The ASES Do-It-Yourself Program

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Executive Summary

It is proposed to establish a Do-It-Yourself (DIY) program for ASES, that can also be shared by any of the other ISES National Sections interested in being involved. Just like the recipes in all good cookbooks, all the DIY recipes will be thoroughly tested by independent people, with the instructions being edited and adjusted until the recipe is as reliable and foolproof as possible. Most of the projects will involve solar energy technology, but there will be some on other topics, and some will be there just for fun and enjoyment. The first project is one for using solar energy for heating swimming pools, that has already been a successful DIY project for over 42 years, and for which the prototype DIY flat plate heating collector has already operated properly for over 42 years.

1.0. Introduction to the ASES Do-It-Yourself Program

ISES and ASES and the other ISES National Sections have been working for about 60 years on R&D to prepare humanity for its eventual transition from fossil fuel and nuclear energy to renewable energy sources. During most of that time society did not worry about energy because it was cheap, mostly because the Hubbert oil peak was still far away. Few had heard about the Hubbert peak oil effect, few knew about global warming, and even fewer realized how serious the Hubbert peak oil and global warming could be.

At present the effects of global warming are already clear to anybody who follows the news, and the future impacts of global warming are likely to be horrible. Petroleum is no longer plenty, since we are already at the world Hubbert oil peak (see http://www.hubbertpeak.com), and the US government took us into a war in Iraq that has now clearly been recognized as a war that was only for oil, and that was started for reasons that were false and were well known to be false. The US Iraq oil war turned out to be an extremely costly and destructive war. It cost the USA 4,500 dead soldiers and $1 Trillion, and in Iraq at least 1,500,000 people were killed..

At present there is a widespread concern about global warming and about the future petroleum supplies. Humanity is looking for oil in outlandish places like in deep water in the ocean, in shale deposits, and in tar sands. The petroleum is hard to recover, can only be recovered at very low rates (compared to the 80,000,000 barrels of oil thar humanity has been using each day) and the environmental damage (for example for the tar sands) can be very bad.

Fossil fuel has clearly given an enormous boost to the productivity and wellbeing of humanity, but it has also produced serious problems, and this has not been limited to the victims of oil wars. It has given us the Exxon Valdez disaster, the grotesque petroleum pollution by Chevron in the rain forests of Ecuador and of BP at its Macondo well in deep water, the pollution and environmental disasters of tar sands, of fracking and of mountain top removal, the widespread health problems caused by the use of “leaded gasoline,” plus smog, global warming, black lung disease, fish contaminated with mercury, etc. The list can go on and on.

Atomic energy never gave us the promised “power too cheap to meter.” Instead it has give us “power too dangerous and harmful to tolerate,” in Chernobyl, in Three Mile Island, in Fukushima, in “depleted uranium ammunition,“ and in many uranium mines around the world that produced large areas covered by dangerously radioactive mining waste.

In the meantime the public is getting more aware of renewable energy technology, and is getting increasingly enthused about it. The technology is also getting better. Wind farms and photovoltaic installations and solar thermal installations are being established all over the world, and these are making an energy contribution to the power grids that is already very significant and is growing extremely rapidly.

Solar energy lends itself to many Do-It-Yourself (DIY) projects and activities. These can help you to save money, to reduce the waste of fossil fuel resources and the pollution of the environment, to limit the destruction we can expect from global warming in the future, to get healthy exercise, to enjoy yourself building and using good equipment, and to get equipment that may well work properly for years and even for more than four decades, as we have seen in our project number 1 on solar swimming pool heating, which started working in 1973 and which still works properly after over 42 years.

Between the American Solar Energy Society (ASES, see www.ases.org), the International Solar Energy Society (ISES, see www.ises.org) and all the other National Sections of ISES, as well as the Regional Chapters and the Student Chapters of all of the National Sections of ISES we will set up a very lively source of well designed and clearly explained Do-It-Yourself (DIY) projects and activities in renewable energy topics. We can tap into an almost unlimited number of highly trained and experienced people to think up and propose and design and test and perfect and edit new Do-It-Yourself projects, and to keep these projects up to date. This is not

limited to the few tens of thousands of people who are associated with our solar energy societies, for the world population at present is over 7,000,000,000, and ideas could come from anywhere, as we hope they will. What we plan to do is to set up the same process that people use to develop serious cookbooks, for after all cookbooks are nothing more than organized lists of DIY projects. Recipes or ideas for recipes do not just get published. They first get proposed and then they get studied and tested and improved and edited until people are happy with the instructions and the explanations and the results, and then and only then do they get into a cookbook for publication. That is not the end of the story either, for they must be kept up to date. On top of that, all competent cooks play around with recipes. One might add a bit more or less salt or garlic, another might add some more chile pepper, somebody might reduce the amount of oregano and add some more cilantro, etc. Before you know it you might have a number of slightly different "variations on the theme of Recipe X or of DIY project Z."

Using a clothesline for drying the laundry is an obvious and very simple example of a renewable energy DIY project. Instead of using utility energy or fossil fuel heating, you can let the free solar energy and the free wind power do the work for you, and the exercise you get in the process of hanging up and taking down the laundry is a totally free benefit. For the traditional approach, the clothes dryer does the work for you using energy you have to pay for, you waste fossil fuel driving to the gym, you pay for the privilege of exercising your muscles on fancy machines, and you force future generations to pay for the increased global warming destruction you caused by being oblivious to reality. For the ultimate in the DIY area, you can install your own clothesline, or go even one step further by growing some plants that produce useful fibers, and spinning your own clothesline and then installing it. When the labor is very enjoyable and therapeutic the cost effectiveness of labor may not be that important, but spinning your own clothesline from home-grown fibers may be going too far.

There are many other renewable energy DIY possibilities. It could involve sundials to find the approximate time of the day and to see the progression of the seasons. It could be a solar stove or even a solar oven, or a barbecue installation using woody biomass or charcoal. It could be a site selector that can tell you where the sun will be in the sky at given times, or where and when you will get shade in the garden. It could be a solar pool heater or a solar water heater or a solar spa heater. It could be a passive solar room or building. It could be a solar fruit or food drier. It could be a solar still, to produce perfectly safe drinking or cooking water out of well water that is dangerously contaminated with arsenic salts or other harmful substances, out of sea water or out of brackish water, or using water sources that may be contaminated with some organic or chemical wastes or with dangerous germs.

It could involve installing a photovoltaic (PV) power supply using one or more PV panels to power facilities that are off the utility grid, or to reduce the power you have to buy from the utility for your grid-connected home. Such PV systems may require battery banks and battery chargers, inverters, circuit breakers and other safety features, electric smarts so that you really know what you are doing, permits, inspections and certifications, and carefulness and thoroughness to make sure you satisfy all the paperwork and the preparations needed to satisfy your own needs and the needs of those who are entrusted with the duty to ensure that you really end up with a system that works properly and safely. You can use such PV power for any of many purposes, like ventilating your attic or your basement, powering air conditioning equipment, powering a toy train circuit, etc.

Do not expect all Do-It-Yourself projects to be simple and easy. Wernher von Braun, who helped Hitler bomb England and who later helped the USA visit the moon, said it well: "You can handle the law of gravity properly, but it takes lots of paper work." It would be silly to be so oblivious to the realities of space travel that you tried to drive a car to the moon, but it is just as silly to start on a Do-It-Yourself project with drawings that are wrong or with instructions that do not make any sense. Understanding is essential. Do not get scared of this and despair! Take advantage of it and learn!

And Now Some History

Serious petroleum production and consumption started around 1860, although humanity had been using some types of petroleum (e.g. bitumen or tar for the mummification of people or for sealing the hulls of ships) for thousands of years. When Alexander the Great was at war he passed one city that was using the petroleum that oozed out of the ground for street lighting at night. However until the end of WW 2 in many areas of the world people used little or no petroleum, but after WW 2 petroleum consumption started growing rapidly everywhere.

In the early 1970s there was a petroleum embargo in which some angry members of OPEC stopped delivering oil to the customers that had made them angry. This reduced the supply of petroleum and increased energy prices greatly. This was widely characterized as: "The Energy Crisis," and caused an enormous increase in the interest that people had in questions of energy. Under US Presidents Nixon, Ford, and Carter there was a great increase in the federal energy R&D budgets, first at the National Science Foundation (NSF), then at the Energy Research and Development Administration (ERDA), and then at the Department of Energy (DOE). Renewable

energy R&D funding increased greatly, and the Solar Energy Research Institute (SERI) was established, and later renamed the National Renewable Energy Laboratory (NREL). People tried to reduce petroleum consumption by switching to natural gas, to coal, to renewable energy, or to energy efficiency, and the consumption of petroleum in the 1970s not only stopped increasing, but actually dropped significantly.

In the late 1970s things suddenly changed. The oil embargo was lifted, with OPEC again hoping to produce and to sell at capacity. The need for oil had however decreased in the 1970s, but the supply suddenly increased greatly, with the USA bringing Prudhoe Bay on line, with Norway and England starting production in their North Atlantic oil fields, and with Mexico also increasing petroleum production greatly, especially in the Cantarell Oil Field, that had been named after the Mexican commercial fisherman who had noticed oil bubbling up above the field in the ocean.

This produced an "Oil Glut," with the price of petroleum dropping greatly, and with many people and governments losing interest in renewable energy. In addition President Carter was not reelected, and instead of the continuing growth of interest in renewable energy that had been seen with Nixon, Ford, and Carter, the USA got President Reagan, who reduced the federal renewable energy budgets by about 80%. Both from the US DOE staff and from the public hearings there had been almost unanimous opposition to any such cuts, but to the Reagan Administration people renewable energy seemed to be no more than a bothersome obstacle to their friends in the fossil fuel energy industry and in the nuclear power industry (FdW, 1985).

And Now Back to the World of Do-It-Yourself Projects!

In the 1970s there was still a fairly limited amount of understanding in renewable energy technology among a very limited number of people, but there were many people with an almost unlimited amount of enthusiasm for renewable energy launching Do-It-Yourself projects. Some of these projects employed components like used beer cans, not because they were really useful for the project, but because they were cheaply available. The project "design" was often developed with virtually no understanding of the technology involved. Rather than leading to understanding and appreciation, such projects could and often did lead to frustration and confusion, and to a dislike for renewable energy as an apparently amateurish and useless technology.

Now things are different. The financial boom for renewable energy of the 1970s did not last, but many of the people who had entered the renewable energy field stayed there and continued studying and improving the technology, and increasing their skills and the usefulness of their computer programs, and of their experimental results. Some were university professors who could continue working in the field on a part time or full time basis. Some simply adopted renewable energy as a hobby and became a member of a solar energy society. In virtually all renewable energy topics one can now find well educated and highly devoted technical people in most countries of the world. Setting up a really serious effort on DIY devices and activities was quite out of the question in the 1970s, but today it is quite possible to do so.

There is also the question of public interest. In the 1970s about 80% of the population preferred renewable energy to the alternatives, but it was a warm goody-goody type of a feeling with no really solid foundation or real choices. Now the renewable energy industry is already very large and experiencing an almost explosive growth, in PV installations and in wind turbine installations. The new renewable generation capacity being installed is already much larger than that of any of its competitors. Solar energy is often more cost effective than the competition. Currently over 90% of the population is very much aware of and in favor of renewable energy, and many are interested in getting involved. DIY projects allow them to become involved.

We are starting this DIY effort with a project for the solar heating of swimming pools. This might be considered somewhat far fetched or outlandish, but it just so happens that this DIY project already existed 42 years ago (in 1973), and that the project prototype has not only survived but performed properly for over 42 years. If you happen to have access to a swimming pool that needs heating, go to it! If you do not have an available swimming pool, it is hoped that the manual will provide you with interesting information.

Our next project will probably be a solar cooker developed in Mexico by Prof. Eduardo Rincón Mejía that I first saw (and ate from!!) at the meeting that the International Solar Energy Society (ISES) held in conjunction with the Mexican Section of ISES in Cancún in Mexico in 2013. I like cooking and I have many cookbooks. I look forward to seeing many solar cookers in use. I have known Prof. Rincón for decades, he is very enthused about getting his solar cooker into our DIY program, and he is getting the instructions and the drawings ready for this. My guess is that we will have his solar cooker in our DIY program in just a few months, both in Spanish and in English.

In time we may also offer a fully reliable solar oven, but it should be recognized that this is difficult. Normal recipes that use an oven typically call for temperatures of 350 F or 425 F (177 C or 218 C). With electric or gas-fired or wood-fired ovens it is fairly easy to get an oven that will provide a reasonably uniform temperature at those temperature levels, especially if it is a convection oven, with a fan that sets up a vigorous circulation of the air inside of the oven. It however requires a very properly and carefully designed and built solar oven to do this, and we should not offer a DIY oven that will deliver a chicken or a duck or a loaf of bread that is well baked on one side and still raw on the other side. It may be desirable to make the oven a solar convection oven, using solar energy to provide the oven heating, and a small PV powered fan to distribute the heating evenly throughout the oven.

1.1. DIY Management and Setting Up New DIY Projects

The Do-It-Yourself (DIY) operation will be shared by the American Solar Energy Society (ASES) with all the other willing National Section Members of the International Solar Energy Society (ISES), as well as with ISES itself. ASES will simply maintain the DIY website.

The source(s) of the individual DIY projects will be identified but there will be no copyright or royalty or license fee concerns, and all the material will be made accessible and available free of charge as a service to humanity on the internet

Governance of the DIY Operation

A reasonable design of the DIY operation and management is still not clear. It will probably require two committees plus groups of people to test the DIY projects, and to edit and prepare the final set of instruction. The committees might be:

A DIY Management Committee to run the operation, and to raise any needed funding.

A DIY Technical Subcommittee to ensure that the proposed new projects are worthwhile, that the project instruction testing and the final "project recipe" development process is under control and on schedule, and that the "project recipes" are continually corrected and fine-tuned and kept up to date.

To keep the operation simple it is probably desirable to have no more than perhaps 10 members in each of these two groups. The question will be how to determine who gets on these committees when many of the ISES dozens of National Sections get involved. It seems desirable to prepare charters for these committees, with the member duties, term length, term limits, frequency of meetings, rules of order, etc. At the beginning, until things begin to settle down, it may be best simply to have the ASES Board appoint the members, using as the source for these members people from all over the world. Most of the meetings could probably be by phone or skype.

For each new DIY project a fairly small group of people should be formed for the timely and thorough performance of the "recipe testing" and for the timely preparation and editing of the final DIY project recipe. The final report of this group should involve more than just the DIY project recipe. It should also include a discussion of the reasons for the recipe steps, and if the DIY project uses specific references in the literature the report should include a list of these references and internet links to their full pdf copies. This list of references does not need to be exhaustive or enormous, but it should not overlook important material. It is to be included with the final DIY project recipe shown on the ASES DIY website together with a request (to the public) for any relevant references that are still missing. This testing and writing project is to be based on a formal agreement in which the tasks are to be clearly described, and in which the schedule and the essential funding is specified.

The use of student groups for the project recipe testing and development is to be encouraged, but it must be ensured that the one and only objective of the effort is to be the timely and reliable preparation of a clearly optimized and properly documented (with references, etc.) DIY package that can be posted on the DIY website, without any distractions and delays by the exploration of topics that might be of interest for term projects but have no real bearing on the DIY project. Student groups are to be made aware that a serious failure on a DIY project will make the school ineligible for work on future ASES and ISES DIY projects for a number of years, so as to be able to address any new DIY projects with a clean slate of students after all the members of the failing team are long gone.

Originating New Projects

Members of any of the ISES solar energy societies as well as members of the public will be encouraged to suggest new projects, whatever the status of the project, whether it is still simply an idea, or whether it has already reached the stage of a working prototype. Ideas or details on new projects are to be sent to URL to be determined……..

2.0. The Solar Heating of Swimming Pools and Spas or Jacuzzis

The best water temperature for a swimming pool depends on many factors. Many cities have clubs of people who go swimming in cold weather when there is ice on the water, but this seems to be for meeting a challenge and not for enjoyment. Swimming pools used for athletes in training for important events like Olympic races are generally kept at around 22 C or 72 F. For very relaxed and comfortable swimming many prefer a temperature of around 27 C or 80 F. Young infants or babies cool down rapidly unless the pool is close to their body temperature, at perhaps 32 C or 90 F, or even higher. The elderly who get into the pool for relaxation instead of vigorous exercise also prefer higher temperatures. In the heating of my pool I have aimed for a temperature of 27 C or 80 F.

One should be very careful to avoid having the water temperature too high in spas or jacuzzis, especially if one is alone. One can easily become sleepy, fall asleep, and drown.

The heat losses from a heated pool generally are largely due to the water evaporation at the surface of the pool, for which the heat comes from the pool water. That is why pool covers work so well, for they prevent water evaporation altogether. These evaporation heat losses are greater when the humidity of the air is lower, and with the low air humidity in Pasadena, California, where the prototype heater for this manual was built, the unheated pool was at 27 C or 80 F for barely two months of the year even with very sunny weather. With the heater installed and operating this 27 C or 80 F swimming season became more than 5 months long, with the pool temperature occasionally reaching 33 C or 92 F.

2.1 The History of this Solar Swimming Pool Heating DIY Project

In the late 1960s I was working at the Jet Propulsion Laboratory (JPL), first on the solar photovoltaic system that was to provide the electrical power to the Mariner 10 spacecraft which went to the planet Mercury after a gravity boost from Venus, and later on the radioisotope thermoelectric generator (RTG) devices that were to provide the electrical power to the two Voyager spacecraft that explored the outer planets of the solar system the outer limits of the solar system, and now space outside of the solar system. I was also doing some outside consulting, which was fine with JPL so long as JPL knew about it, and so long as it was not in any conflict with the work I did at JPL. I was consulting primarily for the Copper Development Association (CDA) and the International Copper Research Association (INCRA), both in New York City, on the use of copper in agricultural and in solar energy heat transfer applications.

I had been involved in carpentry and in metalworking applications at home and at work for decades, and I realized that the solar heating of swimming pools could be done in a much cheaper and more environmentally benign way with a home-built solar heat collector built of copper than with a standard natural gas swimming pool heater. The only thing needed was a clearly written do-it-yourself manual for homeowners who like building things, leading them to a well designed and constructed copper swimming pool heater prototype made of copper sheet material and copper plumbing parts. The heater could be a standard flat plate solar heat collector. No glass or plastic cover was needed since the temperature at which the collection was done was very low, quite close to the ambient temperature. If the collector was designed and built properly it could be a copper roof as well, and copper roofs have been known to last for hundreds of years.

Around 1970 I got a small CDA contract to design and build such a copper swimming pool heater for the swimming pool at my home in Pasadena, and to write the Do-It-Yourself (DIY) manual. In March 1973 the heater was finished and operating. I presented a paper on the program at the UNESCO meeting on renewable energy in Paris (1), and the DIY manual was published first as a draft in 1973, and then as the first formal DIY edition in 1975 (2). The CDA distributed over 100,000 copies of the DIY manual 1975 edition free of charge, and for years ASES sold copies by the hundreds. Now a copy of the 1975 DIY manual can be downloaded free of charge below.

This project had a significant effect on my career, for much of my later work was on solar or natural gas fired water heating, on solar heat collectors, or on the interactions of the components in water heating systems, including the performance and the effects of heat exchangers, and even on the problems one can have with collectors in hail storms. The associated publications are shown as References 1 – 47 (see Section 2.7). Since in the early 1970s there were still no solar energy textbooks, I had to find the important references in solar water heating in the technical literature, and that allowed me to write an annotated bibliography on the flat plate solar heat collector (4, 5), with a much more detailed version coming out years later (32).

The prototype solar swimming pool heater still works properly after more than 42 years. Every now and then a paper with a progress report has been presented at a solar energy conference and included in the conference proceedings, and this includes many references (1, 2, 8, 10, 20, 29, 37, 42, 43, and 47). Over its 42 years of existence it has collected as much heat as would be generated by the combustion of well over 1.5 pools full of petroleum, about 45,000 gallons of petroleum fuels.

The reference list shown as Section 2.7 includes my publications on solar swimming pool heating, solar and gas-fired water heating, flat plate solar heat collectors, and heat exchangers used in solar water heating systems.

For many years I have been thinking about writing a second edition to the do-it-yourself manual. In the first edition it was intended for the builder to do hand calculations with the average solar inputs one gets in the USA. One graph is shown for each of the 12 months of the year on pages 11 - 16 of the manual. These hand calculations (i.e. with a calculator or slide rule but not a computer) reflect what the world was like in the early 1970s. Now for many locations in the world one can download computer files with a Typical Meteorological Year (a TMY file for the local weather) made up of a series of months that were determined to be typical that include direct (beam) and diffuse solar inputs, wind velocity and direction, temperature, relative humidity, and rainfall.

Another edition will come out in 2016 or 2017, with the contents updated to reflect the computer capability almost everyone has now. A Mexican engineer, David Gudiño, prepared a computer program many years ago for evaluating the solar heating of swimming pools. That computer program, with instructions in English, will be made available on the internet.

2.2. My Handyman Background

In 1951, at the age of 15, for a few months I became an informal apprentice in a carpentry that restored antique furniture in the Netherlands, while my family was on an extended vacation in Europe. I learned by helping the owner on all sorts of tasks, and finally I had a project of my own: to make a box to store all the sewing gear of my mother, using good (and very dark) oak lumber that had been part of a derelict piece of furniture dating from the early 1700s. I inherited the box and its contents from my mother, it is still full of her equipment, and it is probably good for many more decades. Ever since then I have spent a lot of time in woodworking, in metalworking, and in plumbing, and in learning to use the lathe and the milling machine and gas and electric welding equipment, at home and at the school shop in high school, while studying at MIT, while teaching at MIT, while working at an engineering firm in the Boston area, while working at JPL, while teaching at Cabrillo College, while taking courses at Cabrillo College and at Hartnell College, and by using the equipment in the shop of my own company. In the high school shop class I started working with copper, at MIT for many years I specialized in heat transfer and had access to all the equipment I could even dream about, and at JPL I got involved in the energy field for spacecraft power in a group with a good workshop.

As part of my engineering practice at present I have a very well equipped workshop, with a lathe, a milling machine, metal welding and brazing and soldering and cutting and shearing and bending and forming and punching equipment, plus a lot of woodworking equipment. This allows me to build metal and wood things to my heart's content, and I use the equipment all the time. I get many journals on metalworking and fabricating and plumbing and engineering design, and I have a totally complete collection of the Fine Woodworking magazine, plus many books on materials and on hardware.

At JPL I had also gotten involved in a study on solar water heating that was funded by one of the local utilities. In the late 1960s it became clear to me that anybody skilled with woodworking and metalworking and plumbing tools could build a long-lasting solar heating collector of copper that could heat a swimming pool more cheaply than could be done with natural gas. I had already been doing consulting work for the International Copper Research Institute (INCRA) and for the Copper Development Association (CDA) anyway, and I convinced the CDA management that a do-it-yourself home-built copper solar swimming pool heater could be a worthwhile venture. I got a small CDA contract to build a demonstration and test solar heater for my home swimming pool in Pasadena, and to write a do-it-yourself

manual for homeowners.

The heater in Pasadena was first turned on in March 1973. Through pure luck this was at the time of the "Energy Crisis" of the 1970s, which was not really an energy crisis, but simply an event in which the members of OPEC reduced the world's petroleum supply severely for political reasons. At any rate it caused humanity to focus on energy, and made many people interested in my solar pool heater.

After more than 42 years of continuing use for me and for 5 later homeowners my swimming pool heater is still in good condition. The 1975 edition of the manual has been very popular. Over the years the CDA distributed over 100,000 copies, and the American Solar Energy Society (see www.ases.org) is still selling them (at $5 each) by the hundreds. It is not known how many people built such a heater, but in some parts of Mexico (notably in Cuernavaca) there is now a cottage industry in which some of the architects and building contractors get such heaters built for interested customers. I wrote a number of papers and of progress reports on the swimming pool heater and its manual (see Section 2.1). The latest time the house was sold the price was more than 23 times what I paid for it in 1968, but the pool heater was certainly only a small part of its increase in dollar value.

2.3. Necessary Skills and Supporting Information and Suggestions

It is assumed that the solar swimming pool heater installation will be made by people who are comfortable with metal and woodworking equipment. Instructions for and guidance on metal and woodworking equipment can be found on the internet, in books and in manufacturers brochures, in local courses at community colleges, from friends, etc.

It should be recognized that power tools are only used because their design and their power greatly increases the speed and the accuracy of the work one is able to do, but that if such tools are used carelessly or improperly they can do an absolutely incredible amount of bodily harm in a fraction of a second. This does not provide a novel danger or a novel experience, for almost everybody drives a car, in which the dangers are quite similar. For example, when driving a car one is extremely careful not to drive at high speed into that telephone pole that is ahead, but there are very few people who are really terrified by cars or by telephone poles. One very simply and very carefully and very confidently does everything necessary to avoid hitting that telephone pole. When driving past that telephone pole, never forget that you intend to miss it, and you need the same approach with power tools. First, make absolutely sure that you know how to use the tools and that you understand the dangers. Then make absolutely sure that everything is set up properly and safely, and if you have any doubts get some outside guidance with this. Finally, when you perform the power tool operation, do not allow yourself to be distracted by anything or anybody else. Do not allow anybody to be dangerously bothersome or distracting, just like you would not allow any drunken back seat driver to scream in your ears suddenly when you are driving. The few seconds or minutes of intense and total concentration you devote to the operation of that power tool (or to the driving of that car) cannot possibly be spent more usefully on anything else.

Copper and the copper alloys are useful for more applications than almost any other material. The copper industry of today represents the culmination of over 5,000 years of effort, since the start of the ages of copper and of bronze, of copper alloy development, of alloy property determination, of the determination and avoidance of conditions that can be corrosive for copper, of fabrication techniques, of the development of standardized parts, and of the development of effective designs for things such as roofs and roofing membranes, plumbing systems, etc.

The Copper Development Association (the CDA) has been established by the copper industry to be the central source of data on copper and copper alloys for the whole world. The CDA (see http://www.copper.org) has prepared many useful publications that can be downloaded, with a publication list at: http://www.copper.org/publications/pub_list . Feel free to tap into their data base, for plumbing, for architectural applications like roofing, for soldering and brazing processes, etc.

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2.4. Downloadable CDA DIY Manual

A full PDF copy of the 52 page file for the publication:

F. de Winter: "How to Design and Build a Solar Swimming Pool Heater," DIY Manual published in 1975 and then distributed free of charge by the Copper Development Association of NYC for a number of years.

is shown in Section 2.5.

2.5 PDF Copy of the CDA - FdW Manual

2.6 Pool Heater Operation and Maintenance Suggestions

Operational Suggestions

The pool circulation and filtering requirements are not affected significantly by the solar heater. To get the most heating from the collector one should keep the pump on during the sunniest part of the day, and if the pool gets too warm one can circulate the water partly or fully at night.

The Use of a Pool Cover

A pool without a pool cover is normally quite attractive, but pool covers rarely look good, and it can be enough of a bother to take the cover off and to put it back on so that one ends up using the pool less frequently. One of the advantages of the solar heater is that it extends the length of the swimming season during which no pool cover is necessary.

The heat losses from a pool are primarily due to the water that evaporates from the pool surface, with the pool cooling down because it provides the heat the water needs to evaporate. A pool cover works primarily by preventing the evaporation of pool water, and by doing this it typically raises the pool temperature by around 5 C or 9 F. By using a pool cover in the spring and in the fall one can extend the swimming season considerably.

Maintenance Suggestions

The maintenance requirements of the heated pool are not significantly different from an unheated pool, but because of the increased water temperature the pool might require a bit more in control chemicals and more water to make up for water evaporation. If you use a pool maintenance service, typically with a weekly visit, the maintenance personnel will take care of that automatically, by controlling the water level and the water chemistry (i.e. the pH).

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