SLIDE 01
Our desire is to get the most out of the fuel that we burn. Would you be happy to receive 288 units of work from an input energy of 100 units? Of course you would be. And this is made possible through a combination of engines and heat pumps.

SLIDE 02
This is how it goes. Let us start with clean fuel like LPG or LNG with an energy content of 100 kWh.

SLIDE 03
We will burn this fuel in the internal combustion engine during a period of 1 hour. Traditionally, we are happy to get shaft energy of 20 kWh. And this is already considered good efficiency. Now we will split the shaft power into two components - one part to drive a generator and the other a refrigeration compressor.

SLIDE 04
We combine the electricity generated here with those coming from "renewable energy" sources, and then store them in batteries or in whatever means, such generating hydrogen gas, and so forth. Or we could use it to drive electrical load, or even send energy back to the grid.

SLIDE 05
At this point, let us become creative. The jacket water is hot at about 90 degrees Celsius or higher. At the same time, the gas at the exhaust manifold is so hot that water would simply flash into vapor upon hitting the metal of the manifold. Now let us use this heat wisely and not waste it out into the environment. We will use this immense heat to produce steam and feed it into a Lithium-Bromide Absorption Chiller. Now we can refrigerate fish, meat and other produce. This chiller is called a "heat pump".

SLIDE 06
At the same time, some of the shaft energy from the engine is conveyed to a compressor to drive a cold storage freezer. On the side of this freezer, a provision is made such that this same system dehumidifies fresh air that will be injected into the heating/drying/evaporating column. The freezer is also a "heat pump".

SLIDE 07
Two sources of heating are now available - 1) from whatever heat can be scavenged within the shelter, and 2) from the condenser of the freezer. Notice that the input is 10 kW, but the available heat is 30 kW. This would normally be higher, but we have used some of the heat to de-humidify the air that we will introduce into the heating chamber.

SLIDE 08
Then there is a third source and that is the heat rejected by the Lithium-Bromide absorption chiller.

SLIDE 09
If the system is provided with a solar collector, this would be the fourth source of heat.

SLIDE 10
And if there is excess steam, then this would be the fifth source.

SLIDE 11
The resulting heated dry air will now enter the drying chamber.

SLIDE 12
And then the water evaporator. An air-tight vapor condenser is provided and is designed to operate at a pressure that is slightly lower than atmospheric to optimize the condensation process of the water vapor. The resulting water will now be clean, but if desired, it could be treated some more.

SLIDE 13
The "Energy Balance" recaps the process.

SLIDE 14
The input is divided into portions. In the normal process, only 20% of the 100% input fuel will be used under ideal conditions.

SLIDE 15
Now, there is 75% more, making a theoretical recovery of 95%.

SLIDE 16
Then the waste heat coming from the two chillers, and the freezing energy are added. This shows available work (or energy) from the system of up to 288%!

SLIDE 17
The availability of energy to do work, that exceeds the input energy isn't really strange. The system is configured such as to include "heat pumps". They scavenge energy from the environment and bring it into the system to do work.

SLIDE 18
The input energy of a chilling and refrigeration process E(i) draws energy from the surroundings, and the combination of these two are normally released into the environment. In our case, we will use E(c) to refrigerate, and E(o) for our drying applications.

SLIDE 19
In an application like the one we are discussing, the measure of desireability is the "Coefficient of Performance" or COP. And this varies from system to system.

SLIDE 20
Just a simple overview of the Lithium-Bromide Absorption Chiller. We start with a chamber under very high vacuum.

SLIDE 21
Water that is sprayed into this vacuum immediatly flashes into vapor at a very low temperature, around 5 degrees C or so. A cooling coil exposed to it will be cooled to almost the same temperature.

SLIDE 22
The formation of vapor from liquid will break the vacuum. A LiBr solution is sprayed into the chamber to absorb the water vapor formed to bring it back into the liquid state. The vacuum is re-established in this way.

SLIDE 23
At a certain point, the LiBr solution will no longer be able to absorb water vapor. So it is heated up so as to release the water. The resulting vapor is condensed in another chamber and will be ready to perform chilling once more. This is a simplified explanation. A lot more engineering actually goes into the whole process.

SLIDE 24
All the heat gathered in the previous processes are now combined into a drying system. The scheme is a standard engineering approach.

SLIDE 25
One might want to produce distilled water and/or high quality salt at the end of the process.

SLIDE 26
This is a functional layout of the system, in 11 parts. Just one note on points 10 and 11. The mechanical design should be such that partial vacuum is established so that the efficiency of the evaporation process is improved.

SLIDE 27
In conclusion, we help the earth by this process and enhance the efficiency of the system. One unit of energy is made to go much farther. The environmental load is also reduced drastically.

SLIDE 28
Please feel free to download the text of this slide show at the "energy efficiency link" at http://www.thcal.com.