

Switch Energy Alliance Case Competition

NEPAL

Team Urjaffinity (#151)

INDIA



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Nepal at a glance



Total population: 29 million



GDP per capita: \$1155



Rural population: 79%



Electricity access: 90%



Total area: 140,800 sq. km



Multi-lingual, multicultural, and multi-religion demography

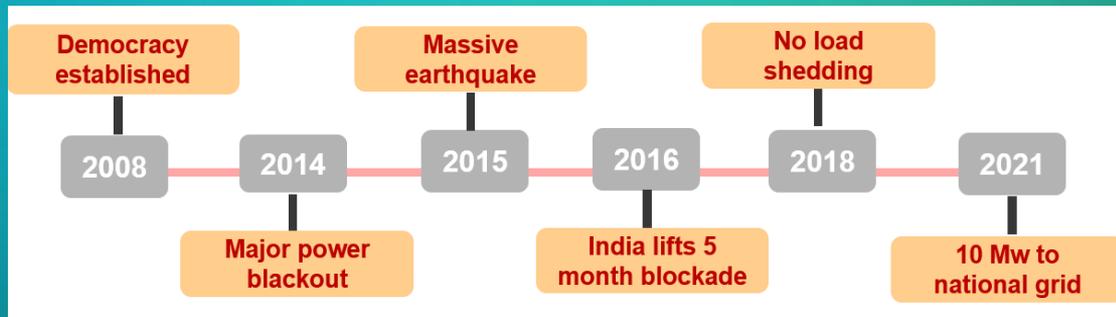


GDP: \$33.66 billion



Population below poverty line: 50.3%

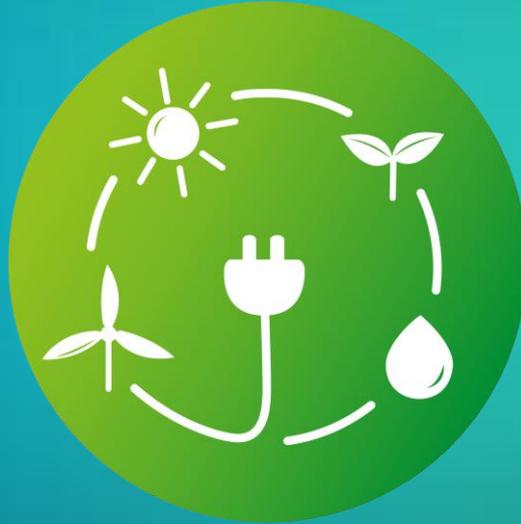
		Population
	Province 1	4,534,943
	Province 2	5,404,145
	Bagmati Province	5,529,452
	Gandaki Province	2,403,757
	Province 5	4,499,272
	Karnali Province	1,570,418
	Sudurpaschim Province	2,552,517
Total		26,494,504



Nepal: The two wheels to a stable ride

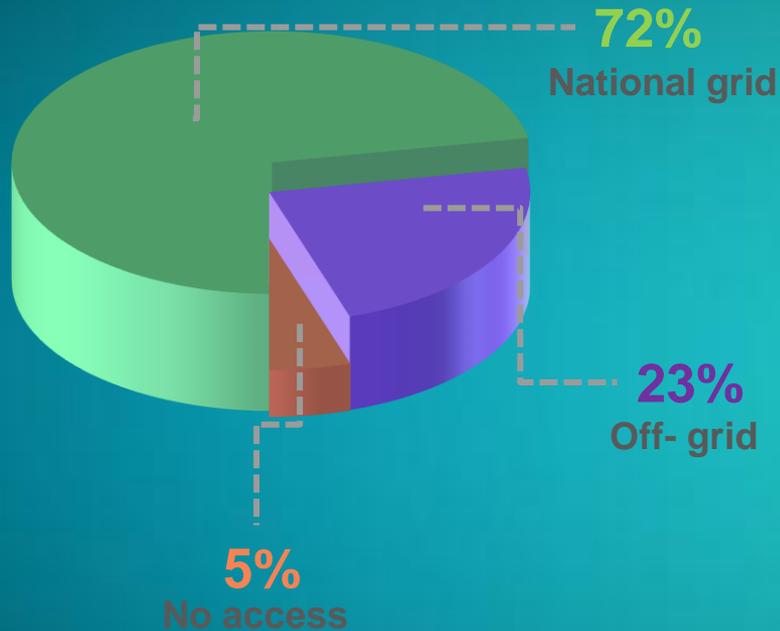


Problems and challenges



Electricity access

Total population



- ❖ Off grid: Mini grid and solar lighting system(SLS) are most common
- ❖ 5 % having no access rely on solid fuel for lightning
- ❖ National grid connection suffers from crippling supply(47% get 24 hrs. electricity)
- ❖ Remaining 53% invest in backup: SLS, Battery power which creates financial burden.



Challenges of On-grid systems

-  70% of households suffer from reliability issues(**Unscheduled power outages**)
-  Unaffordable supply for distant households due to **difficult terrain**
-  Administrative barriers to get ON-grid supply
-  17% household reports voltage fluctuations → Appliances Damage
-  **Added financial burden :** Unreliability causes Additional expenditure on backup sources(~ \$3)

Challenges of Off-grid systems

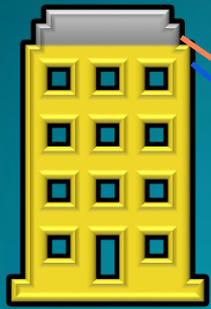
-  **Capacity constraints:** Lack of capacity leads to imposed restriction on usage
-  **Limited supply:** Usage of low power devices(light, radio, television)
-  Low consumption → Lack of economic growth
-  Lack of proper investment and regulations
-  Limited awareness among population

Grid access allocation

Urban

Only 18% population get reliable and quality electricity from grid

Rural



87%



67%



Off-grid access allocation (Out of total 23%)

Source: ESMAP, World Bank group

Capacity is not enough to get all benefits that grid users enjoy

12%

9.6%

0.9%

0.5%

0.1%

Mini grid



Solar lighting



Solar lantern



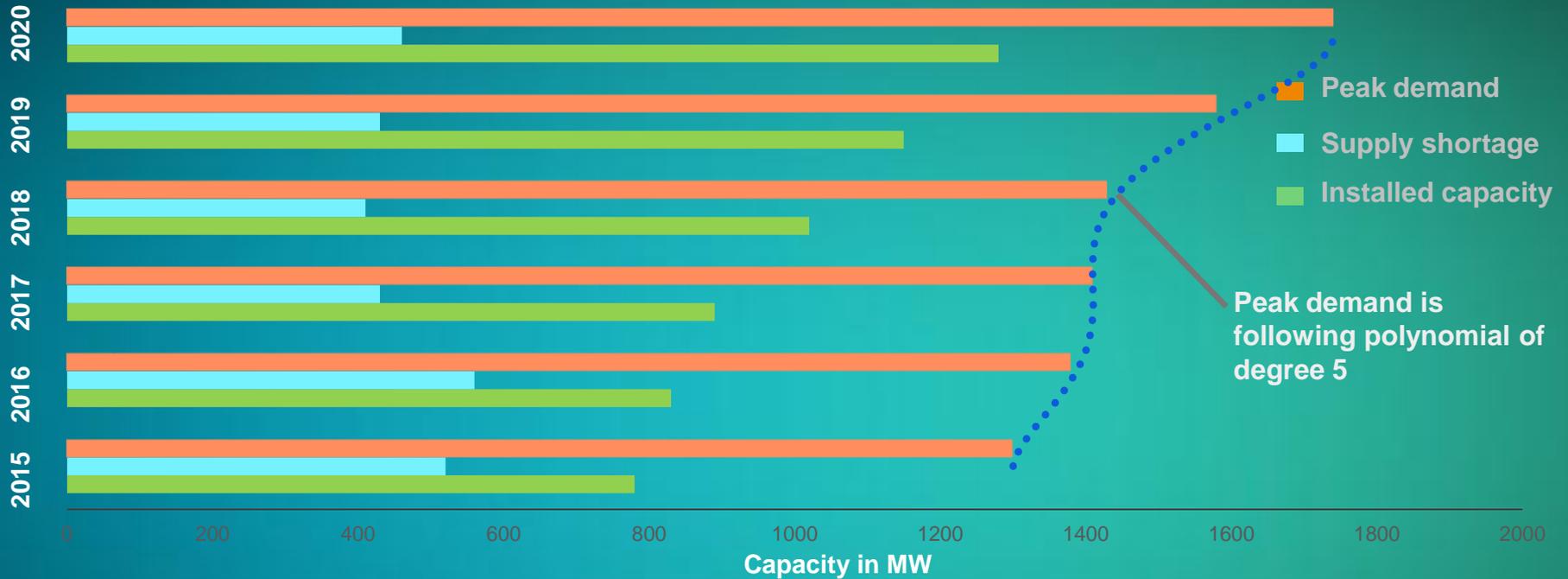
Solar home system



Rechargeable battery



Demand vs Supply



- ❖ 85 % of electricity consumed by residential sector. There is significant shortage of electricity which is the cause of low economic growth.
- ❖ Average shortage of 545 Mw over the last 5 years and due to lack of infrastructure propelled Nepal to import electricity from India
- ❖ Significant transmission and distribution loss(15%-18%) is the major cause of inefficiency. Highest in Janakpur(30%) in province 2.

Supply of electricity

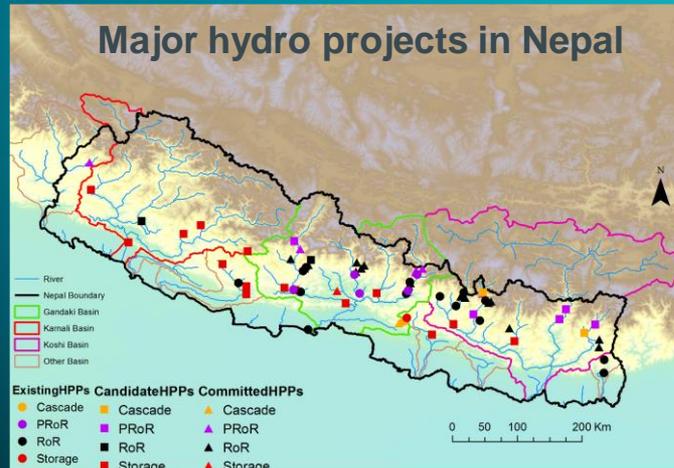
Source	No. of projects	Capacity(MW)
Hydro(*NEA)	16	563
Hydro(*IPP)	62	560
Diesel	2	53.4
Solar	2	1.68
Import from India		400

99% of total installed capacity

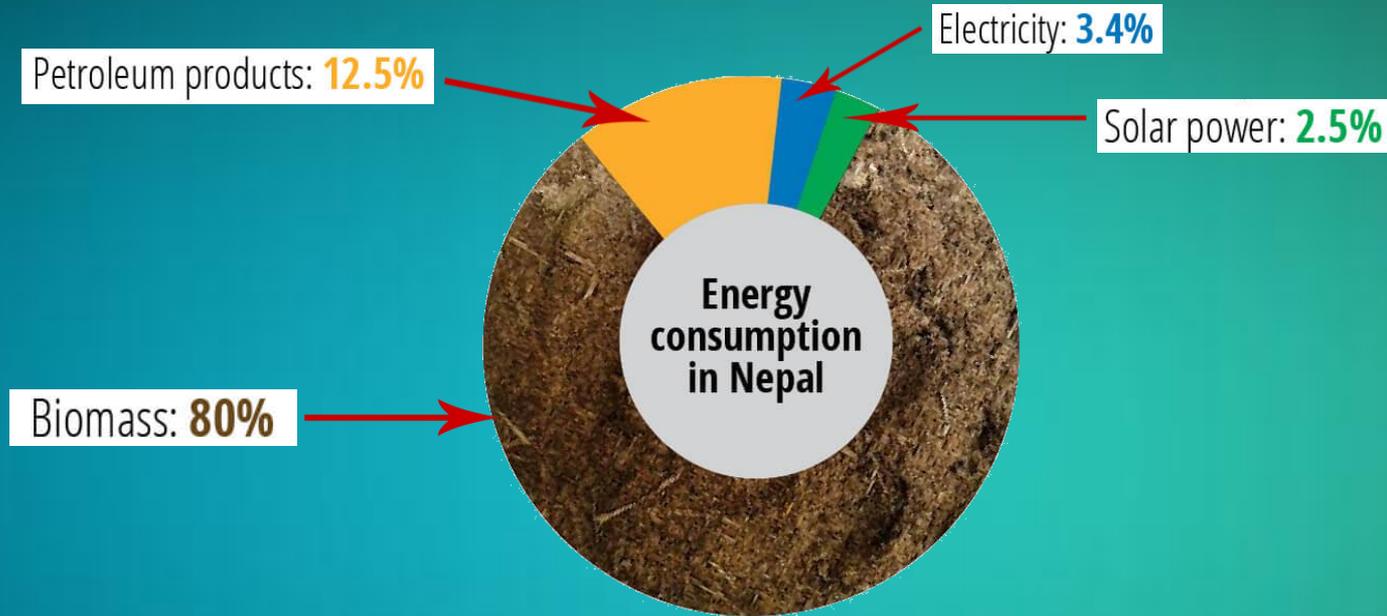
River Basins	Theoretic al Potential(MW)	Technical Potential(MW)	Economic Potential(MW)
Sapta Kosi	22350	11400	10860
Sapta Gandaki	20650	6660	5270
Karnali and Gandaki	36180	26570	25125
Southern River	4110	980	878
Country total	833290	45610	42133

Potential that can be exploit

Particulars	Capacity(MW)
Total installed	1123
Under construction	1017
Planned and proposed	2920



Cooking fuel access



- ❖ Biomass, in the form of fuelwood, animal waste, and crop residue, is dominant in the energy mix
- ❖ Majority of biomass is used for cooking and lighting in urban as well as rural Nepal
- ❖ Due to unaffordable and unreliable supply of electricity, majority of population rely on biomass as their primary source of energy
- ❖ Nepal imports all of its petroleum products from India

Current cooking fuel scenario

Urban: 8.1%
Rural: 17.0%



Open fire

Urban: 37.3%
Rural: 50.4%



Traditional

Urban: 5.4%
Rural: 9.9%



Improved
cook stove

BIOMASS

Urban: 47.1%
Rural: 20.7%



LPG

Urban: 2.1%
Rural: 2.0%

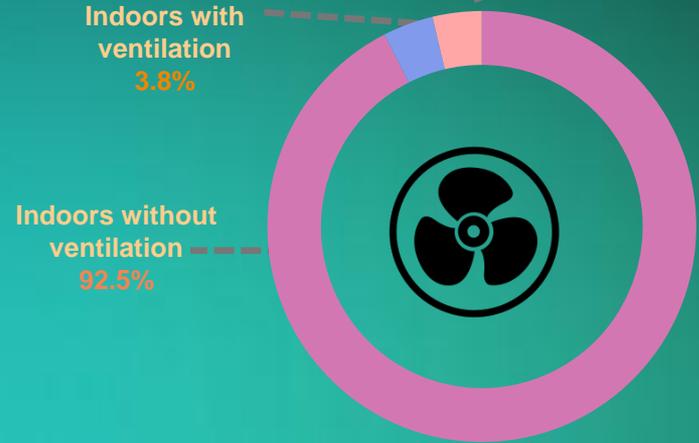


Biogas

Urban: 0.1%
Rural: 0.0%



Electric



- ❖ 76% of biomass is used as fuelwood
- ❖ 28% have access to clean cooking fuel



Dangerous!

Challenges with cooking fuel



Energy poverty in Nepal

Energy

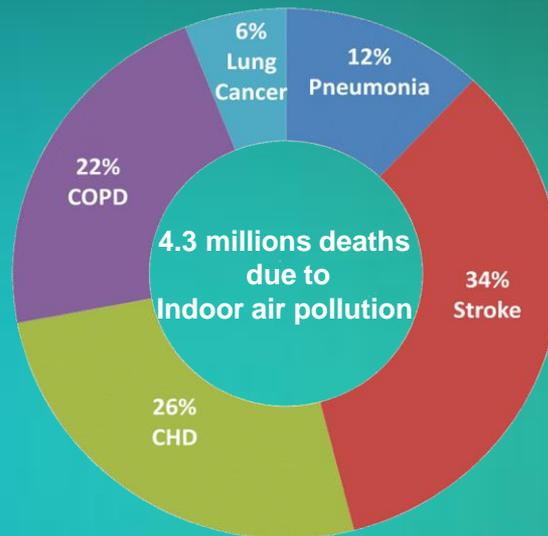


Disparity

Nepal has the highest energy poverty in South Asia with 90 KWH of electricity and 15 GJ of primary energy consumptions per capita in a year.

Nepal has highest photovoltaic and hydro potential

Energy Poverty: The Impact on Health



- 66% of households use unclean fuel, 45% do not have separate kitchen to cook, and 43% have indoor smoking
- Family is prone to indoor air pollution
- Health centres cannot afford apt medical equipment due to lack of stable energy supply
- Emergency Medical services and infrastructure are restricted due to lack of electricity.



Sustainable development goal 3

⌚ LIFE EXPECTANCY	👶 INFANT MORTALITY	⚰ DEATHS UNDER AGE 5
71.74 years (life expectancy at birth, both sexes) View by sex and historical chart	23.4 (infant deaths per 1,000 live births) View historical chart	27.7 (per 1,000 live births) View historical chart

Problem statement



The lack of proper, consistent and efficient supply of electricity impedes the general well being and development of the people



Limited access to clean cooking fuel hampers health and environment alike.



Failure to harness the tremendous solar and hydro potential Nepal has leads to inadequate economic growth impacting all other aspects adversely.



Solution



❖ For ease and efficient implementation of our solution we prefer the following division of population

Tier	Load level	Population distribution based on electricity access	Population distribution based on cooking fuel access
T-0	No access	6.29%	52.9%
T-1	Very low 3-49 W	15.3%	1.9%
T-2	Low 50-199 W	11.5%	6.4%
T-3	Medium 200-799 W	31.7%	8.2%
T-4	High 800-1999 W	17.91%	2.8%
T-5	Very high 2000 or higher	17.3%	14.7%

Solution

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graph TD; Solution[Solution] -.- Off-Grid[Off-Grid]; Solution -.- On-Grid[On-Grid]; Solution -.- CleanCooking[Clean cooking]; Solution -.- Economic[Economic];
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Off-Grid

On-Grid

Clean
cooking

Economic



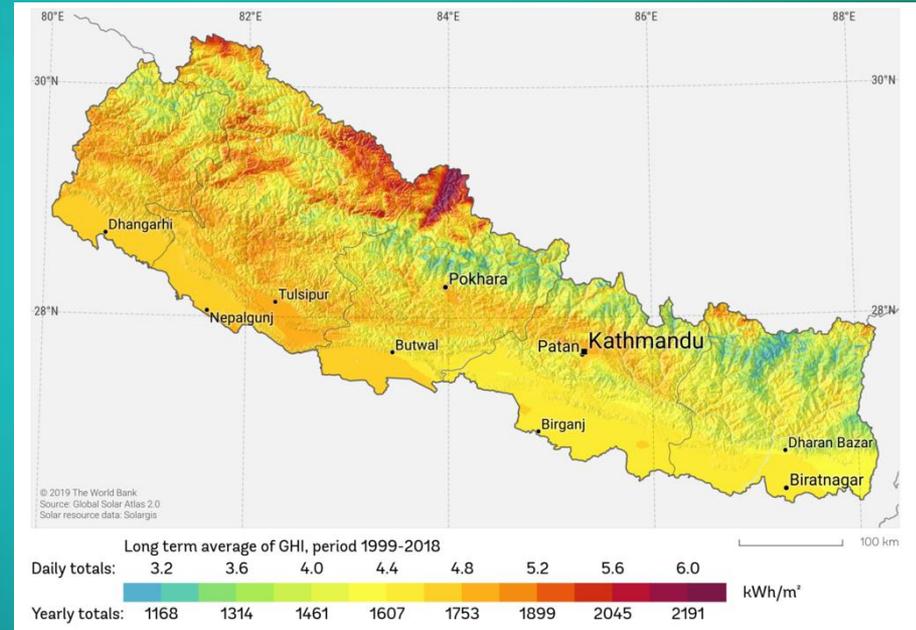
Implementation

- ❖ Solar panels to be used: 40Wp, 210Wp, 840Wp, 1680Wp

Ranking in terms of PV potential

Province name	Ranking
Karnali	1
Gandaki	2
Province 1	3
Lumbini	4
Sudarpaschimi	5
Bagmati	6
Province 2	7

Location

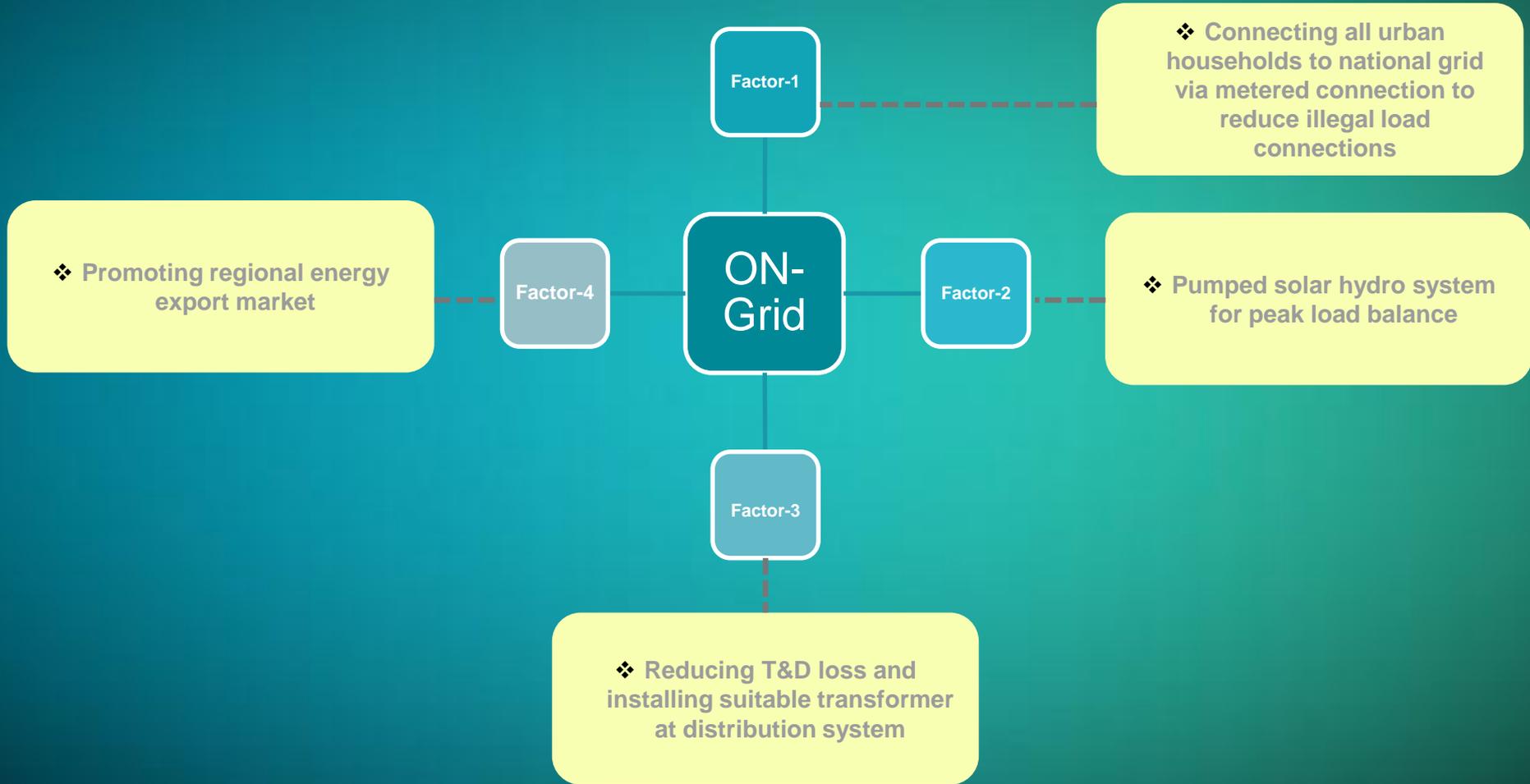


Implementation

Proposed companies

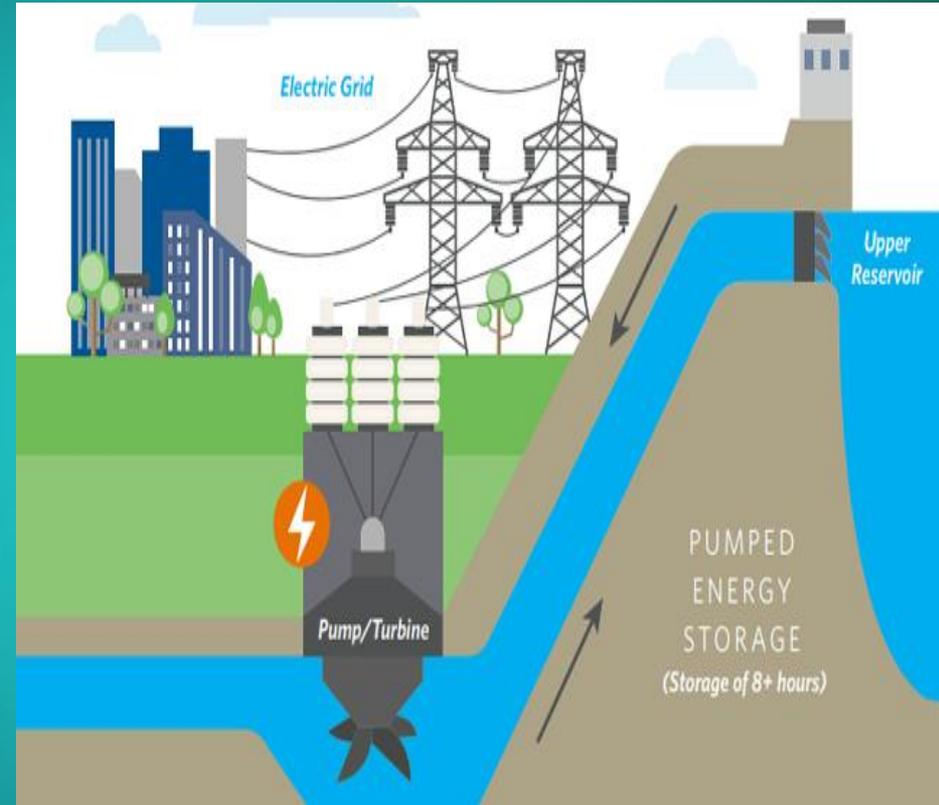
Company	Headquarter	Type of panel	Warranty range	Capital value (\$ billion)
LONGI Solar	China	Monocrystalline	12 years	63.039
JinkoSolar	China	Half-cell technology	12 years	2.73
Risen Energy	China	Thin film amorphous silicon	12 years	20.019

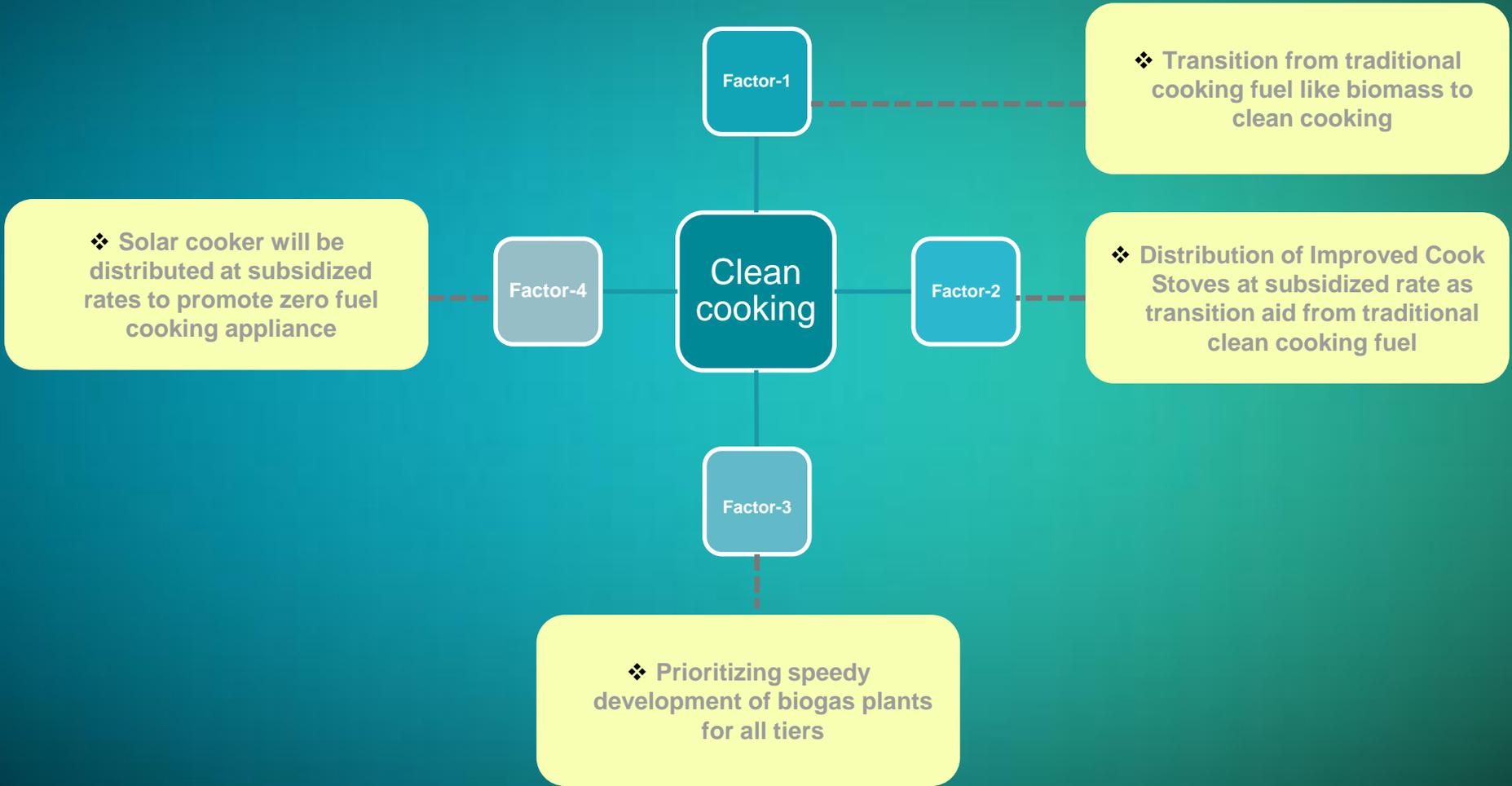
These are the three organizations tasked with developing the solar projects across Nepal.



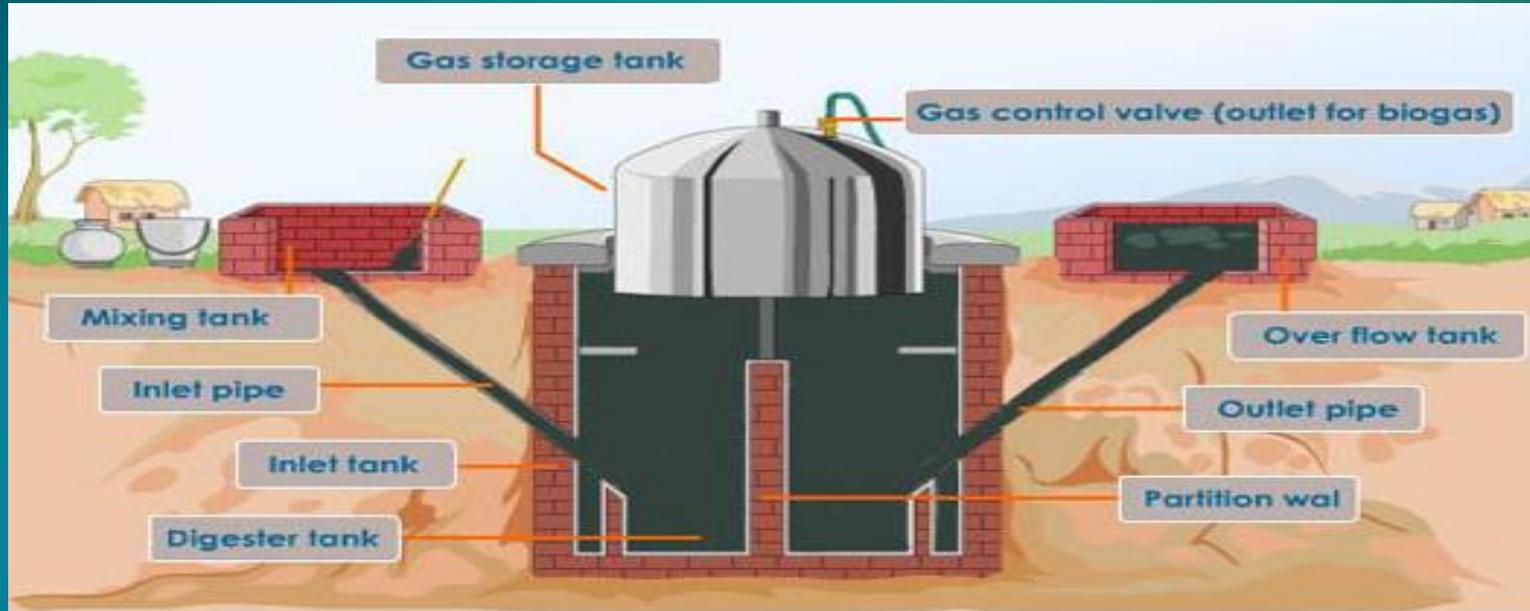
Implementation

- ❖ Managing peak load demand by installing total of 20 Mw Solar pumped hydro plant at different sites. **Karnali province and Province 1** has highest potential
- ❖ Solar arrays are used to pump water during day time.
- ❖ Stored water can be used whenever there is need of extra power in Nepal and in neighboring country as well
- ❖ Managing power outages in during dry season i.e. in summer and winter.

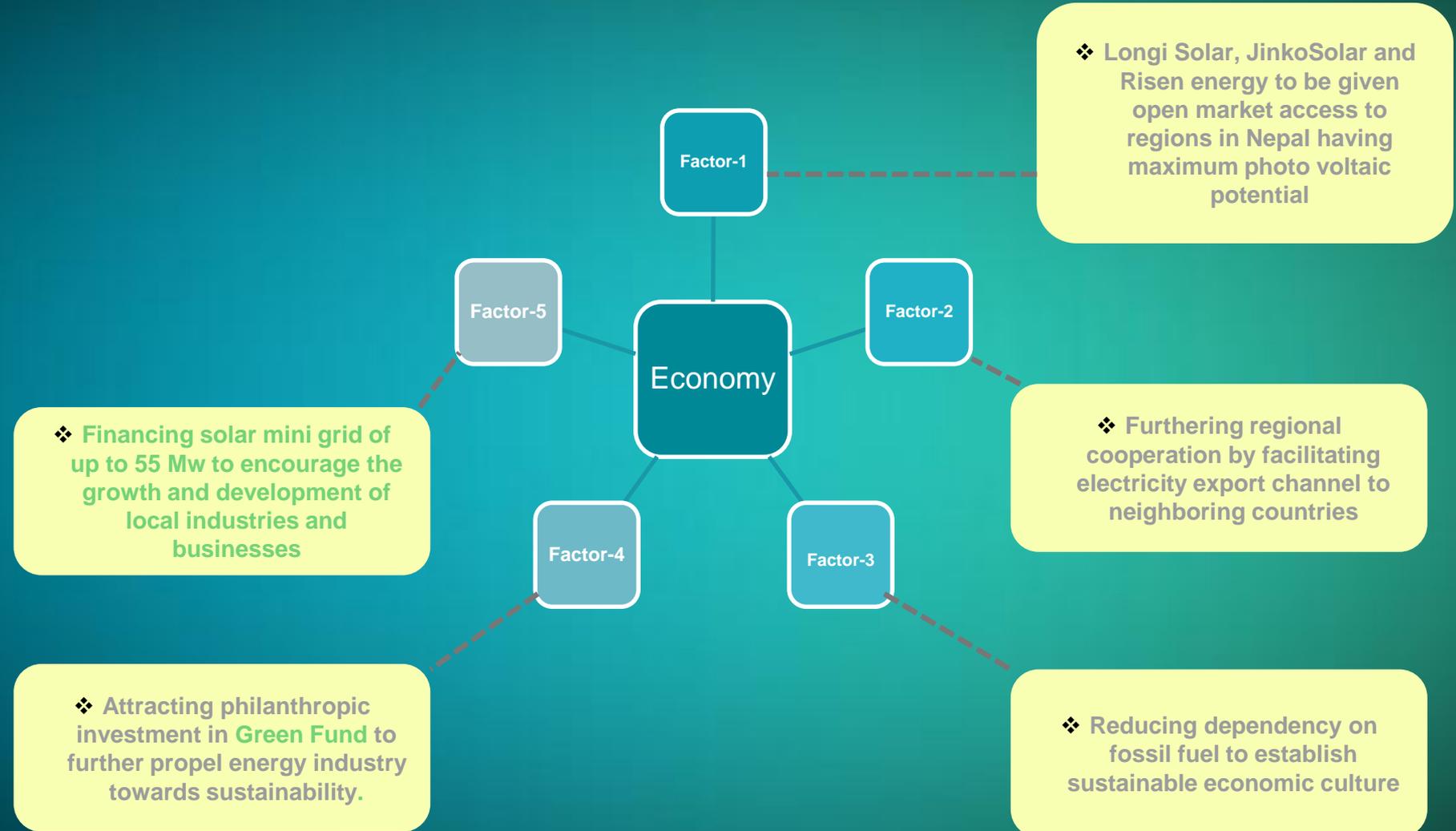




Implementation



Providing ICS as transition aid from traditional cooking to clean cooking



Factor-1

❖ Longi Solar, JinkoSolar and Risen energy to be given open market access to regions in Nepal having maximum photo voltaic potential

Economy

Factor-2

❖ Furthering regional cooperation by facilitating electricity export channel to neighboring countries

Factor-3

❖ Reducing dependency on fossil fuel to establish sustainable economic culture

Factor-4

❖ Financing solar mini grid of up to 55 Mw to encourage the growth and development of local industries and businesses

❖ Attracting philanthropic investment in Green Fund to further propel energy industry towards sustainability."

Factor-5

Implementation

- ❖ The incentive rate from the Nepalese Government per unit electricity produced is \$ 0.065
- ❖ The per unit tariff rate set for solar electricity is \$ 0.03.
- ❖ Local cottage industries and multi-centered small-scale industries will be given 50% subsidies to be paid off in 5 years at very low interest rate of just 2.5 %
- ❖ The stored energy can be exported at 0.08\$ per unit.

Finance

Off-Grid Solar

Phase	Capital amount (\$ mn)	Lender	Total cost (\$ mn) (Capital+intrest)	Pay off period(Yrs)	Simplified cost to household
1(2021-2030)	51.5	NMB Bank	64.334	10	\$ 17.8
2(2031-2040)	51.5	NIB Bank	64.334	10	\$ 17.8
3(2041-2050)	51.5	Civil Bank	64.334	10	\$ 17.8

Cooking fuel

Phase	Capital amount (\$ mn)	Lender	Total cost (\$ mn) (Capital+intrest)	Pay off period(Yrs)	Simplified cost to household
1(2021-2030)	48.28	World bank	49.49	10	\$ 12
2(2031-2040)	24.14	World bank	24.74	5	\$ 12

Pumped hydro

Phase	Capital amount (\$ mn)	Lender	Total cost (\$ mn) (Capital+intrest)	Pay off period(Yrs)	Tarrif rate(export)
1(2021-2035)	56	Asian development bank	71.89	11	\$ 0.08 /KWh

Industrial mini grid

Phase	Capital amount (\$ mn)	Lender	Total cost (\$ mn) (Capital+intrest)	Pay off period(Yrs)	Pay off cost / 100Kw
1(2030-2035)	14.7	Asian development bank	16.63	5	\$ 11,400 / year

Cost requirement

Primary Power Projects

Projects	Target population	Energy capacity	Total installation cost(\$ million)	Subsidy (if applicable)	Net project cost (\$ million)
Individual solar	Isolated+Non grid rural (9.4 million)	6760 GWh	206	75%	154.5
On-grid connection	Urban not connected to grid(1.09 million)	Grid connection	14.06	NA	14.06
Biogas plant	Households in all tiers(6.07 million)	5.42 million m3	72.42	NA	72.42
Pumped hydro	Peak demand balance(On-grid)	20MWp	56	NA	56

Auxiliary projects

Subsidized products	Target population	Subsidy	Subsidy amount (\$ million)
Improved cook stoves during transition	HouseholdsTier-0,1,2,3(3.4 million)	10% per unit	6

Extra cost

Type	Cost (\$ million)
Maintenance	30
Upgradation(T&D + existing projects)	15
Campaigning(Solar cooker)	3
Mini grid financial aid(55Mw)	14.7

Total cost

Allocated budget (\$ million)	Proposed Budget (\$ million)	Remaining (\$ million)
370	365.68	4.32

Implementation Timeline

- ❖ On-grid (factor 2) - 5 years - \$ 18.67 million
- ❖ Off-grid(factor 1) - 10 years - \$51.5 million
- ❖ Clean cooking(factor 3) - 5 years – \$13.03 mn
- ❖ Clean cooking(factor 4) - 5 years - \$6 million

2021-2030

- ❖ Off-grid (factor 1) - 10 years - \$ 51.5 million
- ❖ On grid(factor 1) - 5 years - \$ 14.06 million
- ❖ On-grid (factor 2) – 10 years - \$37.33 million
- ❖ Clean cooking(factor 1 & 2) - 5 years - \$6 million
- ❖ Clean cooking(factor 3) - 10 years- \$56.39 million

2031-2040

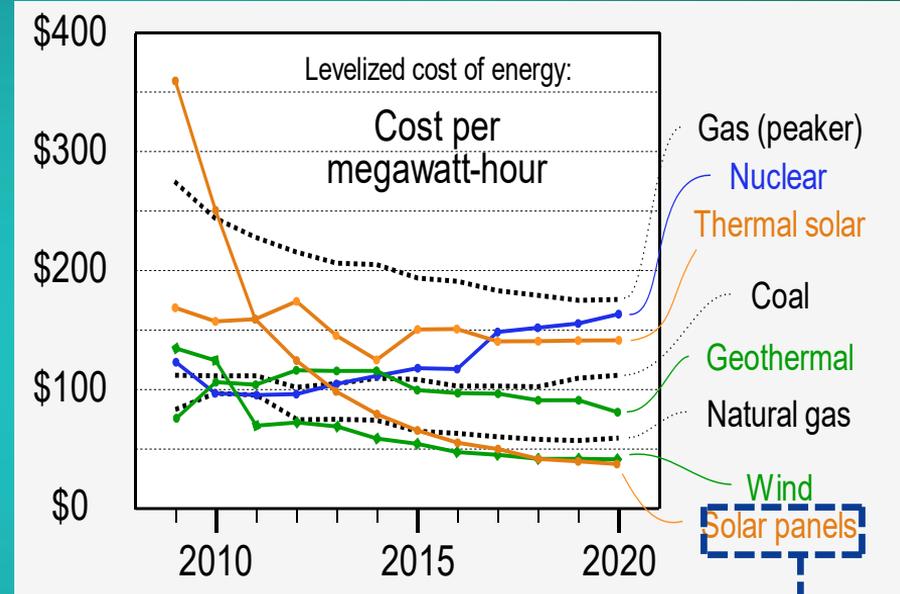
- ❖ Off-grid (factor 1) - 10 years - \$ 51.5 million
- ❖ On grid(factor 1) - 5 years - \$ 14.06 million

2041-2050

Viability

Off- grid solar

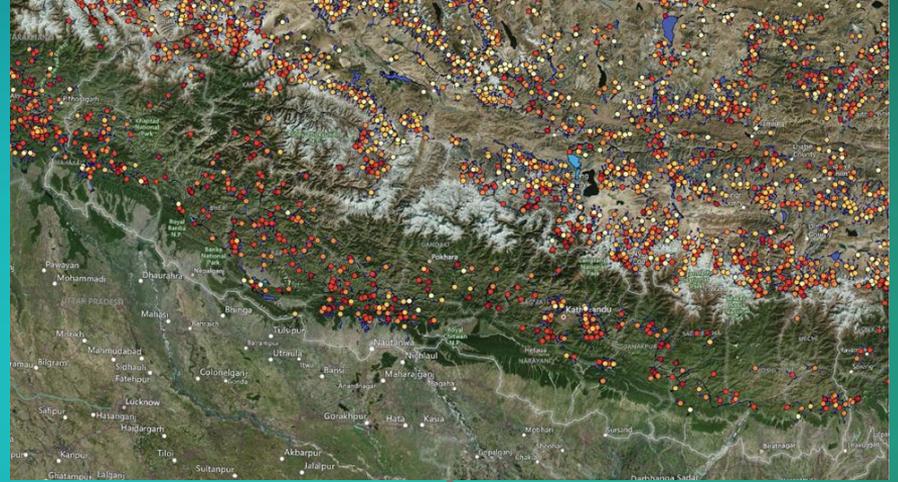
- ❖ All parts of Nepal are favorable for solar energy
- ❖ Price of solar panel which comprise 60% of total cost of project, is falling down due to improved technology.
- ❖ Total solar resource accounts for 7000 times more potential than current consumption.
- ❖ Average irradiation in Nepal is around 4.5 KWh/sqm which is more than sufficient to provide low cost solution
- ❖ The biggest markets for Solar energy are in the rural areas unconnected to the grid.
- ❖ The top three provinces are Karnali, Gandaki, Province 1, with a practical PV potential of 342.85 TWh.



Currently solar power is most affordable and its price will continue to fall in future

Solar Pumped hydro storage

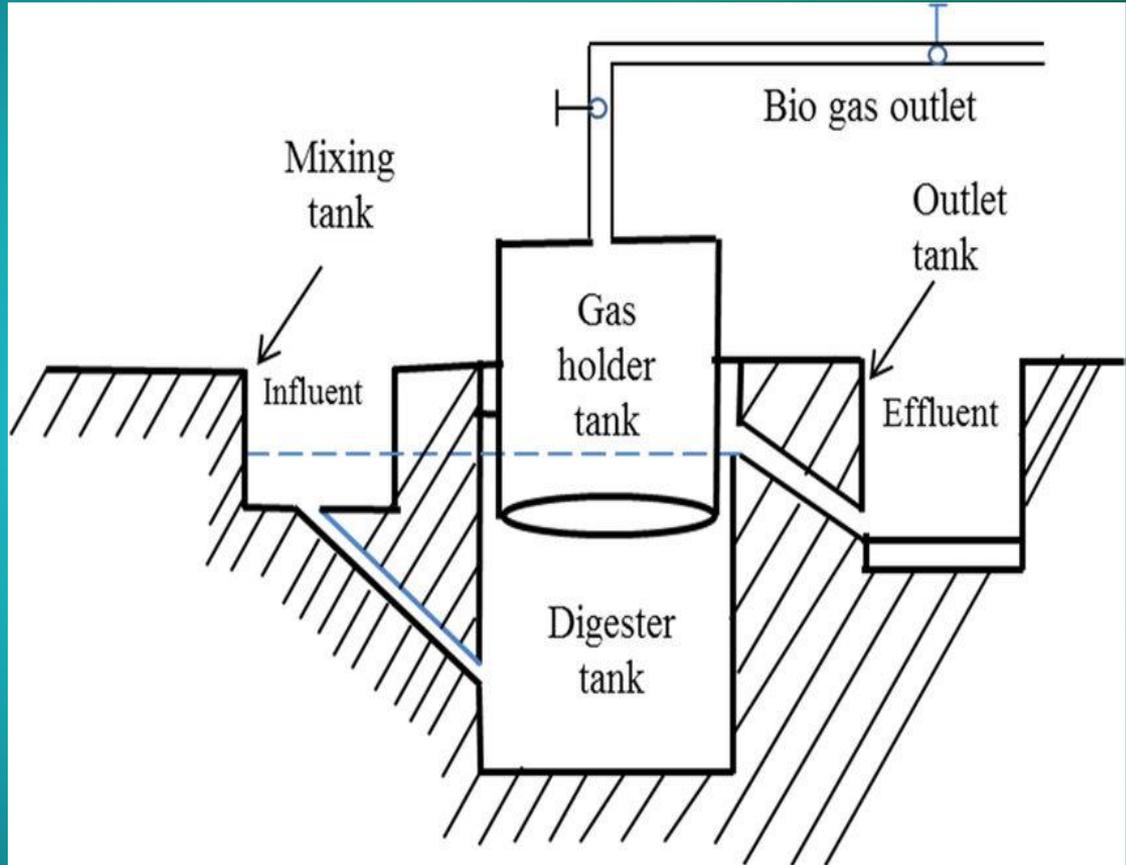
- ❖ Having an enormous solar potential, Nepal has vast low-cost off-river solar pumped hydro-energy-storage potential
- ❖ Eliminating the need for on-river hydro storage and moderating the need for large-scale batteries in solar power.
- ❖ Easy to operate and can supply instantaneous power whenever needed
- ❖ By adopting Solar pumped hydro instead of large scale dams, ecological integrity will be preserved



- Nepal has hundreds of 50GWh pumped hydro storage site
- Karnali province has highest number of sites

Biogas system

- ❖ Farming system in Nepal is heavily dependent on livestock
- ❖ 1.2 million households owning cattle and buffalo
- ❖ Out of total potential 57 percent located in the Terai plains, 37 percent in the hills and 6 in mountain
- ❖ Biogas is a healthier, much cleaner alternative to biomass



Cultural and economic impact

- ❖ Industrial Growth will be encouraged.
- ❖ Local cottage industries and multi-centered small-scale industries will be encouraged and supported
- ❖ Encouraging industrial growth will boost the economy and encourage FDI.
- ❖ The tourism sector will boom with increased electrical capacity.
- ❖ Clean cooking fuel will eradicate health ailments like cardiovascular disease and cataract and improve quality of life



A major problem of deforestation will be solved and biodiversity will be sustained



Quality of life and life expectancy will increase



By adopting efficient power projects like off grid solar; clean, reliable and affordable energy is available to everyone

Conclusion

- ❖ **Nepal is blessed with vast natural energy resources however their fruitful utilization for the well being of its growing population is lagging behind due to the economic, geographical and techno political conditions**
- ❖ **Now with political stability (majority government), adequate experience and FDIs , Nepal can utilize its huge potential in hydropower and solar power to propel its economic growth towards a Developing Country (from LDCS) and be a regional player in fulfilling the energy demand in South Asia.**

THANK YOU