Solar Powered Water System and solar eco-community

Tsinghua University
Renewable Energy Promotes Ecosystem Restoration Project Team

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Drought land – Water - Irrigation-Energy

- Irrigation can increase yields of most crops by 100 to 400 percent. Farmers who switch from surface irrigation to localized irrigation can cut their water usage by 30 to 60 percent.
- It is estimated that poor drainage and irrigation practices have led to waterlogging and salinization of about 10 percent of the world's irrigated lands, thereby reducing productivity.
- In many areas of developing countries, power grids are unavailable, and diesel pumps for irrigation are expensive and heavily polluted

Solar pump

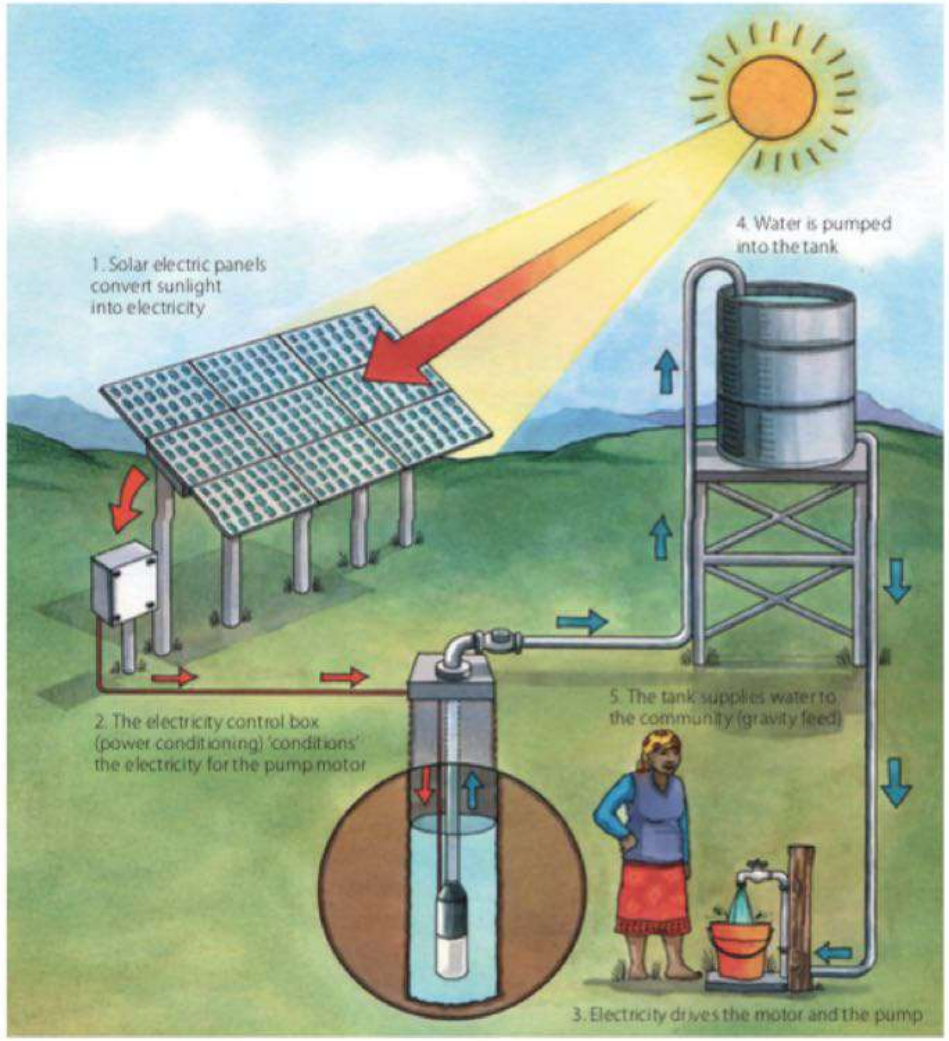
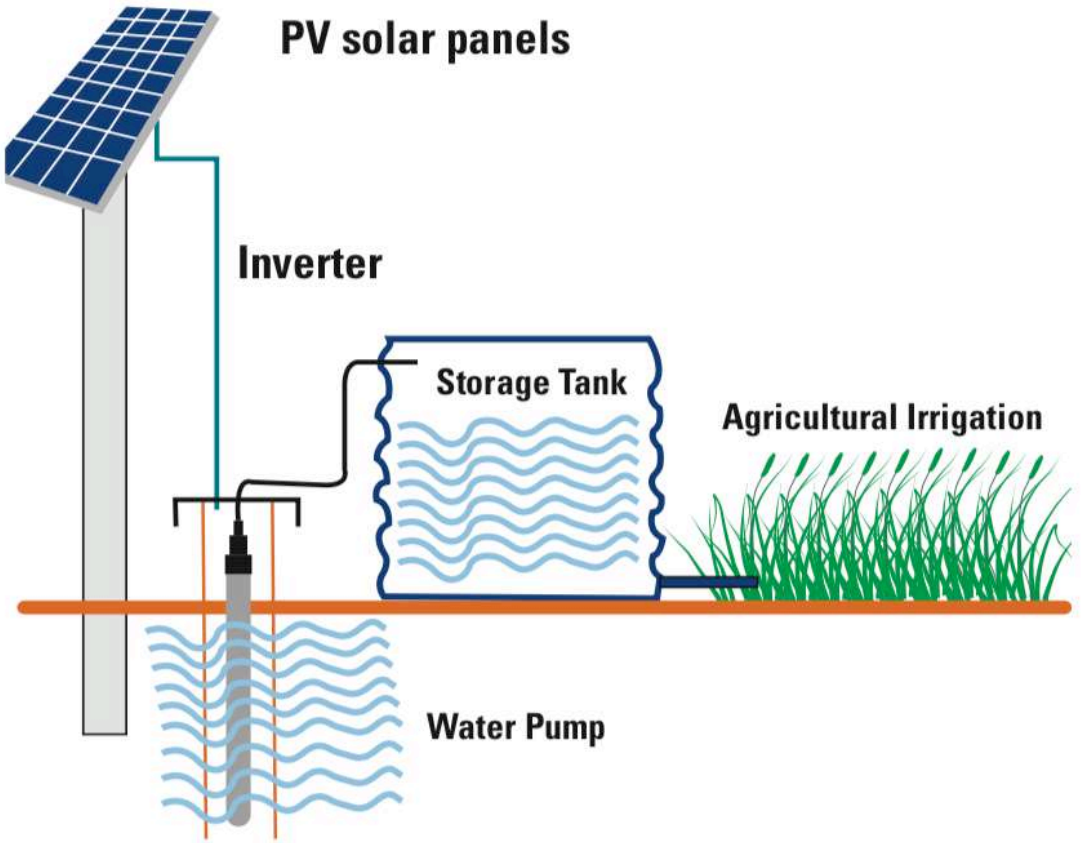
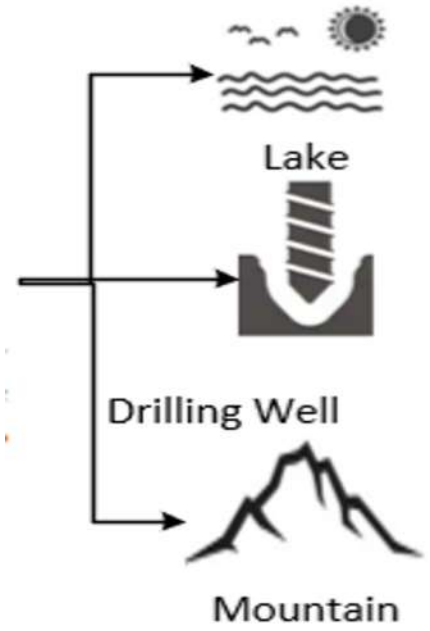


Figure 4. Solar water pumping system. Image credit: Energy and Development Group.

Solar-water-land nexus



Solar Powered Water System



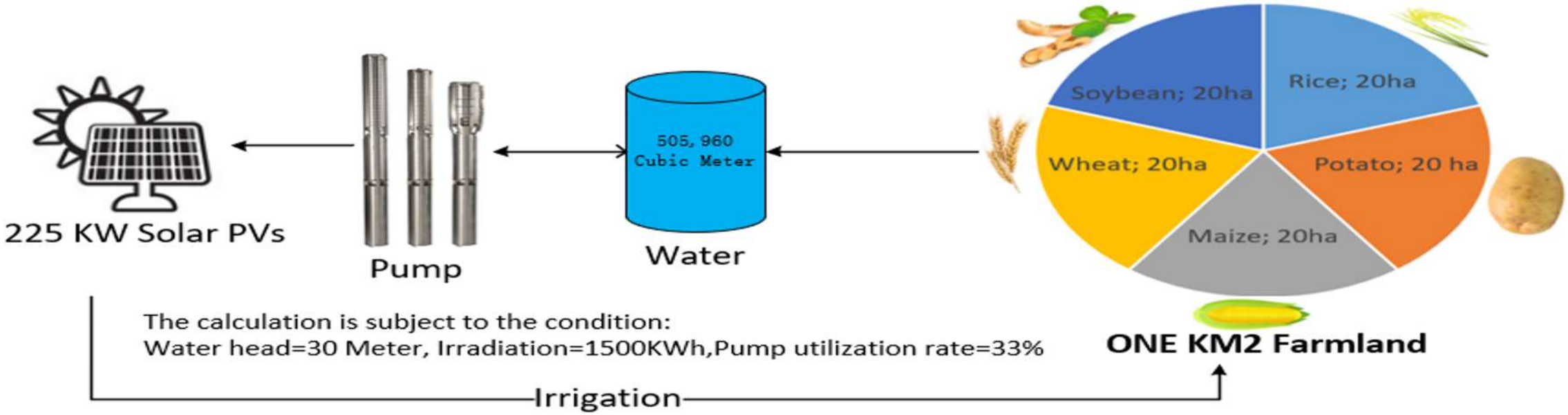
Case	Water Head(m)	Pump Rating(kW)	Flux (m^3/h)
Lake	10	2.2	42,5
	10	5.5	117
	10	11	240
Drilling Wells	50	2.2	8,5
	50	5.5	23,4
	50	11	48
Mountain	200	2.2	2,1
	200	5.5	5,9
	200	11	12

Data:the calculation is based on the parameter of Tianyuan co., LTD.

Factors affecting irrigation area:

1.The underground water level;
2.Types of crops;
3.Pump capacity;
4.Water-saving irrigation technology;
5.Photovoltaic power potential

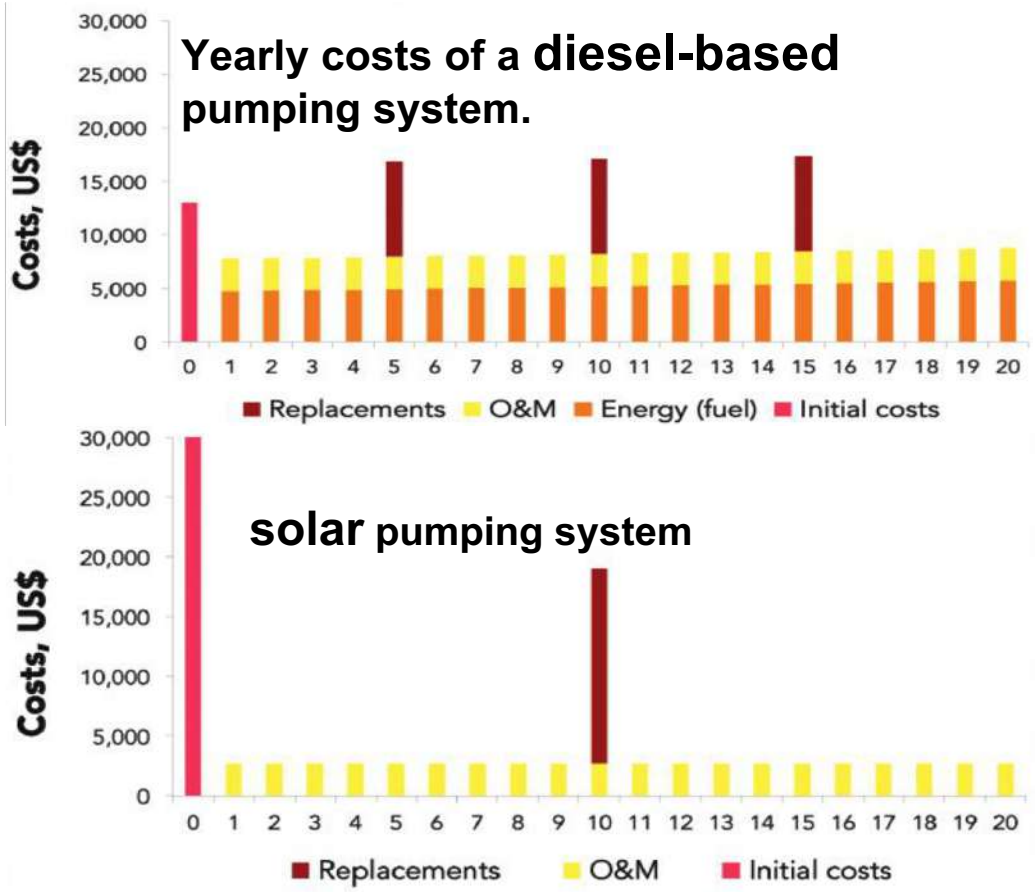
Potential Benefits for Different Crops



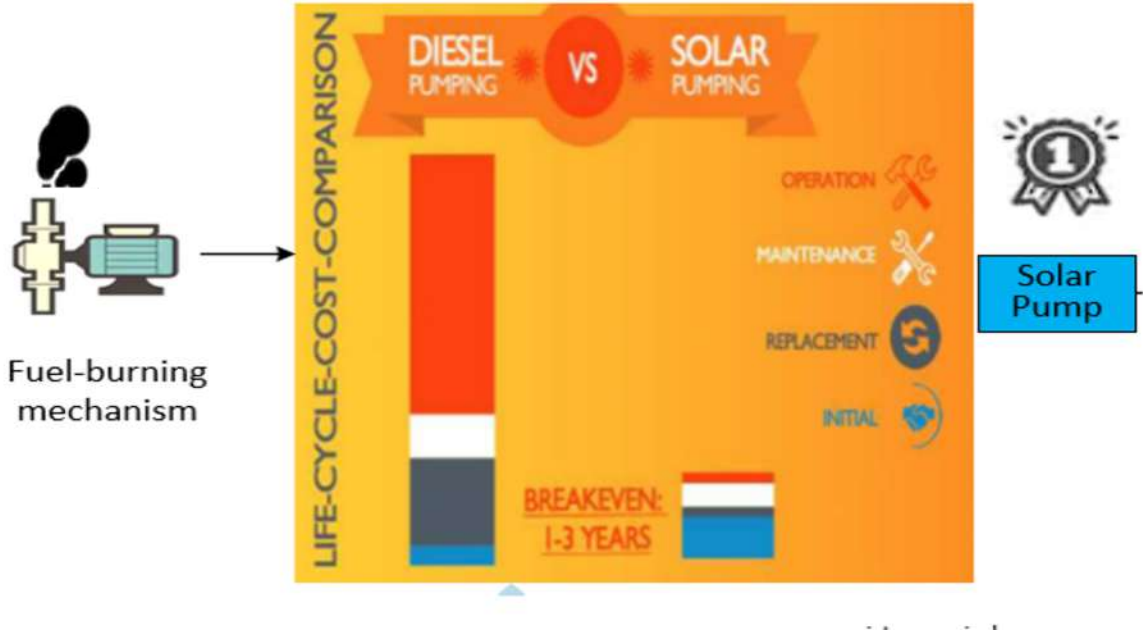
Crops	Yield(ton/ha)	Water(m^3/ton)	Water(m^3/ha/year)	Total Water(m^3/KM^2)	PVs(KW)/ha	PVs(KW)/KM^2
One KM^2 Rice	3.90	1673	6524	652400	2.88	288
One KM^2 Maize	4.47	1222	5462	546200	2.4	240
One KM^2 Wheat	2.74	1828	5008	500800	2.16	216
One KM^2 Soybean	2.24	2145	4804	480400	2.16	216
One KM^2 Potato	59	59	3500	350000	1.56	156

Note: The parameter(Yield, water per ha) in the calculation is based on the report of FAO.

Economic Analysis



Source:(World Bank,2018)



Life-cycle cost analysis

1.Initial costs and installation; 2.Operation and maintenance; 3.Energy; 4.Capital replacements

Pumping systems typically have a 20-year lifespan, higher initial investment(barrier)

- Solar pump will be paid back within 3 years.
- Additionally, solar pumping is more attractive than diesel pump in terms of the **environmental costs from carbon dioxide (CO_2) emissions and lost production costs** from system downtime.

Case1: Solar Pump for Restoration in Ordos Desert

Location

2009

2011

Remarkable transition achieved in 2016

rainfall (mm/year)	evaporation (mm/year)	Solar power kWh/kWp
350	2500	1671

Source:Shenzhen Tianyuan technology co., LTD.

year	solar panels (kW)	head(m)	Water(ton /day)	crops	size(ha)	survival rate	irrigation
2009	3	30	85	watermelon	42.5		micro-spray and drip irrigation
				camphor pine	23	92%	
	controlled group(more than 2 tiimes of water)					62%	traditional pumping and broad irrigation
2011	7.5	30	220	vegetable	809		
				alfalfa and corn	15		

- Solar pumping system was proved to be very suitable in the desert region, it can be used for planting vegetable, fruit, grasses, herbs and other economic crops, which can produce ecological and economical benefits.

Case2: Solar Water Pump and Agriculture in Zimbabwe

- **The average annual temperature in Chinhoyi is 19.8 °C | 67.6 °F. The rainfall here is around 816 mm | 32.1 inch per year.**

year	solar panels(kW)	head(m)	Water(ton/day)	crops/livestock	size	irrigation
2012	3.2	25	30m^3/day	green peppers, canola, kale, spinach, tomatoes, beans, other vegetables.	4.5 acres	drip irrigation
				broiler chickens	4000	

- The system generates 2,628 KWh annually.
- The photovoltaic irrigation project directly created 11 jobs for the town and was also beneficial to the local vegetable vendors working in downstream industries.

Source:Shenzhen Tianyuan technology co., LTD.

Challenges in No-electricity Communities

- Limited access to healthcare services and medicine
- Riskily exposed to malaria, tuberculosis and other diseases
- Lack of public health awareness and medical knowledge

- Backward education facilities, e.g. no electricity
- Low-effective learning environments

- Lacking access to safely managed sanitation facilities
- Lacking access to safely managed drinking water services
- Lacking access to basic sanitation services, such as toilets or latrines

* **900 million people** lack access to clean cooking. (Africa Energy Outlook 2019, IEA.)

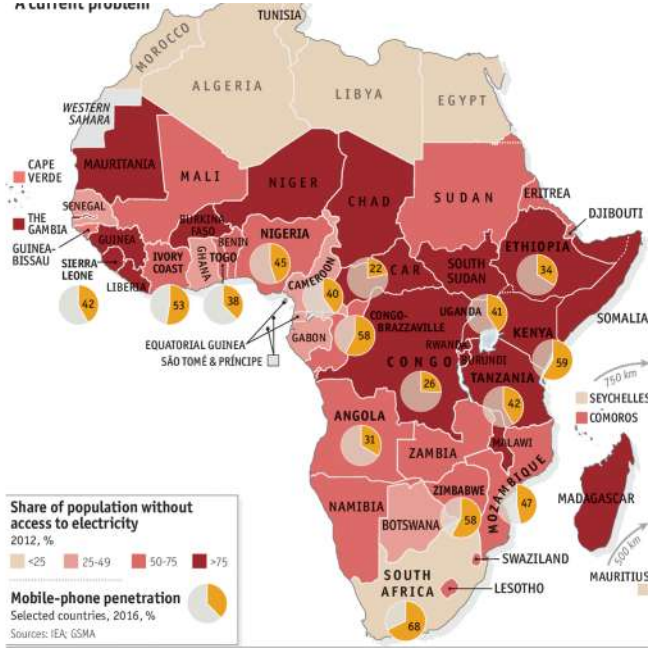
* Two most commonly used fuels for cooking are **wood (deforestation) and farm residue**, representing **74% and 12%** respectively. (Adkins, 2012)

* Use of polluting fuels such as coal, wood for cooking and indoor space heating cause severe **Household Air Pollution** which negatively affects human health. (Buthelezi, 2019)

- Lacking access to modern electricity
- Relying on wood, coal, charcoal or animal waste for cooking and heating
- Limited access to affordable, reliable and modern energy services

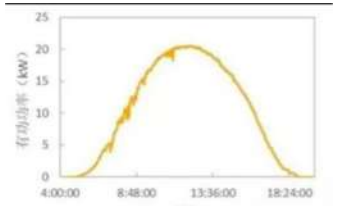
Solar Energy Changes Community Life

Clean
Health
Sustainable



Share of population without access to electricity in Africa

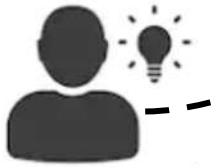
Source: economist.com, 2017



Solar Battery

(Photo: Sia Kambou/AFP/Getty Images)

Brighten Your Life with Solar Energy



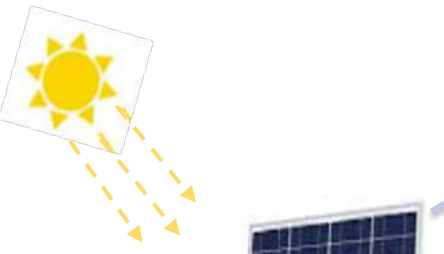
0.7 m² Solar Panel
100 Wp
150 kWh/year

13% of the global population lacks access to modern electricity, especially in Sub-Saharan Africa, 50% of the people live in the dark. (Source:https://www.un.org/sustainabledevelopment/energy/)

Power grid is expensive and unavailable.

Solar energy is affordable, clean, sustainable and easily available !

Solar Empowers Family



Solar Battery

1.Lighting
2.Reading lamp
3.TV
4.Phone
5. Radio
6. Fan
7. Anti-mosquito lamp

Basic Model

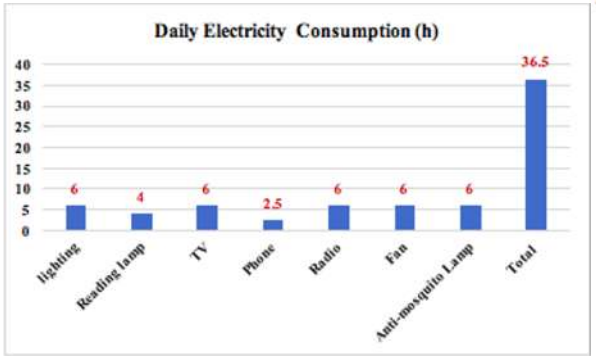
8. Computer
9. Refrigerator
10. Electric bicycles
11. Motorcycles

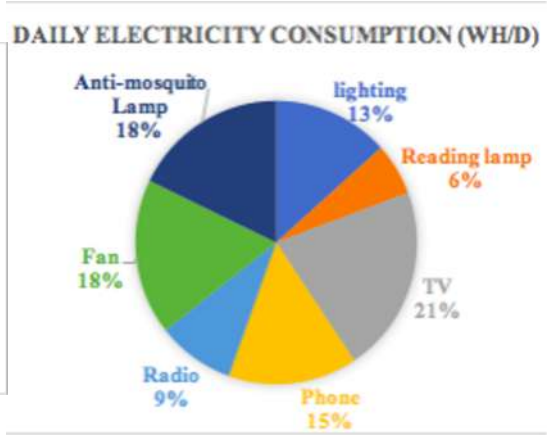
12. Cooking

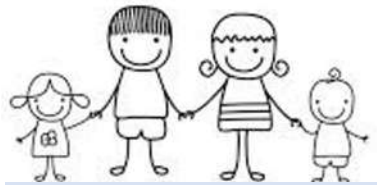
Upgraded Model

Basic Model: Daily Electricity Consumption (Wh/day)

	Lighting	Reading Lamp	TV	Phone	Radio	Fan	Anti-mosquito Lamp	Total
Capacity	2.5 W	5 W	12 W	10 W	5 W	10 W	5 W	
Number	3	1	1	2	1	1	2	
Duration	6h	4h	6h	2.5h	6h	6h	6h	
Total (Wh/d)	45	20	72	50	30	60	60	337







One Family:
400 Wp; 600 kWh/year

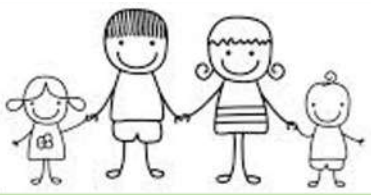
Basic Model: 337 Wh/day

Two solar panels can support a family's daily life ! ($ 336)

Upgraded Model:
Family with Modern and Convenient Household Appliances

Upgraded Model: Daily Electricity Consumption (Wh/day)

	Computer	Refrigerator	E-bicycle	Motorcycle	Basic Model	Total
Capacity	60W	300	250W	300W		
Number	1	1	1	1		
Duration	5h		1h	1h		
Total (Wh/d)	300	300	250	300	337	1187-1237



One Family:
400 Wp; 600 kWh/year

Upgraded Model: 1187-1237 Wh/day

Eight solar panels guarantee a family's modern life!

“Solar +” and Sanitation & Public Health

Photo: Google image

Anti-mosquito Lamp

Reducing the transmission of malaria, tuberculosis and other diseases

Photo: UN SDGs

No Clean Drinking Water

Solar Water Purification

Accessing to safely managed / health drinking water services

Photo: UN SDGs

Limited Access to Healthcare Services and Medicine

Solar Vaccine Refrigerator

Electric Bicycle with Medicine Cabinet

Accessing to medical resources and services, such as vaccine

Photo: Google image

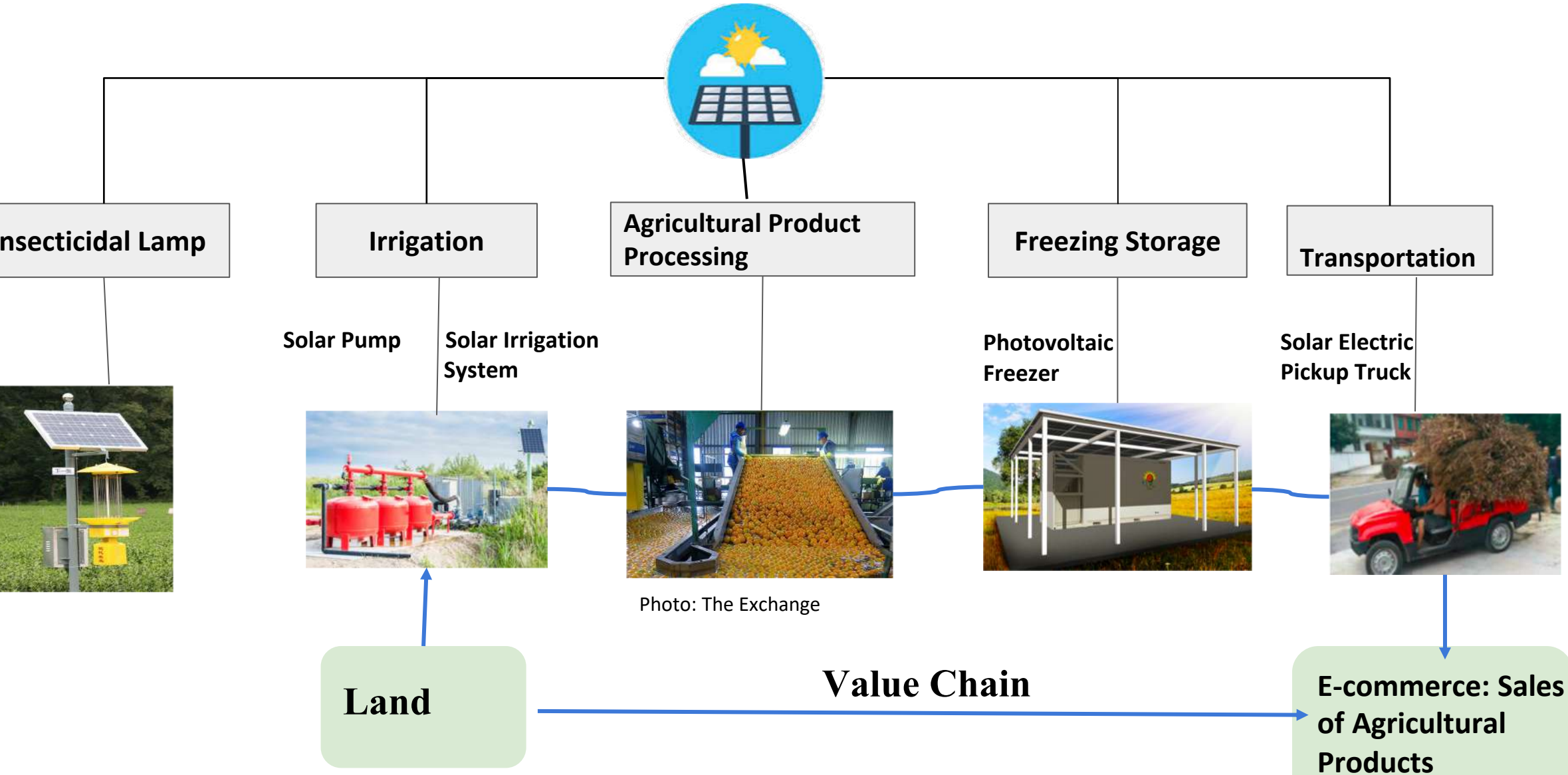
Outdated Medical Facilities

Photo: Poly Solar Technologies CO., LTD

Solar Clinic

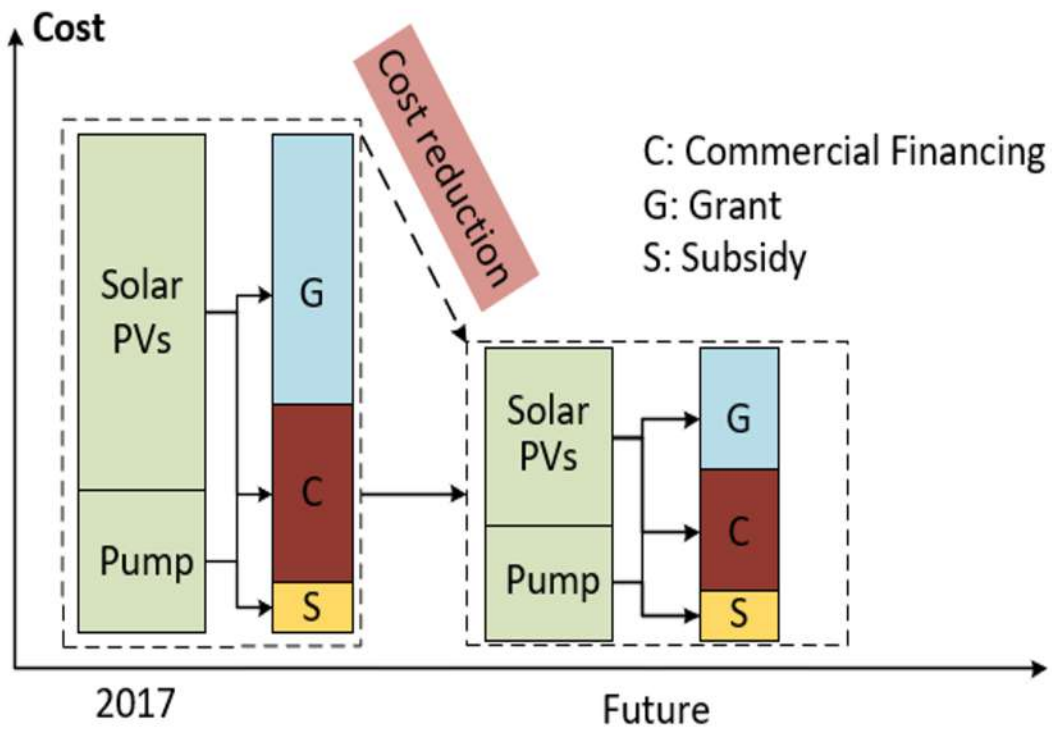
Accessing to clean and modern medical facilities

Solar Power Agricultural Facilities and Extended Value Chain



- The use of solar energy in agricultural production, agricultural product processing and storage has increased the agricultural value chain.
- The e-commerce of agricultural products further extends the value chain which goes beyond space constraint.

Finance Model for Solar Powered Irrigation Systems(SPIS)



Case: Solar Photovoltaic Pumping Systems for Agricultural Irrigation Project in Bangladesh (2014-2017)

Total Finance: $55.442 M

Loan: $20 M from ADB (36%)

Grant: $25.442 M in total, $22.442 M from SCF-SREP, $3 M from CEF (45%)

subsidy:$8.1 M from BREB and the government (19%)

CEF:Clean Energy Financing Partnership Facility

BREB:Bangladesh Rural Electrification Board

SCF-SREP:The Strategic Climate Fund-The Program for Scaling-Up Renewable Energy in Low Income Countries

Source: ADB.Feasibility Study-Proposed Bangladesh: Power System Efficiency Improvement Project (Off-grid Solar Pumping Component).2017.

- The cost of PV has dropped significantly compared to the last decade.
- The cost of SPIS system has been thus greatly reduced and its cost-effectiveness has been significantly improved.
- The percentage of the grant will drop down,making access to finance easier.
- Establish a measurable market mechanism for the ecological public goods.

Business Model for Deployment of SPIS

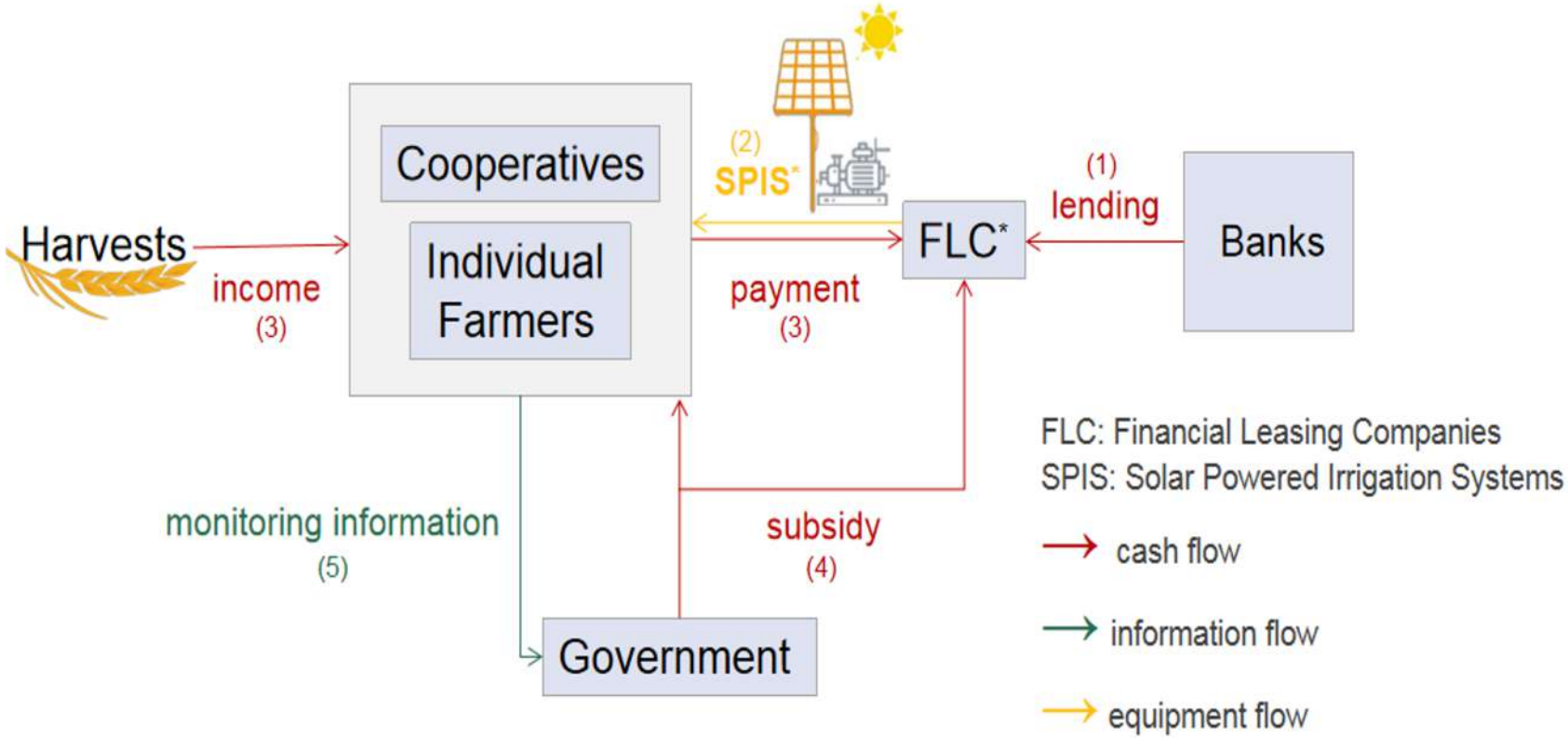
The introduction of financial leasing companies makes access to finance easier

1)Financial leasing companies buy SPIS from the vendors in bulk and access loans from the banks.

2)SPIS are leased to cooperatives with several farmers or individual farmers by FLC.

3)Farmers pay small monthly instalments during the growing season and more after the harvest.

4)Government subsidizes to farmers and FLC



5)Government can optimize policy to manage water and soil, according to the information provided by the monitoring system integrated in SPIS.

Thank you

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