

Work shop for Village Technical Advisors

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Xiengkhuang
11-12 Jan 2010

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Outlines of workshop

I. Technical Session (morning)

- Objectives of workshop
- About LIRE, its partners & activities & pico hydropower in Laos in general
- Pico installation steps and operation & maintenance (focus)

II. Service section (afternoon)

- Roles of Provincial, district and village TA
- Technical advice and installation service charge
- Distributor for shop owners (commission fee)
- And others for example: Battery charging station

III. Service Monitoring Form (afternoon)



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Objectives of workshop

- To allow TAs to understand situation of pico situation in Lao PDR
- To gain understand technical aspects of pico turbine
- To enable TAs to provide advice and service to end users who needs helps
- To build up a TA networks National, Provincial, District and Villages, and their capacities



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About LIRE, its partners & activities

- A platform for research and development
- Young institute for applied research
 - Lao non-profit association of members, set up in 2006
 - Part of LUSEA (under Prime Minister's office)
 - No base funding
 - Own programs and on-demand research (for NGOs, private sector, government)
 - Fully authorized to work in the Lao PDR
- Lao and foreign experts



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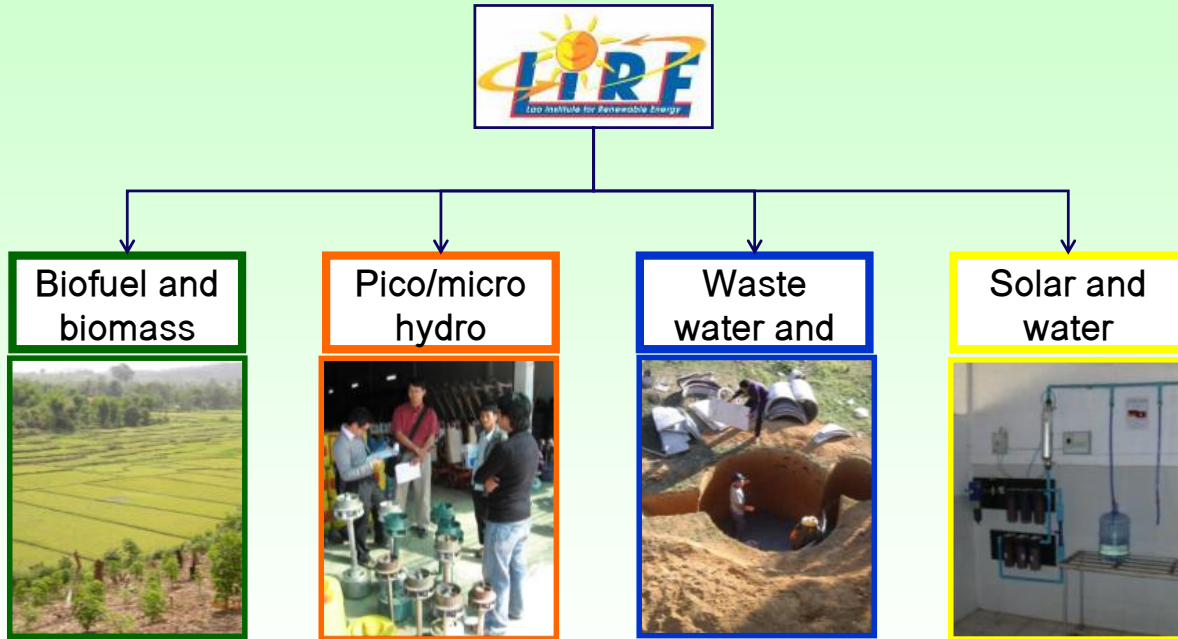
LIRE Staff



LIRE Partners



LIRE programmes



Pico-hydro power in the Lao PDR

- Pico-hydro (PH) turbines (<math><2\text{kW}</math>) widely-used in rural areas
- 40.000 – 60.000 units believed installed
- Little support from local authorities or development organizations.
- Poor safety, reliability, and quality
- Opportunity to enable access to energy through market oriented approach



LIRE Pico hydro power program

- Phase I
 - Started from Nov-2008-Apr 2009 (done)
- Phases II
 - Started from May 2009-Dec 2010
- Funding
 - Given by ETC Energy (Dutch Organization) to support pico hydro project
 - Fund only for supporting technical information
 - Not provide subproject to end users or shop owners (no hardware)



Pico Installation Steps & Operations and Maintenance

- Site Selection
- Water Flow Evaluation
- Installing Your Generator at the River
- Hanging Cable & importance of quality cable
- Installing an Electronic Load Controller and Connecting Appliances
- Managing Load and Sharing Electricity
- How to Select and Test a Generator
- Repairing and Maintaining the Generator
- Safety Tips



Site Selection

❖ Water Fall



Pros	Cons
Easy to install civil	Requires a draft channel
Requires minimal changes to the channel of water leading to the waterfall	Affected by changes in water levels during dry and rainy season and may require modifications based on season like adding a flow gate



Site Selection (Cont.)

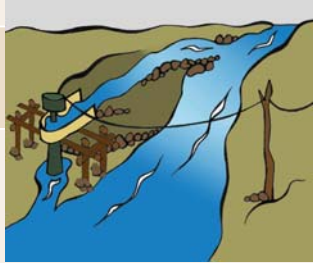
❖ Dam

Pros	Cons
Stable water flow rate	May require a draft channel
Not as effected by changes in water level during dry and rainy season	Requires construction of a dam which may be labor and cost intensive
May allow multiple families to install their own generator on the same dam	Generator and dam may be swept away during unpredictable floods, especially during the start of the rainy season
	The construction of the dam in a flat river (even a small one) may cause unnecessary flooding



Site Selection (Cont.)

❖ Diverted Channel


Pros	Cons
Stable water flow rate	Requires a draft channel
Little risk of the diverted channel flooding so year-round use is possible; no need to evacuate the generator during the rainy season	Requires construction of a diverted channel, which may be time and cost intensive if the channel must be long enough for a flat river
Not as effected by changes in water level during dry and rainy season	
May allow multiple families to install their own generator on branches of the same, long diverted channel	



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Site Selection (Cont.)

❖ Free Standing

Pros	Cons
Easy to install civil works	May require extension shaft for the propeller
May not require a draft channel	Affected by changes in water levels during dry and rainy season
	Risk of generator being swept away by water when the river is high
	Less efficient energy output compared to other installation types
	Increased risk of damage to windings due to vibrations of a long extension shaft
	Increased risk to electrical appliances because of fluctuations in output frequency and voltage



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Evaluating the Water Flow

■ Definition of Flow:

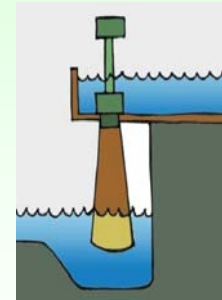
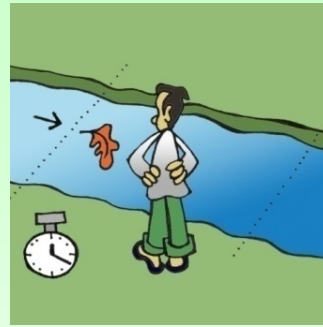
Water flow is the amount of water that passes through the generator propeller in a second (l/s or m³/s)

■ Definition of Head:

Head is the height of the water flowing into the draft channel down to the river below (m)

- Ideal conditions for different generator types and heights of river head include:

Generator	Head (meters)	Flow (l/sec)	Speed (m / sec)
300 W	1.5	35	0.54
500 W	1.5	72	0.5
1000 W	1.5	135	0.41
300 W	1.0	51	0.78
500 W	1.0	106	0.75
1000 W	1.0	204	0.72



Flow determination

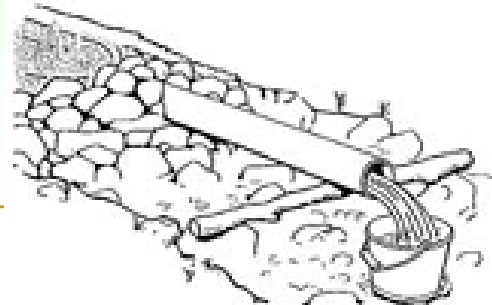
Symbol of flow is Q, and unit is L/s or m³/s. There are 2 traditional methods to get the flow

- Bucket method
- Average velocity and cross section area method

■ Bucket method

This method must do at least 3 time to get more accurate, and the bucket must be big enough at least 5 second of the time to fill water full

$Q = V / t_{av}$ (L/s), V: bucket volume(L), t_{av} : average time to fill water full(s) = sum of each time of measurement / number of measurement



Example1

- Bucket volume of 210 L, □3 times of measurement is done□. First time spend 8 seconds to fill full water in the bucket, second time spend 6 seconds, the third spend 8 seconds. Calculate the water flow rate ?

Solution

$$V=210 \text{ L}$$

$$t_1= 8 \text{ s}$$

$$t_2= 6 \text{ s}$$

$$t_3= 8 \text{ s}$$

$$t_{av}=(t_1+t_2+t_3)/3$$

$$=(8+6+8)/3$$

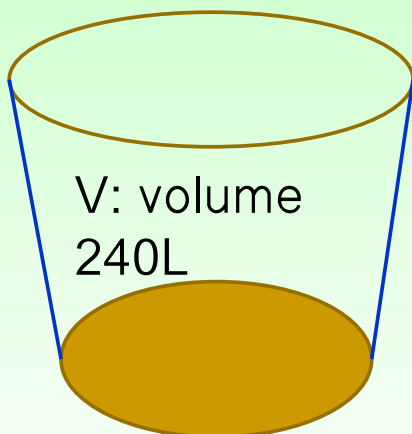
$$=22/3=7.33 \text{ s}$$

$$Q=V/t= 210/7=30 \text{ L/s}$$



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Example2: fill the figure to the blank



- t1: 1st time of measurement 5 seconds
- t2: 2nd time of measurement 7 seconds
- t3: 3rd time of measurement 6 seconds

Time average, t: s

Formula:.....

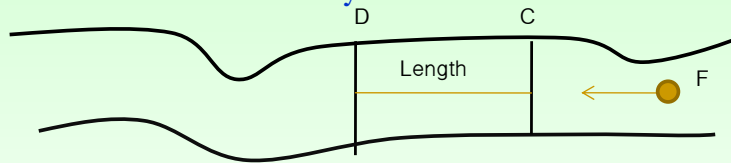
Water flow rate:.....L/s



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Average velocity and cross section area method

- This method comes from the formula $Q=VA$, which V is water velocity (m/s) and A is cross section area of stream(m²). Therefore, we have to determine stream velocity (V) and cross section area(A) of the stream
- Step 1 Calculate stream velocity



- find the straight portion, uniform flow and width as possible
- Mark two end point(C and D)
- Recording the time (t) required to a floating object (F) (use piece of wood, bottle..) from starting point(C) to ending point(D)



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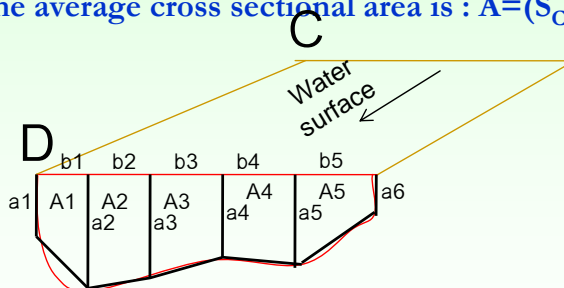
The surface water velocity is

$$V_s=L/t$$

the stream velocity, which will be less than surface water velocity 80%

$$V=0.8*V_s=0.8*L/t$$

- Step 2 Calculate the cross sectional area both edges (C and D)
the average cross sectional area is : $A=(S_C+S_D)/2$



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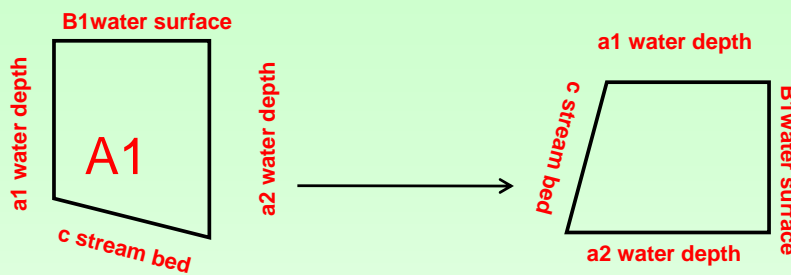
- $$S_D = A_1 + A_2 + A_3 + A_4 + A_5$$

$$= (a_1 + a_2)b_1/2 + (a_2 + a_3)b_2/2 + (a_3 + a_4)b_3/2 + (a_4 + a_5)b_4/2 + (a_5 + a_6)b_5/2$$

For S_C Do the same thing, finally we have : average cross sectional area $A = (S_C + S_D)/2$



Sub Sectional Area Calculation



- Sectional area is $= (\text{sum of both water depth}) \times \text{water surface} / 2$
- $S = (a_1 + a_2) \times b_1 / 2$

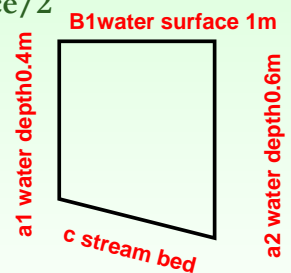
Example 3

Sectional area $= (\text{sum of both water depth}) \times \text{water surface} / 2$

$$S = (a_1 + a_2) \times b_1 / 2$$

$$= (0,4 + 0,6) \times 1 / 2$$

$$= 1 \times 1 / 2 = 0,5 \text{ m}^2$$



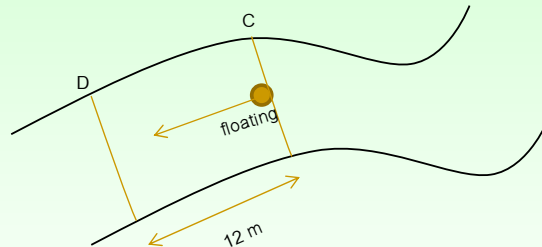
Example 4

There is measurement length 12 m, time of floating travels within 12 m is:
1st 16seconds, 2nd 15 seconds, 3rd 17 seconds

Sectional area of upstream part 1.6 m^2 , sectional area of downstream
 $S_D = 1.4 \text{ m}^2$

Calculate water flow rate Q

- $L = 12 \text{ m}$
- $t_1 = 16 \text{ s}$
- $t_2 = 15 \text{ s}$
- $t_3 = 17 \text{ s}$
- $S_C = 1.6 \text{ m}^2$
- $S_D = 1.4 \text{ m}^2$
- Calculate water flow rate Q?



Solution

water surface velocity

$V_s = \dots\dots\dots$

$V = 0,8 \dots\dots\dots$

$t = \dots\dots\dots$

$A = \dots\dots\dots$

Finally $Q = \dots\dots\dots$



Calculation hydro power in stream

- $P = \text{Head} \times \text{Flow} \times \text{Gravity}$

So: $P_e(\text{W}) = \eta * P = \eta \times H(\text{m}) \times Q(\text{m}^3/\text{s}) \times g(\text{m}/\text{s}^2)$

- η : efficiency of system (50-60%)
- P = Power of Hydro power (W)
- P_e : Power of electrical energy(W)
- Q = flow rate(L/s)
- g = acceleration due to gravity = $9.81(\text{m}/\text{s}^2)$
- H : head (m)



Example 5

- $Q=150 \text{ L/s}$, head $H=2 \text{ m}$,
Calculate electricity power produced $P_e(\text{w})$

Solution

Formula : $P = \dots\dots\dots = \dots\dots\dots = \dots\dots\dots \text{ W}$
electricity power produced :

$P(e) = \dots\dots\dots = \dots\dots\dots = \dots\dots\dots \text{ W}$



Installing Generator at the River

- Adding a Propeller Extension
- **Building a Draft Channel & tube (Formula for IHR and Chinese is required)**
- Building Civil Works
- Installing the Generator
 - For free standing installations
 - For installations using a draft channel
- Decreasing Water Flow with a Flow Gate
- Keeping the Channel Free with a Debris Screen
- Grounding the Generator
- Covering the Generator with a Roof
- Adding a Warning Sign



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Adding a Propeller Extension

- Remove the bolt that holds the propeller in place at the turbine end of the generator
- Remove the propeller
- Screw the extension shaft in place at the turbine



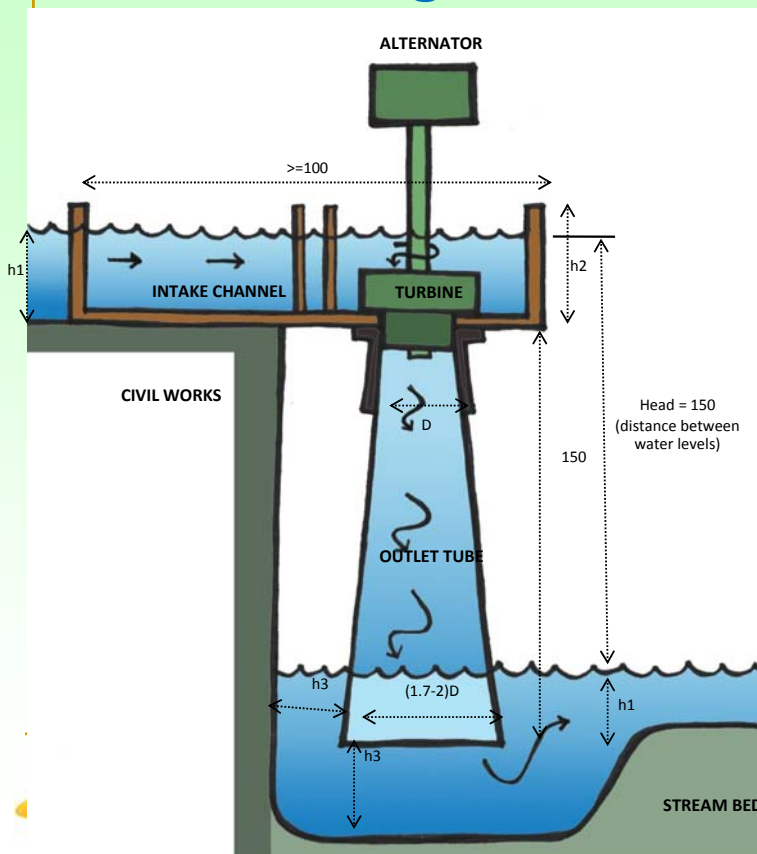
Add an extension shaft so the propeller reaches the water.



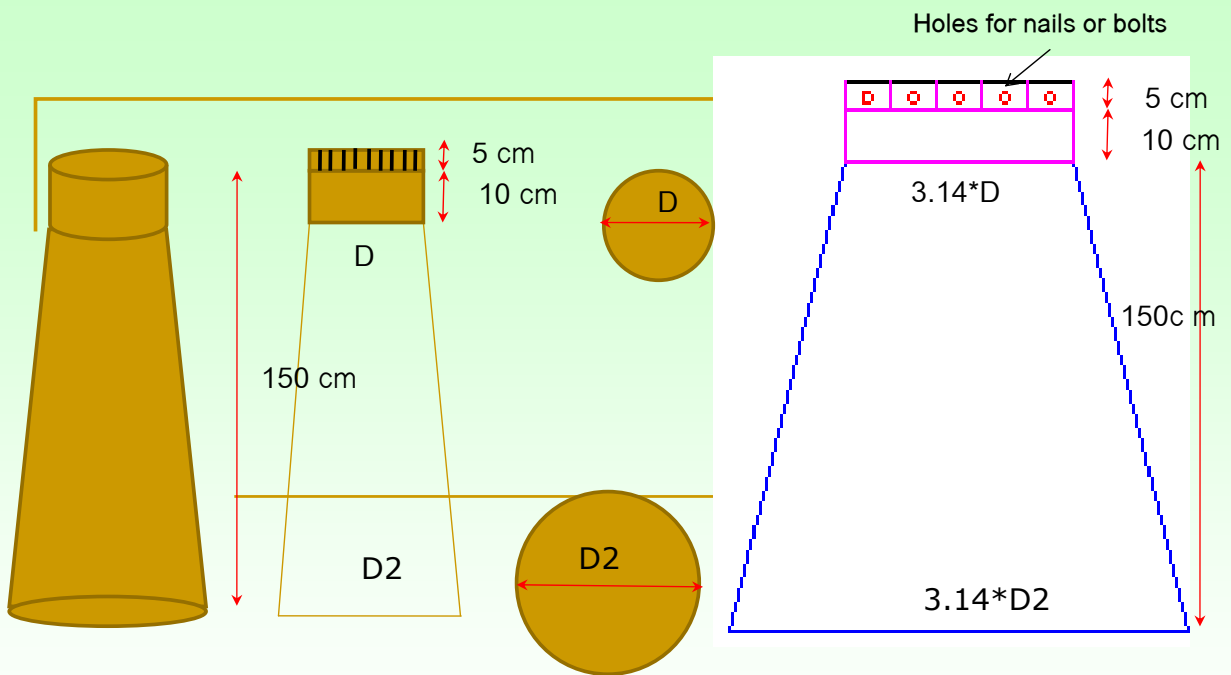
- Attach the propeller to the free end of the extension shaft with the bolt from the turbine
- Before connecting the generator, place it on the civil works to make sure the water hits the propeller; the flow of the water should fall parallel to the propeller blades



Making draft channel & tube



Turbine capacity	h1	h2	h3
300W	20	25	20
500W	30	35	30
1000W	40	45	45

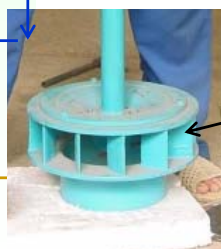
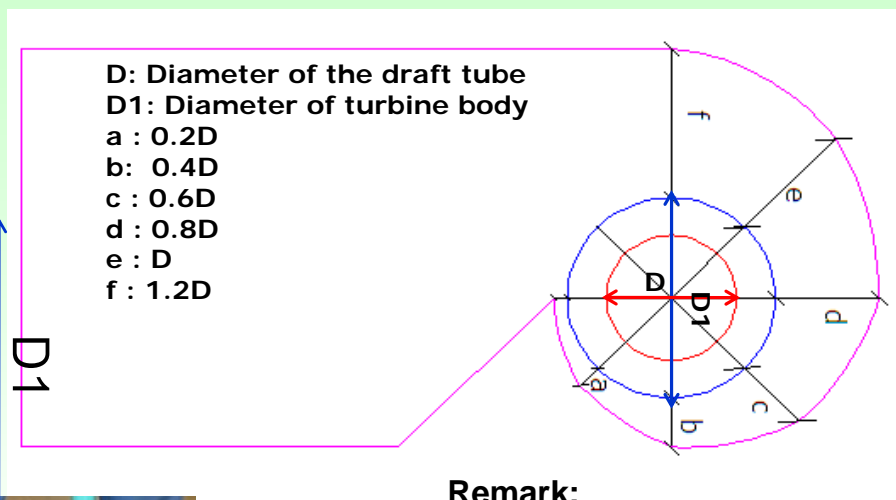


Iron plate with tickness 1.2-1.3mm

$$D2 = 1.7 - 2 D$$

Making draft tube

$\geq 4 D$



turbine body

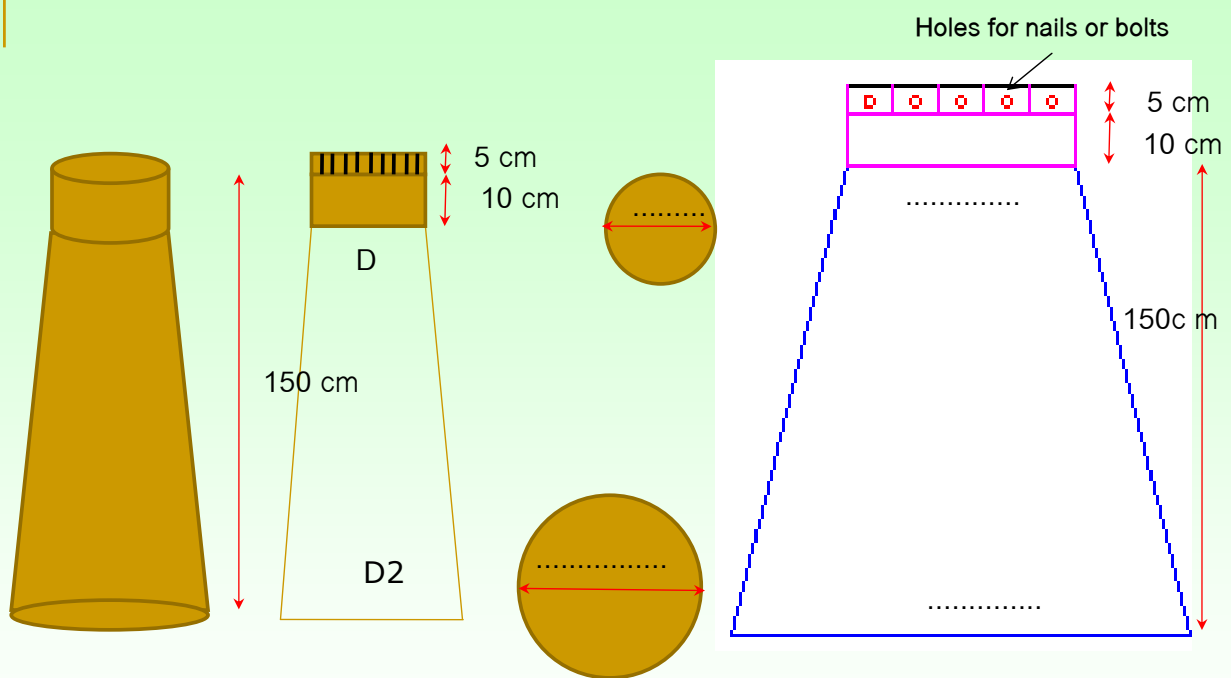
Remark:

D: bigger than turbine diameter(D0)
0.5-1 cm

Example 6

- Chinese turbine 1000 w with turbine diameter 16 cm and turbine body 20 cm, draw the draft channel and tube

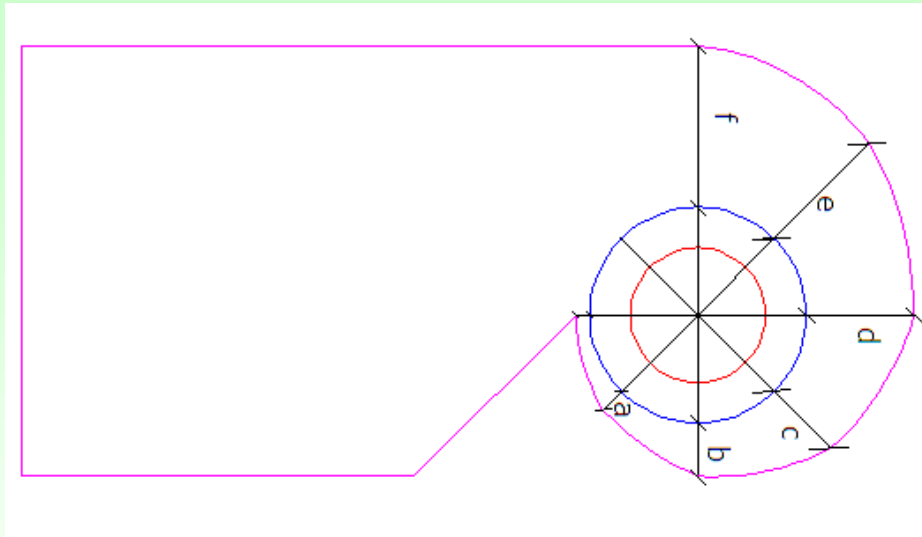
Solution



Iron plate with thickness 1.2-1.3mm

$$D2 = 1.7 - 2 D$$





Guide attendant to draw the channel and tube on paper

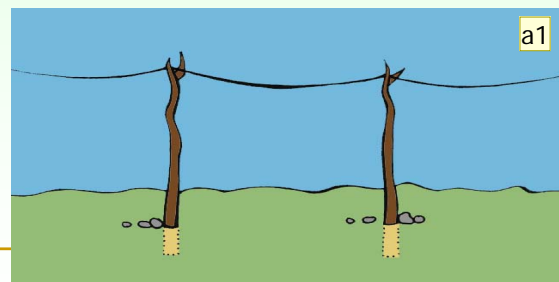
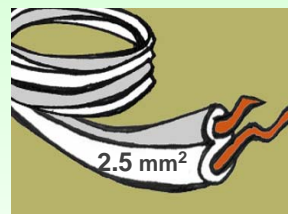


Hanging Cables

- *When you hang cables, be sure the generator is not running or placed in the river.* 

- **Table of appropriate cable sizes**

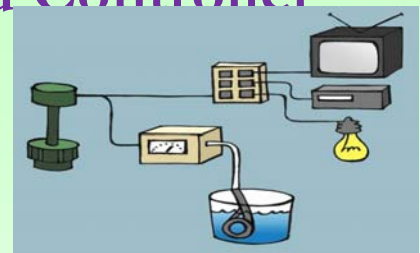
Generator	Distance (meters)	Cable Size (mm ²)
300 W	< 100 m	2.5
	100 – 300 m	2.5
	>300 m	2.5
500 W	< 100 m	2.5
	100 – 300 m	4.0
	> 300 m	4.0
1000 W	< 100 m	2.5
	100 – 300 m	6.0
	>300 m	6 or 10



Installing an Electronic Load Controller and Connecting Appliances

■ What is ELC?

- Electronic load controllers
- Component: ELC box and dumping load



a5

■ Functions

- Protect turbine
- Protect electrical appliances from over voltage

■ Stabilizer

- Stabilize voltage even low or high
- Cannot protect the turbine and appliance

Warning!!!!

- Before installing the Electronic Load Controller, make sure the generator is not running.
- Always make sure the reservoir of the load controller is filled with water. If it is not filled with water, the plastic bucket may catch fire.
- Check to make sure the voltage is correct, especially if the flow of the water at the river increases or decreases because of the rainy or dry season.

Leonics PHR(Thailand)



Dumping load water heating element



Vietnam ELC

Stabilizer



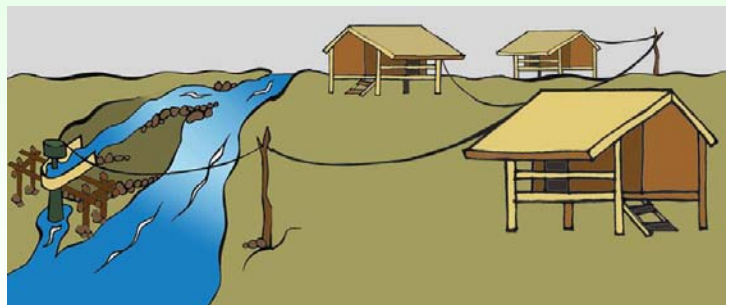
Dumping load air heating element



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Managing Load and Sharing Electricity

- Why sharing - Good?
 - Save money long term
 - Reduce installation place in the village
 - no problem on insufficient water



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How to Select and Test a Generator

- Decide what is your power needs
- See your site location
- See your budget
- Testing at the shop
 - Feel Propeller for Resistance
 - Spark the Generator
- *Cheap products usually poor performance & more expensive one is better quality and last longer, if you have budget, it is better to buy the good one*



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Repairing and Maintaining the Generator

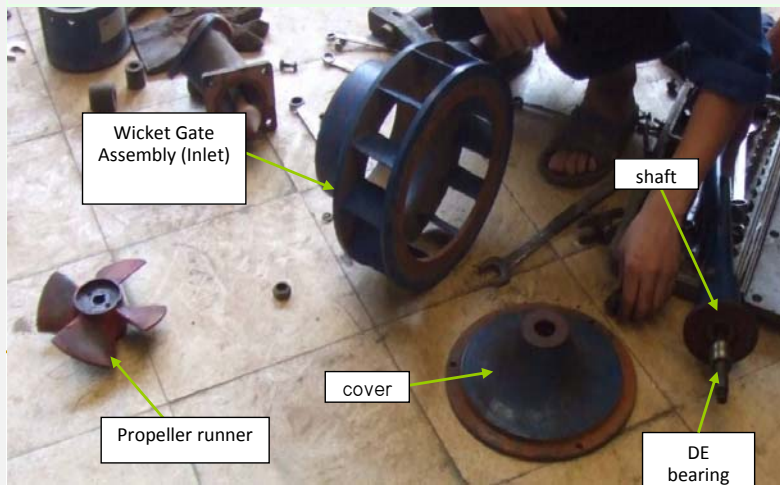
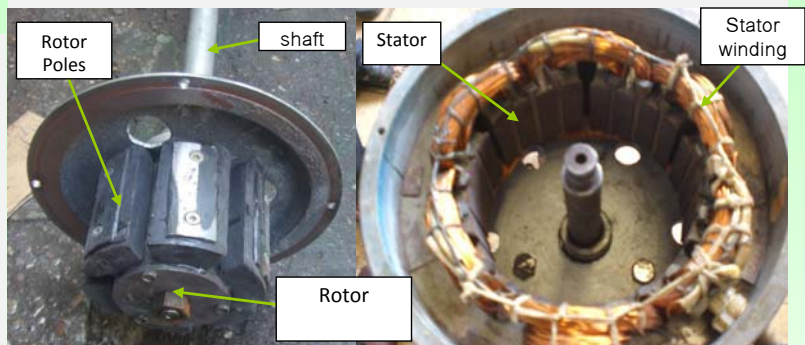
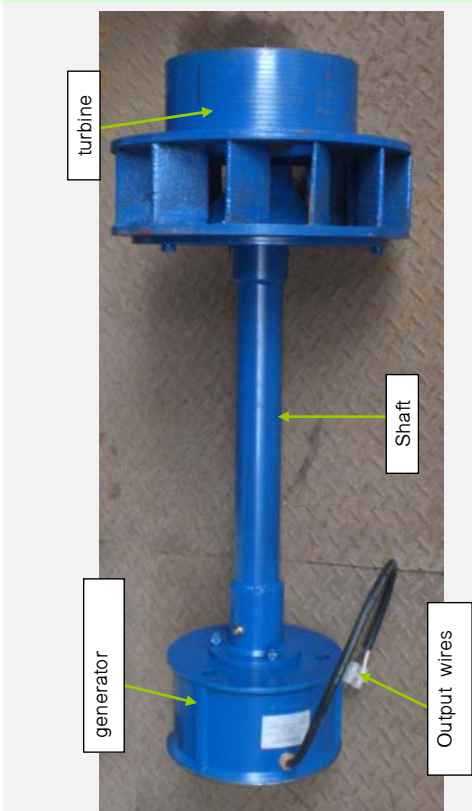
- Introduction to each component of the pico unit a6
- Assembling and disassembling the turbine
- Greasing bearing
- Changing bearing
- Winding maintenance
- Changing winding
- Adjusting and resetting the ELC



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a6 Question to ask participant: How many types of pico hydropower? What are the components of a unit?
admin; 15.10.2009

ສ່ວນປະກອບຕ່າງໆຂອງເຄື່ອງຈັກປະເພດຕ້ອງການແຮງຕົກຂອງນ້ຳຕໍ່າ



Maintenance

Collapsing & maintenance (low head unit)

- **Collapsing & maintenance (low head unit):**
 - Periodic maintenance necessary
 - Regular Inspection help to prevent accidents
 - Periodic maintenance - 6 months to 1 year - to find & replace defective components: bearing balls & rubber, gasket.
- **Unit collapsing order:**
 - Stop unit, power-off, lift the unit from turbine chamber, put it at clean place.
 - Remove generators ' rotor : remove turbine blades, remove stator, remove from shaft, remove rubber bearing from turbine chamber.



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Collapsing & maintenance figure (low head unit)



Step1 : remove blades



Step 2:
Collapsing
generator



Step 3 :
remove rotor

Step 4: cleaning, drying ,
lubricating stator

Step 5: change easy –
scuff components

Step 6 : Assembly in
reversed order

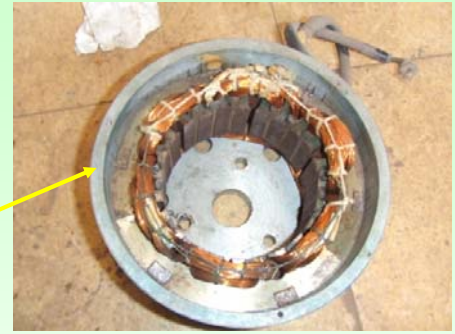


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Pico unit component high head



generator



Turbine



Collapsing & maintenance figure (high head unit)

Step 1 : remove unit from the mount

Step 2 : run sideways & remove blades by specialized tool – (click to see flash)

Step 3 : Collapsing generator

click to see flash

Step 4 : Remove upper cover by screw –(click to see flash)

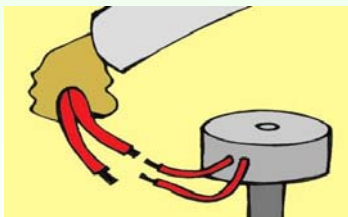
Step 5: Remove rotor by screw clamp(click to see flash)

Step 6 : cleaning, dry stator , lubricating

Step 7 : Assembly is in reversed order



Safety Tips (very important)

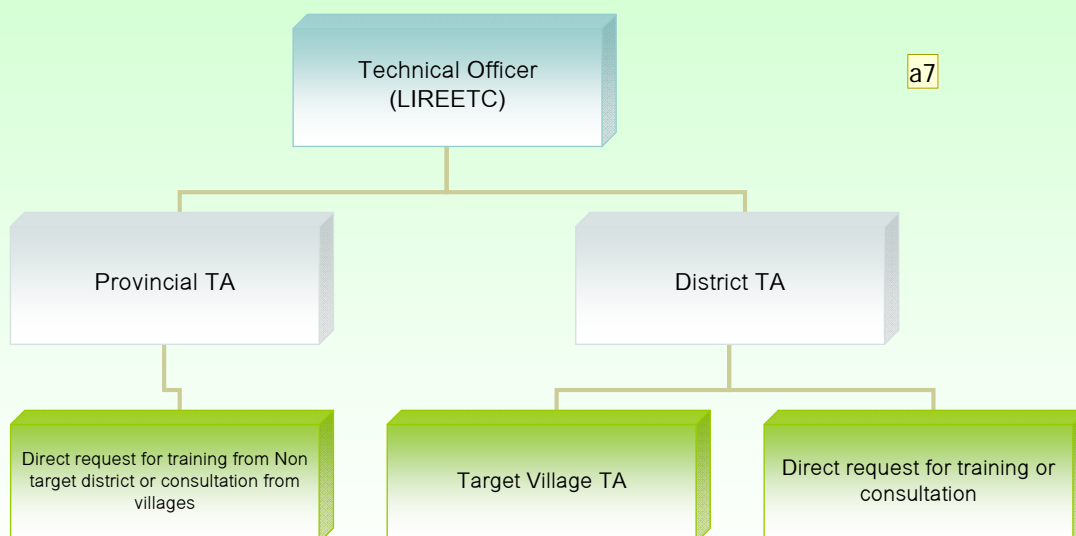


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District TA

II. Service section (afternoon)

■ Structure & Roles of Provincial, district and village TA



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Role of TAs

- **Provincial Technical Advisor**
 - Train DTA or VTA for both target and non-target district upon request
 - Liaison between LIRE and DTAs
 - Coordination in meeting organizations, submitting reports, accompanying LIRE team for field visits
 - Distribute LIRE promotional materials on pico hydropower e.g. posters, manuals & VCD

District Technical Advisor

- ❑ Train VTA in both target and non-target villagers upon their request
- ❑ Liaison between LIRE and VTAs
- ❑ Coordination in meeting organizations, submitting reports, accompanying LIRE team for field visits
- ❑ Data collection at village level



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Village Technical Advisor

- ❑ Provide advice to other villagers on compensational basis
- ❑ Liaison with DTAs
- ❑ Data collection at village level
- ❑ Fill in monitoring form and submit to DTA on quarterly basis



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Other business opportunity for village technical advisor

- A broker for shop owner and get paid on commissioned basis ^{a8}
- Building a local material made draft tubes & channel sales to shop owners or end users
- Build up pico-battery charging station
- Selling electricity to other households
- Training to other villages
- Any other ideas? **Why we do this?**



III. Service Monitoring Form (afternoon)

- Explain how to fill in the manual monitoring form
- Explain how to fill in the TA service form
- Submit of report for every quarter to DTA to LIRE
- Suggestions
- Fill in the training evaluation form



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THANK YOU FOR YOUR ATTENTION



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