Residential HVAC Gas Heat Pumps: Natural Market Baseline

SAG Market Transformation Working Group
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Nicor Gas | Energy Efficiency Program

Agenda

1. Background and Development

2. NMB, Methodology, Assumptions, Data Sources

3. Next Steps

4. Appendix

   - References

   - Sources

NMB Purpose

"…a forecast of the future in which no utility-funded energy-efficiency programmatic intervention exists."

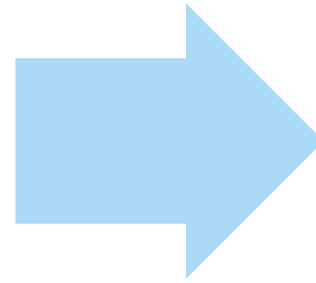**Nicor Gas has had the following developed and reviewed:**
- ✓ Methodology
- ✓ Data Sources
- ✓ Assumptions

The NMB will be revised over time (on a schedule determined in the Theory Based Evaluation plan) based on new data.

Development & Review Timeline

Q3 2023

Draft NMB created

Q2-Q3 2024

Guidehouse review

Guidehouse Natural Market Baseline Review

Data Sources Review

- Guidehouse evaluated the data sources provided by RI for the Residential Gas HVAC NMB, regarding their scope and accuracy, and checked for more recent updated versions.
- Guidehouse reviewed the sources and did not find any discrepancies and confirmed the most recent copies were referenced.

Variables Review

- Guidehouse conducted an in-depth review of RI's methodology for determining NMB variables. This included analyzing given sources and researching market trends.
- Guidehouse found that all variables chosen are well defined and appropriate, with minor comments on how RI may better define proxy technologies used to develop the "early years" section of the hybrid model.

Review Follow-Up

- Commercial Availability, 2027: variable to be reviewed during the first NMB review
- Start of Hypergrowth, 2035: variable to be reviewed during subsequent NMB reviews prior to 2028

Recommendations:

- Define all technology measures used as proxies in the Natural Market Baseline.
- Clarify which data in the primary data collection comes from which technology measures (GHPWHs vs. Res Combi).
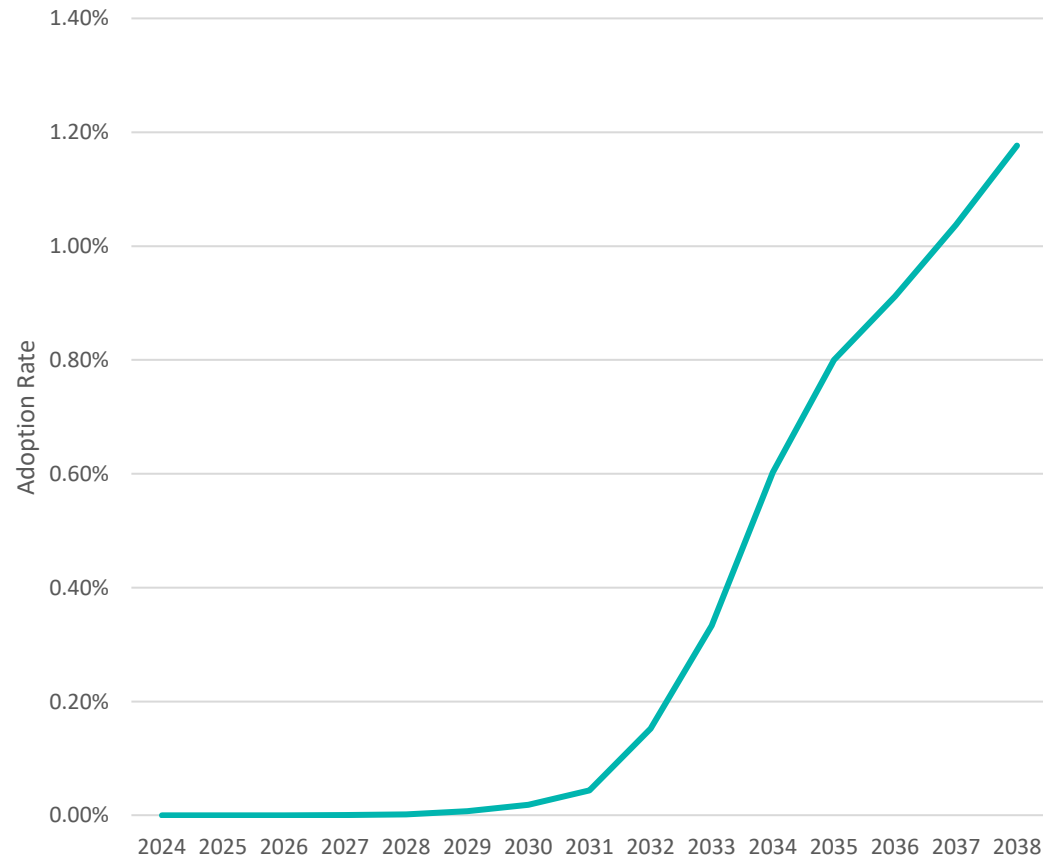
Res HVAC GHPs NMB Forecast 2024 - 2038

Year	Res HVAC GHP Adoption Rate	# Res HVAC GHPs Adopted
2024	0.0000%	0
2025	0.0000%	0
2026	0.0000%	0
2027	0.0003%	0
2028	0.0019%	2
2029	0.0073%	9
2030	0.0183%	23
2031	0.0438%	55

Year	Res HVAC GHP Adoption Rate	# Res HVAC GHPs Adopted
2032	0.1526%	191
2033	0.3334%	419
2034	0.6028%	760
2035	0.8000%	1,013
2036	0.9118%	1,159
2037	1.0370%	1,323
2038	1.1765%	1,508

Res HVAC GHPs NMB 2024 - 2038

Res HVAC GHP NMB:
% Market Share

Res HVAC GHP NMB:
Number of Units
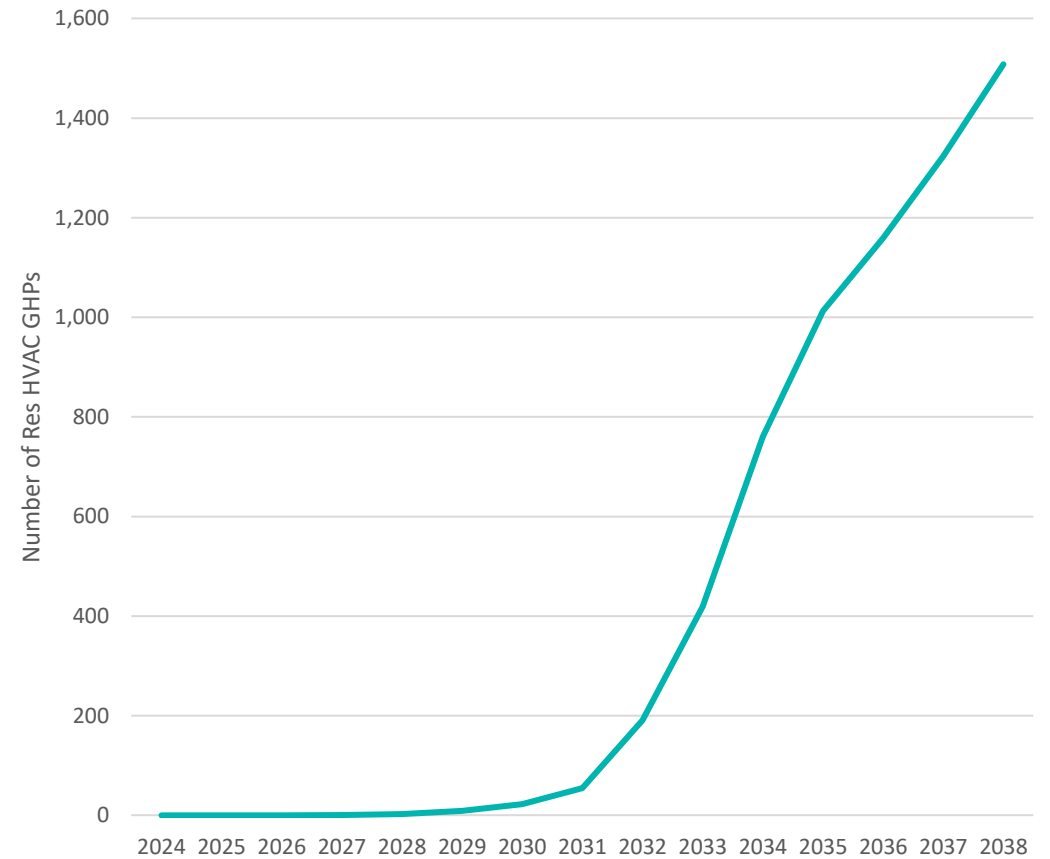
Goal

Forecast the adoption rate and number of units adopted in the absence of utility intervention as realistically as possible

# of NMB Units = # Eligible Units * NMB Market Share

Approach to Forecasting NMB Market Share:

1. Early Years 2024 – 2034: draws on general approach and primary data collected for a similar technology (gas heat pump water heaters)

2. Later Years 2035 – 2038: uses theoretical modified S-Curve

# of NMB Units = # Eligible Units * NMB Market Share

Based on Nicor Gas' 2020 TEAPot* residential customer forecast
- Housing types: single family - regular and low income
- Heating types: furnace & other fossil space heat, boiler

 # Eligible Units = # New Constr$_t$ + # Turnover$_t$ + # Early Repl$_t$

Where:

Furnace & Other: # Turnover$_t$ = (# Total Res Cust$_t$ – # New Constr$_t$) / 20

Boiler: # Turnover$_t$ = (# Total Res Cust$_t$ – # New Constr$_t$) / 25

And:

Early Repl$_t$ = (Total Res Cust$_t$ – New Constr$_t$ - # Turnover$_t$) * 1.5%**

* TEAPot is Nicor Gas' **T**echnical, **E**conomic and **A**chievable **Pot**ential analysis
** 1.5% is an educated guesstimate

1) Early years 2024 - 2034: draws on general approach and primary data collected for a similar technology (GHPWH research)

$$Adoption\ Rate = Consideration\ Rate * Conversion\ Rate$$

Where:
$$Consideration\ Rate^2 = GHPWH\ \%\ Installers\ Familiar * \%\ GHPWH\ Installers\ Recommending\ [of\ those\ who\ are\ familiar]$$

And:
$$Conversion\ rate\ is\ based\ on\ Diffusion\ of\ Innovation\ Curve\ (innovators,\ early\ adopters,\ etc.)$$

2) Later years 2035 - 2038: uses theoretical modified S-Curve

$$Market\ Penetration = \frac{Maximum\ Market\ Share}{1 + Factor \wedge \left(\frac{Start\ of\ Hypergrowth + \left(\frac{Ramp\ Period}{2} \right) - Current\ Year}{Ramp\ Period} \right)}$$

This curve estimates Res HVAC GHP sales (as a % of total heating equipment sales) in each year; does not estimate the cumulative installed Res HVAC GHP stock

Early Years 2024-2034: Use Approach and Primary Data from Gas Heat Pump Water Heater Technology

Gas Heat Pump Water Heater (GHPWH) and Res HVAC GHP systems function similarly
- GHPWHs utilize gas heat pump technology for domestic hot water heating
- Res HVAC GHPs utilize gas heat pump technology for space conditioning and domestic hot water heating

Both systems face similar market barriers
- Very limited number of manufacturers
- New/unknown technology by supply chain and consumers
- Substantially higher first cost of GHP options over baseline technologies
- Consumer reliance on supplier recommendations

Early research only focused on GHPWH
- Due to similarities, GHPWH primary data research used as a proxy

$$\textit{Adoption Rate} = \textit{Consideration Rate} * \textit{Conversion Rate}$$

Where:

$$\textit{Consideration Rate}^2 = \textit{GHPWH \% Installers Familiar} * \textit{\% GHPWH Installers Recommending [of those who are familiar]}$$

And:

$$\textit{Conversion rate is based on Diffusion of Innovation Curve (innovators, early adopters, etc.)}$$

- **Conversion Rate** based on Diffusion of Innovation Adopter Categories
- Analysis assumes:
  - 50% of "eligible" **Innovators** (1.25%) adopt Res HVAC GHPs the year they become commercially available (2027); 100% of "eligible" **Innovators** (2.5%) adopt the next year (2028)
  - 100% of **Early Adopters** adopt 8 years after all Innovators have adopted (16% in 2035)
  - Adoption between 2028 and 2035 grows linearly
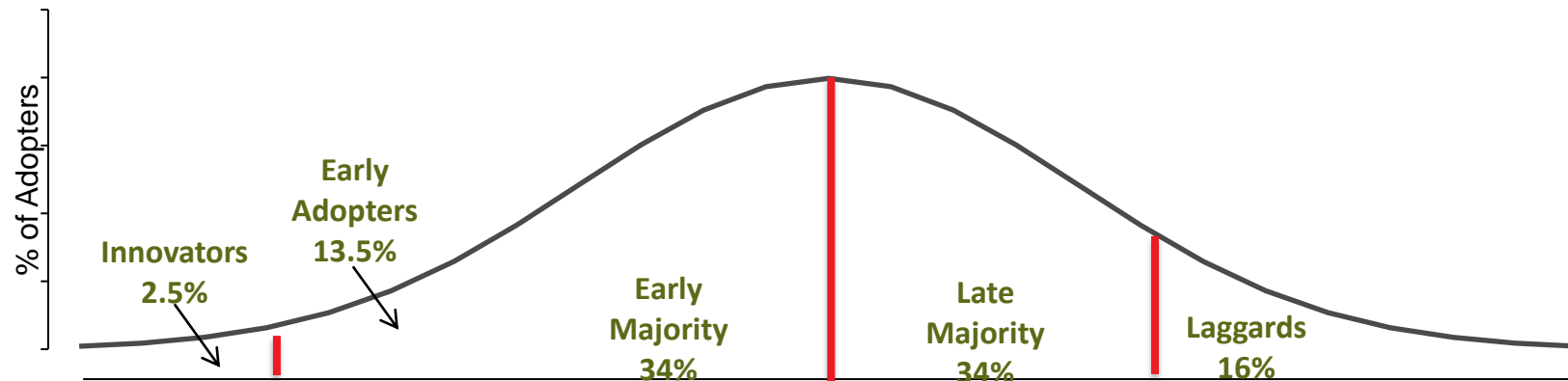
Later Years Uses Modified S-Curve*

Variable (equation inputs in blue)	**Value**
Curve Shape	S-Curve
Year product becomes commercially available *in the absence of utility intervention*	2027
Forecast start year	2019 (graphs show 2024+)
Initial Market Share	0.0%
Start of Hypergrowth	2035
Ramp Period	30 years
Takeover Point	2065
Maximum Market Share	8%
Factor	81

$$Market\ Penetration = \frac{Maximum\ Market\ Share}{1 + Factor^{\wedge}\left(\frac{Start\ of\ Hypergrowth + \left(\frac{Ramp\ Period}{2}\right) - Current\ Year}{Ramp\ Period}\right)}$$

* Estimates Res HVAC GHP sales (as a % of total heating equipment sales) in each year; does *not* estimate the cumulative installed Res HVAC GHP stock

Methodology

The modified s-curve has 4 main inputs to consider:

1. **Maximum Market Share:** the maximum level of market saturation.

2. **Start of Hypergrowth:** The point at which a product's market share begins to rapidly accelerate.

3. **Ramp Period:** The period between the start of hypergrowth and takeover point.

4. **Factor:** A factor based on the estimated upper and lower limits of the ramp period.

   Factor is a result of defining the upper and lower limits of the ramp period in the s-curve. The equation is as follows, where the upper and lower limits are the percent of total market penetration.

   $$Factor = \frac{Upper\ Limit^2}{Lower\ Limit^2}$$

   For example, a common factor used in s-curve modeling is 81: $\mathbf{81} = \frac{90^2}{10^2}$

Next Steps for HPW?

1. **SAG Feedback on NMB**
   - A two-week feedback period for comments; Send to:
     - Celia Johnson (celia@celiajohnsonconsulting.com)
     - Randy Opdyke (RWOPDYKE@SOUTHERNCO.COM)

Questions?

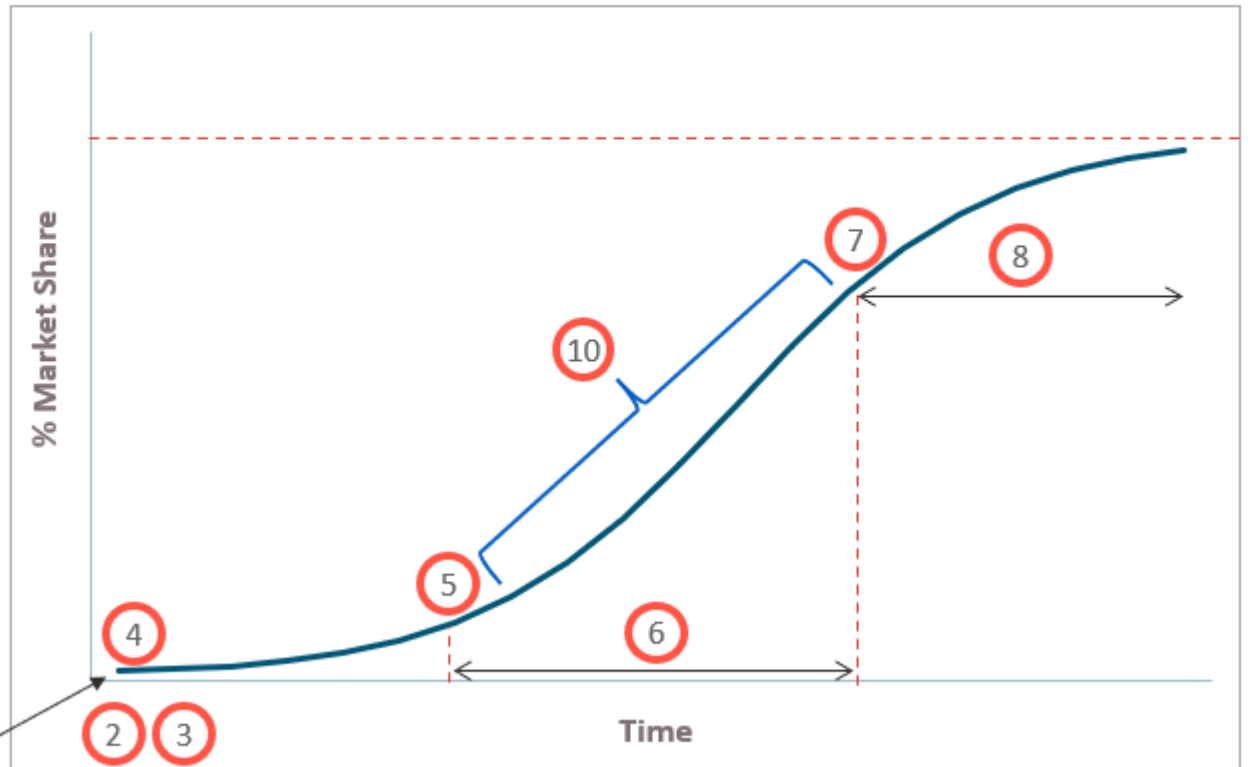Nicor Gas | Energy Efficiency Program

Appendix

Sources

Four publications informed the GHP NMB analysis

Document	Author	Date
North American Residential Combi, Space Heating, and Water Heating Market Characterization Final Report	Russel Research	October 2021
DOE Finalizes Energy Efficiency Standards for Residential Furnaces	U.S. Department of Energy	September 2023
Technical Analysis of DOE Notice of Proposed Rulemaking on Residential Furnace Residential Furnace Minimum Efficiencies	GTI Energy	July 2015
Variable Speed Heat Pump Baseline and Key Assumptions Review	Northwest Energy Efficiency Alliance	June 2023

Res HVAC GHP NMB S-Curve Components

① Adoption Curve Shape

② Year Product Enters Market

③ Forecast Start Year

④ Initial Market Share

⑤ Start of Hypergrowth*

⑥ Ramp Period*

⑦ Takeover Point

⑧ Maximum Market Share*

⑨ Factor—*shape* between 5 and 7*

* Key input variable in NMB equation

Theoretical Natural Market Baseline

% Market Share

Time

Modified S-Curve

$$Market\ Penetration(t)$$
$$= \frac{Maximum\ Market\ Share}{1 + Factor^{\wedge}\left(\frac{Start\ of\ Hypergrowth + \left(\frac{Ramp\ Period}{2}\right) - Current\ Year(t)}{Ramp\ Period}\right)}$$