Woodstock Renewable Heat

June 14, 2018

Vision:

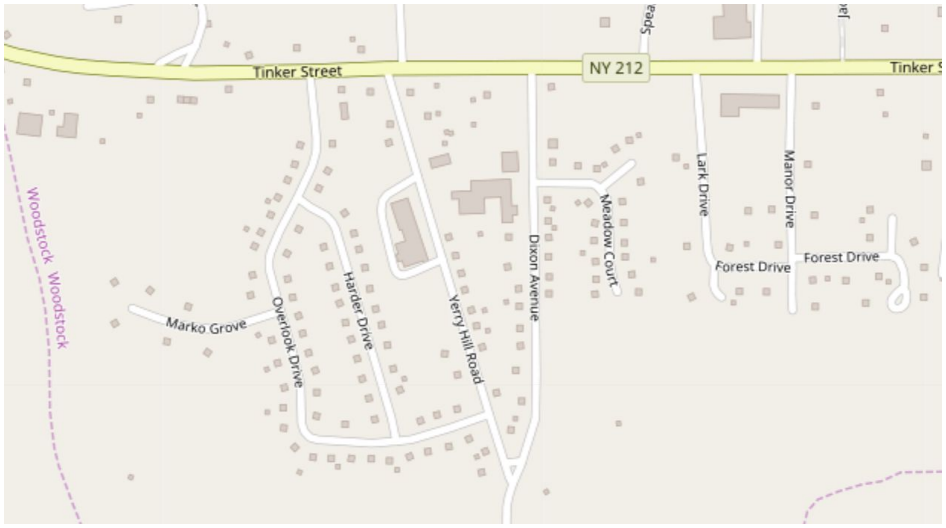
This is a process of inquiry, driven by two questions. Can a networked energy system reduce and stabilize long-term heating costs? And is it a viable and effective pathway to transition from fossil fuel combustion to renewable thermal energy, rather than individual home conversions, knowing that the decision process for a homeowner conversion is time consuming and challenging?

New York State policy calls for an 80% reduction in greenhouse gas emissions by 2050. To achieve this goal at least half of heating needs to convert to renewable energy. Areas not served by natural gas, such as the Town of Woodstock, are the lower hanging fruit.

The goal is to create a viable and economic transition from fossil fuel combustion to renewable space heating and domestic hot water supply for the Western Hamlet of the Town of Woodstock (locally known as the “Bearsville Flats”, the area located adjacent to Bearsville).

To determine the viability of a neighborhood system where participating home and business owners are interlinked in a networked project using any combination of ground and air source heat pumps, thermal storage, recycled heat (where available) and solar thermal. This project could include solar electric generation and batteries sufficient to power thermal energy circulation system during blackouts. The project could be owned and managed by the Town of Woodstock, through its Water and Sewer Department. Currently the project is being led by the Energy Working Group within Woodstock Transition, a local advocacy organization.

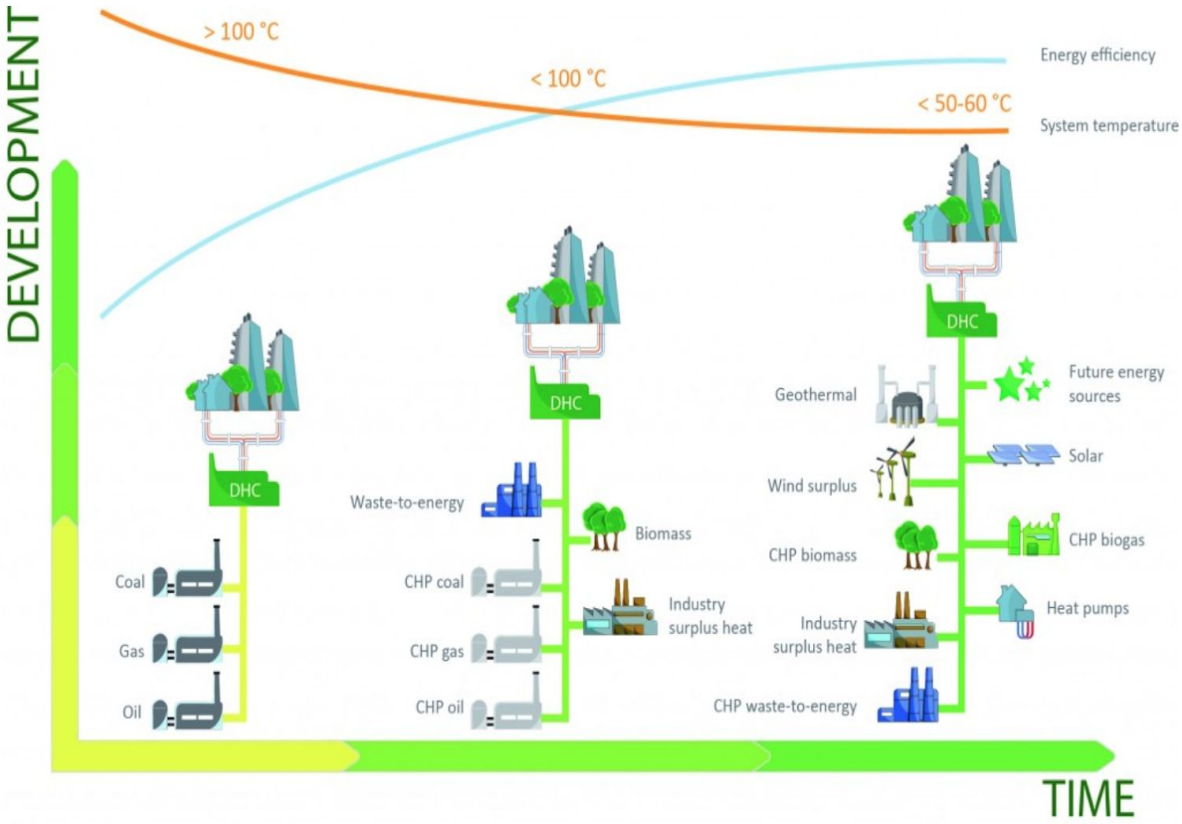
Location Map:



Outline Approaches:

There are several approaches to planning a neighborhood thermal energy project suitable for the Woodstock Western Hamlet area, outlined as follows:

1. ”Deep Green” - Medium temperature or Direct: This would use one or more large-scale heat pumps together with thermal storage, recycled heat, and possibly a combined solar thermal and photovoltaic array provide energy. Renewably generated heat is then circulated in insulated neighborhood pipes at a high enough temperature to directly supply heat and domestic hot water using a residential heat exchanger. This is known as 4th generation district or neighborhood networked thermal energy. The principle characteristics of 4th generation neighborhood energy are: the use of hot water instead of steam; calibrating the temperature of the distribution system to meet the end needs (we do not need steam to raise home heat a relatively few degrees above ambient temperatures); using renewable and recycled heat; and incorporating thermal storage to optimize the system and to enable the use of off-peak electricity for pumping. Such



systems do not preclude the use of fossil fuel, but if used, fossil fuel will likely be a small fraction of the total energy used. This second approach could be referred to as “Deep Green” in that it minimizes the use of refrigerants and system energy use is optimized based on the needs of the community. It is also more resilient than the second approach, below.

2. ”Lite Green” - Low temperature or Indirect: This is one way to bring the benefits of ground source heat pump technology (also known as geothermal heat pumps) to participating homeowners. One or more sources of low temperature ground-source heat is circulated in buried pipes, making this energy available for homeowners to access using individual home heat pumps for heating and cooling. This approach could be referred to as “Lite Green” in that each home will require its own heat pump.

3. Individual homes: The primary purpose of this effort is to determine the costs of a interconnected renewable thermal neighborhood system and compare that with the status quo of individual home heating by conventional means. By designing a compelling and municipally-led energy district we want to determine if the ease and rate of adoption of renewable thermal energy will be higher than if homeowners are left to figure out the best choice in the maze of currently available home energy options.

Deep Green Approach - Direct or Medium Temperature

The goal for Woodstock Western Hamlet is to create a renewable thermal energy project. This direct or **Deep Green** approach uses one or more centralized large-scale heat pumps, solar thermal collector array, together with thermal storage with the resulting energy circulated at a temperature high enough to *directly* supply home heat and domestic hot water. The Direct approach may be the most energy efficient and resilient approach. That said, it is more complex.

During fall and spring, and increasingly during winter, daytime air temperatures are as high or higher than the known ground source temperatures in Woodstock, for at least a few midday hours. Combining temperature activated air-source central heat pumps with thermal storage the system may enjoy higher efficiency than with ground source heat pumps alone.

The Direct approach generates heat at a medium temperature and circulates in insulated pipes at a temperature suitable for direct use for home & business heating, for example, a circulating temperature in a range of 130 to 160°F. The final design temperature, to be selected, is critical to the efficiency of the overall system. With heat pumps a goal is to reduce the temperature difference between the source of low temperature ambient heat (air, ground and water) and the distribution temperature of the district energy supply side as close as possible.

The Direct approach is used in the following three examples, all using fossil fuel combustion, Jamestown, NY, (at a high temperature of 250°F) in a municipally owned and operated system successfully operating for about 30 years, also in Schenectady via a system developed by Proctors about five years ago, and in Trenton, NJ. Trenton is the only one to use thermal storage, albeit pressurized and at high temperature. All three projects operate in conjunction with fossil-fuel power generation, using by-product heat that would otherwise be wasted.

A minor downside to the Direct approach is that the current NYSERDA rebate for the kind of large scale heat pumps suitable for the Direct approach is $1,2000/ton and has a limit of $500,000 instead of the unlimited $1,500/ton for the Indirect approach with its individual home heat pumps, which indirectly supply home heat. That said, the Direct approach as a neighborhood system may attract more interest from funding and granting agencies. For example, the Proctors' hot water based thermal network, serving buildings in downtown Schenectady, received substantial funding, as much as half its capital cost … and it is entirely fossil fueled.

Key points on the Indirect (low temperature or "Lite Green") approach:

The key benefit with ground sourced thermal energy is that it provides energy at a temperature generally warmer than air temperature in winter. Each homeowner and business owner subscribing as a project participant would need to install individual and compatible heat pumps and then connect with the thermal pipe network.

The Indirect approach is simple and compatible with current state funding under NYSERDA's $15 million program (offering a grant of $1,500/ton for residential scale use). The needs of a typical 900 to 1,000 square feet Woodstock Western Hamlet home may be met with a small heat pump, say a two, three or four ton heat pump. Therefore the grant might cover a good portion of the heat pump cost, leaving the municipal low temperature ground loop cost to be determined.

The Indirect system would have lower upfront capital costs. As such, it would likely be viable even with lower homeowner participation than the Direct system. Timely action is required as there is a limit to available NYSERDA funding.

RUPCO, at its Kirkland Hotel office and apartment building on Fair St., Kingston uses heat from a ground source well (with multiple boreholes under the parking lot) which is then circulated to individual heat pumps serving each office room and apartment within the single building.

If the distribution pipes are uninsulated, the system is then somewhat limited in that it cannot enhance the operating temperature of the neighborhood thermal loop by using byproduct heat from commercial facilities, municipal wastewater plants and solar thermal. The source of heat supply to home heat pumps will be at ground temperature.

The key to high efficiency is to draw on an ambient energy resource supply that is of the highest available temperature (such as from ground source water instead of ambient air in winter). The goal is to reduce the temperature difference (delta T) between the thermal source and the desired home temperature (doing so increases the coefficient of performance, COP, a measure of the thermal return on electricity used). Individual homeowners could install desuperheaters at a small additional cost to provide about 50% of domestic hot water needs (percentage of DHW supply is an estimate) or could use separate domestic hot water heat pumps. Desired DHW

temperatures are hotter than most space heating temperature supply needs. The lower the temperature of the space heating heat pump the higher its operating efficiency. Based on this alone we can see the relative complexity of the indirect or “Lite Green” approach. Detailed engineering and cost analysis will guide the planning process.

Sundry:
The Town of Woodstock currently supplies drinking water to homes and businesses in the hamlet area. The coincident reading, by the town water and sewer department staff, of water meters and thermal energy meters would provide an operational saving.

There are existing district energy networks in New York State (and elsewhere in the USA), but to the best of our knowledge, they all use fossil fuel or biomass combustion. In addition to the Proctors and Jamestown examples, Montpelier, VT, brought online a biomass combustion hot water based district heat system in recent years. (Exergy is a key to optimize 4th generation energy, for example, combustion should first generate electricity while at the same time be optimized so as to deliver thermal energy at a useful temperature; this is akin to the Carter-era cogeneration policy, even with its flawed low efficiency standard).

St. Paul, MN, converted its old steam district heating system to hot water about twenty-five years ago and switched from fossil fuel combustion to biomass combined heat and power (CHP) and a solar thermal bank (the latter supplies about 1% of the system's energy). The St. Paul system supplies about 80% of the heat and about 60% of the cooling energy needed by all downtown buildings.

Current energy supply:

- Fossil fuel combustion is currently the primary heat supply for the buildings in the Woodstock Western Hamlet area. The approximately 108 homes have concrete slab floors and almost all the homes are single story with three-inch walls. While improvements can be made to the building shell, such activity if done to any extent, would be disruptive to the homeowner. The supply of renewable thermal energy will avoid the emission of GHGs, and over time will be less subject to fuel price fluctuation, thus providing some price certainty.

- Competing technologies are individual home cold climate air source heat pumps, mini-split air source heat pumps, individual home ground source heat pumps, wood stoves, biomass boilers and continued fossil fuel combustion.

Tax Credit Extender bill of Feb. 2018:
This month Congress passed a tax extender bill, subsequent to an earlier tax bill. This extends significant tax credits to geothermal heat pumps, among other energy technologies, for the next four years. This financial incentive could be both an accelerant and a strengthening of the economics of the proposed project.

Major relevant associations are:
Smart Energy Systems and 4th Gen. District Energy: www.4dh.eu
International Ground Source Heat Pump Association (IGSHPA): https://igshpa.org/
International District Energy Association (IDEA): https://www.districtenergy.org

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Woodstock New York Transition (WNYT), Energy Working Group: Eric Werthman, Kirk Ritchey, Dermot McGuigan, Julie Last

http://woodstocknytransition.org/
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