Week 7, October 17

Impact of Renewable Energy on Development of Alpine Villages in Nepal

Fall 2017

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Department of Mechanical and Aerospace Engineering
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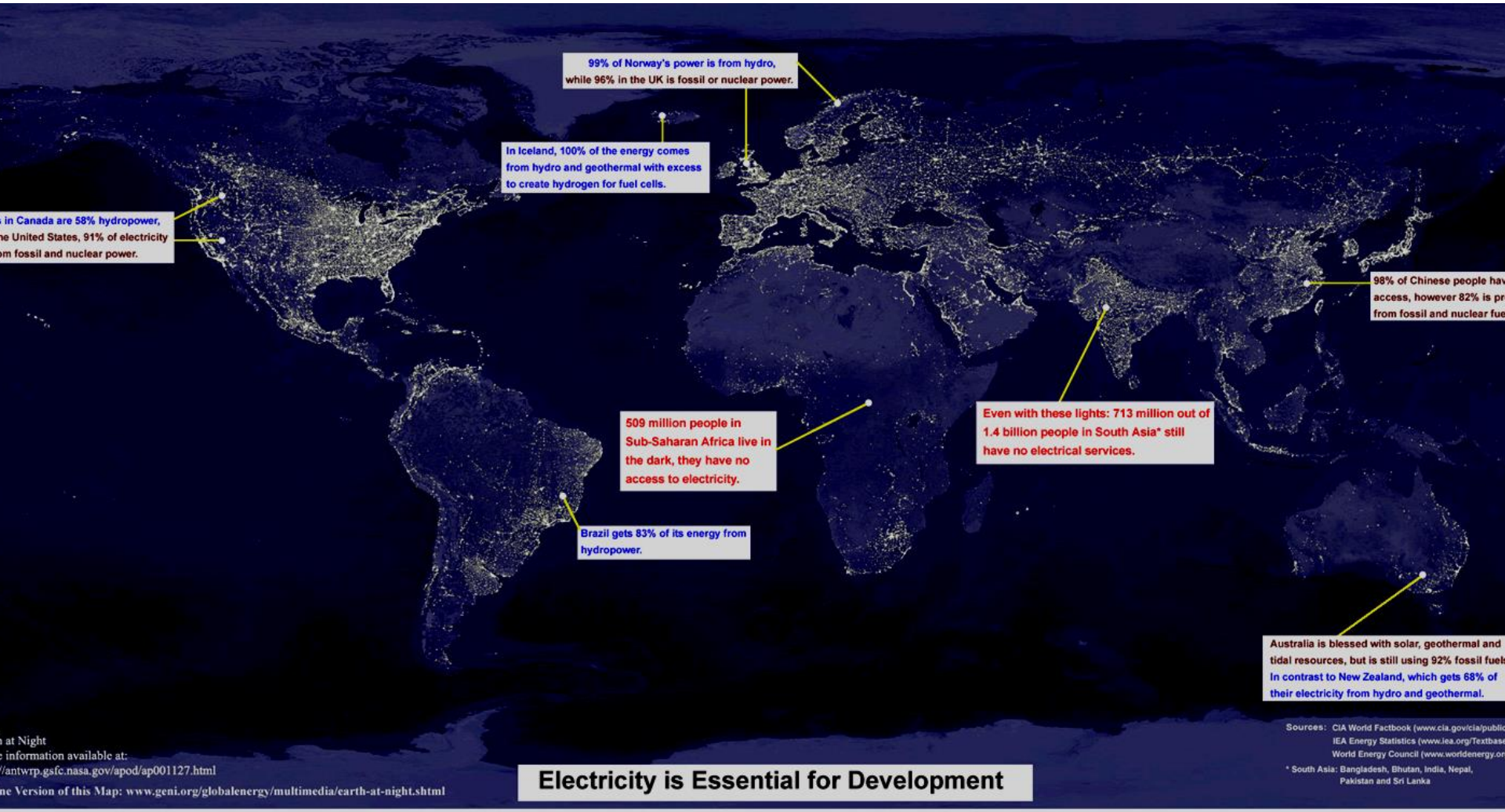
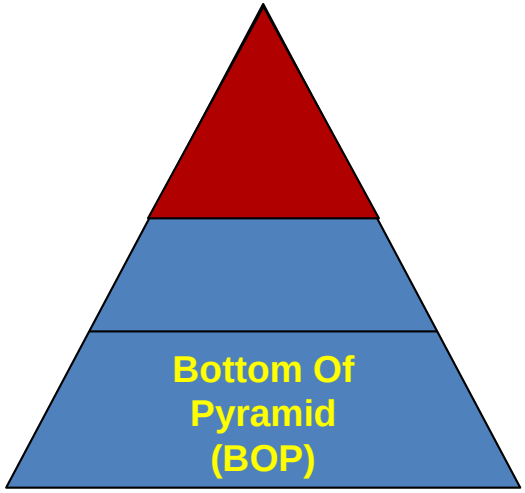
Issues of the world

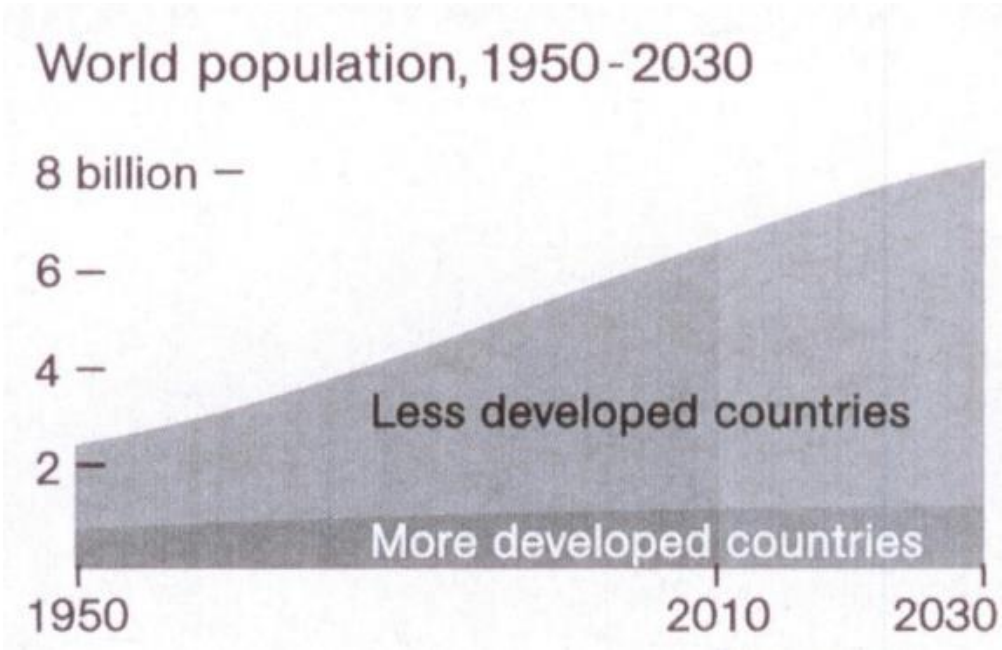
2,000,000,000 people live without electricity



Population-Energy-Environment issues



About 50% of world population live using less than 2 US$/day



These are very urgent and important problems for you to solve!

Why did we go to Nepal?

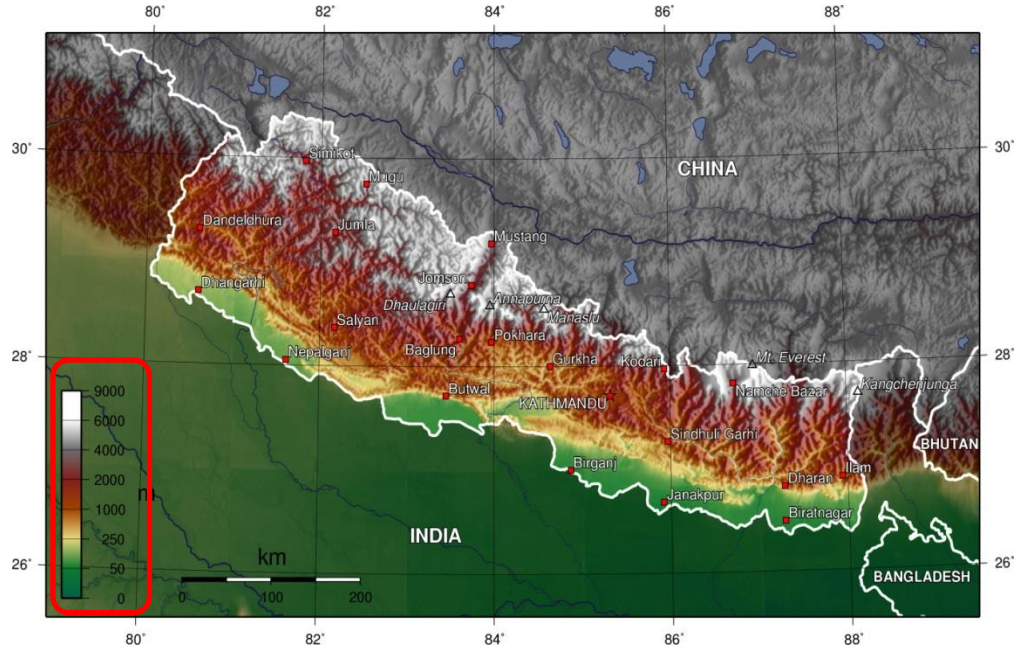
Talking with Nepali student Binayak Bhandari

Start from the discussion at Christian Fellowship at Department of Mechanical and Aerospace Engineering, 2010

Understanding about Nepal

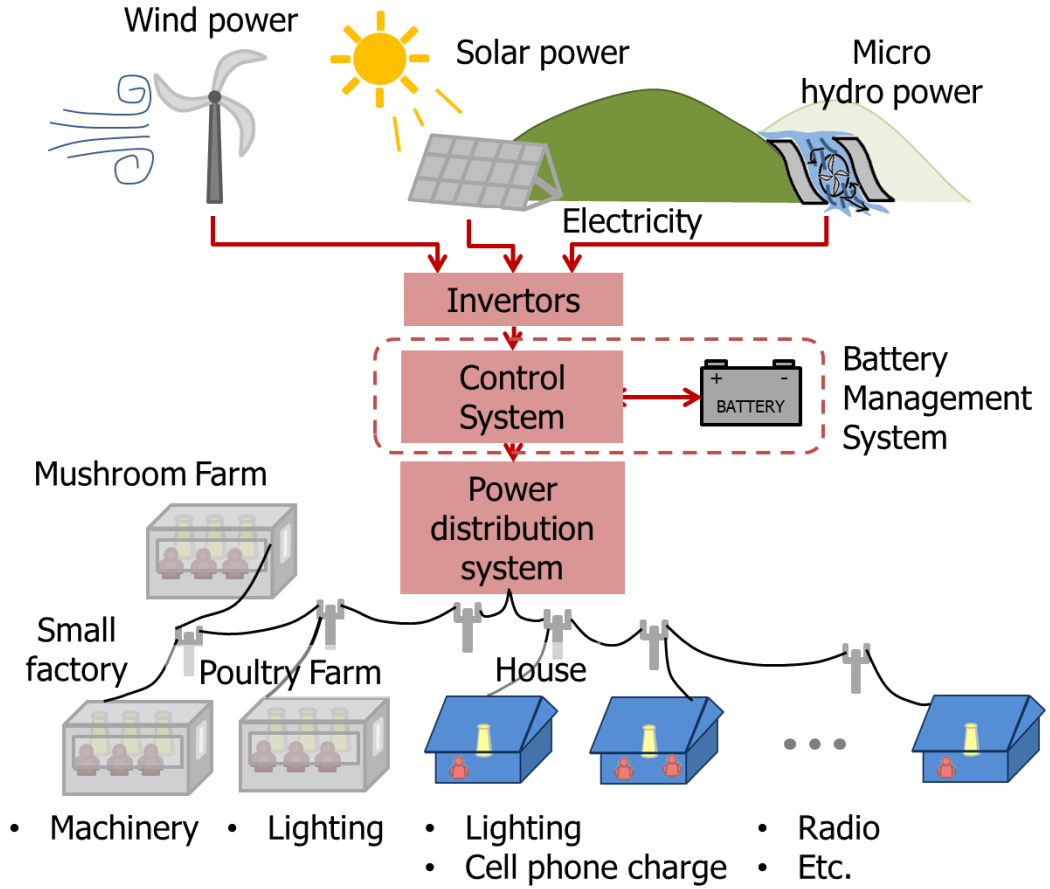
- 8 of the 10 highest mountains including Everest Mountains are in Nepal
- Average income per person : 1,200 US$ /year
- Population : 30 million (80% of population live in rural areas, scattered small villages in highlands)
- Electricity is not provided to large areas due to weak geographic accessibility
- Lack of infrastructures such as road, hospital, education.

Study at home in highland of Nepal



Vision of project

- **Electrify highland villages in Nepal using hydro-solar-wind power**



Select Target Village

- **Condition**
  - First, select 4 **highland villages** which are **difficult to access**
  - Small village which has around **10~20 number of houses** and to which it would be hard to provide electricity within the **next 10 years**.

- **Final selection of 1st target area**
  - Lama hotel
    - Located at **2,500m altitude** in the Langtang National Park
    - **Electricity is not provided** and it would not be provided within the next 10 years.
    - 10 hour from Kathmandu by car and 12 hour by foot.

SNU Nepal-Solar Volunteer Corps

Director & Prof. Sung-Hoon Ahn

Gil-Yong Lee
Ph.D. Candidate

Binayak Bhandari
Ph.D. Candidate

Kyung-Tae Lee
Ph.D. Candidate

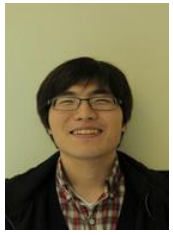
Hae-Sung Yoon
M.S. Candidate

Dong-Hyun Kim
M.S. Candidate

Jong-Seol Moon
M.S. Candidate

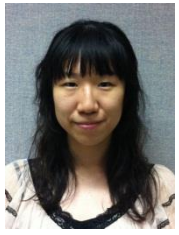
Sung-Hyuk Song
M.S. Candidate

Won-Jong Eun
Undergraduate



Sung-In Kim
Undergraduate

Sun-Kyung Yu
Undergraduate



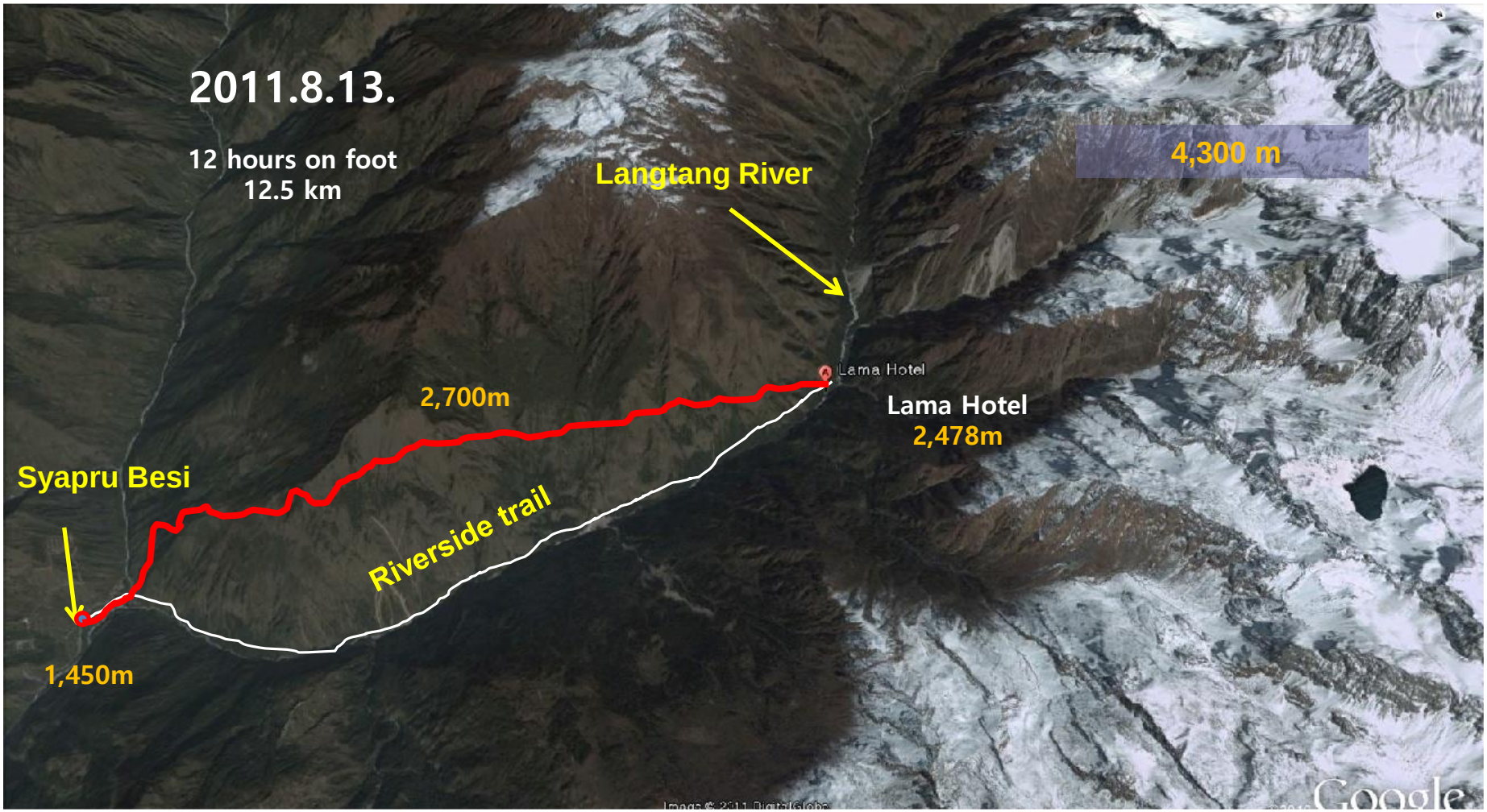
Hye-Seung Jeong
Undergraduate

Yoon-Ho Kim
Undergraduate

Hak-Chan Kim
Undergraduate

Move to Syapru Besi – August 12th

Route to Lama Hotel



Move to Lama Hotel – 8 AM ~ 8 PM

Participants

- Seoul National University : 14 people
- Kathmandu University : 5 people
- Mechanical, electrical engineers : 2 people
- Villager : 20 people
- Porter : over 70 people (2 horses)

  Deliver solar penal modules, batteries, frames and other materials

- Total over 110 people

Indoor Electrical Construction

Solar Panel-Controller-Battery Connection

The First Electric Light in the Kitchen

Power Generator Handing-over Ceremony at 9PM, Aug. 16th, 2011

2nd Visiting – Rimche and Lama Hotel

October 15~20, 2011

Lama Hotel

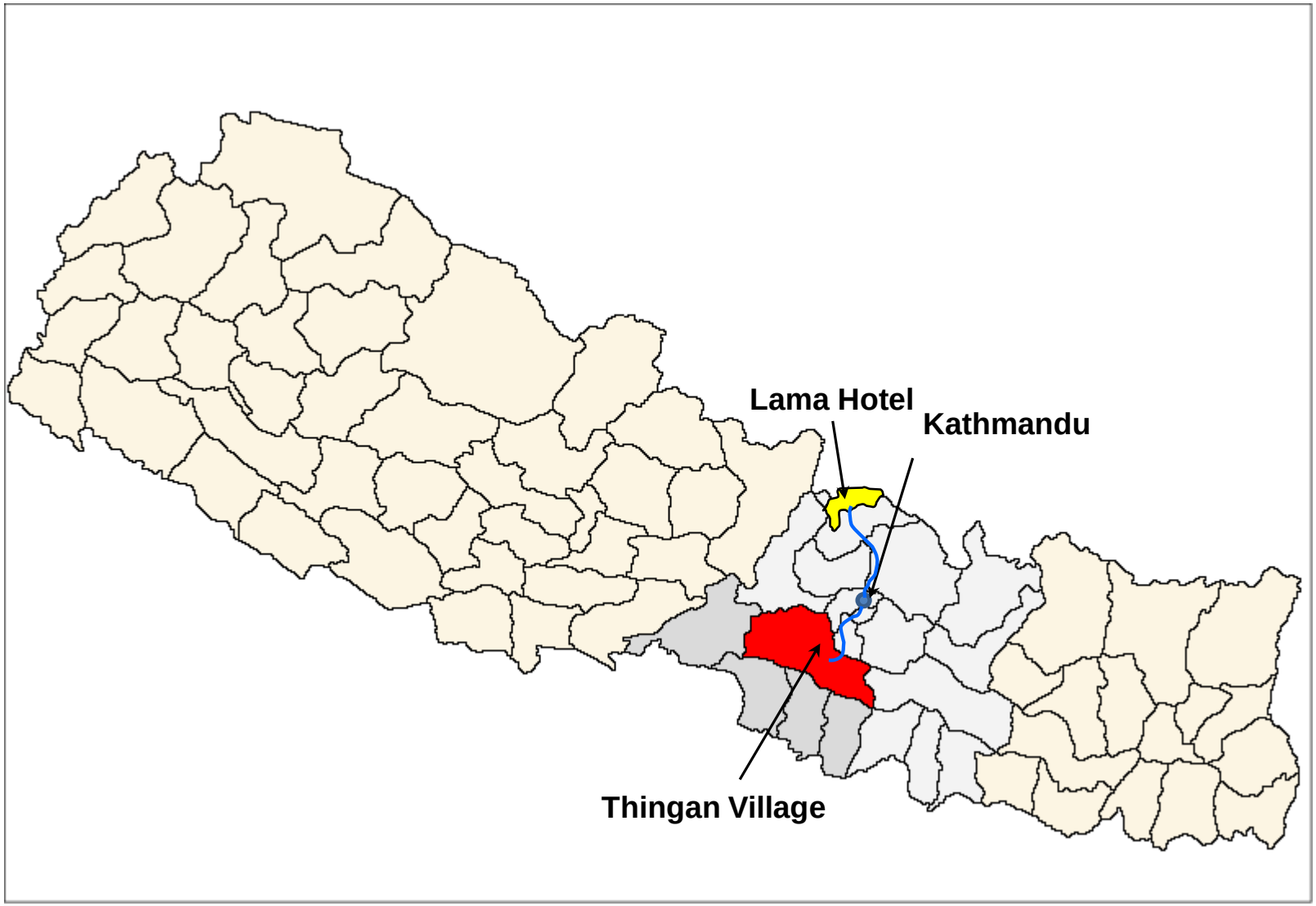
Rimche

Sustainability by electricity

- **Key for sustainability**
  - Increase in income
  - Sustainable business model
  - Continuous support

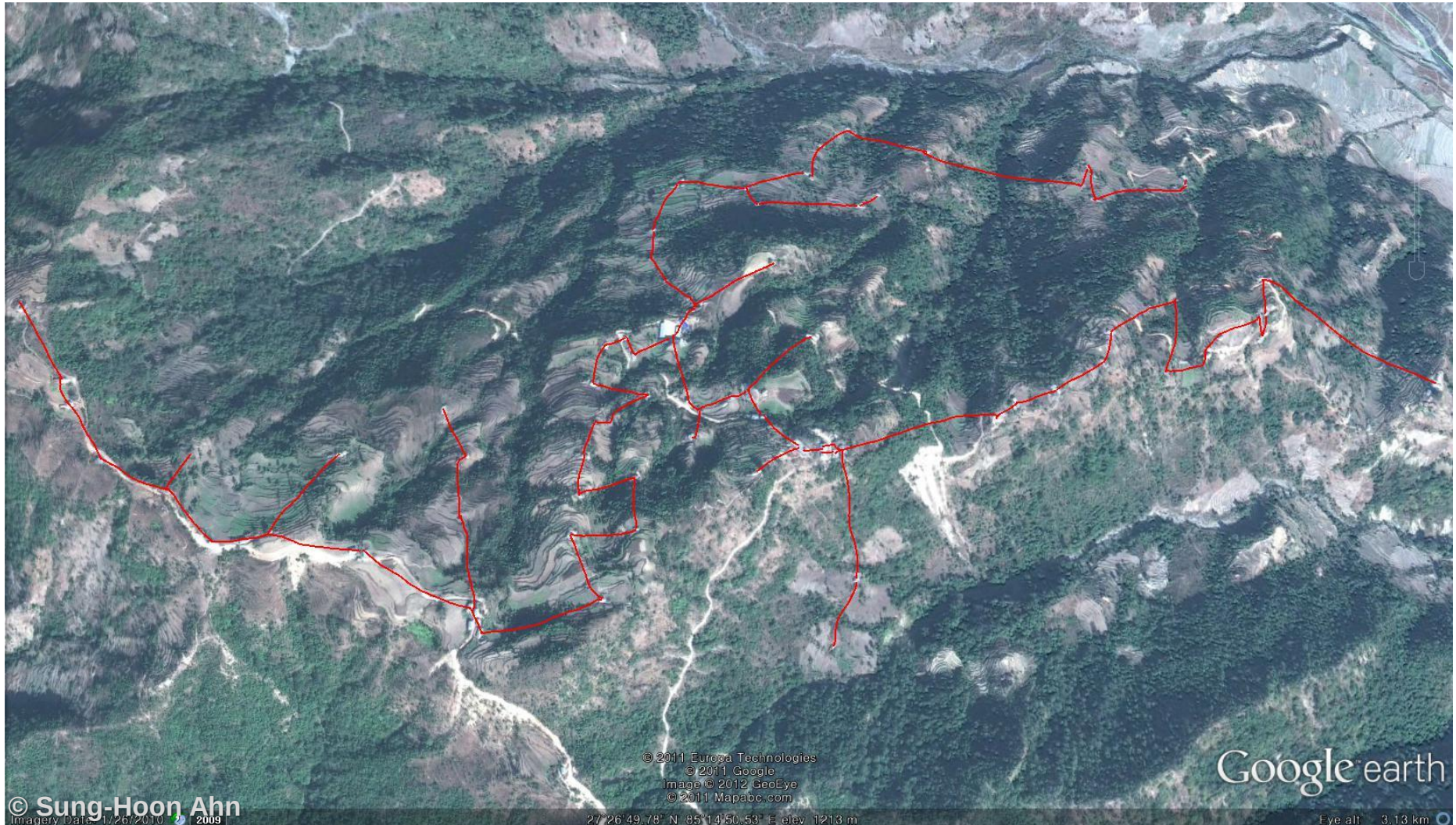
Before electrification	After electrification
Single bed (NRs. 300/night)	Single bed (NRs. 400/night)
Phone (Sometimes)	Phone (Regular)
Camera battery charge (not possible)	Camera battery charge (100/battery)

3rd Volunteer Activity Spot : Thingan Village



Area of Construction

- Map of houses and electric power grid on 2 square kilometers area in Thingan



Result of 3rd Volunteer Activity

- Feb. 13, 2012 ~ Feb. 15, 2012 at Thingan
  - Village located at 27°26′36.36″ N, 85°14′42.43″ E and 1,354 m altitude.
- Facility: 5 kW solar power generation
  Electric power grid (69 electric poles and 57 houses outdoor wiring)
  290 LED Lights, LED chicken farm,
  Library(laptop, beam projector, around 700 books)
- Cost: around 120,000 US$
- Beneficiaries: 57 number of houses in rural areas, polices and others. Around 400 villagers.

Thingan village

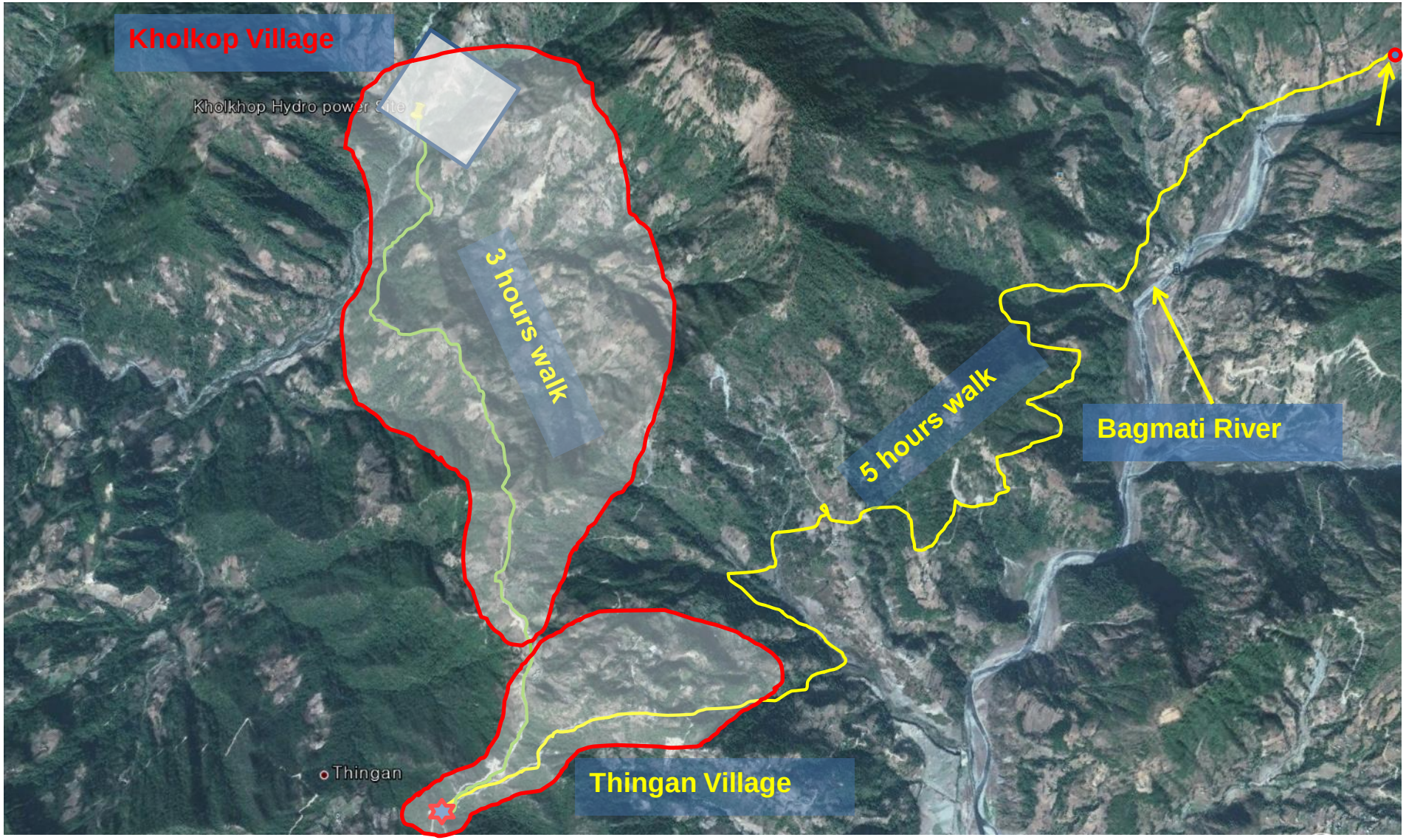
5kW solar panel

Construction of frames

Village representative

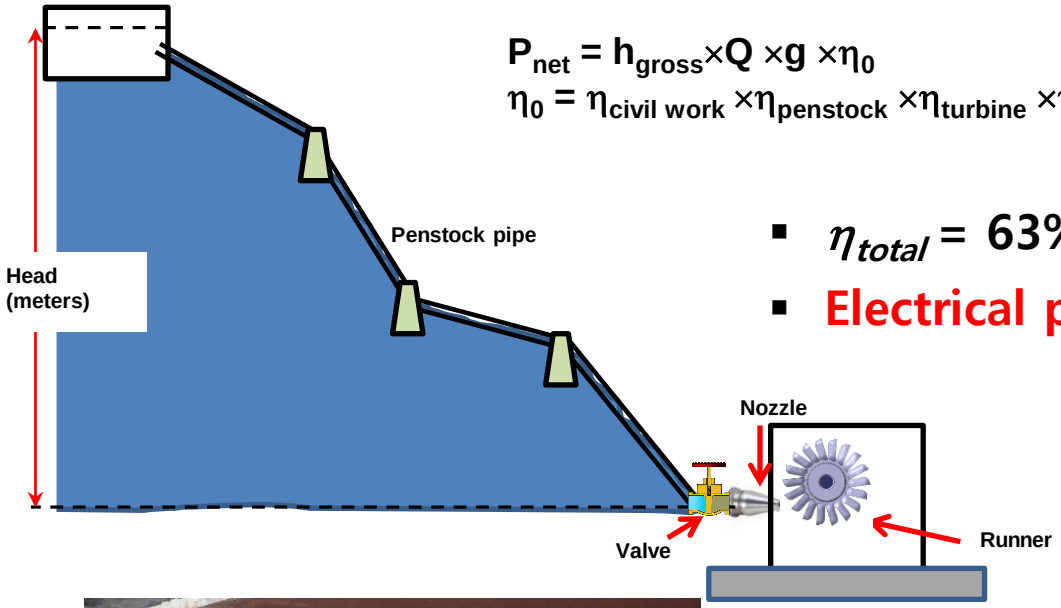
Batteries

4th Volunteer Activity Spot - Kholkop village24



Design Hydro Power Plant and Casting

Hydro power = converting power from water (head and flow) to electricity

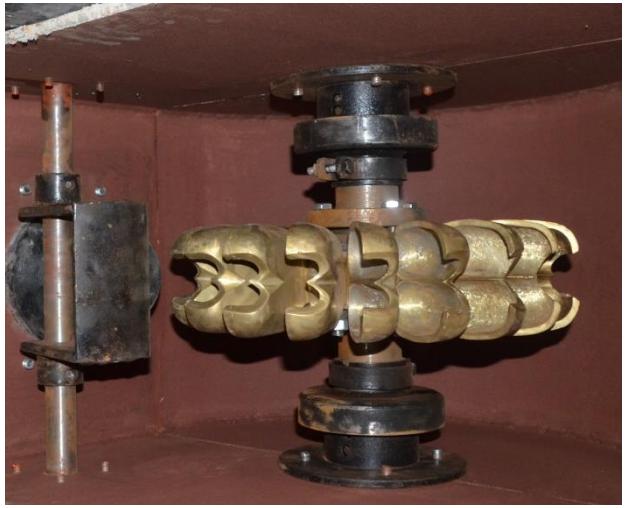


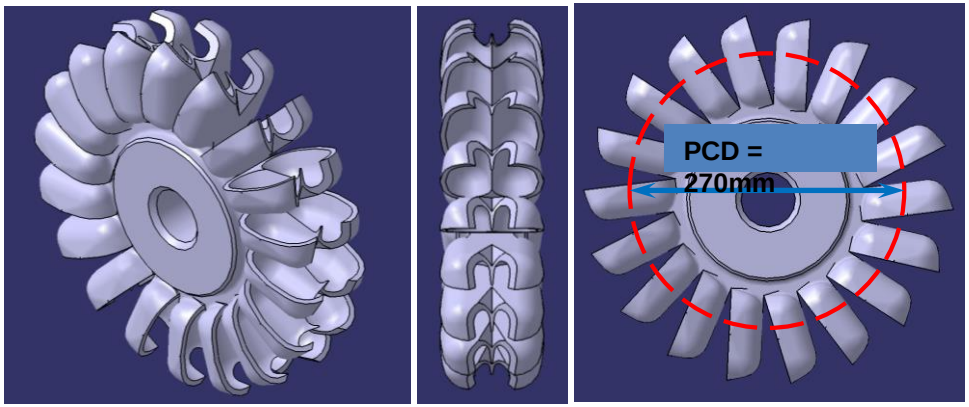
$$P_{net} = h_{gross} \times Q \times g \times \eta_0$$

$$\eta_0 = \eta_{civil\ work} \times \eta_{penstock} \times \eta_{turbine} \times \eta_{generator} \times \eta_{line} \approx 0.5$$

- $\eta_{total} = 63\%$
- **Electrical power output ≈ 21 kW**

Penstock Pipe





Pelton Turbine Design

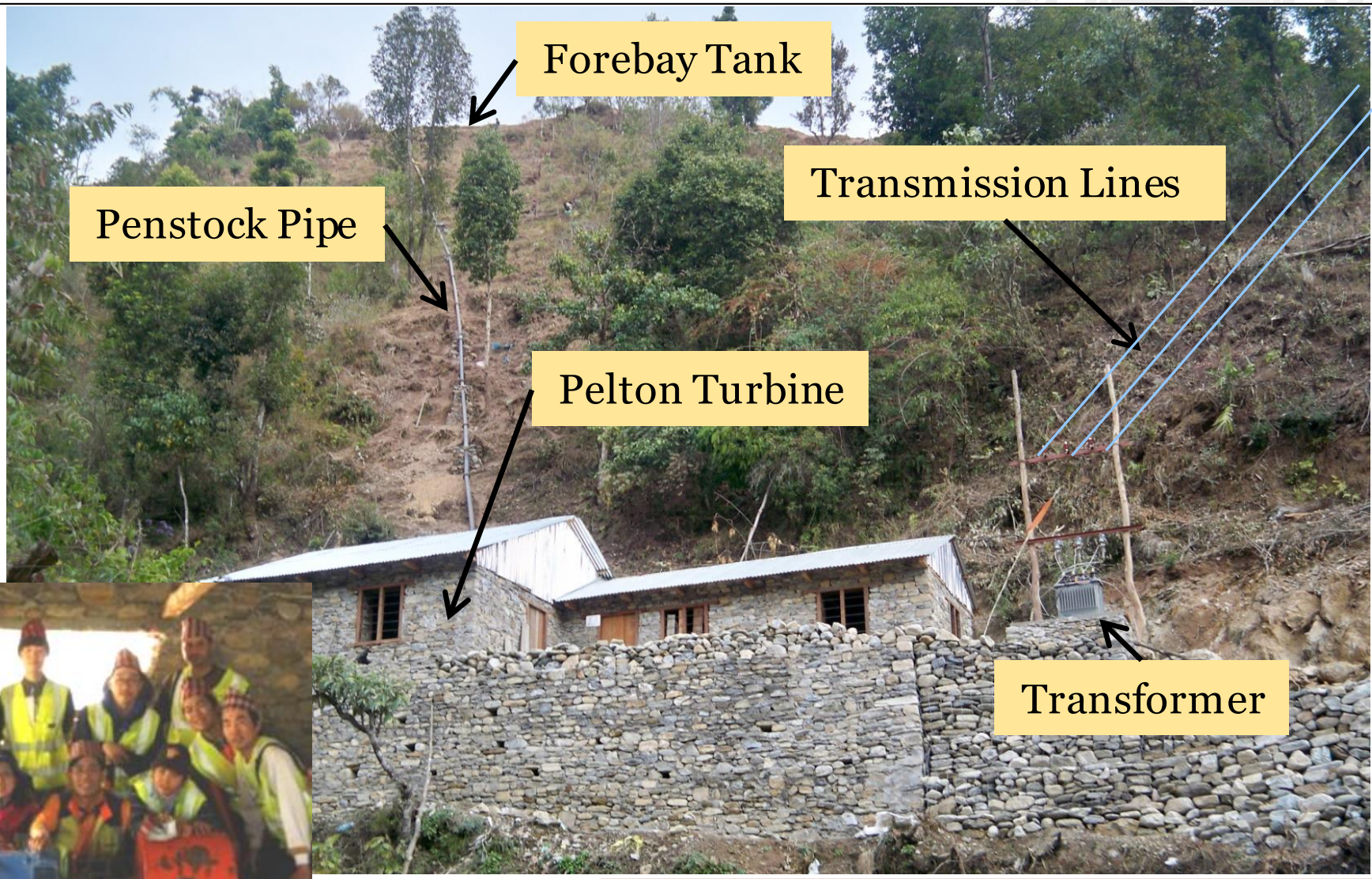
Project launching at Kholkop

Construction of hydro power house

In the middle of construction

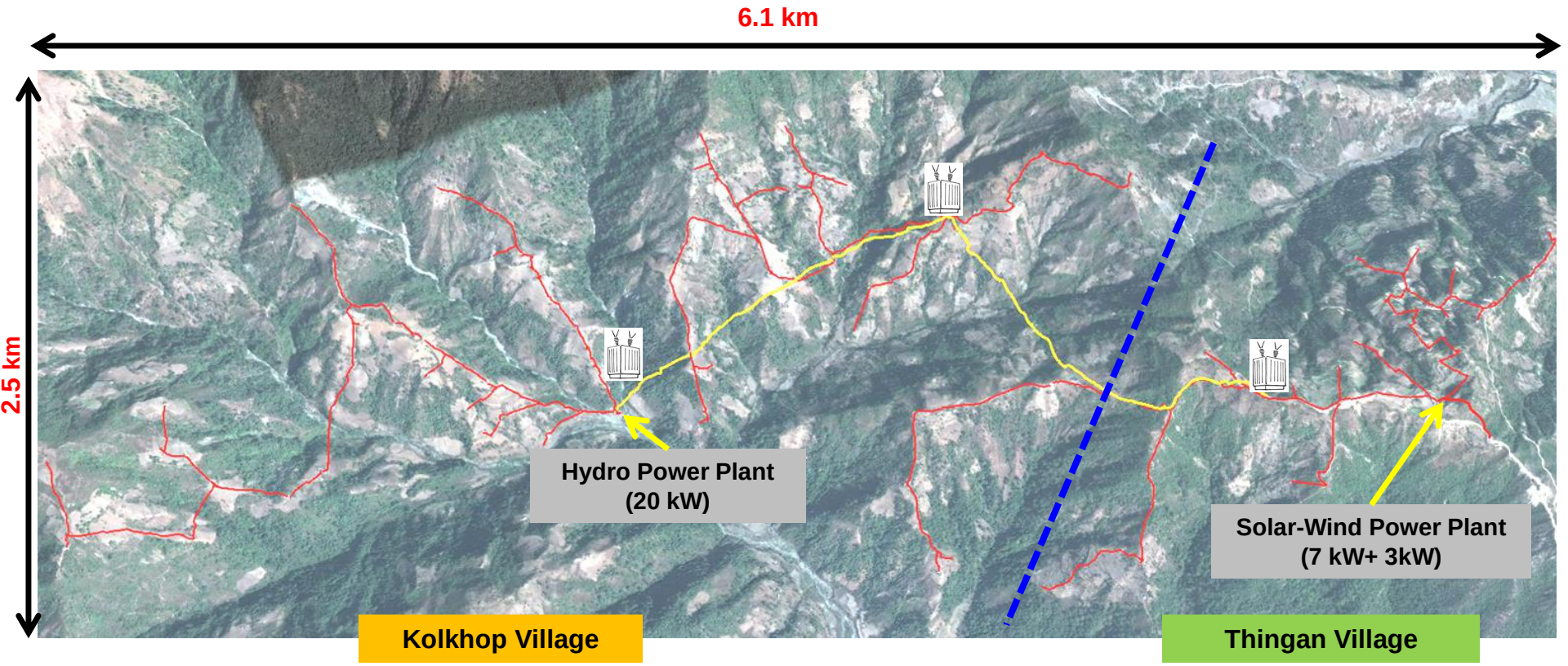
3 kW Wind Power Generator

20 kW hydro power plant



Miteri (Friendship) Power Plant @ Thingan

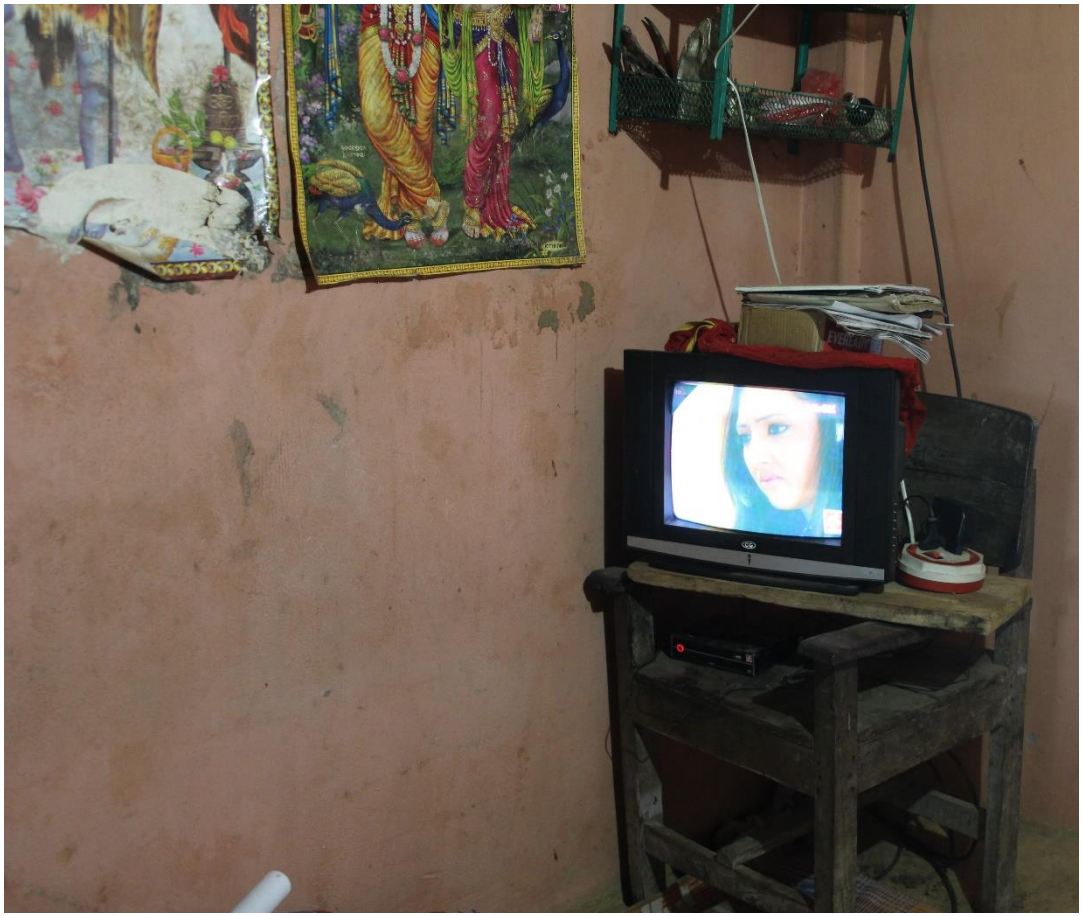
Electrified Thingan and Kolkhop villages



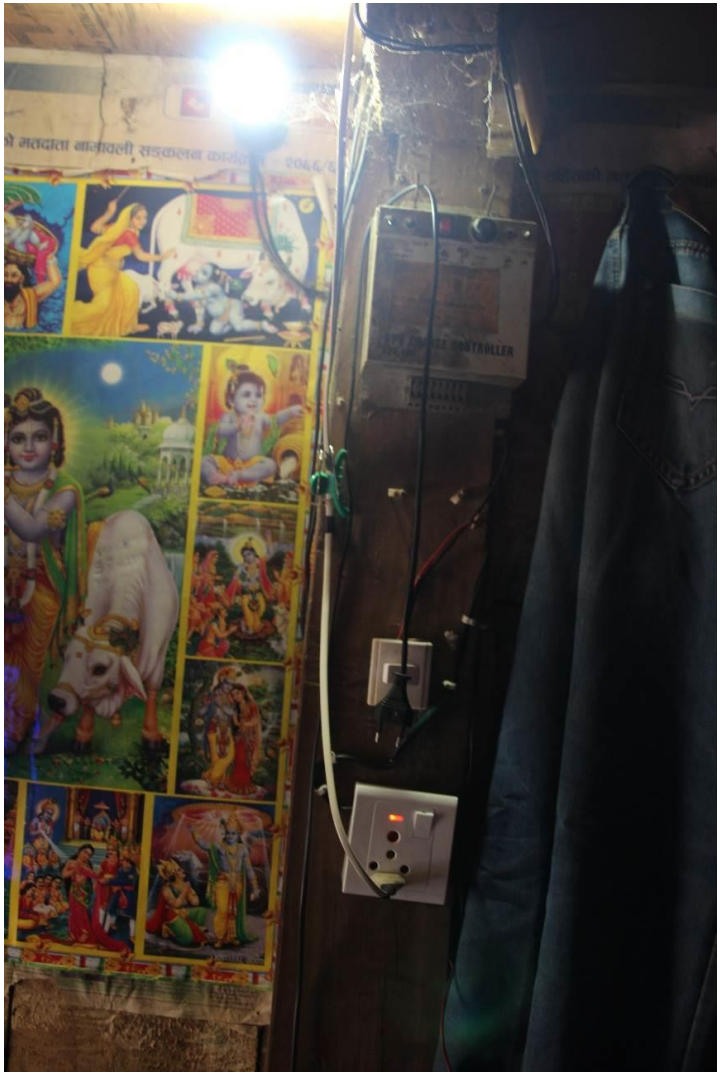
173 Houses, 1200 persons 1 Police Station 1 Health Post 2 Schools	Cottage Industry Chicken farm Library Church	11000 Volt AC 220 Volt AC	Transformer

Use of electricity (Chicken Farming)

Electronics



Color television @ villagers home



Various electronic gazettes

Health post

More work hours

Employment of operators (2 families)

Living Space – Heating, Insulation, Ventilation Problem

Ondol Experiment - Hadong

First Ondol at Nepal

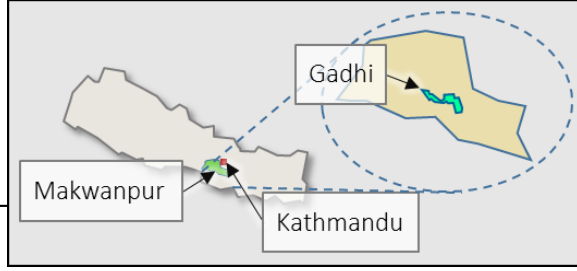
Ondol installed in 50 houses

5th Volunteer Activity - Wind turbine in china






6th Volunteer Activity – Vaccine Delivery System in Nepal

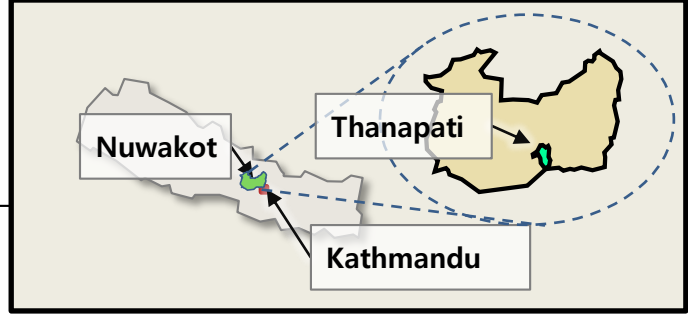


- Period: 2015.01.26 – 2015.02.03
- Place: Gadhi, Makwanpur, Nepal
- Participants: 200 volunteers (Volunteers in Korea: 26; SNU, Hanyang Univ., IVI)
- Installation: **17 kW Hydropower generator**, electric wiring in houses (65 households), LED lights, Ondol (1 holusehold), Ginger Powder Manufacturing System
- Other Activities: Medical treatment (Residents , vaccination, Science camp

6th Volunteer Activity – Vaccine Delivery System in Nepal

6th Volunteer Activity – Ginger Powder Manufacturing System in Nepal 45

7th Volunteer Activity



- Period: 2015. 6. 15. ~ 2015. 7. 22.
- Place: Thanapati, Nuwakot Nepal
- Participants: 50 volunteers (SNU, Kathmandu Univ.)
- Installation: **1 kW hydropower generation system, 3kW Solar PV**
- Beneficiaries: Elementary school and residents (200 people)


Solar energy generator


Frame setting for Solar PV

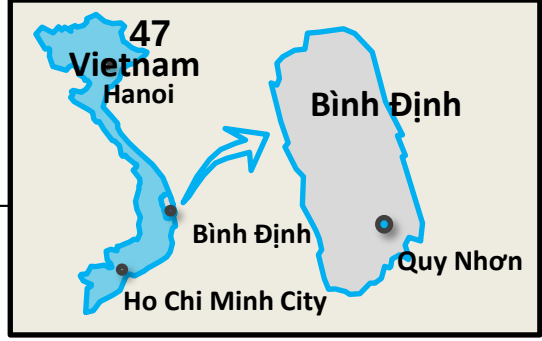

Install Hydropower generator


Installed Solar power generator


Hydropower generator


The village with lights

8th Volunteer Activity



- Period: 2015. 8. 6 ~ 8. 11
- Place: Quy Nhon, Binh Dinh, Vietnam.
- Participants: 60 (SNU, Korea Hydro & Nuclear Power, Global Solar volunteers)
- Installation: BioSand Filter, Water-cleaning facility (12Ton) , 3 kW Solar PV
- Other Activities: Teaching aids for elementary school, education about water resources


Rainwater storage system


Volunteers and School students


Cleaning sands for BioSand Filter

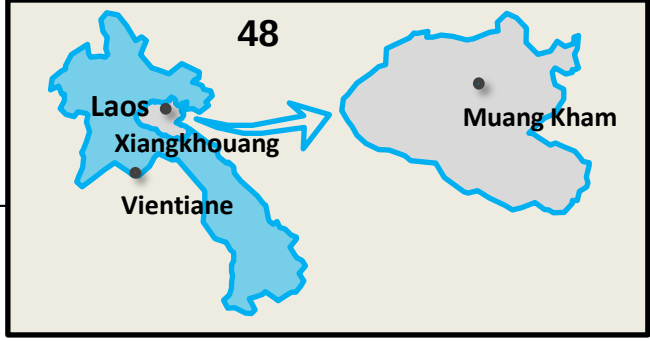

Installed BioSand Filter


Installed solar power generator


Solar PV controller


Water-cleaning facility

9th Volunteer Activity

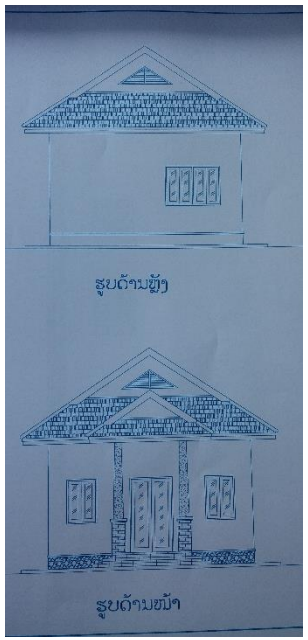


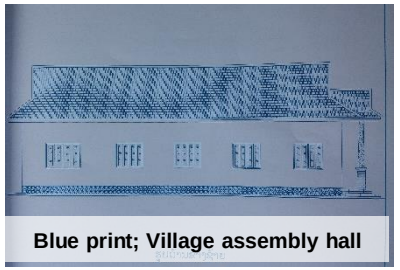
- Period: **2015. 8. 6. ~ 2015. 8. 11.**
- Place: **Dok Kham village**, Xieng Khouang, **Laos**
- Participants: 20 (SNU, Global solar volunteers)
- Installation: **Construct Village assembly hall 60 m² , 2.5 kW PV**
- Beneficiaries: 150 people in Dok Kham village

Discussion with Civil Engineer

Welcoming reception

Village assembly hall
(Under construction)

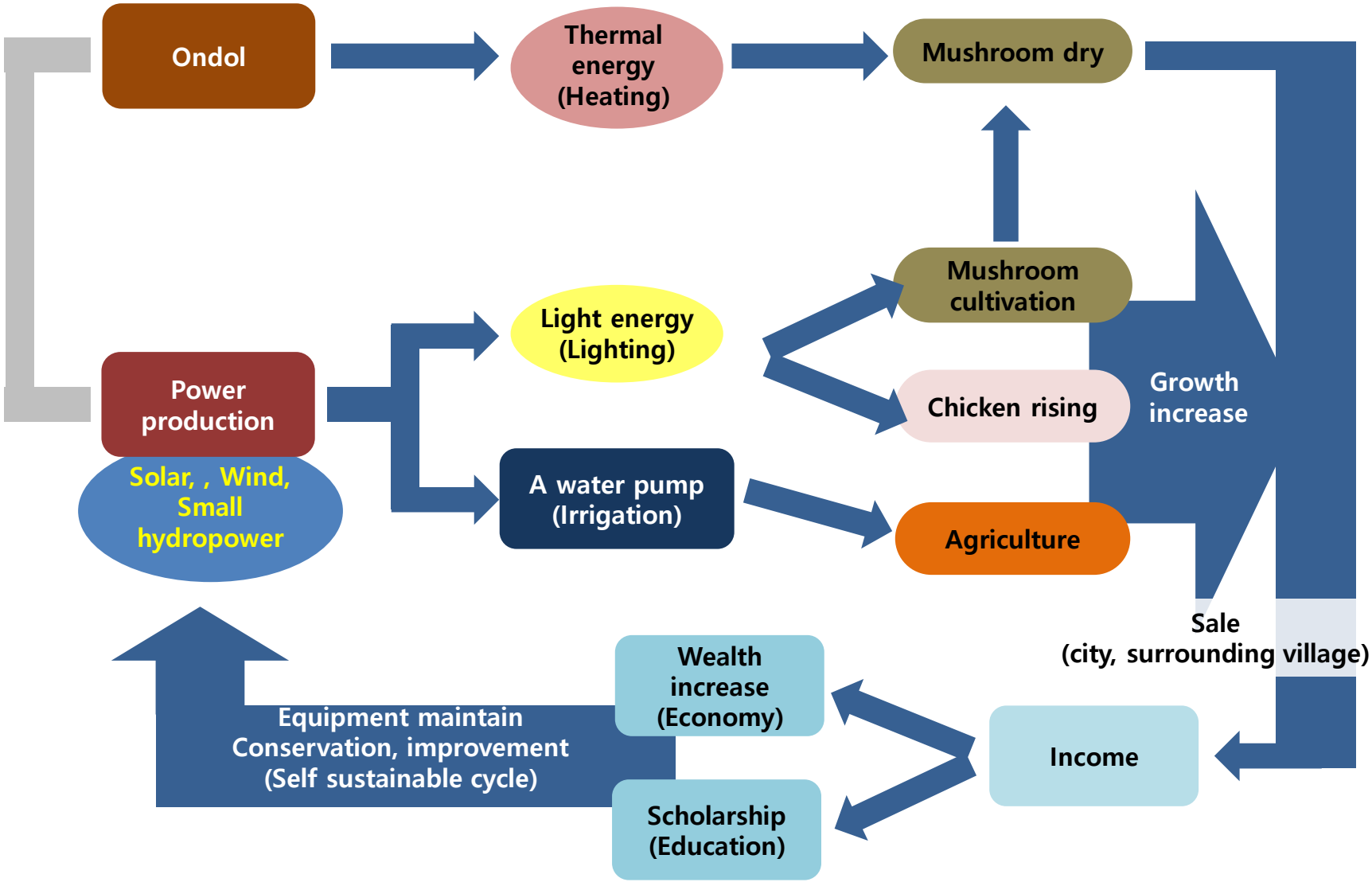




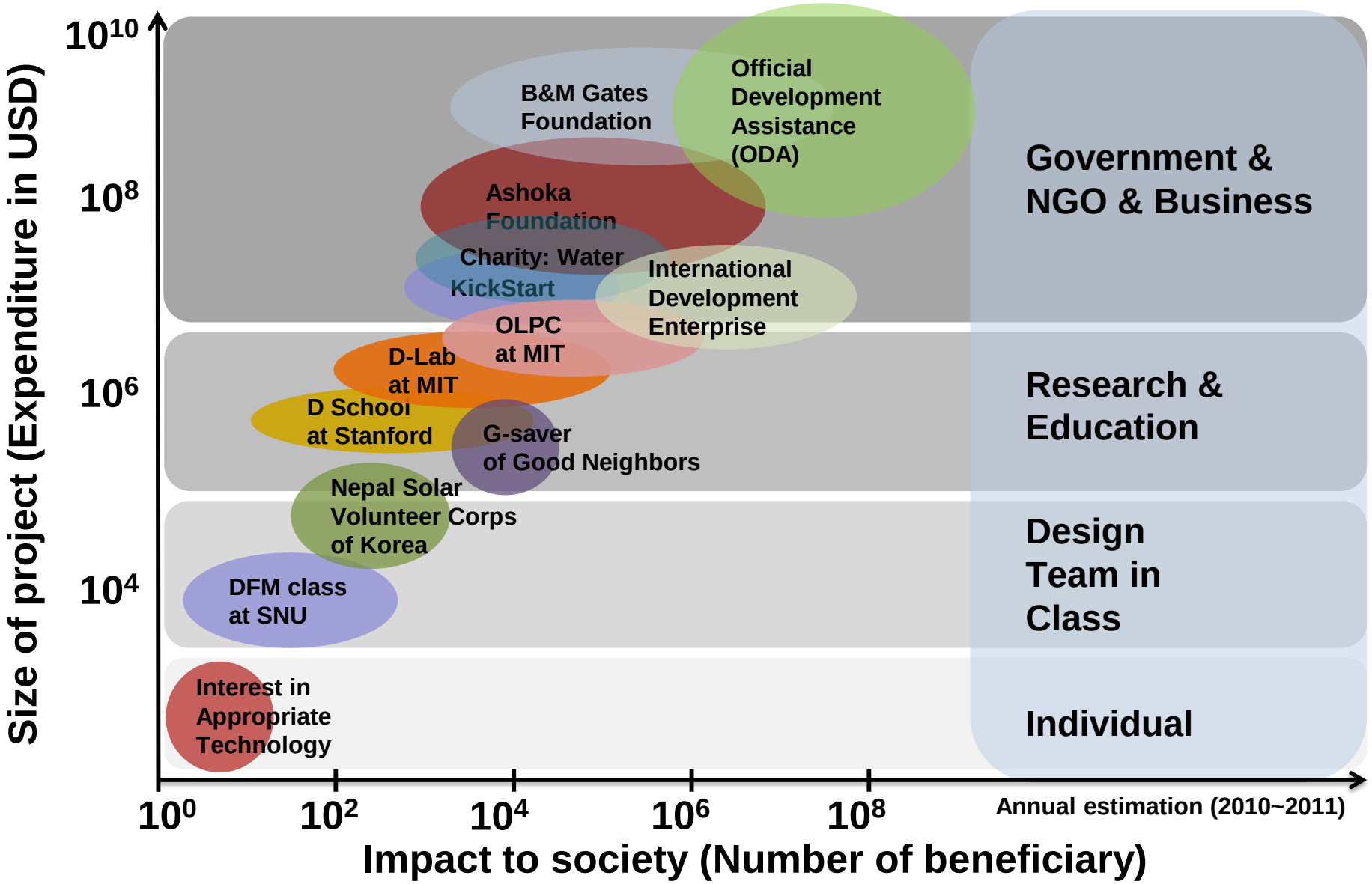
Blue print; Village assembly hall

Village assembly hall
(Under construction)

Sustainability & Synergy effect



Impact of projects

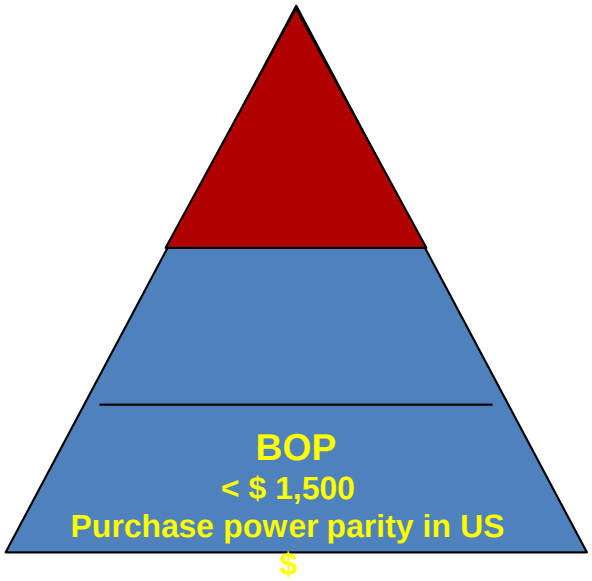


Challenge

"There's plenty of room at the bottom"

– Richard Feynman

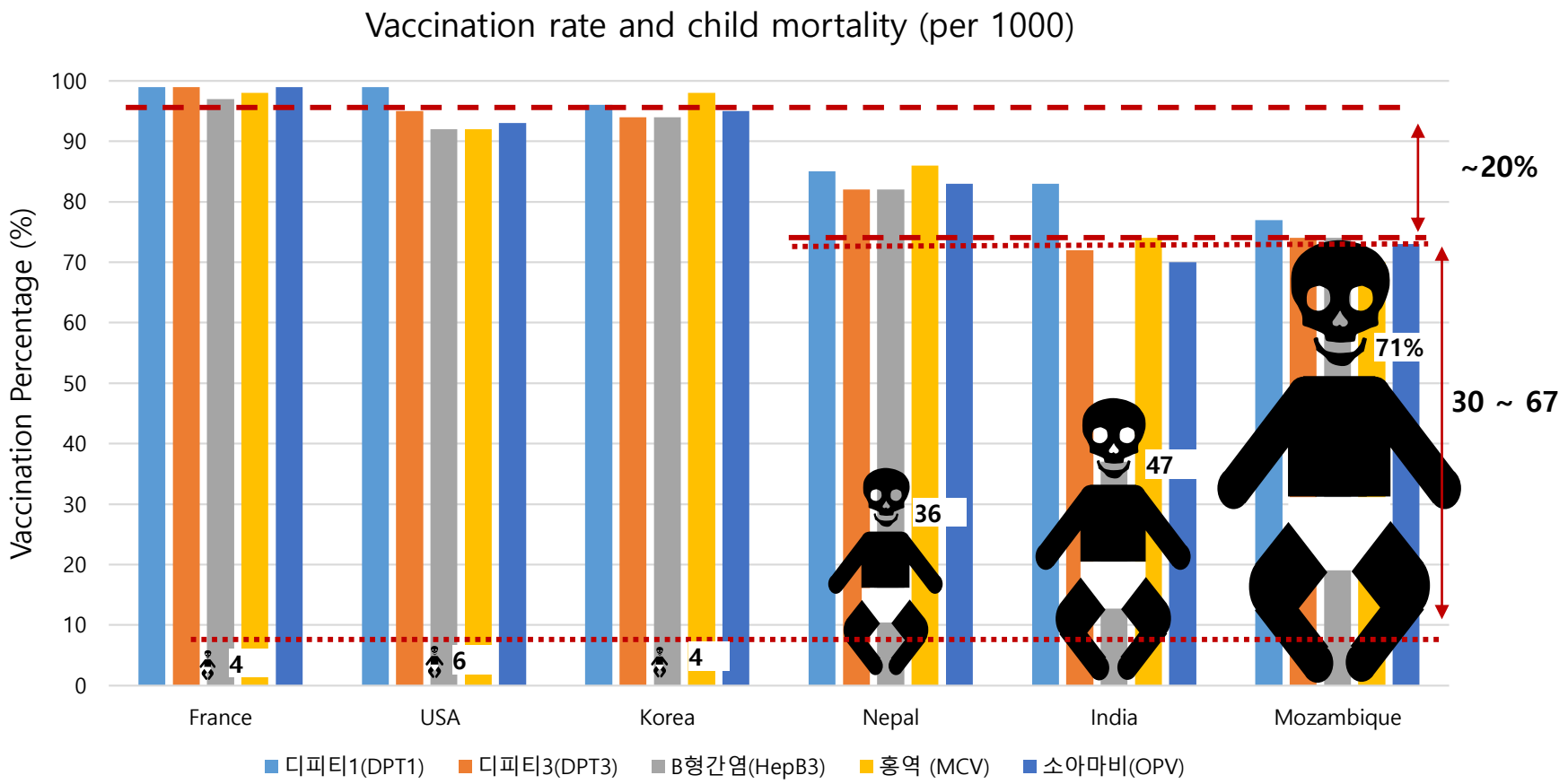
There're plenty of people you can help at the bottom



You have talent, money, and time to make this happen!

Importance of Vaccine

- **Vaccination rate and infant mortality**
  - Disease infection, mortality rate of children is higher than adult.
  - Even though infant is not dead, high disability is shown.



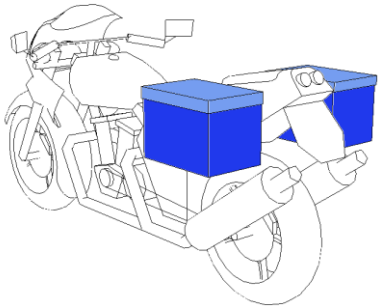
Problem in cold chain of vaccination in developing countries

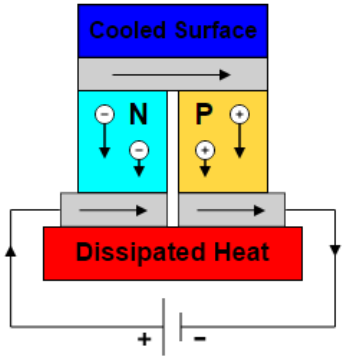
- **Vaccine Storage**
  - Recommended temperature : 2℃ ~ 8℃
- **Expensive Vaccines prices**
  - $7 - $26, Unit cost of Vaccine developed in 2000s
- **Transportation accidents**
  - Difficulties in management
- **No vaccination records**
  - Even the parents are unaware of vaccination schedule

Vaccines delivery Volunteer

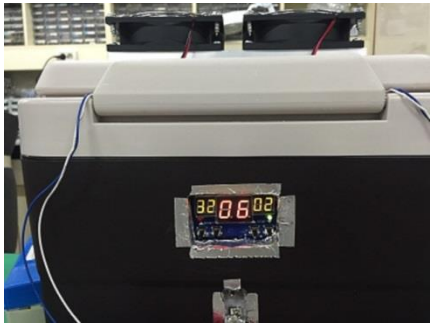
Vaccine carrier - vehicle

- Vaccine carrier based on Peltier freezing effect



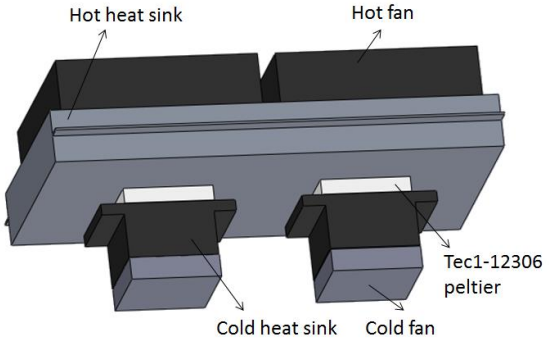


Peltier effect

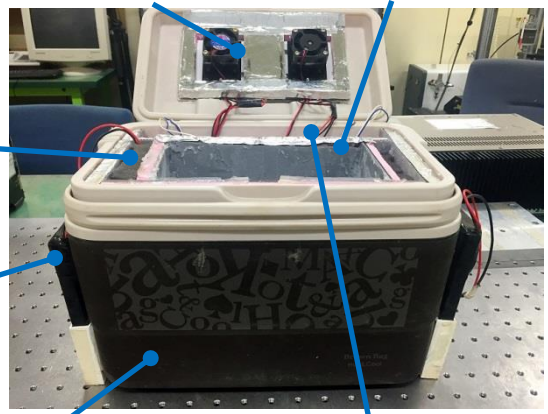


Peltier cooling system

Heat insulation layer



Application of Peltier effect



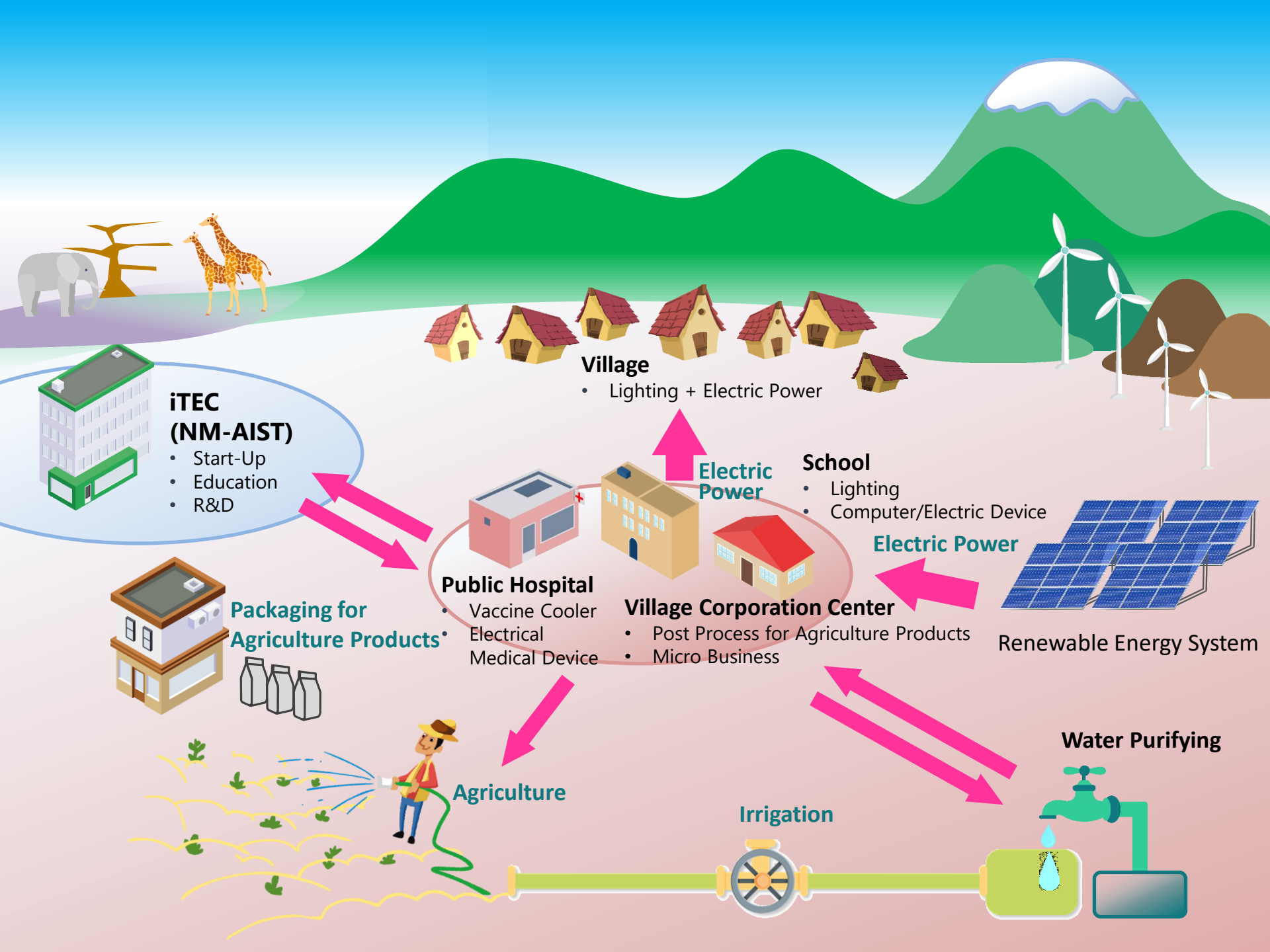
Prototype

Field test in Nepal

Evaluation of vaccine delivery

2017 version vaccine carrier

Motorcycle powered vaccine carrier


Village
• Lighting + Electric Power
iTEC
(NM-AIST)
• Start-Up
• Education
• R&D
Electric Power
School
• Lighting
• Computer/Electric Device
Electric Power
Public Hospital
• Vaccine Cooler
Electrical
Medical Device
Village Corporation Center
• Post Process for Agriculture Products
• Micro Business
Renewable Energy System
Packaging for
Agriculture Products
Agriculture
Irrigation
Water Purifying

iTEC: Research topic

The light of the world shines the town seated on the mountain

http://fab.snu.ac.kr

(Innovative Design and Integrated Manufacturing Lab.)

http://nepal-solar.org

(Global Solar Volunteer Corps)