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Converting to Natural Gas: A Practical Guide

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Newer, more efficient methods of extracting natural gas (NG) are making it more abundant and less expensive. As a result, NG is fast becoming the fuel of choice for everything from electric power plants to poultry houses. NG utility companies are expanding their coverage regions and reaching out into rural areas seeking new customers, and poultry farms are prime targets. It is easy to understand why: in the southern region or broiler belt of the U.S., one poultry house, during a single winter flock can consume as much NG as the average dwelling house will for the entire year in the same area ("Trends in U.S. Residential Natural Gas Consumption," Energy Information Administration, Office of Oil and Gas, June 2010.) Therefore, servicing one four-house poultry farm can be equivalent to servicing 15-20 residential houses. This makes good sense for the NG companies.

It also makes good sense for the poultry grower. If natural gas is available, given current and projected price relationships between propane & natural gas, converting to natural gas offers an excellent opportunity to decrease annual energy costs for heating and brooding. Suffice it to say that NG currently costs 31% less to produce the same BTUs as LP. See inside, page 2 for more information on making cost comparisons.

Given the current economics favoring conversion to NG, the main purpose of this newsletter is to provide a practical, nuts-and-bolts guide to converting from LP to NG. We'll point out where cost factors need to be considered, but focus mainly on the how-to. The conversion process is not difficult, but it must be well thought out – and undertaken with the help of a qualified natural gas technician. This guide gives you the information you need to work efficiently and effectively with that qualified technician to get the job done right.

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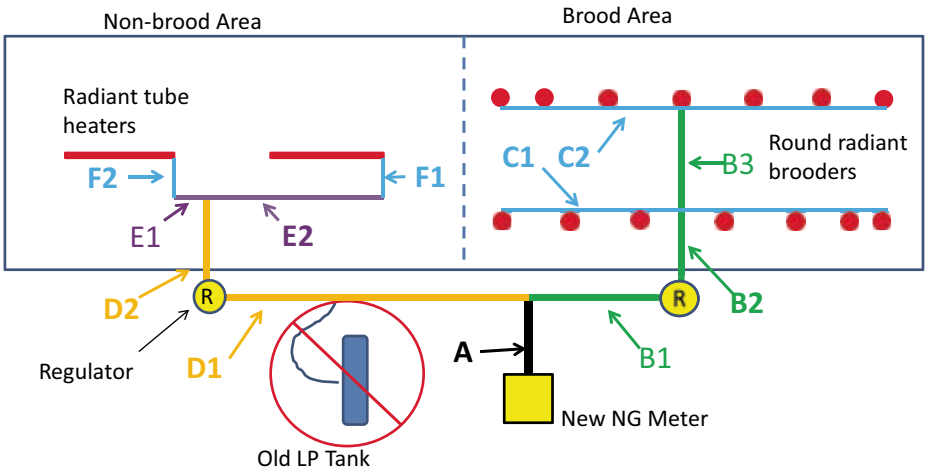

Many plumbing differences need to be considered when converting to NG. The piping plan may look similar to an LP setup, but the need for new regulators, increased pipe sizing and appliance changes must be addressed.

Getting the details right can be the difference between success and failure.

Beware of being told, "All you need to do is drill out the burner orifices." Not true in most cases.

Cost Factors to Keep in Mind

Conversion costs will typically include conversion kits, plumbing upgrades, and labor. Be wary when a NG company offers to hook up a poultry farm and says "all we need to do is drill out the burner orifices." While occasionally this may be true, more often than not, conversion is more complicated. Questions regarding the suitability of appliances for use with natural gas rather than propane should be answered by the manufacturer.

There can also be "hidden costs" with either of these fuel choices. Some NG companies may charge a flexible rate varying seasonally or they may charge a minimum billing amount, regardless of usage. NG bills also may include additional service charges that may add 5% or more to the bill. With LP, growers may be charged an annual tank fee.

The different delivery methods introduce pros and cons that may have cost consequences. With LP the grower may be able to shop competing suppliers for a lower price; but there is also the need to be constantly aware of LP fuel levels in the tanks and the risk of running out. Oftentimes, when the LP companies are most busy and slow to deliver is when the grower is in the worst need of fast LP delivery. Conversely, NG is always there and available, but a grower no longer has the ability to shop competitors for lower priced fuel.

All these points must be taken into consideration, but they are typically not overriding concerns.

How To Compare Costs: Natural Gas vs Propane

There is a misconception that natural gas does not burn as hot as propane. The truth is that the flame temperatures of NG and LP are both approximately 3,560°F.

However, it takes approximately 2.5 times the volume of NG as it does LP (as a gas, not the bottled liquid) to produce the same amount of heat from the same appliance.

This is why NG requires larger piping and larger burner orifices.

NG is typically sold by the therm and LP by the gallon:

One therm of NG = 100,000 BTUs.
One gallon of LP = 91,660 BTUs.

This means an LP gallon is worth only about 91.7% of what an NG therm is worth. Even if the market prices per gallon and per therm were exactly the same, the NG would be a better deal.

Putting that another way: To compare LP gallons to NG therms, simply divide the LP gallons by 1.09. Then apply the market prices per unit to get a true cost comparison.

Example based on current market prices:

Step 1. 20,000 gal LP divided by 1.09 = 18,349 therms NG
Step 2. 20,000 gal LP X $1.20 per gallon = $24,000
Step 3. 18,349 therms NG X $0.90 per therm = $16,614

At these market prices, going with NG would get you the same amount of heat as you would get from 20,000 gallons of LP, for $7,386 less – about a 30% savings!

Note: If NG in your area is sold not by the therm but by the thousand cubic feet (MCF), just divide the MCF number by 10 to convert it to therms. (A therm is approximately 100 cubic feet.)

See Tables 3 and 4 on page 5 for side by side price comparisons. **For more details on NG/LP comparative cost analysis, see NPTC Newsletter #53, "Economics of Converting to Natural Gas" May 2008, www.poultryhouse.com.**

Building New?

If a grower is building a new poultry house, initial plumbing cost for NG should be close to the same as for LP with only marginal differences in pipe size. It may well be a good idea to plumb with NG sized pipe even when NG is currently unavailable, if there is a reasonable chance NG could become available in the future. Oversizing of pipe with LP is not considered to be a problem.

NG Conversion: A Step-by-Step Checklist

Successful conversion requires following a step-by-step process. All elements must work hand in hand for proper heater operation. In situations where growers have been unhappy with their conversion, it is often found that someone did not follow a step-by-step process like the one listed here.

Step 1. Determine total house BTU load (maximum heat needed) and Cubic Feet/Hour (CFH) flow rates needed per house and per chamber.

Step 2. Determine incoming NG gas pressure.

Step 3. Draw (or consult) a house plumbing layout plan, determining lengths of piping needed for all sectors.

Step 4. Install properly-sized gas lines to deliver cubic feet per hour (CFH) of NG needed, based on calculations including BTUs needed, incoming gas pressure, and piping line lengths. Refer to NFPA 54 – National Fuel Gas Code Handbook for proper pipe size guidelines. See also Tables 1, 2a, and 2b.

Step 5. Install proper in-line regulators. Regulators will almost always need to be changed. NG regulators have larger orifices and different internal mechanisms to account for the lower pressure and different flow characteristics typical of NG.

Step 6. Convert heater/brooder appliances – including a) Burner orifices; b) Pilot orifices, if applicable; c) Gas control valves; d) Gas/air mixture control plates; and e) Data plates – to ensure safety for future maintenance.

Growers need to make sure a similar checklist is followed by the installer or the gas company.

A Step-by-Step NG Conversion Example

As an example, let's assume a grower is undertaking a conversion to NG. He has already calculated the economics and contracted with the utility company. Now he must work out his checklist and start the conversion process. This grower has four 40 ft X 500 ft broiler houses in the Southeast U.S. He currently uses LP. Brood areas of the houses are heated with round radiant brooders and the non-brood areas are heated with radiant tube heaters.

Step 1. Determine total house BTU load (maximum heat needed) and Cubic Feet/Hour flow rate needed.

Brood Area = 14 radiant brooders @ 40,000 BTU each = 560,000 BTUs

Non-Brood Area = 2 - 40ft Tube heaters @ 125,000 BTUs each = 250,000 BTUs

House Total = 560,000 + 250,000 = 810,000 BTUs/house

Total Farm = 810,000 x 4 = 3,240,000 BTUs

This calculation means the NG company will be supplying 3.24 million BTUs of natural gas to the farm. NG flow is commonly measured in Cubic Feet per Hour or CFH. BTUs must be converted to CFH using an acceptable average of 1,000 BTUs of heat per CFH.

3,240,000 BTUs / 1,000 BTUs/CFH = 3,240 CFH

The NG utility must be able to supply at least 3,240 CFH of NG to his farm. Adding a small amount for error and possible other small appliances like small space heaters and possible future upgrades, 3,500 CFH will be the final total supply required. That should also be broken down by house, as NG is often supplied with a meter at each house. In this case, each house needs to be supplied with 875 CFH of NG. We also break down the supply requirement by brood and non-brood areas, since NG suppliers often use multiple entry points corresponding to brood/non-brood chambers.

Now the grower has numbers he can use. Breakdown of CFH requirements for example farm:

Total Farm –	3,500 CFH
Total/House –	875 CFH
Brood Area/House –	560 CFH
Non-Brood Area/House –	250 CFH

Step 2. Determine incoming NG gas pressure.

In this example, we assume incoming NG pressure is 5 psi. The grower must consult with the NG company to make sure what this number will be. It is generally accepted that the NG utility company is responsible for the correct plumbing required to get the appropriate CFH supply to the meter at each house at the pressure they are able to supply to a given farm. It is from this point beyond the meter or valve at each house that the grower must ensure his individual houses are properly plumbed.

It is important to note that the incoming gas pressure specification at the meter is based on having all heaters and brooders in the house burning. Whatever pressure is registered at the meter with no appliances burning will drop as heaters are turned on. This is important because any change in the operating supply pressure will change the required size for pipe from the meter to regulators (which drop the pressure to 1/2 psi from that point on). It is not uncommon for NG meter actual operating pressures to be lower than a specified 5 psi, in which case the plumbing must be sized accordingly.

Step 3. Draw (or consult) a house plumbing layout plan, determining lengths of piping needed.

For this example we use the plumbing layout pictured on page 1 and reproduced below, together with Table 1 (below), a working table in which the grower would list (in Columns C and D) the measured lengths of each pipe section needed. The grower also uses Table 1 to enter the CFH requirements (Column B), the operating pressures (Column E), and the existing LP pipe sizes (Column F). We assume for this example that all brooders/heaters are low pressure type using 0.5 psi at the appliance.

Step 4. Install properly-sized gas lines to deliver cubic feet per hour (CFH) of NG needed.

To determine pipe sizes, we consult the National Fuel Gas Code Handbook NFPA 54 (see Tables 2a and 2b, next page), listing natural gas CFH capacity by pipe size and length, according to supply pressures of 0.5 psi and 5.0 psi. We can then enter the NG pipe sizes required (Column G), comparing those with the house's existing LP piping (Column F), and re-plumb as needed.

Step 5. Install proper in-line regulators.

The main considerations for regulators are location and the final appliance operating pressure. It is most common for the NG utility company to supply the proper regulators based on the calculations seen here. The plumbing installer or brooder dealer are also sources for NG regulators.

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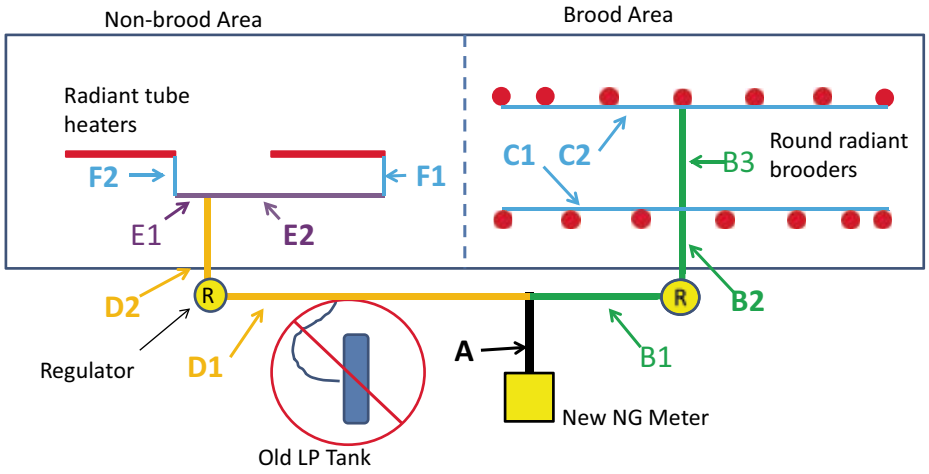
Example Broiler House NG Plumbing Plan



NOTE: The example house plumbing plan and working table shown here represent a typical Southeast US broiler house situation. Growers should draw up their own plumbing plan, measuring pipe lengths carefully, and then construct their own corresponding working table. Getting pipe sizes right can be critical, and using a systematic step-by-step process helps ensure accuracy.

Table 1. Example Working Table for Determining Pipe Sizes Needed (consulting plumbing plan above and Tables 2a and 2b)

A	B	C	D	E	F	G
Pipe Section	CFH requirement	Actual Length of section (feet)	Length of Pipe for Sizing (feet)	Pressure	Existing LP pipe size Schedule 40 Iron	NG pipe size required Schedule 40 Iron
A	*875*	*10*	*130 (10 + 120)*	*5 psi*	*3/4″*	*1″*
B1	*560*	*75*	*130 (10 + 120)*	*5 psi*	*1/2″*	*1″*
B2	*560*	*35*	*190 (75 + 230/2)*	*1/2 psi*	*1 1/2″*	*2″*
B3	*280*	*40*	*190 (75 + 230/2)*	*1/2 psi*	*1 1/4″*	*1 1/2″*
C1	*280 (140 each way)**	*230*	*190 (75 + 230/2)*	*1/2 psi*	*1″*	*1 1/4″*
C2	*280 (140 each way)**	*230*	*190 (75 + 230/2)*	*1/2 psi*	*1″*	*1 1/4″*
D1	*250*	*120*	*130 (10 + 120)*	*5 psi*	*1/2″*	*1″*
D2	*250*	*30*	*115 (30 + 75 + 10)*	*1/2 psi*	*1″*	*1 1/4″*
E1	*125*	*25*	*115 (30 + 75 + 10)*	*1/2 psi*	*3/4″*	*1″*
E2	*125*	*75*	*115 (30 + 75 + 10)*	*1/2 psi*	*3/4″*	*1″*
F1	*125*	*10*	*115 (30 + 75 + 10)*	*1/2 psi*	*3/4″*	*1″*
F2	*125*	*10*	*115 (30 + 75 + 10)*	*1/2 psi*	*3/4″*	*1″*

Highlighted areas assume 5 psi meter pressure with all appliances running. Lower supply pressures will affect pipe size. *sized at 140

Table 2a. Maximum Natural Gas Capacity of Pipe in Cubic Feet per Hour (CFH) for Gas Pressures of 0.5 psi or Less and a Pressure Drop of 0.3 Inches Water Column

Nominal Iron Pipe Size, inches	Internal Diam-eter, Inches	Length of Pipe in Feet													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
3/4	0.824	278	190	152	130	115	105	96	90	84	79	72	64	59	55
1	1.049	520	350	285	245	215	195	180	170	160	150	130	120	110	100
1- 1/4	1.380	1050	730	590	500	440	400	370	350	320	305	275	250	225	210
1- 1/2	1.610	1600	1100	890	760	670	610	560	530	490	460	410	380	350	320
2	2.067	3050	2100	1650	1450	1270	1150	1050	990	930	870	780	710	650	610

Based on a 0.60 Specific Gravity Natural Gas. Adapted from National Fuel Gas Code Handbook NFPA 54.

Table 2b. Maximum Natural Gas Capacity of Pipe in Cubic Feet per Hour (CFH) for Gas Pressures of 5.0 psi with a 10% Pressure Drop

Pipe Size Schedule 40 Standard (Inches)	Internal Diameter (Inches)	Length of Pipe in Feet				
		50	100	150	200	250
1.00	0.824	1989	1367	1098	940	833
1.25	1.049	4084	2807	2254	1929	1710
1.50	1.380	6120	4206	3378	2891	2562
2.00	1.610	11786	8101	6505	5567	4934

Based on a 0.60 Specific Gravity Natural Gas. Adapted from National Fuel Gas Code Handbook NFPA 54.

Tables 3 & 4. Jiffy Lookup for NG/LP Price/Cost Break Points

TABLE 3			TABLE 4		
Price of NG per MCF	Price of NG per therm	Stay with LP if you are paying less than $/gal	Price Paid for LP	Convert to NG if less than $/therm	Convert to NG if less than $/1,000 cu ft.
$8.00	$0.80	$0.73	$2.60	$2.83	$28.34
$9.00	$0.90	$0.83	$2.50	$2.73	$27.25
$10.00	$1.00	$0.92	$2.40	$2.62	$26.16
$11.00	$1.10	$1.00	$2.30	$2.50	$25.07
$12.00	$1.20	$1.10	$2.20	$2.40	$23.98
$13.00	$1.30	$1.19	$2.10	$2.29	$22.89
$14.00	$1.40	$1.28	$2.00	$2.18	$21.80
$15.00	$1.50	$1.38	$1.90	$2.07	$20.71
$16.00	$1.60	$1.47	$1.80	$1.96	$19.62
$17.00	$1.70	$1.56	$1.70	$1.85	$18.53
$18.00	$1.80	$1.65	$1.60	$1.74	$17.44
$19.00	$1.90	$1.74	$1.50	$1.64	$16.35
$20.00	$2.00	$1.83	$1.40	$1.53	$15.26
$21.00	$2.10	$1.93	$1.30	$1.42	$14.17
$22.00	$2.20	$2.02	$1.20	$1.31	$13.08
$23.00	$2.30	$2.11	$1.10	$1.20	$11.99
$24.00	$2.40	$2.20	$1.00	$1.09	$10.90
$25.00	$2.50	$2.29	$0.90	$0.98	$9.81

Step 6. Convert heater/brooder appliances.

It is highly recommended that a grower contact the manufacturer of the heating equipment installed in his houses before undertaking an LP to NG conversion. Most companies that manufacture poultry heating equipment have very detailed and specific guidelines for converting their appliances from one fuel type to another. Often it is best to purchase conversion kits specific to the heating equipment. These can be obtained either directly through the heating equipment manufacturer or their distributor.

Final Check: Once all conversion work has been done and all new plumbing leak-tested under pressure, every heating unit on the farm needs to be turned on at once and every house systematically checked for proper operation at every appliance. With every unit burning, line pressures should be checked at the last brooder/heater on the line and at the incoming line. These pressures should meet the sizing criteria used for the conversion calculations. New NG plumbing should be able to sustain full operation of every heating unit on the farm at once. The only way to ensure this is to test it.

The job is not complete until the farm can pass this all-burners-on test.

The Bottom Line

Generally speaking, if NG is available, given current and projected price relationships between LP & NG, converting to natural gas offers an excellent opportunity to greatly reduce annual heating energy costs. The conversion to natural gas is likely to pay off in the longer term even if the grower has to incur significant cost for conversion and/or a fee for connection.

Growers also need to be aware of the pitfalls of a poor conversion and take steps to ensure that they do the job right the first time. It is vitally important for the grower considering an LP to NG conversion to understand that proper plumbing is of utmost importance if he expects to be satisfied with NG as a heating fuel. Proper plumbing will both maintain proper heating capabilities and ensure that the grower realizes the expected heating cost savings from NG conversion.

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The Poultry Engineering, Economics and Management Newsletter provides up-to-date information on topics of interest to poultry production personnel, focusing on most effective and efficient uses of modern technology and equipment, with a special emphasis on economic implications. The Newsletter is published six times a year, or as needed to address emerging or special issues. Contact: Jess Campbell, National Poultry Technology Center, 226 Corley Bldg., Auburn University, AL 36849-5626, (334) 844-3546, fax (334) 844-3548, jesscamp@aces.edu. Published by:

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