January 16, 2012

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440 Project Proposal for a Rain and Solar Power Generator

Dear Dr. Rawicz:

The attached document, *Proposal for a Rain and Solar Power Generator*, outlines our project for ENSC 440 (Engineering Science Project). Our achievement is to design and implement a power generator which can create electricity for sunny and rainy weather conditions. Our project uses green energy that will cause no effect on nature.

The aim of this proposal is to provide background information and considerations of our project, a basic overview of our product, possible design solutions, our project sources of information and budget, and time scheduling and organization of our project. This document will also examine our project's market potential.

Green Power Innovation consists of five skilled, hard-working, and talented fourth-year engineering students: Frank Feng, Zhiyu Hu, Max Liu, Jeff Bian, and Xiao Dong. If you have any questions or concerns about our proposal, please feel free to contact me by phone at (778) 996-5591 or by e-mail at ffa5@sfu.ca.

Sincerely,

Frank Feng
President and CEO
Green Power Innovation

Enclosure: *Proposal for a Rain and Solar Power Generator*

2012

Proposal for a Rain & Solar Power Generation System

Project Team: Frank Feng

Zhiyu Hu

Max Liu

Jeff Bian

Xiao Dong

Contact Person: Frank Feng

ffa5@sfu.ca

Submitted to: Dr. Andrew Rawicz - ENSC440

Stephen Whitmore-ENSC305

Issued date: January 16, 2012

Revision: 1.1

8888 University Drive, Burnaby BC Canada

FFA5@sfu.ca

EXECTIVE SUMMARY

Table 1: Climatological Information for Vancouver, British Columbia [1]

Month	Mean Temperature		Mean Total Precipitation (mm)	Mean number of Precipitation Days
	Daily Minimum	Daily Maximum		
Jan	0.5	6.1	153.6	18.5
Feb	1.5	8.0	123.1	16.3
Mar	3.1	10.1	114.3	17
Apr	5.3	13.1	84.0	13.9
May	8.4	16.5	67.9	13.0
Jun	11.2	19.2	54.8	11.2
Jul	13.2	21.7	39.6	6.9
Aug	13.4	21.9	39.1	6.8
Sep	10.5	18.7	53.5	8.6
Oct	6.6	13.5	112.6	14.3
Nov	3.1	9.0	181.0	19.7
Dec	0.8	6.2	175.7	19.8

Vancouver has two main weather conditions: rainy and sunny. In summer, day time is extremely long and sunlight is sufficient. For the rain season, it lasts almost half a year. **Table 1** [1] shows Vancouver's climate information based on monthly averages from 1971 to 2000. We can observe from the table that the mean number of precipitation days is 166 days annually. From October to March, the mean total of precipitation is over 100 mm monthly (a considerable amount of rain).

This proposal consists of the manufacturing of a Generation System which can be used during sunny and rainy days. For sunny days, the device collects sunlight by using solar panel and transfers solar energy to electric power. For rainy days, the device collects raindrops and uses Turbo Fans or Piezoelectric to generate electricity.

Green Power Innovations (GPI) consists of five fourth-year engineering students with varying knowledge of programming languages. In addition, all GPI members have previous experience with hardware and mechanical design, with a good familiarity of embedded systems.

We anticipate that the project will spend 14 weeks commencing from January 14 to April 20, 2012. The cycle will include research, design, and integration. The budget is approximated at $808.95 which we intend to obtain from ESSS and other funders.

Table of Contents

1. Introduction

"*Effectively, the provision of energy such that it meets the needs of the present without compromising the ability of future generations to meet their own needs.*" [2] This is the definition of sustainable energy which consists of two factors: energy efficiency and renewable energy. Nowadays, scientists prefer to use sustainable energy over non-renewable energy.

Green energy, another term for renewable energy is the energy produced and can be obtained from natural resources (e.g. solar, wind, rain, and wave energy). As of currently, renewable energy is widely used in four principle areas: hot water (or space) heating, motor fuels, rural energy services, and electricity generation. Green energy can supply approximately one-fifth of the electricity power across the world. In certain countries such as Iceland, Paraguay and Norway; renewable energy is used to generate nearly 100% of their power [3].

A rain and solar Generation System will collect the raindrops and sunlight to produce electrical power. The device uses green engineering and utilizes natural resources to generate electricity. This system will be highly effective in all places, especially in rural areas where the commercial electricity is not in use. It is also useful for the minimizing of power supply load in urban and city areas, which use commercial power supply. The device will prove to be particularly resourceful at areas with more rainfall during the winter season, such as Vancouver, Seattle, and Olympia. Moreover, the device will also assemble solar panels to accommodate the four seasons.

This proposal provides background information, basic overview of our design, possible design concepts, our project sources of information and budget, time scheduling and the team organization.

2. System Overview

Figure 1 shows the function process of the solar and rain power generation system. The sun is a continuous fusion reactor. When weather conditions are good, we expect the solar cell array to provide sufficient voltage and current. Concurrently, the Weather Dependent Control System (WDCS) will turn on the Solar-Mode, which allocates the system resources to obtain as much sunlight as possible.

In rainy days, the rain power generator will play a major role in our system. In this case, the WDCS will redeploy system resources to collect as much rain as possible.

The storage batteries illustrated in Figure 1 are rechargeable and provide power storage and backup power solutions by storing the excess power or a portion of power from the generators. Through the voltage and current regulation block (as shown as the inverter & converter unit in Figure 1, respectively), the rain and solar power are transformed to usable electrical energy for daily purposes.

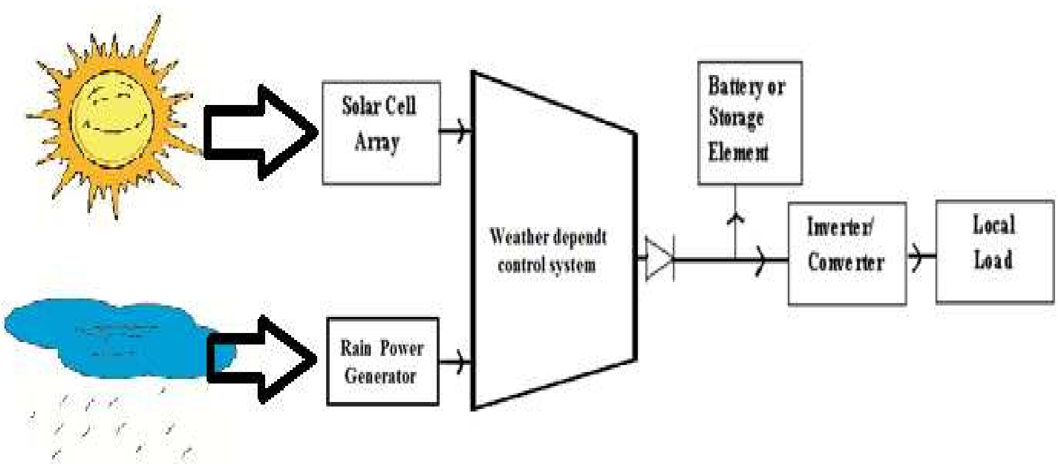

Figure 1. System Overview

Our system has a simple sense signal control interface which is programmable. This sense signal can determine the weather conditions at all times and control the system to change its generation mode between solar and rain mode (**Figure 2** below).

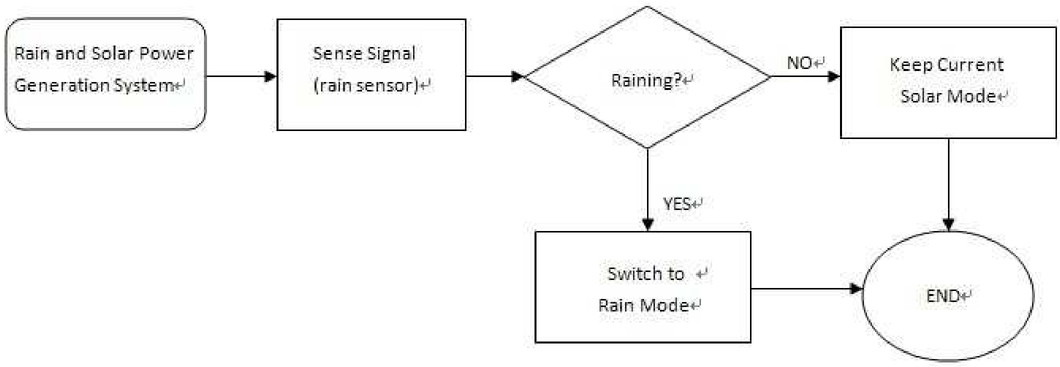

Figure 2. Weather Dependent Control Logical

3. Possible Design Solutions

The energy of nature is ubiquitous, sustainable and at our fingertips. Nowadays, thanks to new technology, solar energy and wind energy are the energy sources that can be collected to provide sustainable power. However, many are aware that rain drops are also a vast reservoir for energy.

This project utilizes the potential energy of rain drops (the downward pulling nature of gravity). There are two ways to convert this energy: Scattered and Accumulative. Scattered rain drops can cause vibrations on special material and thus generate charges. On the other hand, rain water can be accumulated on a high ground. The pond is then released through a turbine like an ordinary hydro-electro generator.

3.1 Piezoelectric Material

One possible solution is to use a 2-layer high performance bending piezoelectric material. This type of transducer converts from mechanical energy to electrical energy. As shown in **Figure 3** [4], when the actuator is deformed, it generates a voltage potential which will trigger a current loop.

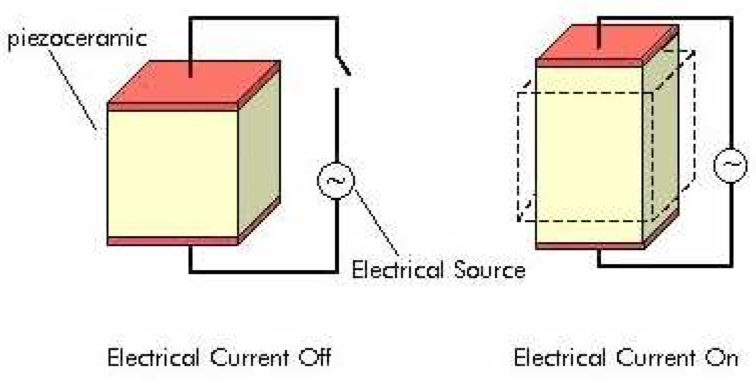

Figure 3: piezoelectric material as an actuator

A closer look of the actuator is shown in **Figure 4** [5]. When a mechanical stress F_{out} is applied on the material, the shape is deformed by ΔX_{out}, the generated voltage is proportional to the deformation.

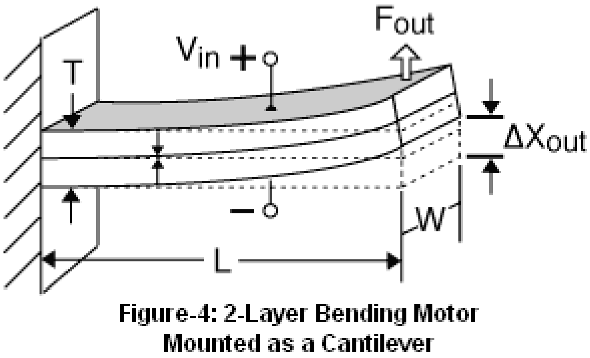

Figure 4: 2-layer high performance bending piezoelectric

In our project, we will collect the rain water in a container and flush the water onto the piezoelectric transducer to cause deformation. The voltage potential generated by the piezoelectric transducer is then used to charge the battery. The advantage of using this material is not only that it is environmentally friendly, but it can also be easily mounted. The challenge at hand is that we are uncertain if the voltage potential is large enough to produce the power needed. However, we may try to increase the size of the surface (i.e. by connecting them in parallel, in order to generate higher power).

3.2. Hydro-electro Generator.

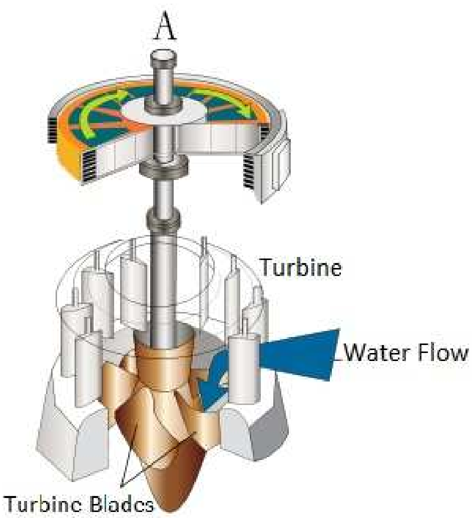

Figure 5: Typical turbine and generator [6]

The basic concept for this solution is very simple and commonly used in many Hydroelectricity Dam systems. The collecting of water is at high ground, which has potential energy relative to the ground. When water is running through the Turbine Blades, it rotates the turbine as well as the mechanical motor, which is attached to the turbine. Therefore the rotor cutting magnetic field lines produce alternating current as shown in **Figure 5** [6]. The advantage of using this method is that all the required components (i.e. Turbine Blades, current Generator Motor) are easy to access and are considerably cheaper in comparison to piezoelectric solution. Also the concept is straightforward and easy to implement. However, in order to have continuous and reliable electric power output, the rain harvest container must be well designed to provide incessant water flow through the turbine.

4. Proposed Design Solution

Our proposed solution is to build a module that combines an existing solar energy generator with a rain power energy generator to harvest renewable energy, which can be stored in a rechargeable battery for daily electrical use.

This system could also be used as a backup power system during the heavy rain fall and windy or stormy weather which may result in power outage.

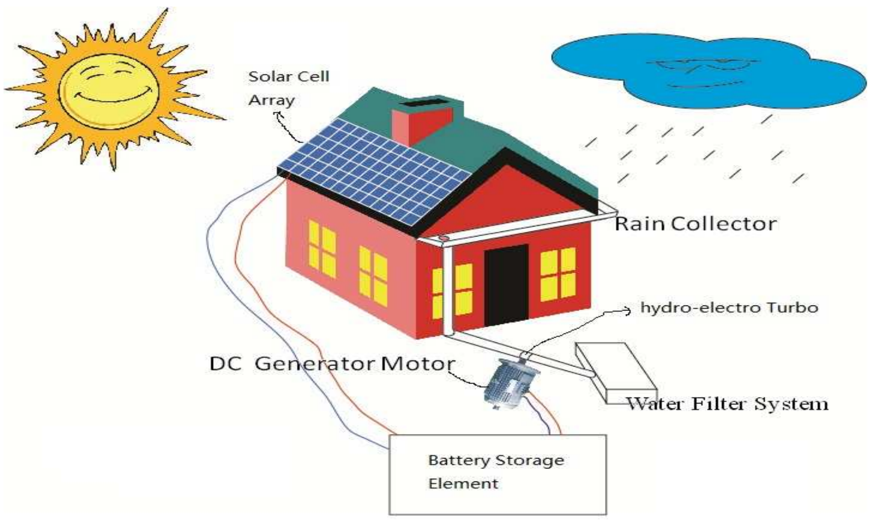

Figure 6 Combined Solar & Rain Power Generation System

Figure 6 demonstrates a conceptual idea of combined Solar and Rain Power Generation system using rain hydro-electro generation solution. By placing it on the roof top, the Solar Cell Arrays not only optimize maximum sunlight received, but it also plays a crucial part in collecting rain above the water container. When water in the container has reached a desired level, water starts to flow along the designed pipe, rotating the hydro-electro turbo and forcing the current generation motor to convert rotating power to electrical power. Moreover, the collected water can be filtered and reserved for other purposes.

5. Sources of Information

In the researching and developing of our project, we collected information from various resources: course textbooks, faculty members of SFU, forecast Vancouver, World Weather Information Service, and piezoelectric component specification sheet.

Forecast Vancouver and World Weather Information Service will provide the accuracy and long term weather report of Vancouver and other cities.

Piezoelectric component specification sheet will provide the most essential information needed for our project. This information was obtained from Dr. Marcin Marzencki in course ENSC 387. The knowledge comes from his lecture notes as well as the internet.

The internet will be widely used to research the technical information of our project, sources of funding, and any relative sources to improve our design progress.

6. Budget and Funding

6.1. Budget

The system overview and possible solution above describe parts/components involved in this project. **Table 2** below shows the detail cost for each part with a model number. The total cost is a good approximation, but might have a small fluctuation.

Table 2 Estimated Cost

Equipment List (Include brand and model # if possible)	Quantity	Estimated Unit Cost
5W5 Watt 12V Flexible Solar Panel Charger(ICO-SPC-5W)	4X $28.49	$113.96
High Performance 2-Piezo Layer Bending Elements(T215-A4CL-103X)	5X $44	$220
Turbo Fans & Gears	-	$30
High Power Low Speed DC Generator Motor	1	$245
Rain Collector and other parts	-	$50
Duracell AA Rechargeable NIMH Battery	4X 2.5	$9.99
Cables and other electronic parts	-	$40
Water Filter System	-	$100
Total Cost		$808.95

6.2. Funding

While the total cost might be underestimated, we will build the project at the lowest expense to avoid waste and failure. We will return expensive components to Engineering Science faculty for future uses. To assist the team in covering the development cost, ESSEF (Engineering Science Student Endowment Fund) has granted a funding of $500 for our project. This support will cover majority of the cost. In addition, we will also apply for the Wighton Fund after the termination of this project.

If we cannot find other funding to cover the entire cost, our team is in full agreement to share the remaining expenses, which will be distributed evenly among all five team members.

7. Schedule

Table 3 shows the expected time for each task of the project and we expect the project to be completed by mid-April. **Figure 7** shows the milestone of the project.

Table 3 Expected time table

	Start	End	January	February	March	April
Research	Jan 5 2012	Feb 13 2012				
Project Proposal	Jan 11 2012	Jan 16 2012				
Functional Specification	Jan 30 2012	Feb 6 2012				
Oral Progress	Feb 6 2012	Feb 15 2012				
Design Specification	Feb 20 2012	Mar 5 2012				
Written Progress	Mar 10 2012	Mar 19 2012				
Integration	Feb 15 2012	Mar 31 2012				
Debugging	Apr 1 2012	Apr 8 2012				
Documentation	Jan 11 2012	Apr 8 2012				
Final Report	Apr 1 2012	Apr 10 2012				

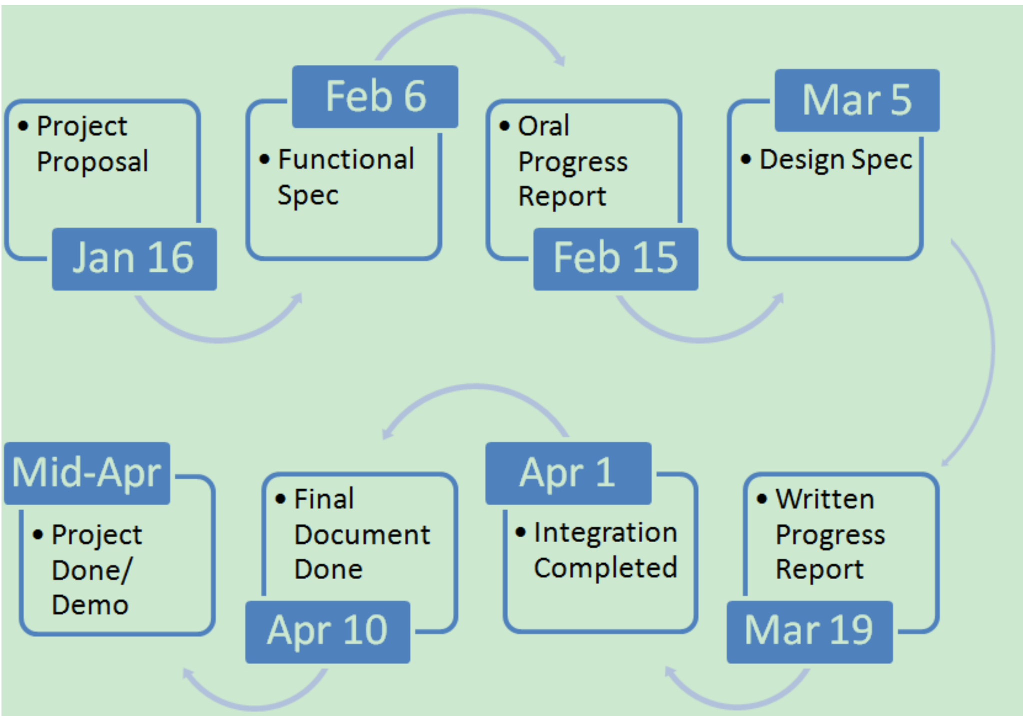

Figure 7 Project milestone

8. Team Organization

We have five engineers in our talented team: Frank Feng, ZhiYu Hu, Max Liu, Jeff Bian and Xiao Dong. We are all fourth or fifth year students at Simon Fraser University. We are responsible individuals and will divide the duties depending on each person's specialization. A brief description consisting of all the team members is shown in the Company Infomation.

With initiative, we can form a group with great dynamics. Upon the encountering of a problem, we will immediately initiate a group meeting to resolve the issue. According to our time table, we meet at the first day of the time period assigned for each task. We will discuss each member's responsibility and work on each part individually after the meeting. Then combining of everyone's work will produce the final version of the task.

Mainly, Frank will be responsible to lead the whole team and ensure that all the documentations are done efficiently. Zhiyu will be responsible for integrating the project and dealing with hardware issues. Jeff will be responsible for project research and enhancing our project by contributing valuable suggestions. Max will be responsible for ensuring that everything proceed on schedule and assist Zhiyu in the integration of the project. Xiao will be responsible for the purchase of all the components required for the project and test them, as well as acting as a treasurer.

9. Company Profile

Frank Feng - Chief Executive Officer and President (CEO)

Frank Feng is a fourth year Engineering Science student, major in system engineering at Simon Fraser University. He has two co-op term work experience at SAP Business Object. His job was to test and maintain Crystal Reports XI 4.0 and used JProfiler to identify and alleviate memory leaks and bottlenecks. He has strong C++ programming skills and high frequency electronics knowledge. He's also highly interested in robotic design and simulation. During his university career, I have kept good academic standing. In addition, I have gained good communication skill and customer service skill while doing my part-time job.

Zhiyu Hu - Chief Technical Officer (CTO)

Zhiyu Hu is a fifth year Electronics Engineering student at Simon Fraser University with previous coop experience in Ericsson Canada Inc. he has strong knowledge both in software and hardware. He is an advanced user of Matlab and Assembly language. He is also familiar with using electronic lab equipment including oscilloscope, function generator, DMM and power supply. His strengths are professional Perl Script programming skills.

Max Liu -Chief Marketing Officer (CMO)

Max Liu is a fourth year Electronics Engineering student at Simon Fraser University with a good background at communication area as well as good skills to project marketing. He has worked with a professor on wireless communicating system for four months. More specifically, He have extensive experience in both object-oriented design, such as C++, and hardware languages, such as VHDL and Verilog.

Jeff Bian - Chief Operating Officer (COO)

Jeff Bian is a fourth year Electronics Engineering student at Simon Fraser University with advanced experience with C, C++, Java, COMSOL, SolidWorks, OpenGL and HTML. He has taken courses in microelectronics, digital system design and computer aided design. He also has abilities to write technical reports with good teamwork skills.

Xiao Dong - *Chief Financial Officer (COO)*

Xiao Dong is a fifth year Electronics Engineering student at Simon Fraser University with excellent experience in using Microsoft Word, Excel, PowerPoint, and Adobe Photoshop. He is also a good software programmer using C++ and QNX.

10. Conclusion

Green Power Innovations is dedicated to provide electricity with solar power and rain power. The main goal is to reduce the demand of non-reusable resource in term of electricity generation, as well as providing electricity in rural areas where the commercial electricity has not reached or undelivered. The secondary goal is to filter the rain water for reusing or drinking. As we have planned, we expect the project to be low cost and high efficient, so it can be largely fabricated for commercial and family uses.

The illustrated timetable and milestone demonstrate that the project has been divided into tasks and each task will be completed on time. We provided our solution for this project, as well as an alternating solution. We provided our budget for this project and the funding we received from ESSEF. Everything is going on the right direction now and we expect to have the project done by Apr 15.

11. Reference

[1] Renewable Energy and Efficiency Partnership (August 2004). "Glossary of terms in sustainable energy regulation" (PDF). http://www.reeep.org/file_upload/296_tmpphpXkSxyj.pdf. Retrieved 2012-1-16.

[2] World Weather Information Service. *Weather Information for Vancouver, British Columbia.*[Online] Avilible: http://worldweather.wmo.int/056/c00266.htm

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[5]Harper, Douglas. *piezoelectric*.[Online] Available: http://www.etymonline.com/index.php?term=piezoelectric

[6] U.S. Army Corps of Engineers (2005). Hydraulic turbine and electrical generator, cutaway view. [online]. Available: http://upload.wikimedia.org/wikipedia/commons/a/a4/Water_turbine.jpg