The Source

by

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Chapter 1

Introduction

The Source is an interactive simulation model where the user is charged with the task of providing energy to a growing population. The purpose of the simulation is to show the benefits and detriments of each type of energy source. Although the game targets young adults, primarily around high school and College/university students; anyone can play and and have a learning experience. Two intended outcomes of the simulation are to demonstrate the ratio of energy output to energy source type, and show the inner workings of each. A third outcome of the simulation is show that each type of energy works in the same way at its most basic level, with the exception of solar power converting kinetic energy into electrical energy.

The user will accomplish the task of providing energy by choosing to invest in different types of energy. The energy types that are at the users' disposal are solar, wind, hydro, coal, oil, gas and nuclear. Users can choose to build any of these power plants, but each type has consequences that others may not have. For example, if a user decided to build a power plant that ran off of coal, environmentalists would be displeased because the burning of coal introduces pollutants into the atmosphere. As well as considering the consequences of their actions, the users must also consider what fuels each power plant and how long each power plant can be sustained for. Fossil fuels and nuclear power are not infinite; the user must find resources to fuel these power plants. Users can choose to invest in renewable resources such as solar, wind and hydro, but the problem the user encounters with these types of resources is that they don't output as much energy as fossil fuels. The users' main objective is to survive for as long as possible and to beat their previous time.

Chapter 2

Energy Today

In our society today almost all our energy that runs our homes and businesses is created in the same way It could be argued that, Micheal Faraday, the inventor of the concept of the generator had the biggest effect on the development of our society. In the early 1800's Micheal discovered that a magnet traveling through a coiled wire could generate a current and that once a current was generated it could be redirected to wherever it was needed. This concept is at the core of all our power generation.

2.1 Generators

All generators operate in the same way of transferring kinetic energy into electrical energy. Some do this buy having a stationary coil and moving a magnet through the coil as shown below or some have a stationary magnet and move a coil through the magnetic field created by the magnet. It doesn't matter which method is used, the same rules of physics are being applied and both ways achieve the result of a flowing current. The faster the movement of the coil or magnet the more current that will be generated. The more current that is generated to power there is to use. Generators have a couple more components to them, gas chambers, rotating pistons ect.. these are all just tools used to convert the potential energy of the power sourse into kinetic energy and finally into the desired electrical energy. This is at the heart of all major production methods of power as discussed below.

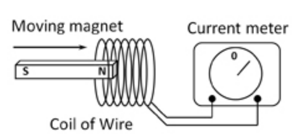

Figure 2.1: Generator Mechanics

2.2 Fossil Fuels

All Fossil fuel plants work in the same way, they burn a substance to heat water, that is turned into steam that is then fed to flow past a turbine. The steam pushes the turbine which is connected to a generator. This feeds kinetic energy to the generator which then turns the energy into electrical energy for people to use.

Fossil fuel plants only differ in the substance that they burn, and some different protocols and buildings to handle the substances but the process is the same for all. Once the substance is burned the heat is transferred into water. In order to obtain as much energy as possible the water is kept under pressure making it able to be heated to temperatures much higher then 100° C. Once the water is at a desired temperature it is fed through a series of pipes where it enters another chamber. In this chamber the water leaves the pipes at extraordinary speeds and instantly turned into steam as the pressure keeping the water in liquid form is being released. The fast moving steam pushes against a turbine causing it to move. In turn components in the generator are being turned and a current in generated. This is shown in figure 2.2 which specifically shows the process of a coal power plant.

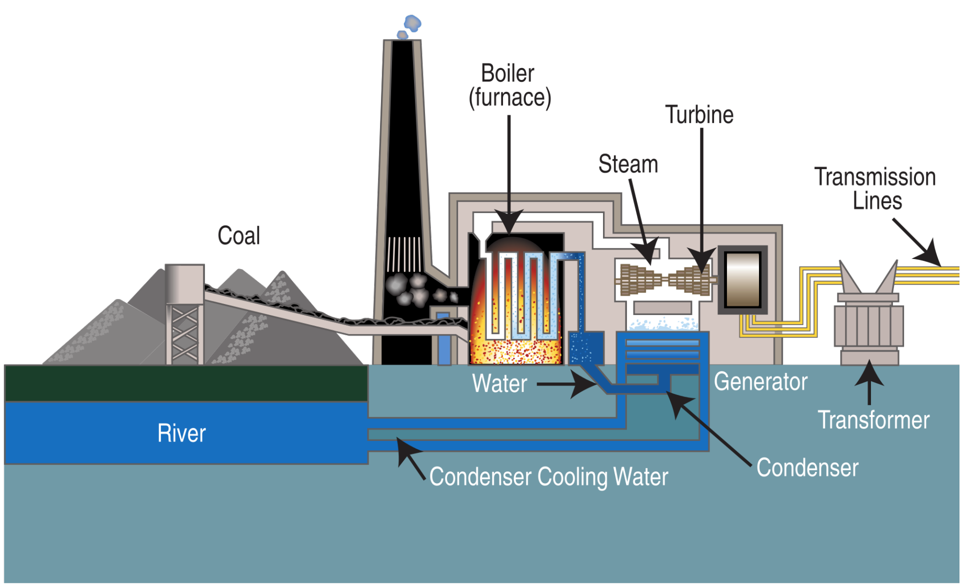

Figure 2.2: Fossil Fuel Cycle

In order to save water the steam is collected and condensed back into water to be used again. Plants are usually built around a water source as water needs to switched out at times to cool components of the plant and since plants use water to function it convientient to have a water source close by. When water gets cycled out of the plant and back into the water source it is warm and can have negative effects on wildlife. Imagine if someone cranked the heating in your house to 40° C, how would you like it?

Fossil fuel power plant generally produce large amounts of power and the price of fossil fuels is generally cheap but they have huge environmental consequences such as carbon dioxide. Fossil fuel plants also run on a limited resource and once the resource is depleted they will be useless.

2.3 Nuclear Power

Nuclear power, maybe the most desired power source on the planet, is capable of producing tremendous amounts of power for doing little work. All nuclear power plants today run off of fission, the process of breaking up atoms into smaller ones and the magical element that nuclear plants run off of is Uranium. Uranium has nice properties for being broken apart, one being that large amounts of energy are released when fission is performed on it and this energy is given off in the form of heat. Just like fossil fuel power plants, nuclear power plants operate by taking this heat, heating water into steam, using the steam to turn a turbine and then the turbine turns a generator.

Of course the process of getting the heat is dramatically different. In the reactor of a nuclear power plant there are uranium rods, these fuel the plant. The rods are bombarded with nuclei that break apart the uranium when they collide. Essentially it's like breaking when playing pool. The cue ball is the nuclei and the triangle of pool balls is the uranium atom. Instead of sound being released when a collision occurs, heat gets released. The uranium rods are surrounded by water and this water absorbs the heat from the fission reaction. Just like in fossil fuel power plants the water is kept under pressure so that it can be heated to higher temperatures. Because this water is in direct contact with the radioactive core it is not turned into steam and is instead sent through a series of pipes away from the reactor. This water never leaves the pipes but is used to heat more water, safe water, that has outside contact with the pipes. From here the process is the same as with fossil fuel power plants. This is shown in Figure 2.3.

Nuclear power plants needs this extra step because the water that has

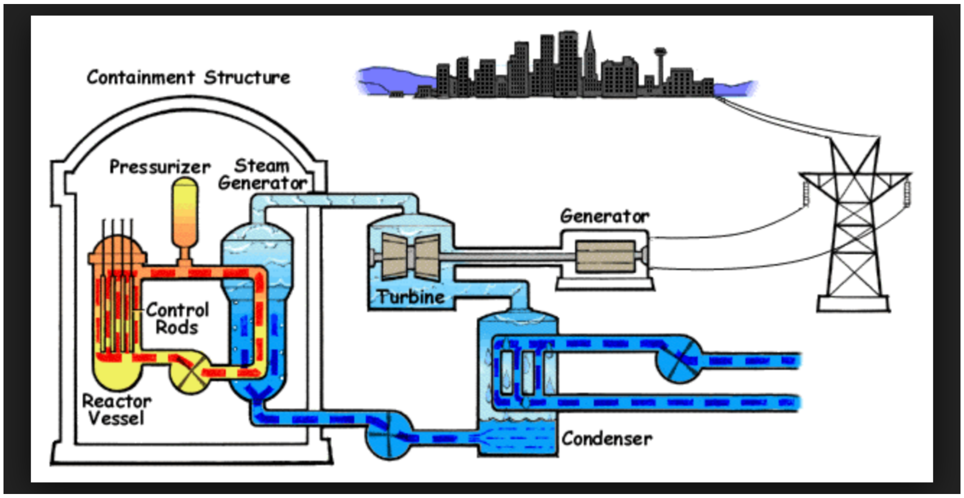

Figure 2.3: Nuclear Cycle

direct contact with the core is radioactive and needs to be handled delicately. As a consequence it can't be in direct contact with other parts of the plant. Nuclear power plants have little waste compared to fossil fuel plants but they do produce radio active waste (left overs from the fission reaction) and it takes energy to mine the uranium, refine it and transport it to the plant.

Like fossil fuels, uranium is a element found in the earths crust and there is a finite amount of it. There is far more uranium then all the fossil fuels combined and we are using it up at a slower rate but one day we will run out and well weill have to find a new kind of power source for fission.

2.4 Hydro Power

Hydro power can arguably be the cleanest source of power due to the fact that it has almost no environmental effects once the plant is built. Like fossil fuels and nuclear power plants, hydro power plants works by turning a turbine that is connected to a generator to produce power but instead of using steam to push the turbine it uses liquid running water.

The rule of thumb for hydro power is the faster the water flows the more power you can generate. This creates a desire for big damns. The idea is that you damn a river causing the area above the damn to flood. The water is held at bay by the damn. Inside the damn there is a generator and turbines connected to it. The turbines are located in a shaft where water will flow. Once the shafts are open water runs through them powered by gravity and the water pressure from the lake. The bigger the damn, the bigger the lake, the more water pressure there is, the faster the flow of water, the more power generated. Figure 2.4 shows this process. Damns don't burn anything for fuel so there are no harmful environmental emissions once its running but damns usually require a giant areas of land to be destroyed. This wipes out any wildlife living there at the time and causes giant environmental shifts to wildlife.

There are some rare cases such as Niagara falls where hydro generators can be placed beneath the falls and naturally falling water does the job with no assistance, so no damns need to be built. Finding a big enough waterfall that can generate enough power near a populated area is rare so this is not the usual option when creating a hydro electric damn.

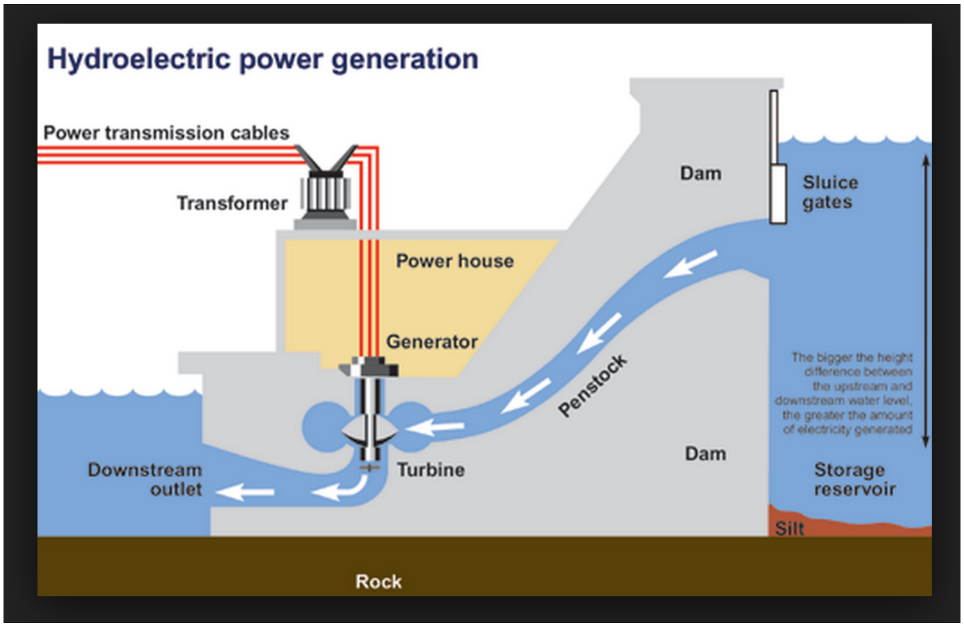

Figure 2.4: Hydro Cycle

2.5 Wind Power

Wind power has maybe the least environmental impact out of all the power sources. They use wind currents to rotate giant blades that are in turn connected by a series of leavers and gears that are directly connected to the generator. Figure 2.5 shows this process. The current is then fed down the shaft of the windmill and off to a population. Once constructed windmills essentially have no maintenance cost and are practically self sustaining except for breakdowns.

Although windmills have minimal environmental effects they have drawbacks that they do not produce a lot of power and that they take up large amounts of space. Windmills kill a fair amount of birds per year and humans that live around them are no fan of the noise nor frequent shadows that they create. They are also costly to build and can only be placed in windy locations to make them worth building.

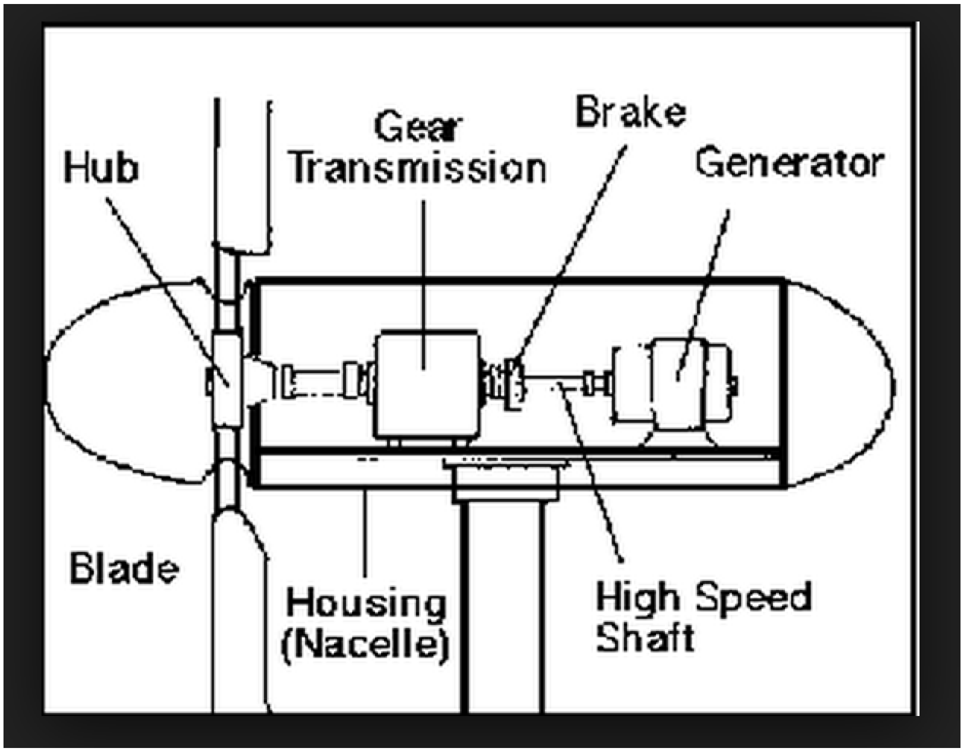

Figure 2.5: Windmill Workings

2.6 Solar Power

Solar power is the one power source that works completely different from all the others. Most objects when struct with light absorb the incomming light rays and the energy gets converted into heat. Solar panels are made from a special substance, usually silicon that when struct with light react differently. When the electrons in solar panels are struct with light they get excited and they raise an energy level. When enough electrons are at high enough energy levels they become loose and are able to move around. Solar panels are specially built so that part of the panel holds a positive charge and the other part holds a negative charge. This makes the loose electrons, in the negative part of the panel want to move to the positive section. This forms a current in the cell and from here all we have to do is redirect the current to where ever we want it. Figure 2.6 shows this process.

Although solar panels have barely no maintenance cost, fit nicely on rooftops and have hardly no environmental impacts they are the least efficient form of power, transforming only about 20 percent of the sunlight that hits them into usable electricity. Solar panels are also expensive to build and in order to generate any significant amount of usable power from them for a mediocrely sized population, farms of solar panels need to be built and this takes up a huge amount of space. Another giant draw back is that they only work during the day meaning another source of power is required for night time activities.

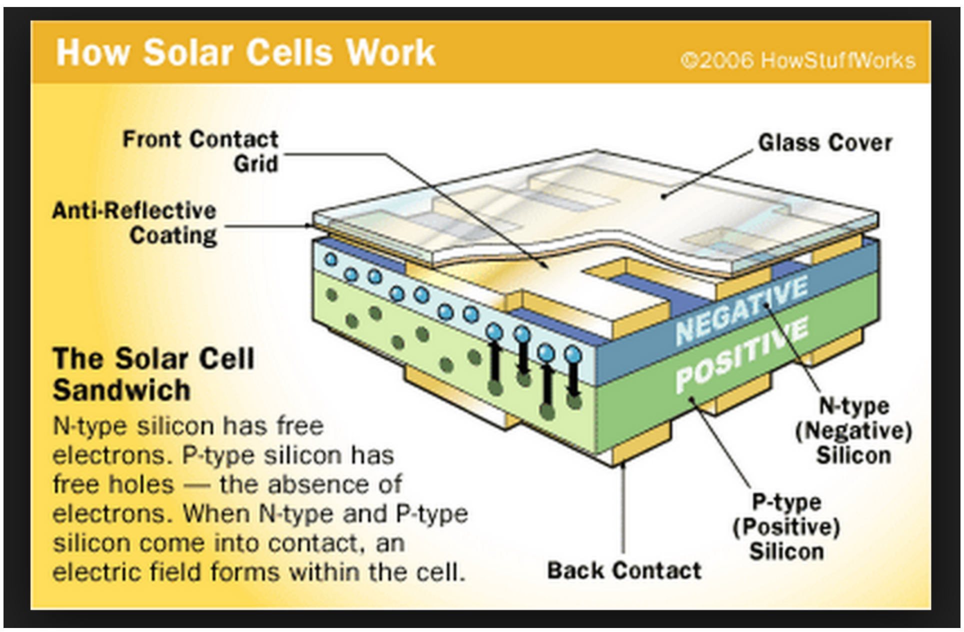

Figure 2.6: Solar Cell Workigns

Chapter 3

The Sourse

The design of the system, as illustrated in figure 3.1 below, is straightforward. The user interacts with the system by purchasing power plants. This is done on a designated screen when there is land for the user to build on. Once the user has picked a type of power he/she must then provide the resources necessary for the power plant to function. The user can obtain fossil fuels by mining for them on the screen designated to represent the land that is currently available for the user to excavate. Once resources have been obtained and a power plant is built, energy can then be created and supplied to the population.

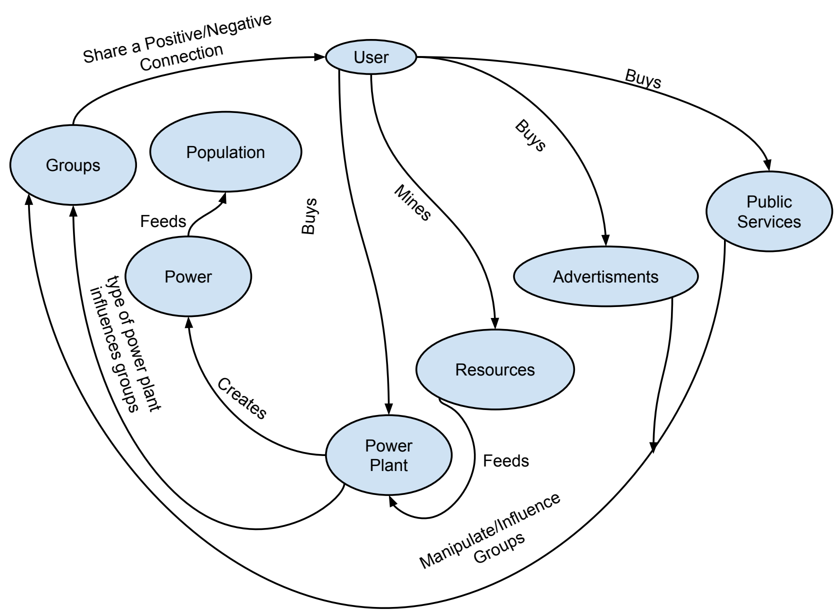

Figure 3.1:

Another option that the user has is that he/she can purchase advertisements or public services to help him/her flourish in the simulation. For example, a user could purchase an advertisement that educates the population to not waste power. This advertisement would reduce the usage of power and allow the user to more easily meet the demand. Users can also buy public services. An example would be a geologist that would survey the land and tell the user where to mine for a specific resource. Both of these purchases can influence groups within the game, such as environmentalists or public opinion.

Users choices in the game affect groups as well, for example if a user invested in coal fueled power plants then the environmentalists group would not be displeased. Groups provide small perks or punishments to the user, usually in the form of grants or fines, which are dependent on the users play style and choices within the simulation.

3.1 Screen Layout

The Source is composed of 8 different screen. The first five mentioned below are know as the five core screens. You can get to any of these screens from any other screen in the game.

The Business Screen (one of the five core screens):
In this screen the user is able to purchase advertisements and pubic services to help him/her progress through the simulation. Here the user is also able to see their progress throughout the game. The user will be able to see data like, money and energy made over time.

The City Screen (one of the five core screens):
Here the user is able to see how the population is doing, the amount of power currently demanded and the amount supplied. This screens purpose is to purely display information.

The Power Plant Screen (one of the five core screens):
This screen, possibly the most education screen shows the workings of each type of energy as well as the inner workings of a generator. As well as seeing this information this screen allows the user to see specifics on the current power plants that he/she has built. Specifics being information such as amount of power produced, cost to maintain, resources required to maintain and more.

The Land Screen (one of the five core screens):

From this screen the user can build power power plants that run off of fossil fuels and uranium. The user will have some designated land to start but he/she also has the option to buy more land to build on if the starting land is all used up.

The Resource Screen (one of the five core screens):

The purpose of this screen is to act like a map for the resources at the users disposal. From this screen the user can see all the resource that will be needed and the user can get at the three resource screens that will allow the user to extract the resources.

The Hydro Screen:

From here the user can view numerous rives that could be damned in order to generate power. Once a river is damned it will be shown on the screen. Rivers can only be damed once.

Solar/wind Power Screen:

This screen shows land in the form of a grid that the user has at his/her to build windmills on or solar canals. Building will have a cost. Once something is built it can be dismantled to open the land to have something else built.

The Fossil Fuels Screen:

Here land that the user can mine will be shown. This will be one large grid that will hold all the fossil fuels and uranium. The user can mine a section by selecting it and he or she will have a chance of discovering any one of the four resources. The resource discovered will go towards fueling the built power plants. Once a section is mined it can not be reused.

The Static Screen:

The static screen is not really a screen at all but a combination of static images that remain on top of all other screens for the entire duration of the game. This serves as the means of navigation between the five core screens. As well as displaying some information such as money and time.

Chapter 4

Sample Content Using Mathematical Notations

4.1 Facts and theorems

If we use a well established fact or theorem

Fact 4.1. *[HUL93, Theorem IV.2.4.2] Define the* marginal function γ *associated with* $g : \mathbb{R}^n \times \mathbb{R}^m \to \mathbb{R} \cup \{+\infty\}$ *by* $z \mapsto \gamma(z) := \inf_x g(x,z)$*. If* g *is a proper convex function and is bounded below on the set* $\mathbb{R}^n \times \{z\}$ *for all* z*, then* γ *is convex.*

4.2 Propositions and lemmas

Here is a lemma followed by its proof.

$$D = \left\{ (x, \lambda) \in \mathbb{R}^d \times \mathbb{R}^+ : \frac{x}{\lambda} \in C \right\}.$$

Lemma 4.2. *Assume* C *is a nonempty closed convex set. Then the set* D *is a nonempty closed convex cone.*

Proof. The fact that D is nonempty and closed follows from C being nonempty and closed. One can check directly that D is a cone....

Hence D is convex. $\square$

Make sure that the qed symbol is always on the last line of the proof. If the last line is an equation, you can enforce the qed on the same line with the `qedhere` command.

For citations, please use BibTex. A sample article to verify formatting and style is [BGLW08]. Use the bibliography style `ubco`, which is basic `alphaurl` style with inline links enabled. Please compile multiple times when generating the references. The last entry in a reference are the back references to the pages with the citation. They need an additional compilation, once the bibtex entries are generated.

Note that the bibliography style is discipline dependent so feel free to use the style adopted by your discipline, for example siam for mathematics.

Chapter 5

Landscape Mode

The landscape mode allows you to rotate a page through 90 degrees. It is generally not a good idea to make the chapter heading landscape, but it can be useful for long tables etc.

This text should appear rotated, allowing for formatting of very wide tables etc. Note that this might only work after you convert the `dvi` file to a postscript (`ps`) or `pdf` file using `dvips` or `dvipdf` etc.

Chapter 6

Conclusion

Here comes the conclusion.

Table 6.1: A publication quality table. Very very very very very very very very very very long title.

Item		
Animal	Description	Price ($)
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.50
Emu	stuffed	33.33
Armadillo	frozen	8.99

Your conclusion can go on for several pages.

Bibliography

[BGLW08] Heinz H. Bauschke, Rafal Goebel, Yves Lucet, and Xianfu Wang. The proximal average: Basic theory. *SIAM J. Optim.*, 19(2):768–785, 2008. → pages 13

[Fea05] Simon Fear. Publication quality tables in LaTeX [online]. 2005 [cited April 18, 2010]. → pages 21

[HUL93] Jean-Baptiste Hiriart-Urruty and Claude Lemaréchal. *Convex Analysis and Minimization Algorithms*, volume 305–306 of *Grundlehren der Mathematischen Wissenschaften*. Springer-Verlag, Berlin, 1993. → pages 13

Appendix

Appendix A

Tables

Here you can have additional tables. Table captions are always on top.

In order to use publication quality tables, one should use the guidelines in [Fea05]. In short, do not use vertical rules or double rules, units in the column heading (not in the body of the table), precede decimals with a digit, and do not use ditto signs. Table A.1 is according to the guidelines.

For tables, the caption goes on top, for figures, the caption goes on the bottom. If possible, always position tables and figures at the top of a page.[1] Use the option `tbph` for the placement.

Table A.1: A publication quality table. Very very very very very very very very very very long title.

Item		
Animal	Description	Price ($)
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.50
Emu	stuffed	33.33
Armadillo	frozen	8.99

[1] In this case, the chapter heading prevents the table from being at the top.

Table A.2: Another table

Table A.3: Another table

And other table materials (I needed to generate two pages for that appendix to test the formatting of the table of content).

Table A.4: Another table

Table A.5: Another table

Table A.6: Another table

Table A.7: Another table

Table A.8: Another table

Table A.9: Another table

Table A.10: Another table

Table A.11: Another table

Appendix B

Figures

Here you can have additional figures. Figure captions are always at the bottom.

And other additional figures (again I needed to generate two pages :-).