FAA WORLD

October 1979

Fueling Our Tomorrows

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Correction

In "How To Bid On a Job," FAA WORLD August 1979, page 3, the statement on who may use the National Seniority Opportunities program was incorrect. Any full-performance-level center or terminal controller in the national air-traffic bargaining unit, whether a PATCO member or not, may use the National Seniority Opportunities program.

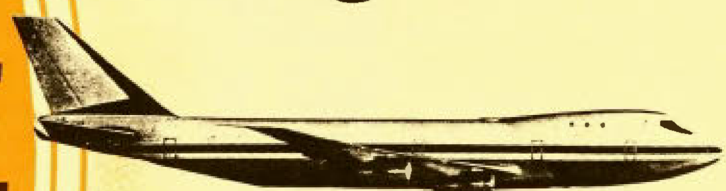
The cover: *These optical modules at Phoenix Sky Harbor Airport in Arizona represent one of a multitude of approaches for meeting our energy needs of the future through conservation and new technology. With October being International Energy Conservation Month, FAA WORLD looks at our energy future.*

SAVE ENERGY

The need for continued energy conservation in the National Airspace System is greater today than at any time in the past.

We must recognize that the interruption of a significant portion of the United States' foreign oil supply could produce a crisis of even greater

Fueling Our Tomorrows



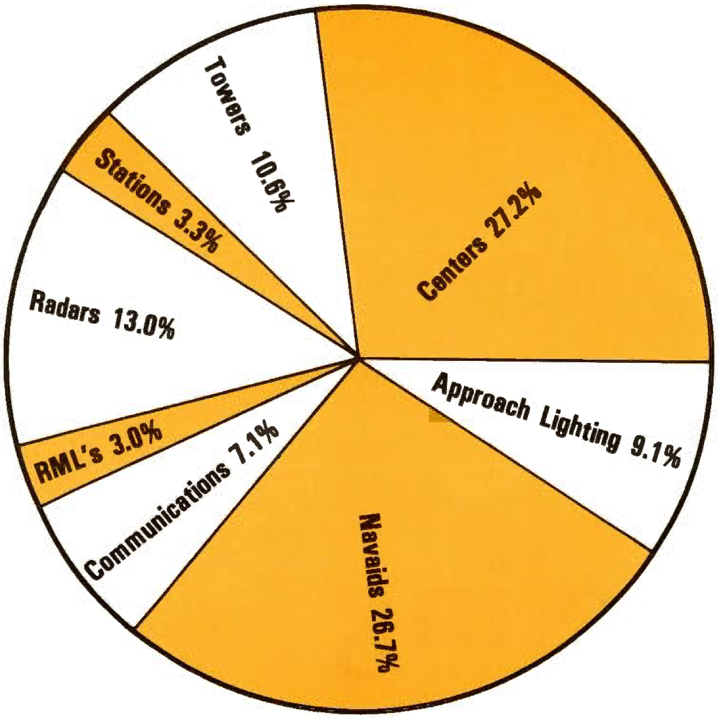
By Langhorne M. Bond
Administrator

severity than we faced in 1973-74. At that time, the U.S. imported less than 35 percent of its oil; now, it's almost 45 percent.

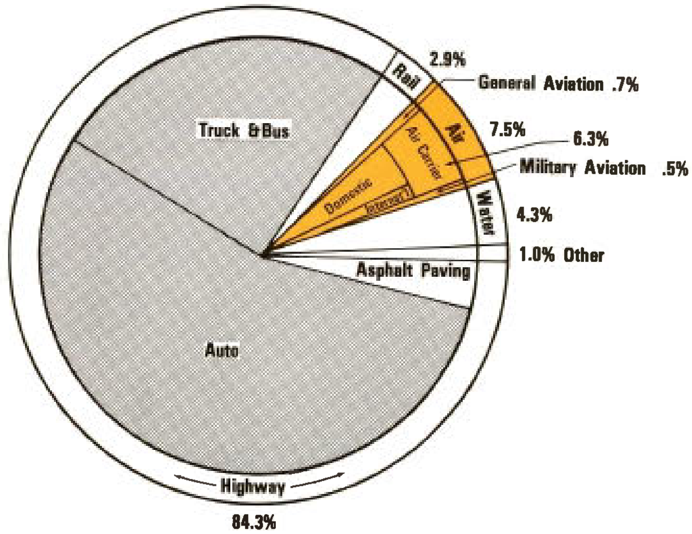
As a result of this rate of growth, the President recently imposed a ceiling on the amount of oil this country can import in the future. And aviation could be among those hardest

Total Annual Energy Consumption
By Type of Facility

Total Consumption Est. 661 Million Kilowatt Hours Per Year



Transportation Domestic Energy Demand (1976)



hit by an oil shortfall, for right now there is no alternative to fossil fuels for aircraft.

The answer to these problems can be found in the goals established by the President. We must reduce oil imports through *conservation*, improved *efficiency*, the development of *alternative and renewable energy sources* and the *increased domestic production* of conventional fuels. Three of those four are within our province in FAA and the aviation industry.

Through planning before and during the 1973 crisis, our industry was able to bring about a 35 percent aviation fuel efficiency improvement. But much remains to be done, both in putting our own house in order and in continuing to work with the aviation industry in an effort to conserve energy in the operation of the National Airspace System.

FAA's energy conservation program emphasizes the reduction of energy consumption in our facilities and the efficient use of aviation fuel without compromising safety. We have taken new looks at how we use conventional energy, how new facilities can be built to be more energy efficient and how we can apply the growing technology of alternative and renewable energy sources.

Early approaches to conservation have been in the realm of air traffic control, in which safe aircraft operations are combined with energy-efficient operations. Cruise speeds have been lowered to near optimum levels, and climb and descent procedures have been vastly improved by the airlines. Controllers have cooperated by assigning requested altitudes when practical and have helped make ground operations more fuel efficient. Improved flow control has also helped cut fuel waste by reducing delays.

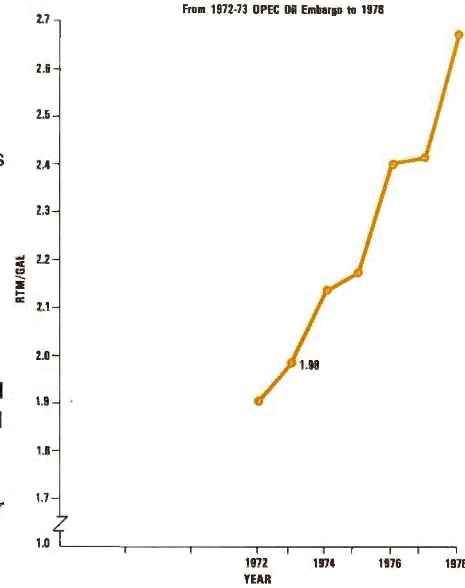
As a result, while domestic passenger and cargo airlines saw a 13.8 percent growth in revenue ton-miles carried between 1973 and 1978, their fuel consumption rose only 3 percent. The gross fuel efficiency had improved by about 35 percent.

With aviation a fuel-sensitive industry and domestic crude oil production not keeping up with the absolute increase in demand, this improvement is not enough. Then, too, we may find that some of our energy-saving solutions in

continued on page 9

Air Carrier Fuel Efficiency
Revenue Ton-Miles Per Gallon (RTM/G)

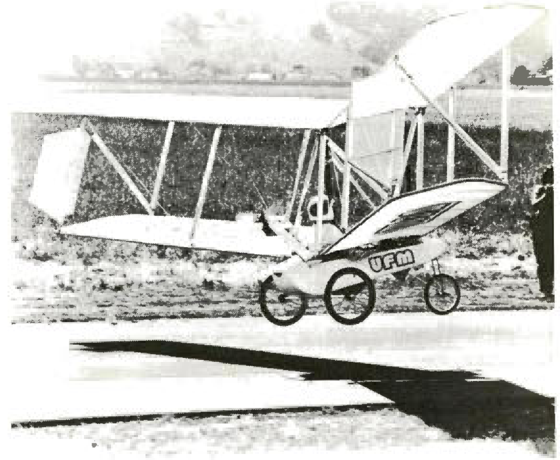
From 1972-73 OPEC Oil Embargo to 1978

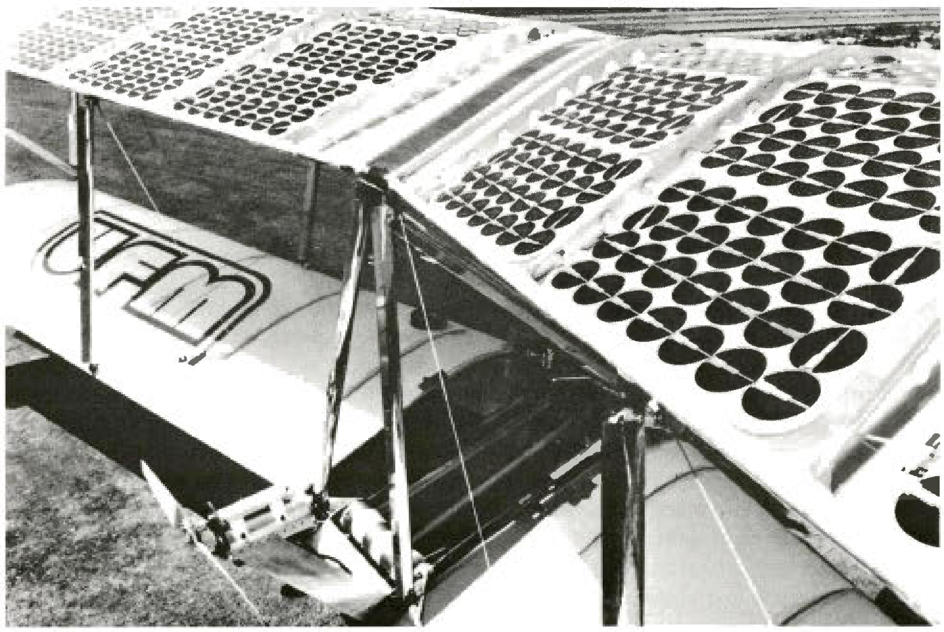


SAVE ENERGY

Fueling Our Tomorrows

Searching for New Aviation Fuels





Larry Mauro demonstrated his Solar Riser—the first solar-powered aircraft—at the Experimental Aircraft Association's annual fly-in at Oshkosh, Wis., last summer. The upper wing is arrayed with 600 photovoltaic cells that power a 4-hp electric motor . . . briefly. (Ultralight Flying Machines photo)

Once upon a time—before airplanes were invented or birds evolved—the skies belonged to the ...ng reptiles. And the largest and ...est of these scaly fliers—with a ...ngspan greater than many modern general aviation aircraft—was the pterosaur.

For many years—maybe 75 million or more—the pterosaur flourished. This was the Age of the Dinosaur, and great creatures roamed the globe. The pterosaur's food supply—the fuel he used to power himself through the air—seemed inexhaustable.

Then the world changed. The dinosaur gradually disappeared from the earth, and the pterosaur soon followed him into extinction.

Today, it looks as if history is prepared to repeat itself. The bones of the dinosaur (and pterosaur, too) were compressed with other materials into the fossil fuel deposits known as petroleum and have been used over the last century to power a variety of vehicles across the land, over the seas and through the air. For years, many believed these deposits were inexhaustable. No one believes that anymore.

Over the past decade—and particularly since the Arab oil embargo of 1973—there has been a growing awareness of the need both to conserve our dwindling fuel reserves and to develop new, alternative energy sources. Aviation is particularly sensitive to this requirement, because it relies almost entirely on petroleum products.

Innovations in aircraft design and operating procedures offer only short- and medium-range answers to the current energy crunch (see separate story). None address the critical question of "What happens to aviation when the petroleum runs out?"

In the last several years, discussions of alternative energy sources have shifted increasingly from the academic to the practical sphere. Indeed, President Carter has thrown his full weight and influence behind a "Manhattan Project" approach to developing a new fuels and energy sources. And terms like synfuels, solar power cells, hydrogen fuels and gasahol are now part of just about everyone's vocabulary.

Still, everyone involved in energy research concedes that there is no magic solution to our energy problem. Just about every alternative to petroleum carries with it a separate set of challenges, some of which clearly are beyond the capabilities of current technology. But research is continuing and progress is being made.

Out in California, for example, a designer named Larry Mauro built a small, one-passenger biplane powered by a four-horsepower electric motor spinning a 41-inch propeller. He installed 600 solar cells in the top wing which convert sunlight to electricity. His first flight lasted 1½ minutes and covered a distance of one-half mile, a significant improvement over the Wright Brothers' initial flight, which took only 12 seconds and covered a distance of 120 feet.

That aircraft now is in a museum, and the designer is working on a more advanced version that he says will be lighter in weight and carry two to three times as many solar cells. "But the real challenge," he adds, "is to come up with more efficient, less-expensive solar cells."

Another approach being tried at both the amateur and professional levels is the use of pure alcohol as a fuel. Admittedly, alcohol is less than the ideal fuel for airplanes, but pilots of light aircraft could make it work until something better comes along. Besides, alcohol can be brewed legally at home if one has the "fixings."

There are two basic alcohol fuels that can be used in today's aircraft engines. One is methanol, or wood alcohol, and the other is ethanol, which is obtained through the fermentation process.

A serious deficiency with either methanol or ethanol alcohols as alternative aviation fuels is that they don't burn very hotly. Airplane engines run on the thermal-cycle principle; that is, the engine operates as a result of heat forcing an expansion of gases. The expanding gases force an engine piston down or, in the case of jets, create thrust.

Conventional airplane engines achieve their total range depending upon the heat content of the fuel. So, if you drained the gasoline from your engine and poured in the same amount of alcohol, you wouldn't be able to fly as far. Nevertheless, scientists, engineers and backyard inventors are continuing to experiment with alcohol fuel.

Another approach that has been around for some time, particularly in Brazil, is adding alcohol to gasoline—gasohol. Brazil has been blending 20 percent gasohol for years in an effort to solve the fuel problem there, since that country has virtually no petroleum resources of its own. But Brazil does have millions of acres in manioc, a potato-like plant that produces enormous quantities of starch, which ferments quickly into alcohol.

Gasohol, as an aviation fuel, seems to be an excellent expedient by way of extending gasoline supplies. While pure alcohol doesn't work too well because of its heat content, when blended with gasoline, it actually improves engine performance. So the slight loss of heat as a result of using alcohol as a blender is more than balanced by the improved performance it makes possible.

Unfortunately, the blend hasn't been tested under all conditions of flight as yet. There's a feeling by some engine experts that problems may be encountered with the separation of alcohol and gasoline that might occur when a significant amount of water is present.

At this time, however, gasohol can be made readily available if the country needs to extend available oil supplies.

Oil from coal, oil shale and tar sand provides the best near-term possibility for refinement into aviation fuel and for other industrial uses as well. What's more, the U.S. has, according to best estimates, a 600-year supply of it on hand just waiting to be mined.

These are the prime sources of the so-called "synfuels." The problem with all synfuels, however, is that it takes a lot of energy to produce a high-heat fuel. In other words, it may cost more to make the synfuel than it's worth.

In the case of coal, Germany actually tested an aircraft engine that burned powdered coal during World War II. It worked, but not too, well. A more practical method was to process the coal into some liquid form. But German scientists didn't figure that out until too late in the war.

Synthetic gasoline is easily manufactured from coal. In fact, it's in wide use right now in a number of South American countries, using the process developed in Germany at the close of World War II. The problem for us in America is that our "fuel economy" is petroleum based. To obtain the needed quantities of synthetic gasoline from coal, although technically "easy," at this time is very expensive. This is because of the enormous investment needed to build coal refining plants. President Carter has proposed a federal outlay of $88 billion to create a synthetic fuel industry by 1990.

Even so, the experts say, getting the machinery in place to extract oil from shale and convert coal deposits and gooey tar sands won't be easy. In fact, they say, if the U.S. can get even a doze[n] plants in operation by 1990, oil production then would likely amount to only two million barrels a day. By the year 2,000, they say, we might be able to produce as much as 40 percent of all U.S. energy needs from coal derivatives such as diesel oil, kerosene and gasoline. Right now, the prospects are all very "iffy." Given the right impetus, engineers predict we could double that 40 percent by the year 2000.

Looming on the horizon are the more exotic fuels, among them boron compounds and liquid methane. Of the two, methane is the most readily available. It can be obtained from natural gas, coal and organic wastes (garbage, sewage, etc.) The problem with liquid methane is that, so far, it's difficult to transport and has a comparatively low energy content. Like alcohol, it doesn't burn hotly enough.

Boron is a non-metallic element that is obtained in the refining of borax. Its use as an aviation fuel has been researched for some time by the U.S Air Force a[nd] its suppliers. It burns quickly and furiously. Its big problem is that very toxic by-products develop in the combustion process, making it unacceptable from an environmental point of view. In addition, however, even if its toxicity could be eliminated, and that's doubtful, it's not very abundant.

Probably the most exciting fuel on the horizon is hydrogen. In fact, theoretically no fuel is so perfect as hydrogen. It's the most plentiful single atom in the universe. It's capable of producing three times the heat per pound of any other fuel, it's the most readily available and, finally, it's the perfect answer to the environmentalist's dream. The by-product of its combustion is nothing but water vapor, except for nitrous oxide when coal is the feedstock.

The method for producing hydrogen fuel is simple, too, and the supplies unlimited. It comes from natural gas, and coal, but mainly from water—and we have oceans available.

Using the electrolysis process, water is broken down into its two elements, hydrogen and oxygen. Once separated, the hydrogen is collected and stored for use. The problem is that a vast amount of electricity is needed for electrolysis. To accomplish this task cheaply enough, only two energy sources are currently available—solar power or the currently suspect nuclear energy. In the future, we may be able to rely on thermochemical processes.

A change from hydrocarbons (petroleum) to hydrogen as the energy source for aircraft will have a profound impact upon aircraft design, as well as upon the entire commercial aviation industry.

There is a widespread public impression that hydrogen is a

Aircraft Technology Keeps Apace

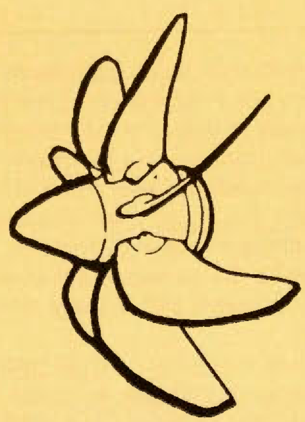
One focus of energy conservation is aircraft technology. Since aircraft are currently locked in on fossil fuels, fuel efficiency is of utmost importance.

Of particular interest is engine technology, since this is where the fuel is actually burned, and the jet engine is especially voracious.

When the Jet Age began, commercial aircraft designers adopted the "pure jet" engines developed for high-performance military aircraft. But these engines proved too expensive for commercial operations because of their high fuel consumption, and there were other problems as well, such as noise. So the turbofan engine came on line, cutting fuel consumption by about one-third and bringing noise relief to airport neighborhoods.

More recently, evolving technology has produced an even more fuel-efficient and quieter power plant called the high by-pass ratio engine that is found on all the wide-body jets. And this technology now is being applied in the development of engines for small jet transports as well.

Moreover, designers are taking a new



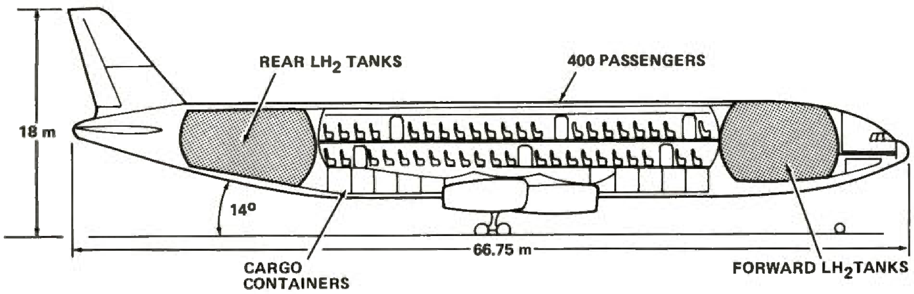
look at propellers for commercial transports, since a propeller-driven engine is inherently more fuel efficient than a jet.

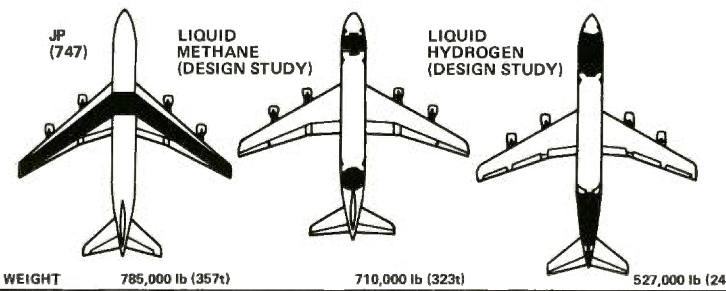
The propeller fell into disuse on modern air carriers because as engines became more powerful, propeller "tip speed" began to impose limitations on airplane cruise speeds. However, recent NASA research indicates that multi-bladed propellers with "swept tips" will permit higher airplane speeds. Parallel research in structures and acoustics also indicate that noise and propeller vibration at high speed can be greatly reduced.

As a result, aircraft designers now believe it possible to design turboprop airliners capable of operating at jetliner speeds and altitudes with far greater fuel economy. Both McDonnell Douglas and Lockheed are doing studies on swept-tip-propeller technology.

Airframe designers have been equally active. NASA has developed what is known as a "supercritical wing" design that promises fuel economies of 10 to 15 percent. This new wing is about 50 percent "fatter" than the conventional wing, and this permits changes in the interior structure which actually reduces total weight. And being lighter, the wing can be lengthened. The result of this increased wing span is a more efficient design and, thus, improved fuel economy.

Another innovation by NASA is the "winglet." This is nothing but a small vertical plate that is added to the aircraft wingtips, but it provides about a five percent increase in fuel economy. It sounds simple, but NASA engineers worked for years to devise exactly the right shape and size. What the winglet does is to reduce wing drag (friction). The Gates Learjet Corporation is testing winglets on one of its new executive transports.





GROSS WEIGHT	785,000 lb (357t)	710,000 lb (323t)	527,000 lb (240t)
• RELATIVE HEATING VALUE/lb	1	1.16	2.77
• RELATIVE DENSITY	1	0.52	0.085
• LIQUID TEMPERATURE	AMBIENT	-162°C	-253°C
• PRICE PER MILLION BTU	$3.00-$6.00	$4.00-$7.00	$8.00-$15.00

AIRPLANE COMPARISON AT CONSTANT PAYLOAD/RANGE

particularly hazardous fuel. This is not true, but it will take a big educational effort to dispel public fears. Hydrogen does not detonate easily. It burns for a very short time and it has a very high ignition temperature. Experience in the space program and in other experimental aircraft-engine programs has shown that, properly handled, hydrogen is as safe as gasoline or jet fuels.

In recent years, the operation of nearly every type of internal-combustion engine using hydrogen fuel has been undertaken. This includes reciprocating engines, rotary engines, turbojet and rocket engines. Not only do these engines turn out very favorable performance characteristics, but when operated with liquid hydrogen, they are virtually emission free.

That's the good news. The bad news is that switching from a "petroleum economy" to a "hydrogen economy" will be difficult at best. For one thing, the logistical problems in connection with hydrogen fuels are enormous. It has to be stored in a liquid state at something approaching minus 400 degrees. So, that means the development of new delivery systems and storage tanks at airports.

The fuel system of a liquid-hydrogen-fueled aircraft must be designed to withstand the extremely low storage temperatures. All fuel tanks and pipes must be carefully and extensively insulated to reduce losses due to liquid hydrogen "boil off." And since the density of liquid hydrogen is extremely low, less than one-tenth that of the now conventional JP-type fuel used in jetliners, very large fuel tanks are necessary. This is not a particular problem for large commercial aircraft, but it could be for small aircraft.

All in all, to develop a complete liquid-hydrogen air-transportation system, desirable as it is, will require a great deal of research and development and a very great deal of money. All of this will be required not only to design safe, efficient and economical aircraft but also to determine and overcome operational problems associated with that fuel's use.

Back to the good news again. Despite these problems, the Lockheed Aircraft Corp. is participating in a six-nation effort to use hydrogen fuel.

The proposal before the group of scientists and businessmen is to convert four L-1011s to run on liquid hydrogen by 1986 as an experimental freight airline between the U.S., England, Germany and Saudi Arabia and possibly Canada. The respective governments will be asked to commit funds, with Lockheed prepared to ask for $650 million.

The expectation is that the hydrogen would be made from coal in the U.S., Germany and England, from natural gas in Saudi Arabia and through water electrolysis in Canada.

Pratt & Whitney and General Electric have bench-tested standard jet engines on hydrogen fuel and have found they work well, without the surges of power common to burning jet fuel. Because hydrogen fuel doesn't clog engines with carbon, they found, it would mean less servicing, longer engine life and quieter engine performance. As stated above, air pollution is virtually non-existent.

The modified L-1011s are expected to carry liquid hydrogen fuel in two huge fuselage tanks, one fore and one aft. When totally new hydrogen-fueled aircraft are designed, Lockheed judges that they would have longer fuselages and shorter wings, which could be thinner because they no longer carried fuel tanks.

The way things are going, hydrogen fuel may well become economically competive by the year 2,000. With all of hydrogen's virtues, aviation wants to be ready.

By Ben Lee

INTRODUCTION from page 4

the air may work at cross purposes with objectives other than safety, such as solving the aircraft noise problem.

The pressure for further improvement in fuel efficiency will lead FAA and the aviation industry to advanced technology for solutions. The FAA's advanced automated air traffic control system and industry's aircraft and engine technology improvements will account for the bulk of the long-term fuel-efficiency improvements. The early introduction of some existing technology, such as retrofitting air carrier aircraft with new technology high by-pass ratio engines, may provide a 10-20 percent gain in passenger miles per gallon.

FAA's Office of Environment and Energy has a number of programs and studies under way to delve into fuel efficiency and its relationship to FAA operations. They are developing mathematical computer models. One—the aircraft fuel-burn calculation model—is being developed for analysis of specific aircraft fuel consumption under any flight regime. This model will be incorporated into our airspace simulation model so that the effect of ATC procedures and traffic volume on fuel use, along with the environmental impacts, can be measured at any particular airport or over any route.

On the ground, in FAA's own operations, is where the opportunities for energy conservation abound and where we are well under way in good energy management and technological improvements.

A major Airway Facilities effort to increase system reliability is the replacement of older tube-type equipment with solid-state devices and the installation of remote-maintenance monitoring equipment. The extra benefit from all this is reduced energy consumption and less gasoline burned through fewer trips to remote sites.

Analyses of facility environmental systems have shown ways of cutting heating and cooling costs by improving efficiency or cutting off service to non-critical areas.

In addition, Airway Facilities is moving into creative solutions to the fuel shortage. Battery emergency power supplies are being tested as replacements for gasoline- or diesel-powered generators. Solar collectors for heating and cooling are being built into new facilities. Photovoltaic cells are being used to power navigation aids, while research goes on to adapt these generators of electricity for efficient heating and cooling. And Airway Facilities is looking into ways of using waste heat from computers and other equipment to heat and cool the facilities they are located in.

Airway Facilities has planned or currently under way programs calling for a 20 percent net reduction in electricity consumed by 1985.

By reducing airspace system delays, by more efficient use of existing fuels in aircraft while seeking new ones, by better management of our facility operations and by applying our inventive genius, we will help find the solutions to the energy crisis and improve the economic well-being of the aviation system.

A Chance To Prove They Can Do

Handicapped does not mean "not able."

The Mike Monroney Aeronautical Center knows this only too well, having more than 200 handicapped persons on its payroll. For having programs that recognize this fact, the Center was named "Handicapped Employer of the Year" last spring by the Oklahoma Association of Retarded Citizens (ARC).

In addition to the permanently employed handicapped, the Center has been using 14 clients of the Mid-Del ARC Metro Workshop on a 12-month records-conversion project. Approximately 130,000 airman medical case files involving over 11 million documents are being place on microfiche by these employees. Working in two eight-hour shifts, they have been exceeding their quote of filming 2,300 files a day.

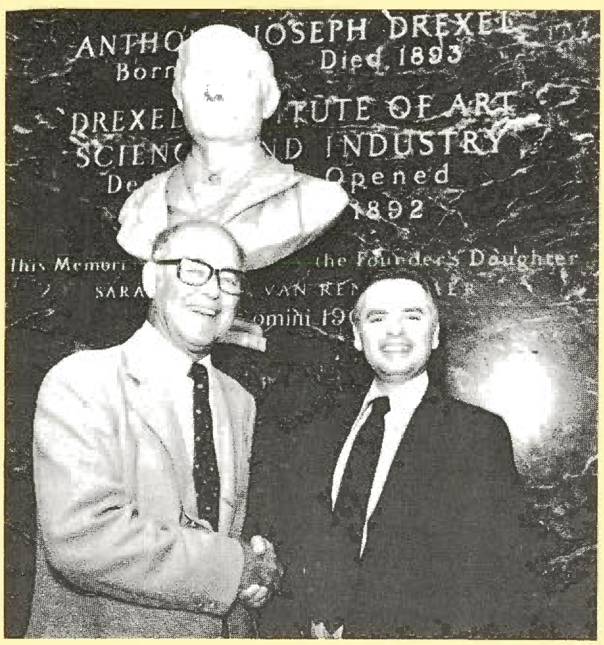
The Mid-Del Workshop offers 24-hour counseling, social and work-adjustment assistance, job training and job referrals for its clients. They stress that "handicapped" means many different types of disabilities, including learning disabled, retarded, epileptic, visually impaired, etc. Their primary goal is to increase the level of self-sufficiency of the handicapped. They strive to teach each client to use previously untapped abilities as they assume responsibilities for their daily lives.

One of their and the Center's most gratifying services is finding employment for those persons who are capable of working. In addition to the 14 working on airman files, the Center has taken on 40 additional persons under another Mid-Del contract for a larger project. They will convert records in the aircraft registry, handling over 250,000 files comprising well over 15 million documents in a 24-month period. Judging by past experience, the Center expects that the work will progress smoothly and be completed satisfactorily.

More than in the award, the Aeronautical Center's satisfaction comes in helping people discover that they have a lot to offer, that their abilities are needed and appreciated and that they are able.

Faces and P

DOUBLE-THREAT AIRMAN—*Boeing Tower chief Charlie Crum (left) congratulates controller Bob Jorgensen for helping rescue two men whose canoe had capsized in Puget Sound. The Seattle controller was pilot of a Chinook helicopter during an Army Reserve training exercise. A few minutes' delay in their rescue could have been fatal to the men.*



BUILDING EXPERTISE—*NAFEC Acting Director Joseph M. Del Balzp shakes hands with Drexel University Pres. William Hagerty after signing an agreement to offer NAFEC employees Master's degrees in electrical engineering and mathematics. Tuition is paid by NAFEC. According to Del Balzo, the program is designed to attract high-technology talent and then keep them abreast of developments in their fields.*

A QUIET LOOK—*Bill Cook, chief of the Norwood, Mass., GADO, e. Plymouth, Mass., Municipal Airport and got his first glider flight at the Society of America and a member of the Plymouth Airport Safety*

TOP COUNSELOR—*With his wife, Joan, looking on, Robert L. Feibel Marysville, Ohio, receives a trophy as accident-prevention counselor of t. year from Great Lakes Regional Director Wayne J. Barlow (second from rig and Ed Eisele, chief of the Columbus GADO.*

Photo by Ett Sha

aces

ned the non-standard traffic pattern at the ds of Sam Francis, director of the Soaring mittee. Photo by Stan McDonnough

RACING CONTROLLERS—*Fullerton, Calif., tower controllers Jon Slipp and Jane Wright prepare for take off in Wright's Grumman American for a fund-raising "Skirts and Shirts" 300-mile round robin race of the local chapter of the 99s. The pair was sponsored by tower personnel. Although they didn't finish in the money, it was for a good cause.* Photo by Jan Tankink

BRIGHT-IDEA MEN—*Frank Ebeling (center), CDC crew chief in the Kansas City ARTCC AF Sector, presented Beneficial Suggestion Award Certificates to electronics technicians Roy Wiklund (left) and Leonard Buehler. Adopted for national use, their idea cools computer cabinets using under-floor air via existing cabinet openings. It cuts noise, power consumption and fan replacement.*

AS YOUNG AS YOU FEEL—*Controller Harold Herron, a two-decade veteran of the Denver ARTCC became a great-grandfather this year. And despite two hip operations, he still outshoots his fellow controllers in golf and hunting.*

TOP STATION—*The 1978 Great Lakes Air Traffic Facility of the Year Award went to the Green Bay, Wis., FSS. Left to right are William Pollard, asst. Air Traffic Division chief; specialist Mardie Gieser; former FSS chief Walter Brown; specialist Don Wick; assistant chief Edward Simpson III, Regional Director Wayne Barlow; and John Heath, chief of the facility.*

SAVE ENERGY

Fueling Our Tomorrows

By Conservation

Discussing chilled-water pump reductions at the Los Angeles ARTCC are (left to right) Stan Hawkes, Southern California Edison Co.; Bob Snoddy, Environmental Unit chief at the center; Jan Svalbe, environmental TID; and Frank Crowder of the Edison Co., who presented an energy management award to the center for achieving a 10 percent reduction in power consumption.

Tomorrow is always upon us before we realize it. Facing up to our energy problems means not only our accelerating the development of new technology but also managing the energy we have now.

Conservation of fossil-fuel energy doesn't always mean doing without or even with less, but using it more efficiently.

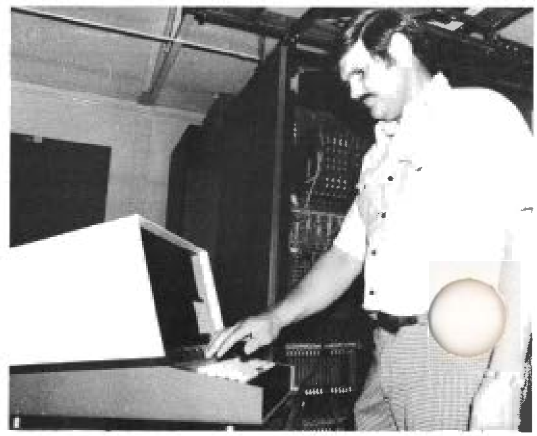
It's no loss in comfort, for example, to turn off the lights when you leave the office for the day or to carpool if you can get in with a congenial group, contrasted with burning out a car that you paid for in just a few years of commuting alone.

But it takes some organizing and thinking through the problem to make a transition from squandering energy to managing it for the comfort of all.

Many of the regions have organized committees that have taken innovative approaches to saving gasoline.

Rather than penalizing carpoolers and solo drivers alike with a uniform parking fee, the Alaskan Regional Office stimulated carpooling by assessing fees based on the number of people per car. Single occupants paid $30 per month.

James Timko, environmental technician at the Washington ARTCC, checks a readout on the Central Control and Monitoring System. Installed at all centers, the CCMS senses heating, ventilation and air conditioning needs throughout building and switches equipment automatically to respond to them individually.



Don White, Wichita, Kan., technician-in-depth, checks a readout on a portable terminal of information from a remote monitoring system under test at a radar site near Hutchinson, Kan. The purpose is to save unnecessary trips to the site to check the functioning of its equipment.

The Central Regional Office was recognized this year by the Federal Executive Board for leadership in energy conservation. Former Regional Director C. R. "Tex" Melugin (left) and Airway Facilities Division chief Donald Schneider shared receipt of the award.

Sprouting all over the country are solar collectors, as individuals seek their own energy independence. John Cuprisin, Burlington, Vt., ATCT, had a solar hot-water system installed by the builder of his new home.

Cars with two riders were hit for $25, and vehicles with three or more paid a total of $16 a month. An unprecented number of employees took advantage of the carpooling rates.

In the Seattle FSS, chief Dean Lane restructured the team assignments for the 42 employees to coincide with their home geographical distribution, permitting team members to set up carpools.

In a similar vein, NAFEC mapped out the residential locations and densities of its employees to devise potential bus or vanpool routes that would encourage maximum participation. And Northwest Region's Logistics Division worked directly with Seattle Metro Transit to improve express bus service to the regional office and provide additional bus-stop shelters.

Among the most significant savings, however, are those that can be achieved by improved mechanical efficiency, which also can have the smallest negative impact on our life styles. Basically this means improving the productivity of the fuels we now use. One study states that such measures could reduce energy consumption in the United States by 40 percent and that they could extend the time available for the transition to benign, renewable energy sources to 50 or 60 years from now.

Simple technological innovations are one source of improvements in energy productivity, such as improving the thermal design of new buildings, increasing insulation and heat recovery in existing buildings, increasing efficiencies of appliances, furnaces and air conditioners, improving gas mileage by lightening vehicles and using more efficient engines, co-generating electric motors and increasing the recovery of industrial waste heat.

For example, an engineer at the National Aeronautics and Space Administration devised what is called a Nola Power Factor Controller. This device can be added to an electric motor to reduce the amount of current drawn with no loss of shaft power.

In many ways, FAA is moving into these areas of increased efficiency; in others, the technology is coming or waits at the door for funding.

The newest building at the Mike Monroney Aeronautical Center is an energy miser. A $3 million structure, the new Radar Training Facility is a two-story-plus-basement windowless building with an earth berm rising several feet along its walls. The latter is expected to reduce the rate of heat transfer through the walls by about 54 percent over a conventional building. The roof has special insulation to cut heat loss or gain by 62 percent and is designed to take the addition of solar collectors in the future.

The waste heat generated by equipment supplies much of the building's winter heating needs, and controlled air volumes in each laboratory and room help in summertime cooling. A timer shuts down systems during unoccupied periods, and lighting is controlled by a dimming system that uses electrical current proportional to the foot candles of illumination desired.

Using waste heat is an idea whose time has come. Flight service stations are switching to a design that expels equipment heat during the summer, lowering air conditioning loads, and reroutes it in the winter to supplement normal heating systems.

The Energy Research & Development Administration is fostering waste-heat recovery, pointing out, for example, that diesel electric generators send 34 percent of the heat energy from the fossil fuel up the exhaust stack. This can be recycled to deliver 20 percent more shaft horsepower to the generator.

NAFEC's new Technical & Administrative Building of more than half a million square feet is designed to be energy efficient to the tune of saving a quarter of a million dollars a year at today's fuel costs. The lion's share of that saving will be accounted for by a waste-heat recovery system called a double bundle condenser. It will recover 10 million BTUs per hour of heat generated by the building's computers, employees and lights. The waste heat will be used to make hot water and will be pumped through a perimeter heating system inside the building's exterior walls. On very cold days, additional heat will be supplied by conventional boilers.

Other aspects of the NAFEC building will involve more efficient insulation, fewer windows, tinted windows, structural shading, double entrance doors and a variable air-volume ventilation system that uses computer

A windowless exterior and an earthen berm covering the lower portion of the walls are among the elements of the new energy-efficient Radar Training Facility that has risen at the Mike Monroney Aeronautical Center.

For his efforts in tightening up the energy ship at the Los Angeles ARTCC, environmental TID Jan Svalbe (center) was presented a Special Achievement Award by Western Regional Director Leon Daugherty (right), as Airway Facilities Sector manager Robert Cox looks on.

analysis to cool each room to the proper temperature.

Control of different areas in a structure is the idea behind the commissioning of Central Control Monitoring Systems in all the en route centers and the Atlanta Tower. These use computers programmed to regulate heating and cooling throughout the centers.

Sometimes, the solutions to wasting energy are not so esoteric; it's just a matter of an inquiring mind and good judgment.

During an engineering survery at a control tower in New York State, a regional engineer noticed a problem with an airport-owned air conditioning system and offered to look into it. He found a filter rack in a duct transition that airport personnel didn't know existed, so they hadn't cleaned it in years. Replacement of the filter increased the air flow, prevented freezing of the coil and obviated the need for installation of additional air conditioning. It saved 900 kilowatt hours per year.

In several large facilities, it was found that while the air conditioning was going full tilt, the boiler was pumping out at 80 percent of its capacity. Turning off the boiler during the summer resulted in a savings of about $60,000 a year as well as scarce fuel at one facility. The problem may have arisen from the attempt to set air conditioning temperatures at 78 degrees. To wring the moisture out of the air had required supercooling the air, then heating the distributed air back to the required level.

At an airport in Virginia, a regional engineer noticed that an airport-owned air conditioning system that had previously served several areas now vacated was too large for the FAA equipment room. The installation of two small window units was authorized, and the airport system was shut down, with a reduction in space rental charges to FAA. The energy saving is expected to be almost 88,000 kilowatt hours per year.

The war on energy waste in FAA facilities has been effective when followed through on a day-to-day basis. So effective was it at the Los Angeles ARTCC that the Southern California Edison Co. for the first time presented an award for outstanding achievement in Energy Conservation and Load Management to the center, which had achieved a 10 percent reduction in power consumption—the highest of any customer in the entire power grid area.

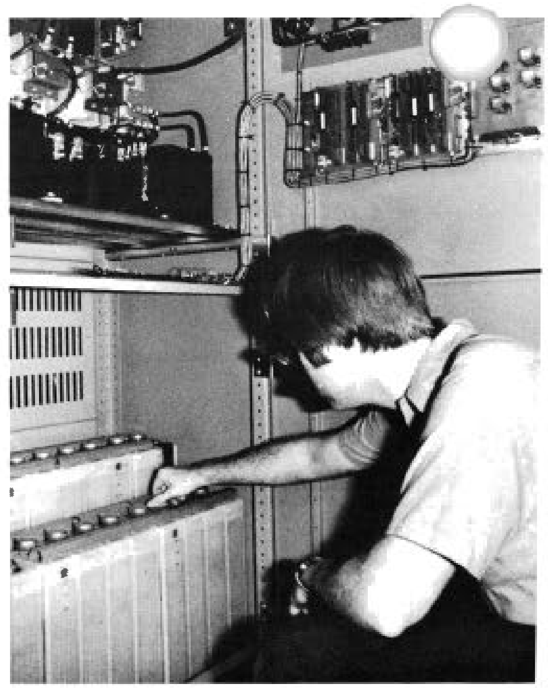
The achievement was the result of the efforts of the Environmental Support Unit and its technician-in-depth, Jan Svalbe, with the support of the sector and the regional Airway Facilities Maintenance Engineering Branch and Establishment Engineering Branch Environmental Sections.

There were three steps to the savings achieved. The power factor, or the efficiency of transferring power from the utility's lines to the center's equipment, was improved significantly by adding capacitors to the power lines.

The second step focused on peak energy demand. A high demand at one time requires greater capacity on the part of the utility and results in higher bills. Svalbe compared the Central Control Monitoring System's logs with the utility company's printouts, which led to his rescheduling engine generator runs, cycling of high-electrical-usage equipment and rescheduling non-time-critical loads.

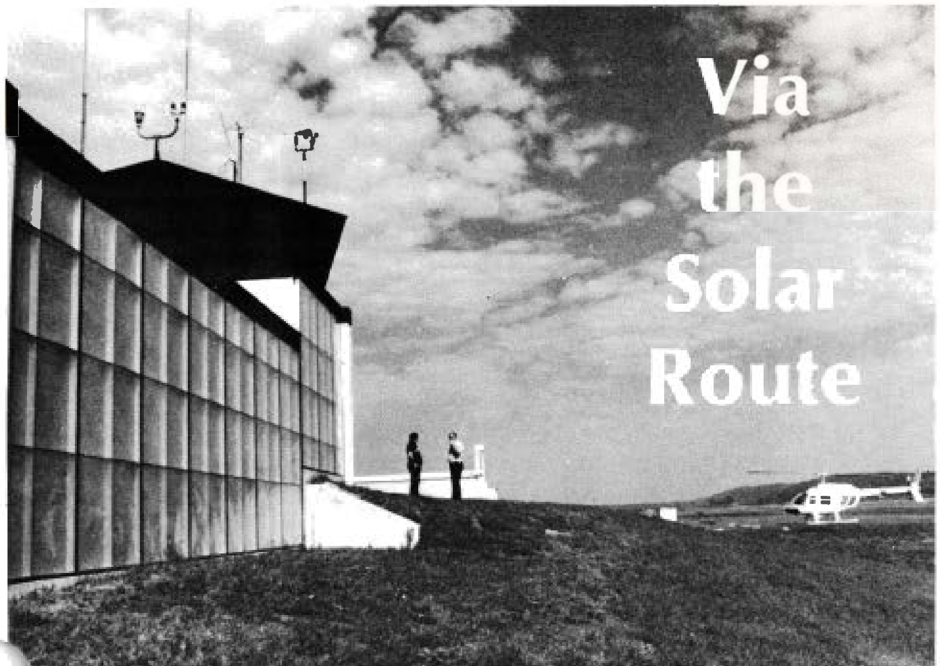
Finally, he analyzed the use of each environmental control system with an eye to turning off the unit or reducing its capacity.

The savings from the program totals $30,000 a year or over 75,000 kilowatt-hours per month. It also resulted in Jan Svalbe receiving a Special Achievement Award for spearheading this effort.



A new battery emergency power system under test at the Hutchinson, Kan., RCAG site, expected to replace petroleum generators, is checked by engineer Randy Downing.

The Spirit of St. Louis Tower has sported a prototype solar-collector wall for the past year. The standard-design collector wall for new tower construction incorporates improvements based on experience with this tower.



Via the Solar Route

One of the units of a solar power system to be used at Dallas-Fort Worth Airport. It consists of a plastic Fresnel lens that concentrates sunlight on silicon photovoltaic cells or on a fluid-bearing pipe. The collector is designed to track the sun.

In the long run, conservation and more efficient use of our existing energy sources are stopgap measures. While they promise a minimum adverse impact on our environment, life styles and the economy, they only delay the inevitable exhaustion of oil and gas supplies.

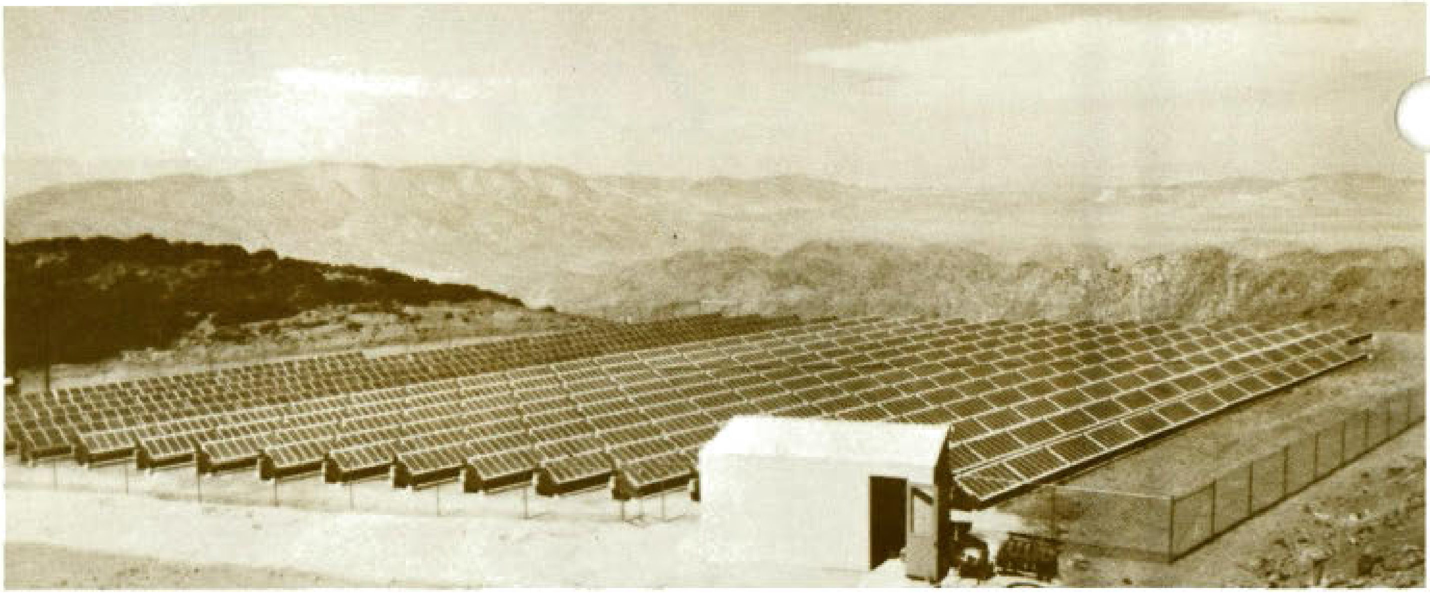
The future lies elsewhere—in other forms of solar energy that are renewable and safe. No one form is a complete answer. The solar age has dawned with a variety of developing technologies just beginning to shake themselves out. Techniques and materials are being improved upon; new insights are refining old ideas; and escalating fossil fuel costs are making higher-cost alternatives practical.

Nuclear power is not an alternative we will consider here. It is a practical source only of electricity and amounts to an expensive way to boil water, with environmental hazards that are likely never to be fully resolved. Industrial [illegible]tions consume only 10 to 15 percent of their end-use energy in the form of electricity, and that accounts for only a small fraction of oil consumption. Then, too, nuclear electricity for heating from new plants costs about $100 for the heat equivalent of a barrel of oil.

Among the alternatives already on the scene or yet to come are solar heat collectors, photovoltaic cells for direct generation of electricity, wind power, wave power, ocean thermal energy conversion (see page 18) and biomass fuel.

FAA is in the process of constructing most new intermediate- and high-activity towers with passive solar collector walls on the south face of their base buildings. The agency expects to provide up to 40 percent of the tower's space heating needs.

Roof- and ground-mounted collectors have sprouted around the landscape. More effective than building heating systems are solar hot-water systems. The Edwards AFB RAPCON has a ground array of collectors for the purpose, and John Cuprisin, chief of the Burlington, Vt., Tower, talked his builder into including a solar hot-water system in his new home at cost. Between tax credits and saved fuel costs, Cuprisin



The field of photovoltaic cells that helps power the Mt. Laguna Air Force Station and Los Angeles Center radar occupies half an acre. The power system's output is 60 kilowatts.

believes that the system will pay for itself in a couple of years.

For $220, Al Duncan of the Westfield, Mass., Tower built his own to supplement the regular hot-water system. It's a ground-mounted passive unit that takes advantage of uplift convection.

Photovoltaic cells have been developed to a highly reliable state, but their costs are high. Although photovoltaic systems have declined from $22 per peak watt to $7 in the last three years, they will become commercially practical when mass production can lower their price below $1 per peak watt.

Several demonstrations of interest to FAA are in progress. E-Systems of Dallas, Tex., is installing a photovoltaic concentrator to supply 27 kilowatts of electricity and hot water as supplemental power to the Dallas-Fort Worth Airport's central utility plant. It consists of a linear Fresnel lens concentrating about the equivalent of 25 to 30 suns on photovoltaic cells.

Phoenix Sky Harbor Airport in Arizona will use 7,200 optical modules to produce 283 kilowatts to power about half of the south concourse of a new terminal next year. The module is a reflective bowl that concentrates about 70 suns onto a mirror mounted above the bowl that, in turn, reflects the light onto a photovoltaic cell below.

The heat produced, however, would destroy the efficiency of the cell, so a refrigerant must be used. In the Dallas-Fort Worth system, the thermal output would be used to preheat boiler feedwater in the utility plant.

The Phoenix optical module arrays are linked to track the sun on two axes. As a result, Airway Facilities personnel at the airport had to work with Motorola Corp. and Arizona Public Service engineers to devise a method of shielding the modules to prevent reflections on FAA's radar antenna and interference with radar video cables.

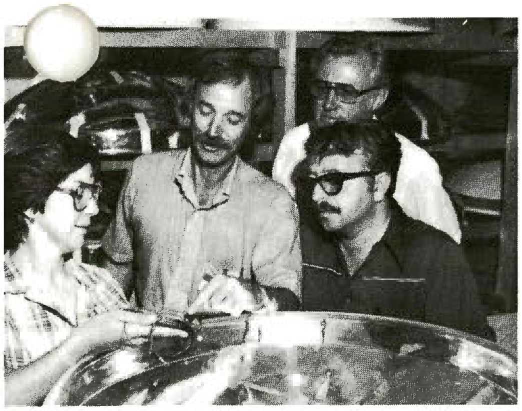
Already in operation is a solar photovoltaic power plant supplying 60 kilowatts of electricity to the Mt. Laguna Air Force Station near San Diego. Producing about 10 percent of the total needs of the station, the ground-mounted 97,000 solar cells help power the joint-use FAA-USAF air route surveillance radar and other equipment that serve the Los Angeles ARTCC. In about a year, FAA will take over the Mt. Laguna site.

FAA's major requirement in terms of solar energy is not in the heating, however, but in the cooling, according to Joseph Morelli, design engineer in the Environmental Systems Division of the Airway Facilities Service. FAA is looking for the technology to progress to where equipment is available for purchase. Surprising as it may seem, the equipment and personnel in many of our facilities generate sufficient heat to require air conditioning to run constantly, all winter long, even in Alaska.

Bill Watson, assistant manager of the Kansas City International Airport Sector, looks over an array of photovoltaic cells, which charge batteries that run the ILS outer marker.

Further progress in the development of solar collectors is needed to produce the low-grade steam to operate an absorption chiller. Most promising in terms of efficiency and size are the concentrating collectors, such as the parabolic trough or the evacuated tube, which consists of concentric tubes in the configuration of a fluorescent bulb.

One of the most important aspects of a concentrating collector is its ability to track the sun for maximum light-gathering. Previous tracking mechanisms were expensive servo-motor systems that consumed powe



Phoenix Sector electronics technicians Pat Sepulveda (left) and Dick Ruscillo (right) worked with Motorola engineers Cy Zittle (center) and Glenn Kinzer (rear) to protect FAA radar equipment from interference from the optical modules installed near Sky Harbor Airport.

their operation. Now being developed is a system of collector tubes containing a refrigerant on each side under the reflector. When the sun has moved enough to heat one side, the refrigerant will expand and create a differential pressure in a cylinder to move the reflector.

Morelli believes that practical solar cooling requires a special refrigerant that will work in an absorption chiller, which won't require the enormous amount of space demanded by ammonia or lithium bromide refrigerants now used.

Another important boon to solar cooling, he says, is the Rankine cycle engine. In this two-loop system, steam or a heated low-pressure refrigerant from a solar collector or waste-heat sources drives a low-pressure turbine, which is connected on the same shaft through an overrunning clutch to an electric motor and straight through to a compressor on the air conditioning loop. When the turbine is turning fast enough to engage the clutch, it drives the motor in a relaxed state. The faster the turbine drives, the less current the motor draws. If the turbine overdrives the rated speed of the motor, it will actually generate electricity back into the power line, running the electric meter backwards. The charm of the Rankine cycle approach is that with efficient solar collectors, it can be added to the existing efficient air conditioning systems we now have on the roofs of our facilities.

The real inroads of solar energy, Morelli suggests, will come with alternative solar fuels in a utility company setting, such as wave power, wind power, biomass and ocean thermals.

Wave power uses the natural rise and fall of waves to spill into a tube and drive a generator. It has been described as solar energy twice removed, since the sun creates temperature differences that power the winds that create waves.

Lockheed Missiles & Space Co. has designed a 250-foot-diameter artificial atoll that is mostly submerged in the sea. Its shape causes the waves to spiral into the center, creating a vortex as it drops down a shaft onto the turbine, which turns a generator that can produce one or two megawatts.

Lockheed points out that this "Dam-Atoll" could replace the diesel pumps necessary for the desalinization of sea water and would create natural harbors around it because it removes energy from the waves in its vicinity.

An allied power source, but not considered solar, is tidal action. Where such action is pronounced, coffer dams can be built with turbines that work on the ebb and flow of the tides. A tidal power plant has been in operation for a decade in La Rance estuary in Brittany, France.

Like ocean thermals, the wind as a source of power is important in areas where the right natural conditions prevail. Steady winds of perhaps 25 miles per hour are necessary. One government estimate has it that by the year 2000, about 30,000 small windmills and a million large ones will be generating between three and five percent of the nation's electricity.

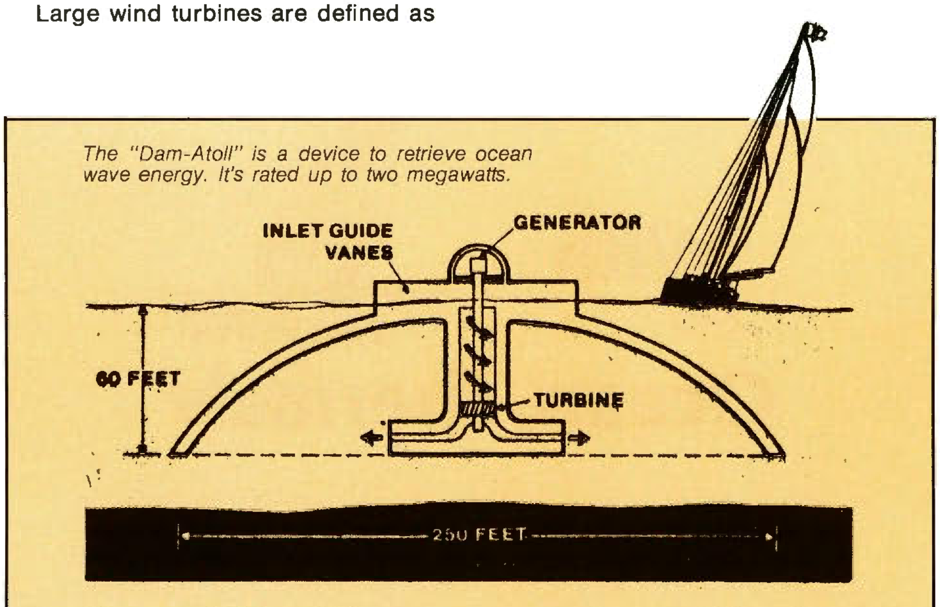
Large wind turbines are defined as having rotors at least 75 feet in diameter and generating at least 100 kilowatts. Southern California Edison Co. is building a wind turbine near Palm Springs that will be capable of generating three megawatts. Already in operation is a 200-foot unit near Boone, N.C., built by General Electric for the Department of Energy, that is generating two megawatts. Smaller ones are going up elsewhere, like the 125-footer at Clayton, N.M., that provides about 15 percent of the town's power.

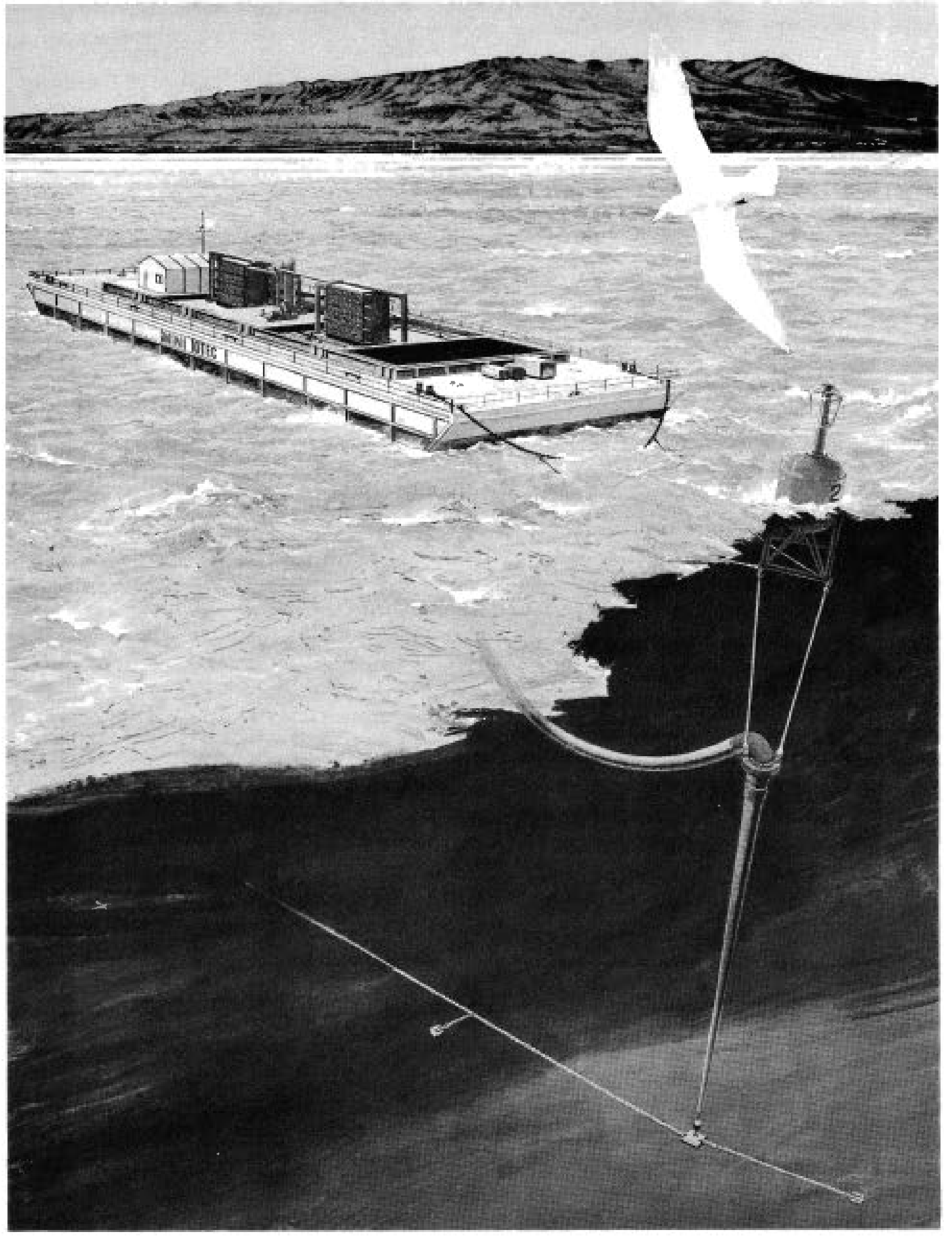
So far, FAA's involvement in wind power has been on the other side in a manner that is likely to increase. The agency recently was called in to evaluate a 160-foot-high windmill about three miles from the Reading, Pa., airport as to whether it would be a hazard to air traffic.

Biomass is a huge and diverse source of the sun's energy. After plucking a couple of ears of corn from a plant, we waste the six-foot plant remaining. The entire mass of waste from farming, the organic trash from our offices, schools and homes and sewage is stored solar energy that can be, and has been, used to fuel power plants and produce methane or a storable liquid fuel. Scientists are now even promoting cattails as an excellent, quickly renewable energy source that can be grown in the some 90 million acres of wetlands in the U.S.

The solar solution is a multifaceted one, and FAA is looking ahead with the rest of the country to meeting our energy needs and at lower cost to the taxpayer and the environment. **By Len Samuels**

The "Dam-Atoll" is a device to retrieve ocean wave energy. It's rated up to two megawatts.





SAVE ENERGY

Fueling Our Tomorrows

With Ocean Thermals

A mile and a half off shore from Ke-ahole Airport, which serves Kona, Hawaii, is an anchored Navy barge producing electricity without using fuels. It's the world's first Ocean Thermal Energy Conversion (OTEC) plant.

The experimental unit in the deep waters off the western coast of the big island is the first successful test of a closed-cycle, self-sustaining OTEC system that is expected to be the forerunner of a plant that could supply a quarter of the island's electrical needs, including powering FAA air traffic and navigational facilities at the airport.

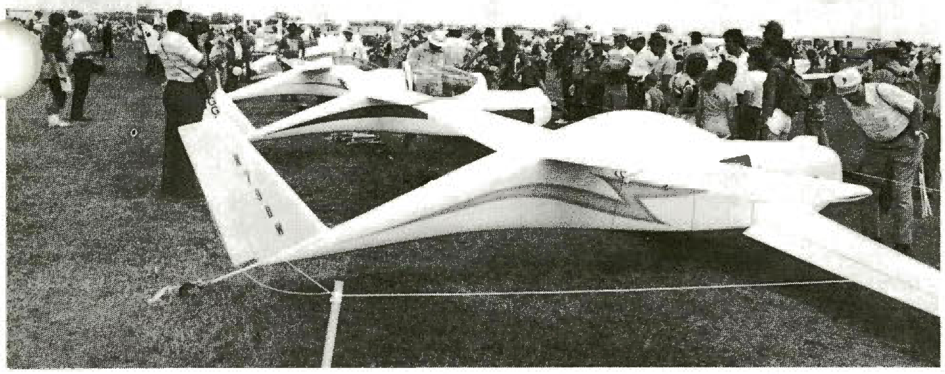
The fuel is, in fact, a form of solar energy. The warm surface waters are pumped through heat exchangers to heat ammonia, Freon or some other working fluid. The expanding gas drives a turbine and, in turn, a generator. Cold water—42.6 degrees—is drawn up from 2,700 feet to cool and condense the fluid back to a liquid state to begin another cycle. As with other solar systems, OTEC is non-polluting.

The action from this system has generated 50 kilowatts of electricity, sufficient to run all the equipment aboard the barge, plus a bank of nine floodlights and a television set.

The next step, according to Hawaii Gov. George Ariyoshi, is a 10- to 40-megawatt plant, which could be built for about $140 million. As a comparison, Ariyoshi said, "The first airplane wasn't much of an airplane, but it was a start—it proved man could fly. The Ke-ahole OTEC is a similar breakthrough."

Ed Loo, chief of the Kona Airway Facilities Sector Field Unit, looks still further ahead. "The region will surely realize some savings on its fuel bill if the Ke-ahole Airport area's power needs are met by OTEC. But at the same time, other industries than tourism may be attracted to the Kona Coast by this power."

The experiment was a joint project of the State and County of Hawaii, Lockheed Missiles & Space Co., the Dillingham Corp. and Alfa-Laval Thermal of Sweden.



The Quickie is an unusual canard design: The wide-spreading wheel struts carry the elevators. Its 18-hp engine pulls it an average 110 mph at a miserly 65 miles per gallon.

This pair of powered hang-gliders appear to be swooping even at rest. They made 200 miles per day from California to Oshkosh to become part of the gaggle of 66 ultra-lights.

Fuel- and Safety-Wise at EAA

Swarms of ultra-light aircraft darkened the sky over the Experimental Aircraft Association's annual fly-in at Wittman Field, Oshkosh, Wis., this past August.

While the total number of planes at the extravaganza was down this year, due to bad weather in the east, nearly three times as many ultra-lights—hang-gliders and sailplanes—as last year were represented among the 1,377 exhibition aircraft.

Although aviation fuel supplies got tighter through the summer, rising an average of nine cents a gallon, pilots flying into Oshkosh experienced little difficulty in getting enough. But fuel and fuel economy was in the minds of many.

The Quickie canard design, introduced last year and which gets 65 miles per gallon, had several representatives on display, and 280 are reported to be under construction. A growing display of VariEzes were evident, along with 66 ultra-lights. A pair of Pterodactyls—hang-gliders powered by a single-cylinder snowmobile engine—flew from California to Oshkosh, then were converted to run on alcohol at the show before continuing to Kitty Hawk, N.C. And a solar-powered aircraft made its debut (see story on page 6).

EAA president Paul Poberezny had his Volkswagen-powered Pober Pixie converted to run on grain alcohol by enlarging the carburetor fuel jet 40 percent and adjusting the timing. After flying it, Poberezny said it ran exactly the same as with gasoline, except it burned 20 percent more fuel and its exhaust smelled sweet, like hot bourbon.

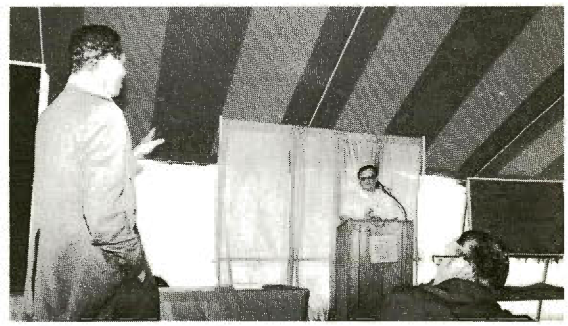
Poberezny's topless VW car as well as a powered hang-glider—Easy Riser—were also converted to alcohol-burners, and Poberezny's Cuby was flown with gasohol fuel, again performing the same as with aviation gasoline.

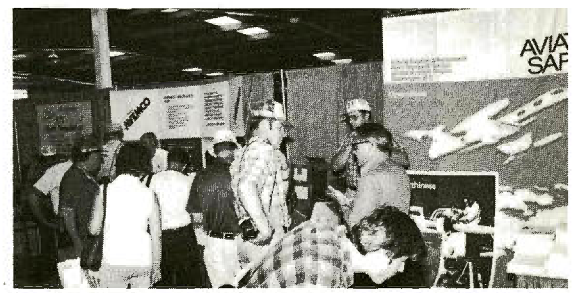
Also symbolic of today's thinking in sport aviation was the presence of Bryan Allen—the non-pilot who flew—or rather, pedalled—his way over the English Channel in the Gossamer Albatross last June. Now, he has soloed in a powered aircraft.

As usual, FAA's presence was felt throughout the show, with air traffic controllers handling 41,311 itinerant and fly-by operations, more than twice that of O'Hare's controllers for the same eight days. Flight service station personnel from Green Bay and around the Great Lakes Region provided briefings; a temporary GADO was set up to handle show waivers and issue licenses to foreign pilots; and Oshkosh Airway Facilities Sector personnel maintained the heavily used equipment. Chicago EMDO inspector Ron Wojnar, himself an award-winning homebuilder, lectured on certification procedures, Deputy Administrator Quentin Taylor spoke and William J. Sullivan, headquarters Safety Regulations Staff chief, lectured on "Helping the Regulators Regulate."

Story and photos by Thom Hook

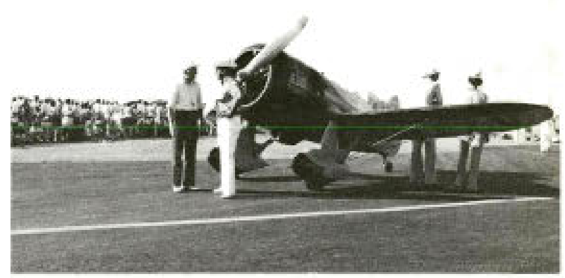
Lecturing at the EAA convention was William J. "Joe" Sullivan, chief of the Safety Regulations Staff, here fielding a question from Al Whiting, VP of EAA Chapter 4.





Great Lakes FAAers Bill Ryther, Rich Phillips and Martin Oosta (not in photo) did a land-office business in FAA safety literature at the exhibition hall. They ran out of 5,000 copies of the "Guide to FAA Publications" in the first two days of the convention.FAA World Oc

Bernie Geier (left), chief of the General Aviation and Coommercial Division, Office of Flight Operations, looks over a Gee Bee Z replica with Verne Jobst, FAA air show monitor designee. The original Granville Brothers racer won the 1931 Thompson Trophy race.



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CENTRAL REGION

William W. Buck, chief of the Fairfax Tower in Kansas City, Kan., from the Wichita, Kan. Tower . . . **Jack L. Langston**, chief of the Garden City, Kan., FSS, from the Central Region Training Branch . . . **William J. Levisay**, assistant chief at the Kansas City International Airport Tower, from the Denver Tower . . . **Richard R. Merriman**, chief of the Air Carrier-General Branch in the Flight Standards Division, from the Minneapolis, Minn., GADO.

EASTERN REGION

Edward J. Carr, chief of the Air Carrier Branch in the Flight Standards Division, from the New York ACDO . . . **Paul M. Kimes**, assistant chief at the Philadelphia Tower . . . **Manning H. Poston, Jr.**, deputy chief of the New York ACDO, from the Flight Standards Branch at the FAA Academy.

GREAT LAKES REGION

James R. Nelson, chief of the Crystal Airport Tower, Minneapolis, Minn., from the Minneapolis Wold-Chamberlain Airport Tower.

NORTHWEST REGION

Allan H. Brug, chief of the Ashton, Idaho, Sector Field Office, from the Burley, Idaho, Sector Field Office.

ROCKY MOUNTAIN REGION

William T. Butler, chief of the Pueblo, Colo., Tower, from the Aspen, Colo., Tower.

SOUTHERN REGION

Wendell A. Wright, chief of the Anderson, S.C., FSS, from the Knoxville, Tenn., FSS.

SOUTHWEST REGION

Edward D. Chambers, chief of the Fort Worth, Tex., FSS, from the Amarillo, Tex., FSS . . . **Edmond R. Johnson**, deputy chief of the Fort Worth ARTCC, from the Eastern Region . . . **Donald L. Petty**, chief of the Alice, Tex., FSS, from the Wink, Tex., FSS . . . **Clyde D. Santifer**, maintenance mechanic foreman in the Little Rock, Ark., Airway Facilities Sector, from the Houston, Tex., AF Sector.

WESTERN REGION

Donald A. Dunn, assistant chief at the Oakland, Calif., ARTCC . . . **Lloyd Golden**, deputy chief of the Los Angeles TRACON, from the Ontario, Calif., TRACON . . . **John J. Medina**, assistant chief at the Phoeni[illegible] Ariz., TRACON . . . **Henry M. Van Sa**[illegible] chief of the Bakersfield, Calif., Tower, fr[illegible] the Ontario TRACON . . . **Darrell L. Young**, assistant chief at the Phoenix TRACON.