Generating electric power

Three of the primary renewable energy sources can be combined with gas into a single integrated system that solves the key limitations of the individual sources and improves their productivity. *(Preliminary outline of the concepts)*

Limitations:

- ***HEAT networks*** do not produce electricity
- ***Windmills*** provide only intermittent power
- ***Solar systems*** operate only seasonally

The ***HEAT networks*** and gas can be combined with either or both of the other two sources, but for the sake of brevity this outline will cover of all four sources being used together. See ***The role of combustible fuels*** for an explanation re. the gas.

Windmills

Windmills do not operate when the wind is not blowing, and they provide only reduced power when the wind is blowing gently. If the electric power demand is constant a windmill can meet only about 30% of the demand. The remaining 70% must be provided by some other source, such as hydro power or gas-fired generators. Moreover, the demand itself varies by more than a factor of two, so without some means of storage the potential for using wind power amounts to less than 15% of the peak demand.

Windmills deliver mechanical power. If that mechanical power is used to compress air that is then fed through a ***HEAT networks*** storage field then that energy (and the compressor's mechanical losses) can be stored in the form of heat and pressure, along with the heat stored via the ***HEAT network's*** normal process. Gas recovered from garbage and/or natural gas would be burned in pods in front of an output turbine that converts the heat energy to mechanical power and provides the compressor power when the windmill is not operating. The gas keeps the compressor operating at a constant speed but from a thermodynamic point of view the storage system provides a steady flow of energy. The system performance is determined by the net amount of heat added between the compressor and turbine stages, and that will be very nearly constant, and the stored energy can match the supply to the demand. In such a system the ***HEAT network*** would also glean waste heat from the turbine's output so it could operate at a higher temperature, eliminating the need for heat pumps in the homes, thus reducing the capital cost.

Solar power

If the air feed coming from the compressor flows over a large black panel covered by an insulating window, solar heat will be collected at a relatively high temperature by the panel on sunny summer days and will be stored in the ***HEAT network's*** storage field, where it is efficiently retained and will eventually be used to supply part of the energy extracted from the output turbine. The result again is long term (seasonal) storage plus the ability to cope with both supply variations and fluctuating demand loads. Conceptually at least, none of the energy produced by either the windmill or the solar collector would be used directly for external loads (although that is not impossible). The mechanical and electrical outputs of the system would come from the turbine.

Thermodynamics

Physicists will recognize this system as the thermodynamic equivalent to a jet engine. The first stage is a compressor that adiabatically compresses the input air, which heats the air. Then more heat is added as the air flows through the solar collector and (in winter) through the storage field. Then energy is recovered by an expansion spool at the output end. Adding gas combustion chambers just ahead of the spool neatly integrates all of the energy sources except hydro.

In the summer the ***HEAT networks*** exchanger and the solar collector will give up heat to the storage medium and in the winter that transfer is reversed, so the net effect will be that the electrical or mechanical output will tend to be constant throughout the year. Although such systems achieve high overall efficiency, the electric power efficiency is limited.

HEAT networks

The ***HEAT network*** component of the system is essential for either of the other energy sources to store their energy. Using air instead of a liquid for the heat exchange fluid does not alter the design principles. The storage field will operate at a higher temperature, but the increased heat loss is expected to be tolerable, especially as it would eliminate the need for heat pumps in the homes. Such a system would use separate fields for storing heat and cold, but that will normally be the case anyway.

HEAT networks provide a complete and sustainable solution for the thermal needs of our cities. They also provide a solution to the need for electric power by:

- displacing the huge summer power peak
- creating the potential for N-S electricity exchanges
- providing a near term surplus of natural gas for power
- directly generating electric power as explained here

Moreover the benefits of these changes can be realized very quickly. The initial and easiest applications of ***HEAT networks*** are for new suburban communities and high rise buildings, which constitute the primary cause of the summer peak demand for electricity. We really only need to change the pattern of that demand, from growth to shrinkage, to relieve the most fundamental problem. Once that problem has been met, as more natural gas is made available part of it can be used for power generation for the near term period. In due course the power generation by natural gas can be replaced by solar and windmill energy, which will be stable, reliable power sources once the storage problem has been addressed.

The primary potential for the reduction of greenhouse gases is through the elimination of fossil fuels for heating and cooling. That can be achieved simply and quickly by using ***Heat networks*** as previously described. This outline addresses the longer term potential for extending the concept to the production of electricity by a permanently sustainable means, but that extension will require more detailed study.