Technical Scoping Report- NFA U.P.

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For more information

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Introduction

The Norwegian Framework Agreement (NFA) between the Norwegian Ministry of Foreign Affairs (MFA) and TERI aims at addressing national and global concerns of energy security and climate change through a cooperative effort between TERI, Norwegian and other third party institution.

Under this TERI is implementing the project **"Clean Energy Interventions for Livelihood Enhancement in Rural India"** under the project **"Innovating to bring clean energy for livelihood generation in India"** that intrudes in the rural areas of the states of Uttar Pradesh, Odisha, Assam and Madhya Pradesh.

The project aims towards enhancing rural livelihoods via provisions of renewable based technologies. Uttar Pradesh has been identified as one among the four states for interventions assessing the poor rural electrification scenario. To promote renewable energy for livelihoods on sustainable basis, it is binding to develop a business model where the rural inhabitants themselves invest, operate and are able to generate revenue from the renewable based enterprise.

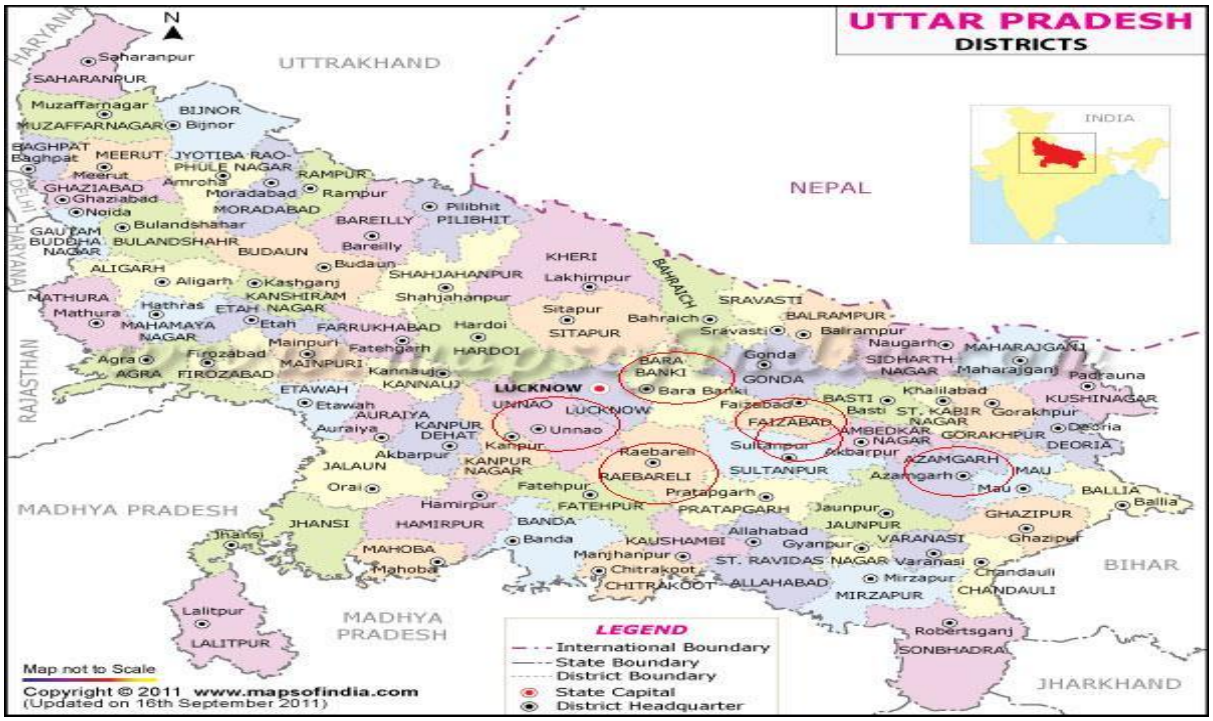

Figure 1: District map of Uttar Pradesh. The red circle marks the five districts for the project sites

Reconnaissance visits to various locations inferred need for lighting facilities during evening hours to facilitate livelihood activities such as handloom, handicraft, pottery, poultry and rural shops.

To fulfil this demand in total 34 energy providers[1] at various locations covering five districts are identified. The system capacities have been decided ranging from 60 Wp to 800 Wp depending on the Energy Provider's ability to invest and number of end users willing to take up connections. As per date, the approximate number of potential end users stands at 1400.

The Energy Provider charges a monthly fee in lieu of electricity service and delivery. A part of revenue collected is utilized for the operation and maintenance of the equipment and the rest can be the source of income generation for the entrepreneur. The consumers can use the electricity for activities related to livelihood generation, adding to the existing revenue generation and their socio-economic upliftment.

Table 1: List of villages and the no. of connections.

SL	Name of Entrepreneur	SITE			No of connection	End user category
		Village	Block	District	In number	
1	Anil Kumar Shukla	Shivgarh	Shivgarh	Rai Bareli	95	shops
2	Lakshmi Prasad	Kalu khera	Asoha	Unnao	100	shops
3	Pawan Kumar Tiwari	Pure Tiwaripur	Triwediganj	Barabanki	20	households
4	Ashish Dikshit	Amilahara	Haidergarh	Barabanki	20	households
5	Indra Mohan Singh	Gulalpur	Haidergarh	Barabanki	20	households
6	Kapil Dubey	Misrauli	Jagdishpur	CSM Nagar	20	households
7	Ram Krishna	dakhin goan	Jagdishpur	CSM Nagar	20	households
8	Mewa Lal	Imli goan	Jagdishpur	CSM Nagar	20	households
0	Sidharth Mishra	Phanhuna	Singhpur	CSM Nagar	40	shops
10	Sidharth Mishra	Phanhuna	Singhpur	CSM Nagar	40	shops
11	Shah Alam Ansari	Kintoor	Siroli	Barabanki	25	handicraft units

[1] Energy provider is a villager who is capable and agrees to invest and operate solar micro grid under the above mentioned project

SL	Name of Entrepreneur	SITE			No of connection	End user category
12	Md. Naushad Ahmad	Chaksikhti, PO Islampura	Sathiyaon	Azamgarh	100	handloom units
13	Md. Shareef	naveda	Sathiyaon	Azamgarh	40	handloom units
14	Md. Bailal	rasoolpur	Sathiyaon	Azamgarh	20	handloom units
15	Virendra Kumar Verma	Bhawanigarh	Shivgarh	Rai Bareli	40	shops
16	Rajendra Prasad	Zamalpur, rampur	Bahadurpur	CSM Nagar	40	shops
17	Md. Tasleem Quraishi	Bhatgoanva	Gauriganj	CSM Nagar	40	shops
18	Surendra Kumar Singh	Purabgoan, jagdishpur	Gauriganj	CSM Nagar	40	shops
19	Ayodha prasad	jamo	jamo	CSM Nagar	40	shops
20	Ayodha prasad	jamo	jamo	CSM Nagar	80	shops
21	Rahul Gupta	Mohna	Bajarsukul	CSM Nagar	40	shops
22	Mehdi hasen	Pure zalim	Musaffir khana	CSM Nagar	40	shops
23	Sushil Kumar jaiswal	kadipur	Sidhaur	Barabanki	40	shops
24	Madan Gopal	Asandra	Sidhur	Barabanki	40	shops
25	Dinesh Kumar pandey	Pure pandey, saidpur	mawai	Faizabad	40	shops
26	Ramji Kaushal	Tursampur, PO Palpur	Amniganj	Faizabad	40	shops
27	Dinesh pal	Godiyan ka purva	jagdishpur	CSM Nagar	10	households
28	Sukhdev Prashad	Mejarganj	Rahi	Rai Bareli	40	shops
29	Sikandar Kaushal	Raniganj	Jagdishpur	CSM Nagar	100	shops

SL	Name of Entrepreneur	SITE			No of connection	End user category
30	Ashok Tiwari	Badosarai	Siroli	Barabanki	40	shops
31	Ram Milan	Bamhrauli	Haidergarh	Barabanki	20	households
32	Ram Sukh Varma	Manikapur	Triwediganj	Barabanki	40	shops
33	Nanhe Babu	Katehti	Jagdishpur	CSM Nagar	10	poultry
34	Vikas Jaiswal	Rasoolpur chauraha	Sidhaur	Barabanki	40	shops
	TOTAL				**1400**	

This report covers the resource assessment and technology feasibility analysis to find out the suitable technology to be installed.

Methodology

- Resource assessment.
- Load assessment.
- Selection & Design of Technology.
- Techno-economic details

Clean Energy Resource Assessment

Planning and operation of renewable energy conversion system needs a detailed knowledge of the availability of energy resources.

The average annual solar radiation in Uttar Pradesh ranges between 4.0 to 7 kWh/m2/day (source:- solar resource map, SEC, MNRE).

Uttar Pradesh, because of its sub-tropical geographical location between latitude 26.8500° N, 80.9100° E, receives an abundance of solar radiation throughout the year except for some interruption during the monsoon and winter seasons.

The solar resource potential of the project sites was ascertained from the data available via RETScreen(NASA).

Unnao:

Month	Air Temp°C	Daily Solar Radiation kWh/m2/d
January	16	4.06
February	19.7	5.15
March	25.4	6.31
April	29.6	7.14
May	30.3	6.5
June	29.9	5.69
July	28.3	4.6
August	27.8	4.58
September	26.4	4.58
October	23.9	5.15
November	20.6	4.54
December	16.8	3.98

Raebareli:

Month	Air	Daily Solar Radiation
	Temp °C	kWh/m2/d
January	15.9	3.81
February	19.6	4.88
March	25.4	6.03
April	30.1	6.61
May	31.2	6.69
June	30.7	5.84
July	28.7	4.74
August	28	4.47
September	26.6	4.57
October	24.3	4.93
November	20.8	4.35
December	16.8	3.72

Faizabad:

Month	Air	Daily Solar Radiation
	Temp °C	kWh/m2/d
January	16	4.06
February	19.7	5.15
March	25.4	6.31
April	29.6	7.14
May	30.3	6.52
June	29.9	5.69
July	28.3	4.62
August	27.8	4.58
September	26.4	4.58
October	23.9	5.15
November	20.6	4.54
December	16.8	3.98

Azamgarh:

Month	Air	Daily Solar Radiation
	Temp °C	kWh/m2/d
January	16.2	4.04
February	19.8	5.18
March	25.2	6.38
April	28.9	7.13
May	29.3	7.3
June	29.2	6.07
July	27.9	4.65
August	27.5	4.59
September	26.2	4.58
October	23.7	5.15
November	20.6	4.73
December	17.1	4.01

Barabanki:

Month	Air Temp °C	Daily Solar Radiation kWh/m2/d
January	15.9	3.81
February	19.6	4.88
March	25.4	6.03
April	30.1	6.61
May	31.3	6.69
June	30.7	5.84
July	28.7	4.74
August	28	4.47
September	26.6	4.57
October	24.3	4.93
November	20.8	4.35
December	16.8	3.73

Sultanpur:

Month	Air Temp °C	Daily Solar Radiation kWh/m2/d
January	16	4.06
February	19.7	5.15
March	25.4	6.31
April	29.9	7.14
May	30.3	6.52
June	29.9	5.69
July	28.3	4.62
August	27.8	4.58
September	26.4	4.58
October	23.9	5.15
November	20.6	4.54
December	16.8	3.98

Load assessment:

Current Energy Scenarios

As of now Independent System Operators (ISO's) were providing lighting services to the village population in these areas by running a conventional diesel generator. The ISO's charged the end users Rs. 5 to Rs. 8 per day for one light point, which totals to Rs.150 to Rs.240 per month from each end user. The technological interventions made would replace the use of these diesel generators which are not environmental friendly with clean lighting solutions.

The load assessment for the project site is depicted in the following table:

SITE-Village	Connections (In no.)	End user category	No of 3W LED	No of 2W LED	No of 1 W LED	hours	Load (kwh)
Shivgarh	95	shops	95			4	1.14
Kalu khera	100	shops	100			4	1.2
Pure Tiwaripur	20	households		20	20	4	0.24
Amilahara	20	households		20	20	4	0.24
Gulalpur	20	households		20	20	4	0.24
Misrauli	20	households		20	20	4	0.24
Dakhin goan	20	households		20	20	4	0.24
Phanhuna	40	shops	40			4	0.48
Phanhuna	40	shops	40			4	0.48
Kintoor	25	handicraft units		25	25	5	0.375
Chaksikhti, PO	100	handloom units		100	100	5	1.5
Naveda	40	handloom units		40	40	5	0.6
Rasoolpur	20	handloom units		20	20	4	0.24
Jamo	40	shops	40			4	0.48
Jamo	80	shops	80			4	0.96
Mohna	40	shops	40			4	0.48
Pure zalim	40	shops	40			4	0.48
Kadipur	40	shops	40			4	0.48
Pure pandey, s	40	shops	40			4	0.48
Godiyan ka pur	10	households		10	10	4	0.12
Mejarganj	40	shops	40			4	0.48
Raniganj	100	shops	100			4	1.2
Badosarai	40	shops	40			4	0.48
Bamhrauli	20	households		20	20	4	0.24
Manikapur	40	shops	40			4	0.48
Katehti	10	poultry	10			12	0.36
Rasoolpur chau	40	shops	40			4	0.48
Jamo	40	shops	40			4	0.48
Mohna	40	shops	40			4	0.48
Phanhuna	40	shops	40			4	0.48
Phanhuna	40	shops	40			4	0.48

3. Technology: Selection & Design

Technology Selection

An assessment was made to evaluate the energy demand for the selected sites .The power requirement for the lighting load was estimated to be relatively low due to lower number of houses .Solar PV technology with DC micro grid setup was selected as the most suitable clean energy based solution for the intervention.

3.1 DC Micro Grid Technology

The interest in DC micro grids over the past 10 years has been growing. A micro grid consists of interconnected distributed energy resources capable of providing energy to a significant portion of internal load demand. A DC micro grid can be deployed in a portion of a building, building-wide or covering several buildings.

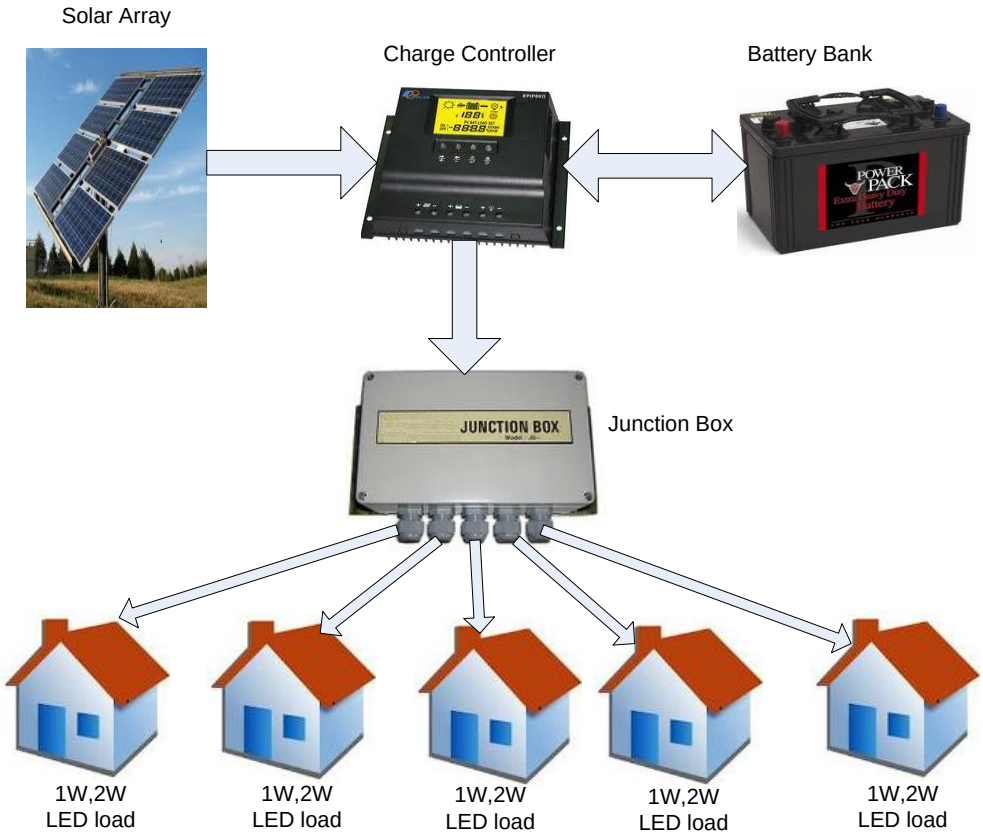

Figure 2: Schematic for a DC Micro Grid

3.2 Proposed Configurations of DC Micro Grids at different project sites

3.2.1 DC micro grid for 10 numbers house hold / 10 number business center

One unit of solar micro grid consist of following

1. One number of 12V, 75 W solar module
2. One number of 12V-75Ah battery
3. One number of 12V-10A charge controller unit
4. One number 1 W and one number 2 W LED Luminary for each house hold and one number 3 W LED luminary for each business center.
5. Ten numbers house hold / business center will be connected through suitable cable

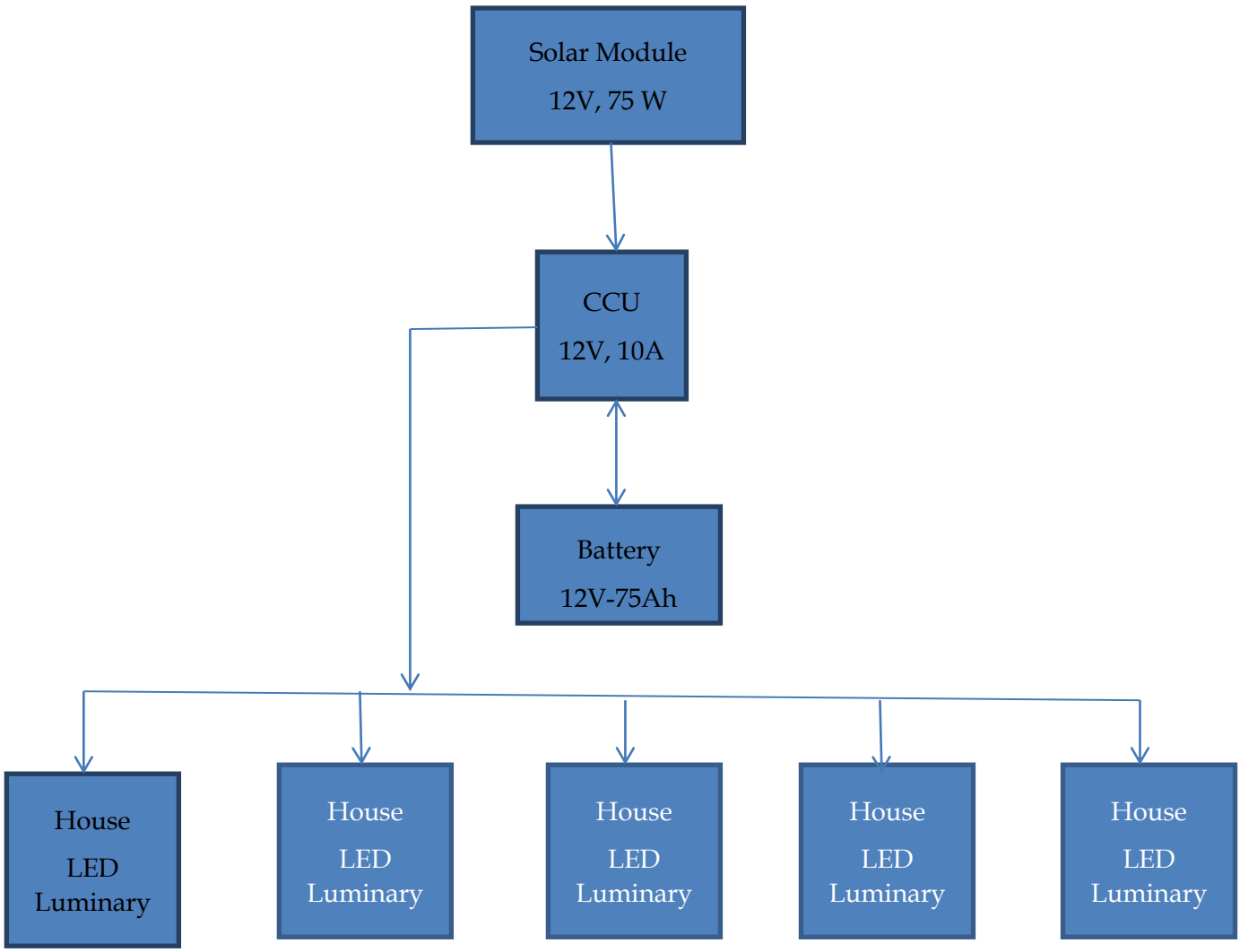

Figure 3: Line diagram of a DC micro-grid with 10HH

Table 3.2.1: Technical specification of each configuration for a DC micro-grid for 10HH is given below

Features / Parameters	Requirements
Solar PV Module	
Power rating	Power output of 75 W @ 16.4V under STC for a 12V Systems
Battery	
Type of battery	Lead acid positive tubular plate
Nominal voltage	12V
Capacity @ C/10	75 Ah
Charge controller unit	
Nominal Voltage	12V
Capacity	10A
Protection	Battery reverse polarity protection Reverse flow protection Short circuit protection Over charge / over voltage protection Deep – discharge protection Load reconnect Temperature compensation The over current device shall be rated for at least 156 % of the short circuit current.
Indication	When battery is charging When battery is fully charged Battery low indication
Idle current	< 10 mA
CCU efficiency	CCU efficiency : 85 % (Min)
LED Luminary	
Nominal Voltage	12V

Nominal wattage	1 W & 2 W for house hold and 3 W for business center
Electronics Efficiency	80 % (min)
Type of LED	White Power LED
Mounted	Wall mounted
Lumen efficiency	100 lumen per watt (min)
View angles	120 deg (Min), LEDs which emit ultraviolet light is not permitted
Switch	Each luminary should be ON / OFF switch
DC Electricity Distribution	
Nominal voltage	12V
Type of wire	Two core copper wire
Size of wire	4 mm^2
Number of house hold / business center connected	10 numbers
Mounting Structure	
	The mounting structure shall be of galvanized metallic frame of M.S. Flat / Angle with corrosion free

3.2.2 DC micro grid for 20 numbers house hold / 20 number business center

One unit of solar micro grid consist of following

1. Two number of 12V, 75W solar module (24V, 150Wp)
2. Two number of 12V-75Ah solar battery (24V-75Ah)
3. One number of 24V-10A charge controller unit
4. One number of 1W and one number of 2W LED Luminary for each house hold and one number of 3W LED luminary for each business center.
5. Ten numbers house hold / business center will be connected through suitable cable

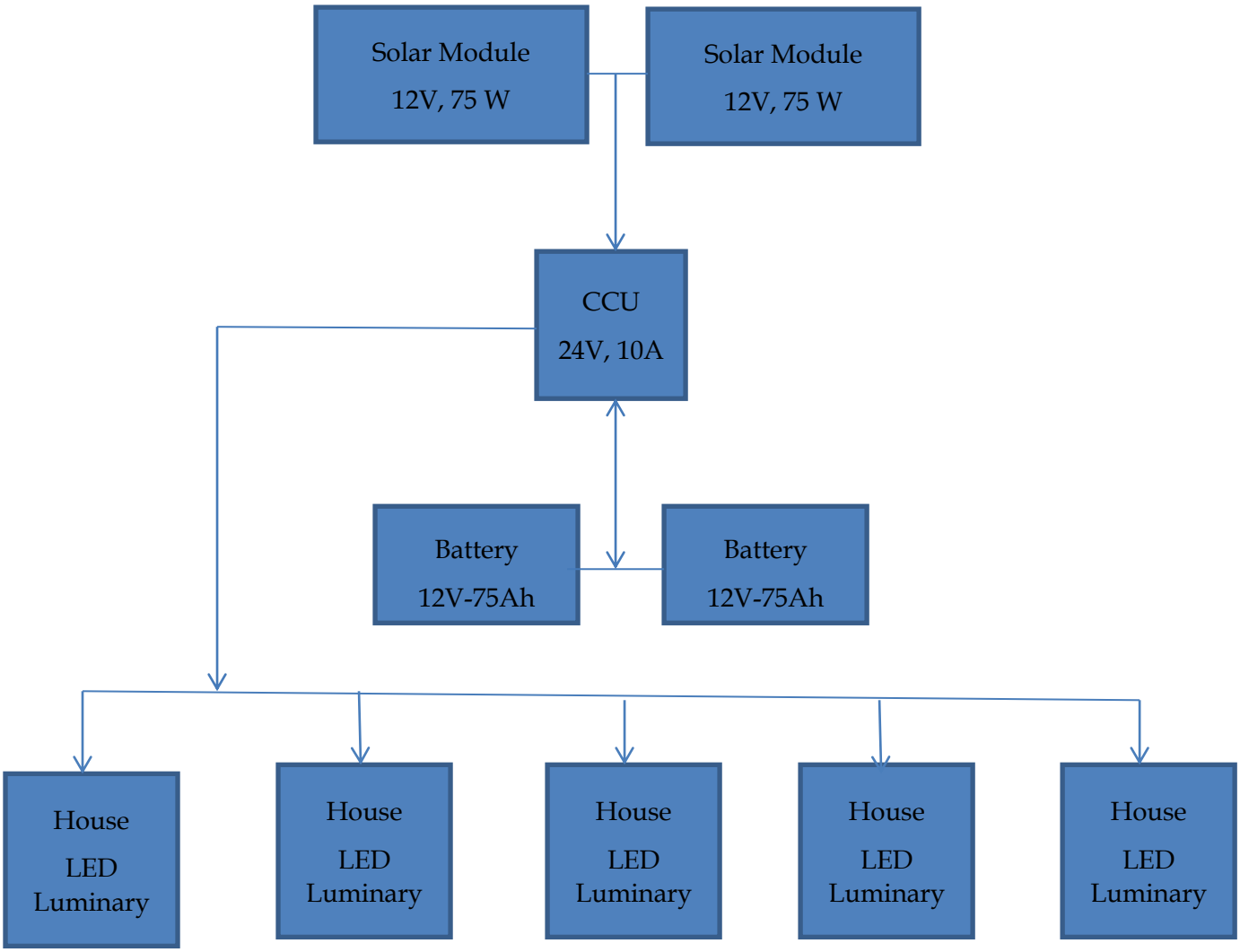

Figure 3.2.2: Line diagram of a DC micro-grid with 20HH

Table 3.2.2: Technical specification of each configuration for a DC micro-grid for 20HH is given below

Features / Parameters	Requirements
Solar PV Module	
Power rating	Power output of 150W @ 32.8V under STC for a 24V Systems
Battery	
Type of battery	Lead acid positive tubular plate

Nominal voltage	24V
Capacity @ C/10	75 Ah
Charge controller unit	
Nominal Voltage	24V
Capacity	10A
Protection	Battery reverse polarity protection Reverse flow protection Short circuit protection Over charge / over voltage protection Deep – discharge protection Load reconnect Temperature compensation The over current device shall be rated for at least 156 % of the short circuit current.
Indication	When battery is charging When battery is fully charged Battery low indication
Idle current	<10 mA
CCU efficiency	CCU efficiency : 85 % (Min)
LED Luminary	
Nominal Voltage	24V
Nominal wattage	1W & 2W for house hold and 3W for business center
Electronics Efficiency	80 % (min)
Type of LED	White Power LED
Mounted	Wall mounted
Lumen efficiency	100 lumen per watt (min)
View angles	120 deg (Min), LEDs which emit ultraviolet light is not permitted
Switch	Each luminary should be ON / OFF switch

DC Electricity Distribution	
Nominal voltage	24V
Type of wire	Two core copper wire
Size of wire	4 mm^2
Number of house hold / business center connected	20 Numbers
Mounting Structure	
	The mounting structure shall be of galvanized metallic frame of M.S. Flat / Angle with corrosion free

3.2.3 DC micro grid for 40 numbers house hold / 40 number business center

One unit of solar micro grid consist of following

1. Two number of 12V, 150W solar module (24V, 300Wp)
2. Two number of 12V-150Ah solar battery (24V-150Ah)
3. One number of 24V-20A charge controller unit
4. One number of 1W and one number of 2 W LED Luminaries for each house hold and one number of 3W LED luminary for each business center.
5. Ten numbers house hold / business center will be connected through suitable cable

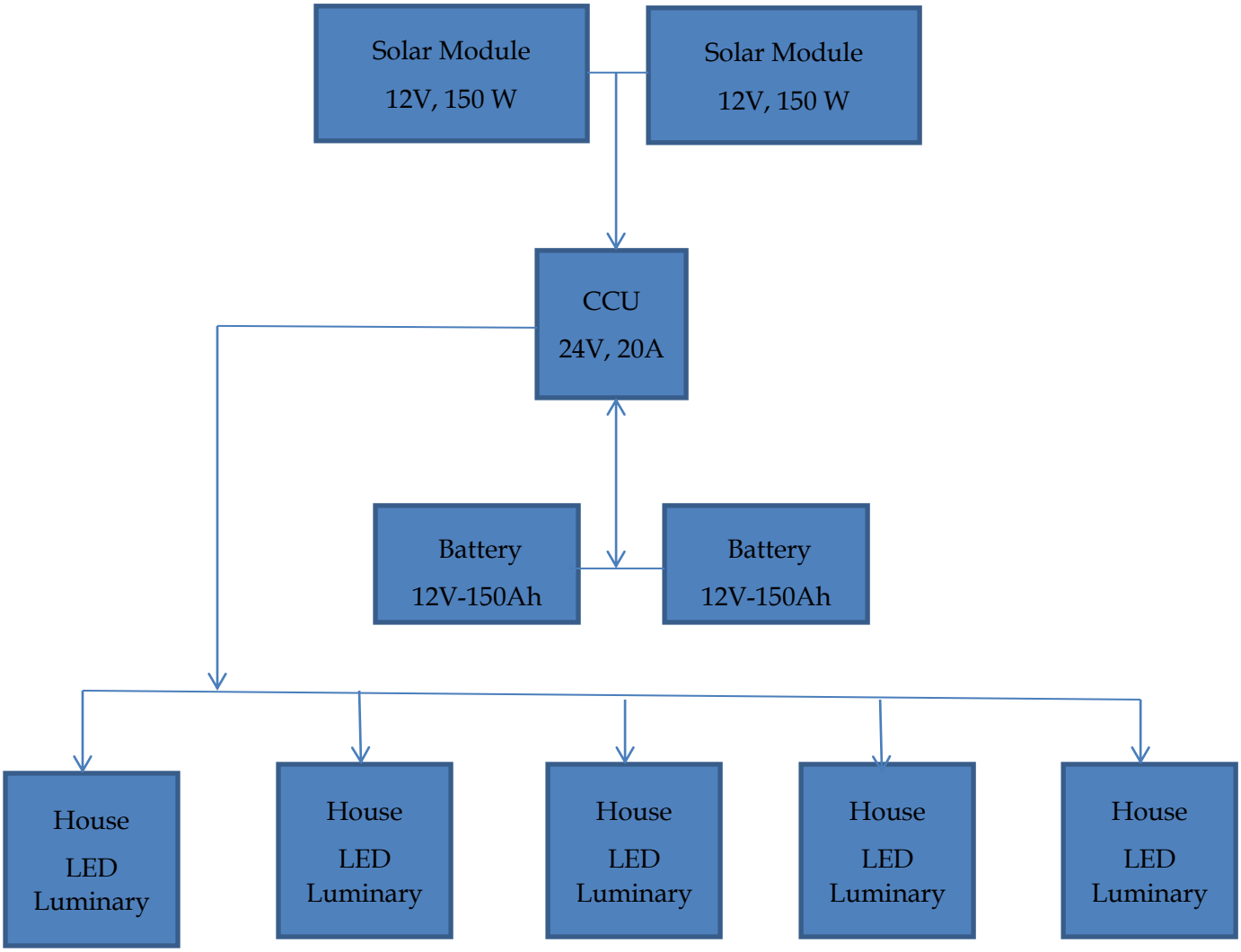

Figure 3.2.3: Line diagram of a DC micro-grid with 40HH

Table 3.2.3: Technical specification of each configuration for a DC micro-grid for 40HH is given below

Features / Parameters	Requirements
Solar PV Module	
Power rating	Power output of 300Wp @ 32.8V under STC for a 24V Systems
Battery	
Type of battery	Lead acid positive tubular plate

Nominal voltage	24V
Capacity @ C/10	150 Ah
Charge controller unit	
Nominal Voltage	24V
Capacity	20A
Protection	Battery reverse polarity protection Reverse flow protection Short circuit protection Over charge / over voltage protection Deep – discharge protection Load reconnect Temperature compensation The over current device shall be rated for at least 156 % of the short circuit current.
Indication	When battery is charging When battery is fully charged Battery low indication
Idle current	<10 mA
CCU efficiency	CCU efficiency : 85 % (Min)
LED Luminary	
Nominal Voltage	24V
Nominal wattage	1W & 2W for house hold and 3W for business center
Electronics Efficiency	80 % (min)
Type of LED	White Power LED
Mounted	Wall mounted
Lumen efficiency	100 lumen per watt (min)
View angles	120 deg (Min), LEDs which emit ultraviolet light is not permitted
Switch	Each luminary should be ON / OFF switch

DC Electricity Distribution	
Nominal voltage	24V
Type of wire	Two core copper wire
Size of wire	6 mm^2
Number of house hold / business center connected	40 Numbers
Mounting Structure	
	The mounting structure shall be of galvanized metallic frame of M.S. Flat / Angle with corrosion free

TECHNO-ECONOMIC DETAILS:

The project includes an entrepreneurial model of electricity service and delivery. A local solar entrepreneur is the owner of the DC micro grid setup. The connections from the grid have been provided to the households in exchange for a monthly fee. The part of revenues collected is used to cover the operational and maintenance costs and the rest amount can be a source of income generation.

Also the consumers tend to get benefited from the extra hours of lighting facilities available to them, which can add to their livelihood generation and improve their socio-economic conditions.

The table below gives the techno-economical details of the project implementation site. This also gives the detail in equity share holding for the private entrepreneur:

SNo.	Site	No of connection	No of 3W LED	No of 2W LED	No of 1W LED	Usage hrs	System voltage	SPV capacity	Battery	CCU	Approx. cost	TERI	Entrepreneur
	Village					**hrs**	**In Volt**	**In Wp**	**In Volt - Ah**	**Amp**	**Rs.**	**Share (55 %) Rs.**	**Share (45%) Rs.**
1	Shivgarh	95	95			4	24	800	24V-400Ah	30	310803	170942	139861
2	Kalu khera	100	100			4	24	800	24V-400Ah	30	310803	170942	139861
3	Pure	20		20	20	4	24	150	24V-	15	62000	34100	27900

	Tiwaripur								75Ah				
4	Amilahara	20		20	20	4	24	150	24V-75Ah	15	62000	34100	27900
5	Gulalpur	20		20	20	4	24	150	24V-75Ah	15	62000	34100	27900
6	Misrauli	20		20	20	4	24	150	24V-75Ah	15	62000	34100	27900
7	dakhin goan	20		20	20	4	24	150	24V-75Ah	15	62000	34100	27900
8	Imli goan	20		20	20	4	24	150	24V-75Ah	15	62000	34100	27900
9	Phanhuna	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
10	Phanhuna	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
11	Kintoor	25		25	25	5	24	300	24V-150Ah	20	124734	68604	56130
12	Chaksikhti, PO Islampura	100		100	100	5	24	1000	24V-500Ah	40	361550	198853	162698
13	naveda	40		40	40	5	24	400	24V-200Ah	20	144900	79695	65205
14	rasoolpur	20		20	20	4	24	150	24V-75Ah	15	62000	34100	27900
15	Bhawanigarh	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
16	Zamalpur, rampur	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
17	Bhatgoanva	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
18	Purabgoan, jagdishpur	40	40			4	24	300	24V-150Ah	20	124734	68604	56130

19	jamo	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
20	jamo	80	80			4	24	600	24V-300Ah	30	230750	126913	103838
21	Mohna	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
22	Pure zalim	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
23	kadipur	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
24	Asandra	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
25	Pure pandey, saidpur	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
26	Tursampur, PO Palpur	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
27	Godiyan ka purva	10		10	10	4	12	75	12V-75Ah	10	30000	16500	13500
29	Mejarganj	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
29	Raniganj	100	100			4	24	800	24V-400Ah	30	310803	170942	139861
30	Badosarai	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
31	Bamhrauli	20		20	20	4	24	150	24V-75Ah	10			
32	Manikapur	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
33	Katehti	10	10			12	24	200	24V-100Ah	15	51550	28352.5	23197.5

34	Rasoolpur chauraha	40	40			4	24	300	24V-150Ah	20	124734	68604	56130
		1400									**4430371**	**2436704**	**1993667**