 176 x 373	380 x 176 x 373	380 x 176 x 374	354 x 181 x 272	326 x 168 x 247
Weight (kg)		65	25.9	38	56	52	60	38	25
Single Unit cost (USD)		297.00	400.00	350.00	325.00	292.00	350.00	225.00	160.00

Table S3.4 Diesel Fuel Genset specifications based on manufacturer datasheet [17]

Sl. no	Specifications		Unit	Various Genset Data								
	Rated Power @ RPM		kVA	5	7.5	10	15	20	25	30	40	45
			kW	4	6	8	12	16	24	24	32	36
1.	Frequency		Hz	50								
2.	Power factor		lagging	0.8								
3.	Voltage		V	230 (1 $\phi$ ) & 415 (3 $\phi$ )								
4.	Noise Level		dBA	<75								
5.	Fuel consumption	At 100 % load	Ltrs./Hr.	1.6	2.21	3	4	5.1	5.8	7.6	9.2	10.3
		At 75 % load	Ltrs./Hr.	1.3	1.62	2.4	3	3.8	4.4	5.8	7.4	8.7
		At 50 % load	Ltrs./Hr.	1	1.21	1.8	2.2	2.7	2.9	4.4	5.5	5.9
6.	Genset weight with canopy	Dry	Kg.	640	650	710	810	880	1040	1040	1180	1180
		Wet		890	700	760	860	930	1090	1090	1215	1215

Table S3.5 Various converter model with their specifications [18]

Model	MTP-412F	MTP-413E	MTP-414F	MTP-415F	MTP-416F
Manufacturer	Leonics [18]				
Rated Power (kW)	15	25	30	45	50
Nominal input DC Voltage (V)	230, 380, 415 V				
Maximum AC Current (A)	151.1	227.3	303	378.8	454.5
Weight (kg)	360	460	500	550	805
AC Input Voltage (V)	380/400/415 Vac (L-L), 220/230/240 Vac (L-N) $\pm$ 10 %				
AC Output Voltage (V)	380/400/415 Vac (L-L), 220/230/240 Vac (L-N)				
Frequency (Hz)	50/60 Hz $\pm$ 0.1 %				
Distortion (%)	THD < 4%				
Efficiency (%)	95 %				
Protection	Short Circuit, Overload, Overvoltage, Overcurrent, Overtemperature				
Operating temperature ( $^{\circ}$ C)	0-45 $^{\circ}$ C				
Relative Humidity (%)	0-95 % (Non-condensing)				
Cooling	Automatic Air-cooled system				

**Table S3.6 Various microgrid component cost and simulation parameters**

Details of various component				Capital Cost	Replacement Cost	Operation & Maintenance Cost	Life
				USD	USD	USD	Years
PV module ( $S_{PVES}$ )/0.31 kW [19]				150.92	150.92	2.5/ year	25
Free Stream Hydrokinetic Turbine System ( $\mu H_{KES}$ ) / 5kW [20]				15226.18	15226.18	100 / year	15
Battery ( $B_{ESS}$ )/3kWh				297	297	10/ year	As per life cycle
Converter /kW				200	200	0	10
Diesel Fuel Genset ( $D_{FGen}$ ) /kW				206	206	0.15/ hour	15
Pump hydro energy storage ( $P_{HESS}$ ) [21, 22]	Capacity of upper reservoir (m <sup>3</sup> )	Head ( $h_{phss}$ ) (m)	Reservoir dimensions (L x W x D) in m				
	1000	50	15.55 x10.53 x 6.11	27377	27377	250/year	15
	1000	70	17.43 x 10.7 x 5.36	34221	34221	285/year	15
	1000	80	18.5 x 12.8 x 4.22	38328	38328	380/year	15
	1000	100	20.4 x 12.5 x 3.92	45172	45172	425/year	15
	1500	70	18.5 x 14.45 x 5.61	51332	51332	450/year	15
	1500	80	18 x 15.5 x 5.38	57492	57492	520/year	15
	1500	100	20 x 16.32 x 4.60	71865	71865	625/year	15
	2000	80	21.5 x 15.8 x 5.89	84869	84869	800/year	15
	2000	90	22.56 x16.35 x 5.42	95820	95820	1000/year	15
2000	100	23.25 x17.32 x 4.97	114984	114984	1150/year	15	
Other key simulation parameters							
Average Currency Conversion Rate (EURO* to USD\$)					1 Euro = 1.21907 USD [23]		
Average Currency Conversion Rate (USD\$ to INR <sup>₹</sup> )					1 USD = 73.0536 [23]		
Nominal Discount Rate					10.57 % [19]		
Assume Project Period					10 years		
Assumed electrical load demand growth rate (%/year)					5% [24, 25]		
Diesel Fuel Rate					0.95 [26]		
Average inflation rate (2020)					5.35% [27]		

USD\* = United States Dollars, INR<sup>₹</sup> = Indian National Rupees

**Table S3.7 Assumed scaling to assess the aquatic life impacts of the river**

Sl.No	Microgrid System Description	Qualitative Impact Scale	Assumed Quantitative Scale
1	System with no $\mu H_{KES}$ and $P_{HESS}$ units.	None	0
2.	System with only single $\mu H_{KES}$ units.	Moderate	1
3.	System with single $P_{HESS}$ units.	Low	2
4.	System with multiple $\mu H_{KES}$ units (below 5).	High	3
5.	System with multiple $\mu H_{KES}$ units (below 5) and single $P_{HESS}$ units.		
6.	System with many $\mu H_{KES}$ units (above 5).	Highest	4
7.	System with many $\mu H_{KES}$ units (above 5) and single $P_{HESS}$ units.		

## References:

- [1] T. L. Saaty, and L. G. Vargas, *Models, Methods, Concepts & Applications of the Analytic Hierarchy Process*, 2 ed.: Springer US, 2012.
- [2] S. H. Power. "Data Sheet for SMART MONOFLOAT Turbines " 06-08-2020; [https://www.smart-hydro.de/wp-content/uploads/2015/12/Datasheet\\_SMART\\_Freestream.pdf](https://www.smart-hydro.de/wp-content/uploads/2015/12/Datasheet_SMART_Freestream.pdf).
- [3] S. H. Power. "Datasheet for SMART Free Stream Turbine "; [https://www.smart-hydro.de/wp-content/uploads/2015/12/Datasheet\\_SMART\\_Freestream.pdf](https://www.smart-hydro.de/wp-content/uploads/2015/12/Datasheet_SMART_Freestream.pdf).
- [4] N. E. Corporations, "Datasheet for EnviroGen 005 Series Turbine ".
- [5] N. E. Corporations, "Datasheet for EnviroGen 025 Series Turbines ".
- [6] V. H. LLC. "Datasheet for Bladeless SETUR turbines," [https://vortexhydro.com/wp-content/uploads/2020/09/SETUR\\_turbine\\_Specs.pdf](https://vortexhydro.com/wp-content/uploads/2020/09/SETUR_turbine_Specs.pdf).
- [7] I. Inc. "Datasheet for Riverlution Turbine," <https://idenergie.ca/wp-content/uploads/2016/11/Brochure-Id%C3%A9nergie-Riverlution-Turbine-2016-EN.pdf>.
- [8] G. E. N.-A. Group. "Datasheet for P66 Hydrokinetic turbine," <https://www.guinard-energies.bzh/wp-content/uploads/Flyer-P66-Guinard-Energies.pdf>.
- [9] A. Solar, "Datasheet for ETERNAL Series Mono-crystalline PERC Silicon Solar PV Modules ".
- [10] E. P. Power, "Datasheet for Mono PERC Module."
- [11] V. Solar. "Datasheet for SOMERA PRIME," <https://35bjk3fzaio4epare24j5l9-wpengine.netdna-ssl.com/wp-content/uploads/2017/11/Somera-Prime-1500V.pdf>.
- [12] V. Solar. "Datasheet for SOMERA GRAND," <https://35bjk3fzaio4epare24j5l9-wpengine.netdna-ssl.com/wp-content/uploads/2017/11/Somera-Grand-1500V-2.pdf>.
- [13] G. Solar. "Datasheet for Goldi 72 GN1 Mono PERC "; <https://www.goldisolar.com/mono-modules/#>.
- [14] D. E. Corporation. "Data Sheet for 12VRE-3000TF-L," 06-11-2017; <http://discoverbattery.com/product-search/view/12VRE-3000TF-L>.
- [15] C. Battery. "Datasheet for 12CRV100 AGM Deep Cycle Battery "; <http://atlanticbatterysystems.com/wp-content/uploads/12CRV100.pdf>.
- [16] T. B. Company. "Datasheets and literature of 12 Volt Deep-Cycle Flooded Batteries," <https://www.trojanbattery.com/literature/#datasheets>.
- [17] I. Kirloskar Oil Engine Limited (KOEL). "KOEL iGREEN Diesel Generator," 06-11-2017; <https://www.koelgreen.com/diesel-generator>.
- [18] T. Leonics. "Datasheet for APOLLO MTP- 410," 06-11-2017; <http://www.leonics.com/product/renewable/inverter/dl/MTP-410-091.pdf>.
- [19] *Determination of levellised generic tariff for FY 2019-20 under Regulation 8 of the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources)* G. o. I. Central Electricity Regulatory Commission, 2019.
- [20] S. H. Power. "SMART PRICES & PRODUCTS OVERVIEW," 06-08-2020; <https://www.smart-hydro.de/renewable-energy-systems/prices-hydrokinetic-photovoltaic/>.
- [21] G. o. A. P. Public Work Department, *Analysis of Rates 2014*.
- [22] G. o. A. P. Public Work Department, "Schedule of Rates (APSR)."
- [23] X-Rates. "Historical Monthly Exchange Rates "; <https://www.xrates.com/average/?from=USD&to=INR&amount=1&year=2020>.
- [24] I. E. Agency, "World Energy Outlook ", 2020.
- [25] W. B. Group, *Global Economic Prospects, June 2020*, World Bank, Washington, DC, 2020.
- [26] I. Indian Oil Corporation Limited. "Prices of non-branded Diesel across state capitals (Rs./Litre)," <https://iocl.com/Products/PetrolDieselPrices.aspx>.
- [27] T. M. BV. "Historic inflation India - average inflation India (CPI) - by year," <https://www.inflation.eu/en/inflation-rates/india/historic-inflation/cpiinflation-india-2020.aspx>.