Efficient Rooftop Units:
Natural Market Baseline

SAG Market Transformation Working Group
August 29, 2024

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Nicor Gas | Energy Efficiency Program

Agenda

- Technology Overview
- Development Process
- Natural Market Baseline
- Sources

Efficient Rooftop Units: Technology Overview

What are *Efficient* Rooftop Units?

- Improvement over the historically inefficient RTU product
- Improvements affect whole-box efficiency
- Two tiers of equipment with both a prescriptive and performance path to compliance.
    - Tier 1 includes box upgrades (box insulation and low leak dampers)
    - Tier 2 includes Tier 1 upgrades and an Energy Recovery Ventilator or Condensing Furnace.

Other organizations developing ERTU initiatives:

- Northwest Energy Efficiency Alliance (NEEA)
- CEE (MN)
- CalMTA
- Department of Energy

https://betterbricks.com/solutions/efficient-rooftop-units

ERU Tiers and Components

Tier 1: Prescriptive Path

- All panels (door liners, top panels, divider panels, and mullions) adjacent to conditioned air, including the base, shall be fully insulated with a minimum of R-12
- Leakage rate of outdoor and return air mixing dampers shall be no greater than the rate described in ASHRAE/IESNA 90.1-2019 Table 6.4.3.4.3

Tier 1: Performance Path

- ≥ 0.65, as measured by CSA P.8 – Edition 3.0

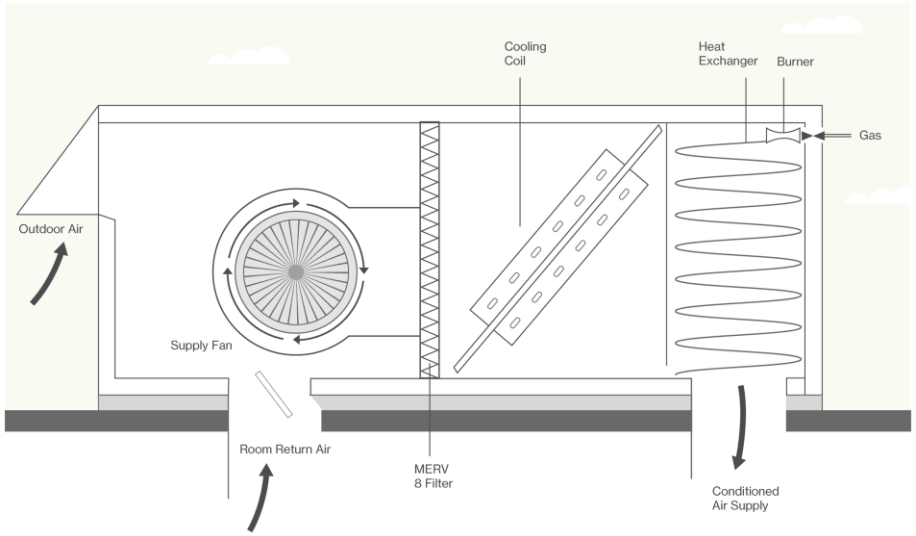
Tier 2: Prescriptive Path -- must meet all Tier 1 requirements, and:

- 2A: The unit includes heat or energy recovery with a heat/energy recovery ventilator
- 2B: A furnace with a condensing heat exchanger (90+% TE)

Tier 2: Performance Path

- ≥ 0.80, as measured by CSA P.8 – Edition 3.0

Standard RTU



https://betterbricks.com/solutions/efficient-rooftop-units

Efficient Rooftop Units NMB: Development Process

Natural Market Baseline Purpose

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

Nicor Gas has developed, and its evaluator has reviewed:

- ✓ Methodology
- ✓ Data Sources
- ✓ Assumptions

The NMB will be reviewed and potentially revised according to the schedule in the Theory Based Evaluation plan.

Development Process

GTI ENERGY
solutions that transform

Provided insight into the existing ERTU market in Nicor Gas's service area, conducted by GTI

2022 - 2024

neea

Informed Nicor Gas' NMB

Q3 2022

cee
Center for Energy and Environment

MN CEE's NMB informed the Nicor Gas' NMB

Spring 2024

Guidehouse

Covered review of methodology, data sources, and final NMB curve

Q3 2024

Guidehouse Natural Market Baseline Review

Data Sources Review

Guidehouse evaluated the data sources provided by RI for the efficient rooftop units (eRTU) Natural Market Baseline (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 the eRTU NMB variables. This included analyzing given sources and researching market trends.

Guidehouse found that all variables chosen are well defined and appropriate.

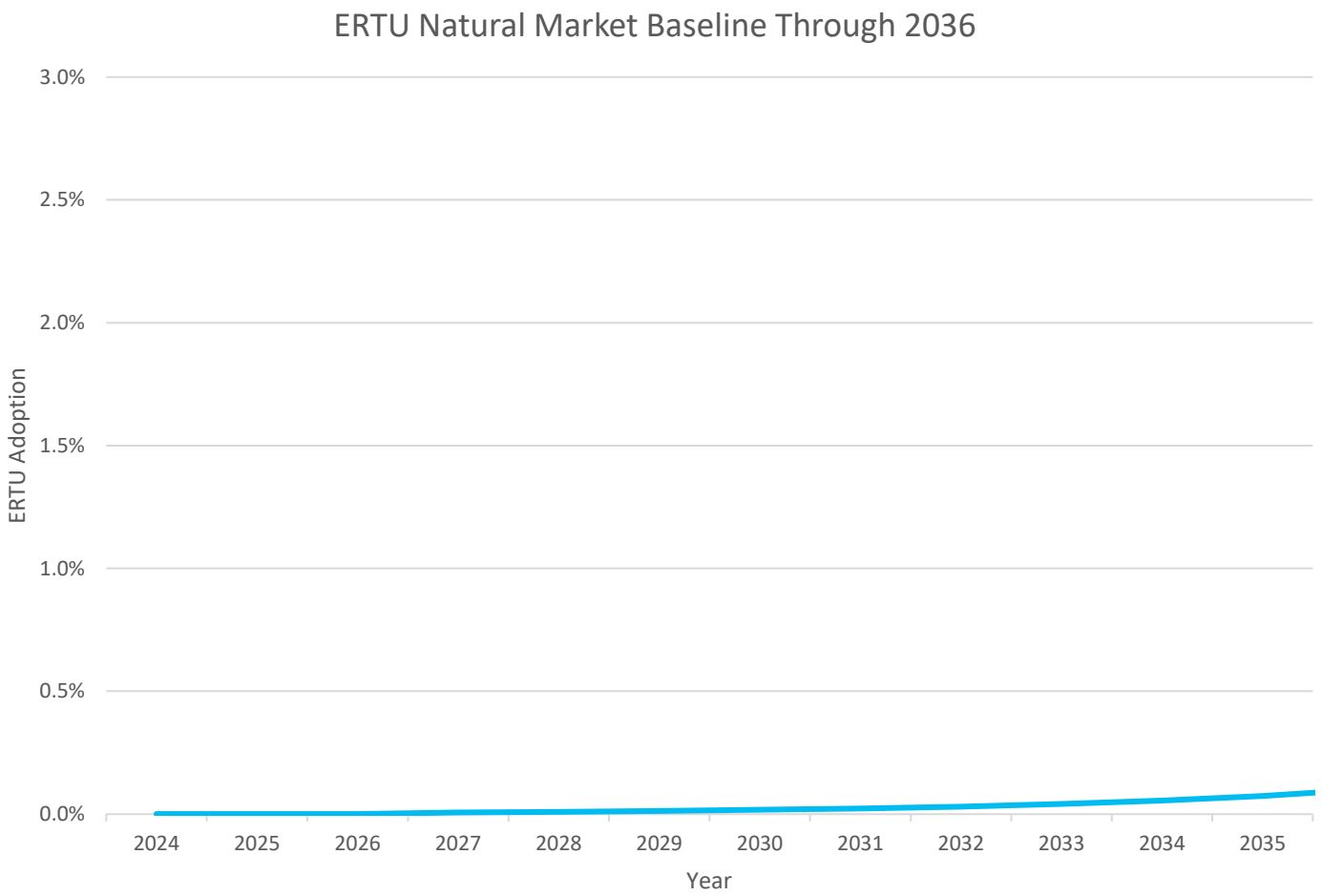
Review Follow-Up

Guidehouse generally agrees with the natural market baseline metrics and recommends revisiting the baseline if historical data on Tier 1 and Tier 2 adoptions within the region become available.

Guidehouse generally agrees with the forecast start year but recommends that this be reviewed during the first NMB review.

Guidehouse generally agrees with the maximum market share but expects this variable to be reviewed during subsequent NMB reviews.

Natural Market Baseline



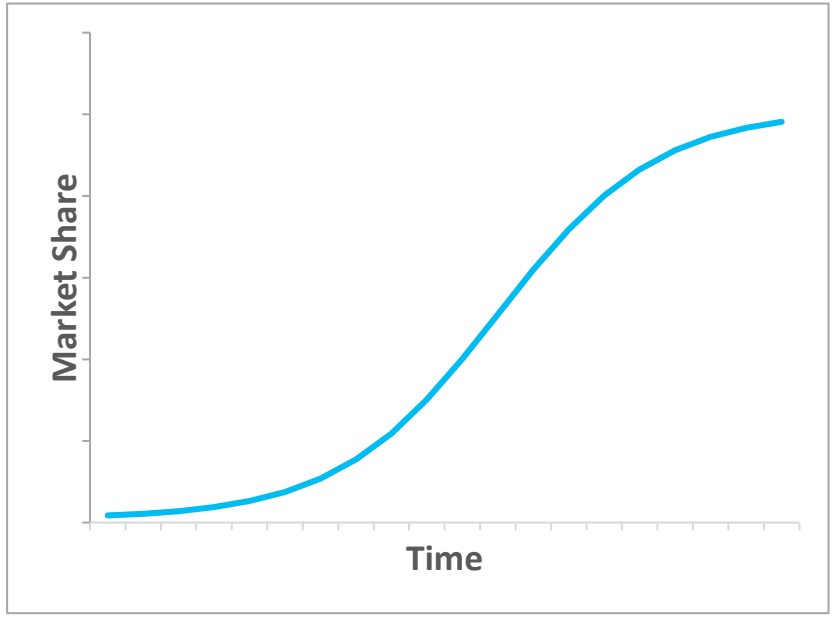
Year	ERTU Adoption Rate	ERTUs Adopted
2024	0.00%	0
2025	0.00%	0
2026	0.00%	0
2027	0.01%	0
2028	0.01%	1
2029	0.01%	1
2030	0.02%	1
2031	0.02%	1
2032	0.03%	2
2033	0.04%	3
2034	0.06%	3
2035	0.07%	5
2036	0.10%	6

Theoretical Model

- ERTU NMB adoption curve developed using a modified S-curve, defined by:

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

- Very little ERTU and ERTU-proxy data is available, NMB relies on theoretical modified S-curve.



Model Inputs

- The model start year was when Nicor Gas started intervening in the market.
- The initial market share was estimated from the market research.
- The start of hypergrowth, the ramp period, and the maximum market share had several contributing factors.
- The factor was chosen because of its slower initial adoption rate but stronger adoption during hypergrowth.

Variable	ERTU NMB Value
Model start year	2022
Initial market share	0.00%
Start of hypergrowth	2040
Ramp period	20 years
Maximum market share	20%
Factor	361

Sources

1. CEE (MN). *High-Performance RTU Energy Savings and Market Evaluation Plan.* May 2024. Link
2. GTI. *Characterization of Existing and New/Replacement RTUs on Buildings.* (Available upon request).
3. IL SAG. *Illinois Technical Reference Manual, Version 12.0.* September 2023. Link
4. MEEA. *Illinois Benchmarking Policies.* September 2023. Link
5. NEEA. *Review of Market Share Forecast and Key Assumptions for Efficient Rooftop Units.* August 2022. Link
6. NREL. *Long and Winding Road to Higher Efficiency—The RTU Story.* 2021. Link
7. St. Louis MO Gov. *Building Energy Performance Standards. 2024* Link
8. US DOE. *Commercial Building Heat Pump Accelerator. 2024* Link
9. WSDC (Washington State Department of Commerce). *Clean Buildings Performance Standard. 2024* Link

Comparison NMBs

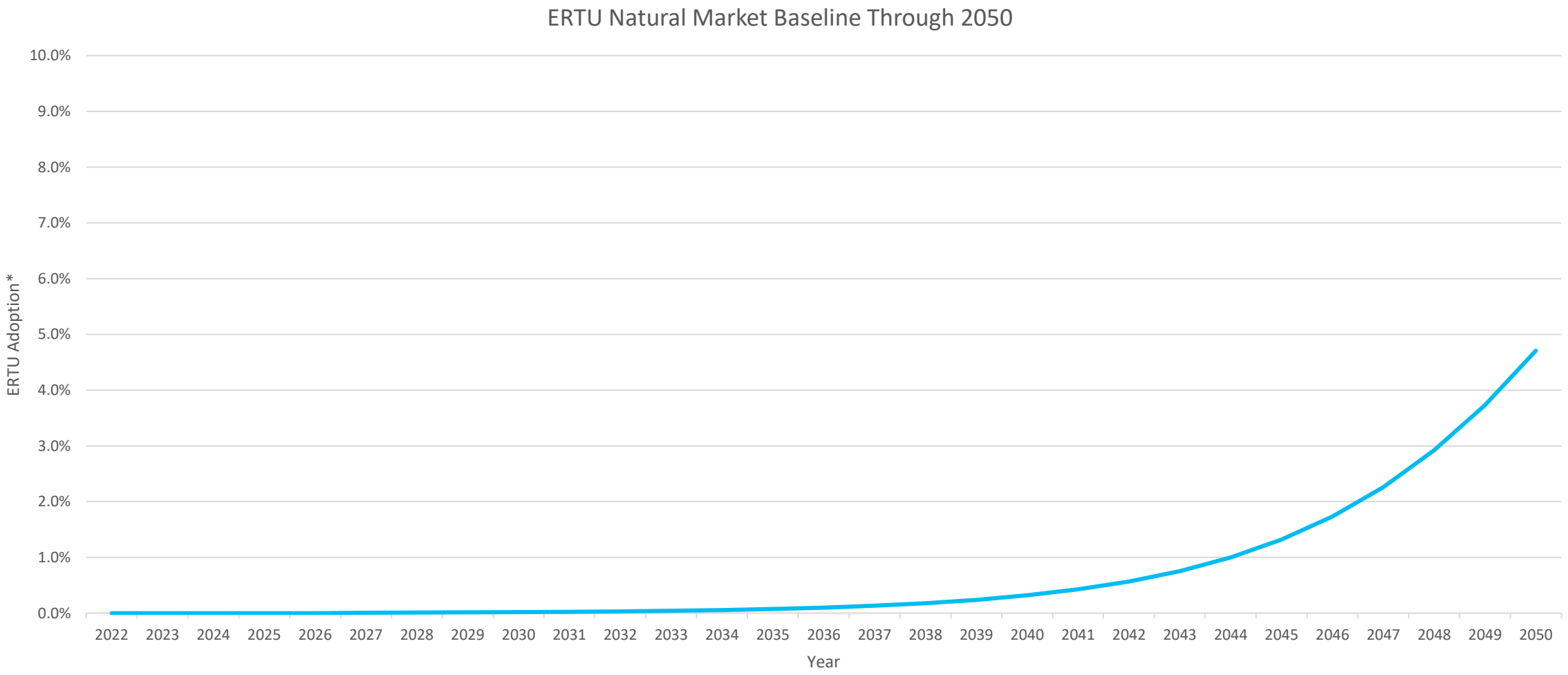
Variable	Nicor Gas	NEEA	CEE (MN)
Focus	Box, ERV	Box, ERV	Heat pumps, ERV
Initial Market Share	0%	0.3% (Condensing)	1.5% ERVs, 0.2% of Dual Fuel HP RTUs
Max Market Share	20%	20%	
Start of Hypergrowth	2040	2036	2044+ for ERVs and Dual Fuel HP RTUs
Takeover Period	20 years	15 years	

Next Steps for ERTU

1. SAG Feedback on Natural Market Baseline
   - Two week feedback period for comments
   - Celia Johnson (celia@celiajohnsonconsulting.com)
   - Randy Opdyke (rwopdyke@southernco.com)
   - Rocco Guaragno (aguaragno@resource-innovations.com)

Efficient Rooftop Units: Appendix

Natural Market Baseline to 2050



Natural Market Baseline Units

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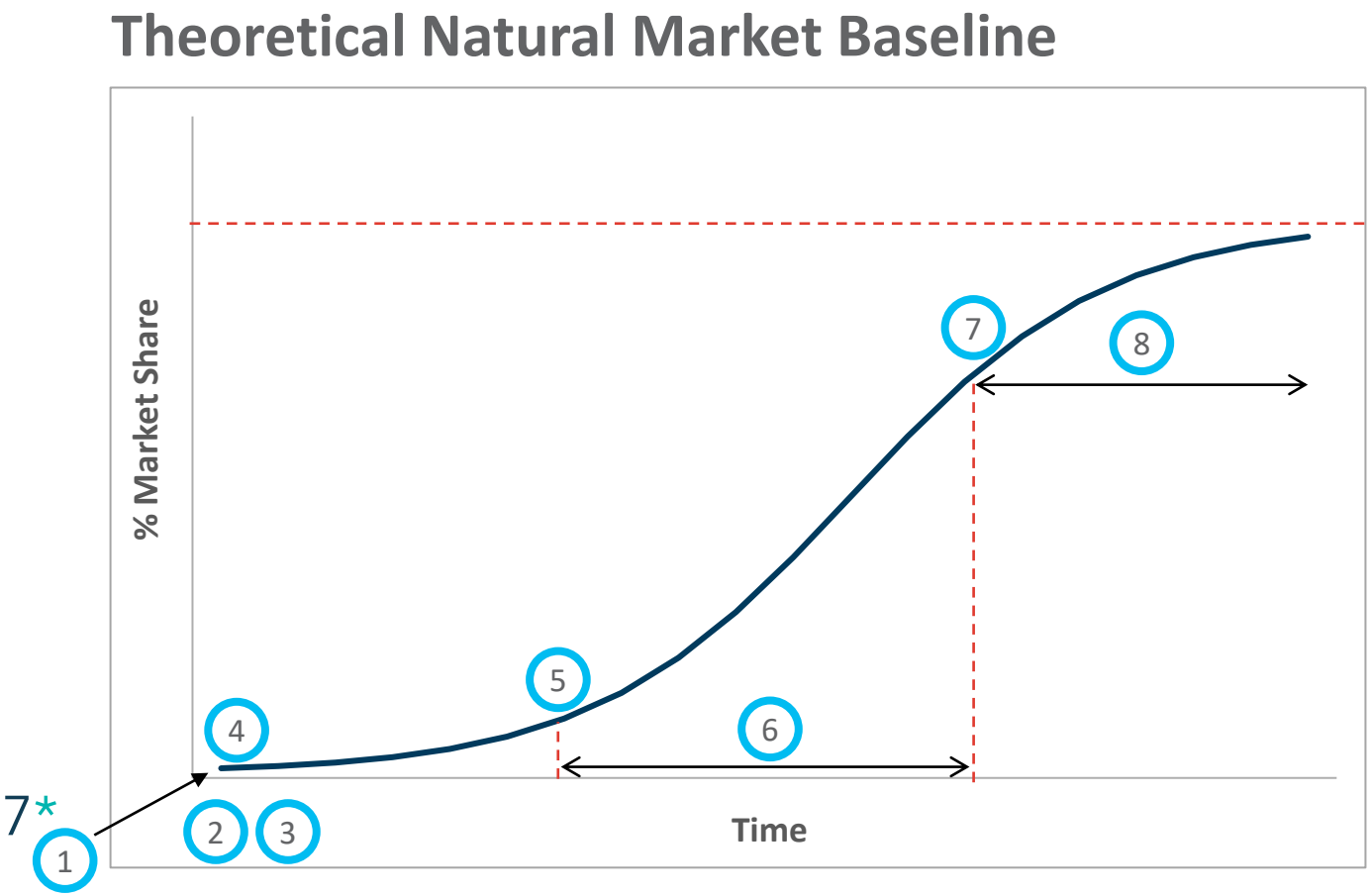
2028	0.01%	1
2029	0.01%	1
2030	0.02%	1
2031	0.02%	1

Year	ERTU Adoption Rate	ERTUs Adopted
2032	0.03%	2
2033	0.04%	3
2034	0.06%	3
2035	0.07%	5
2036	0.10%	6
2037	0.13%	8
2038	0.18%	11

Diffusion Theory: NMB 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*



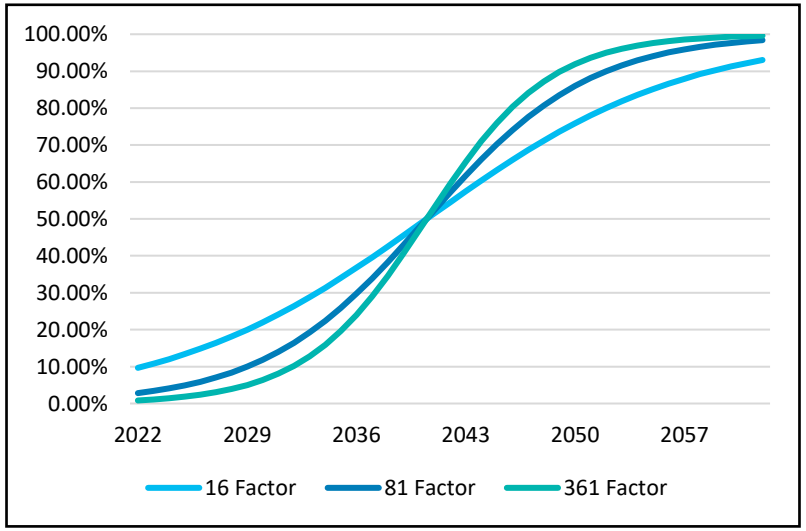
Factor

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.

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

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

This indicates that the hypergrowth phase starts at 10% of *maximum market penetration* and ends at 90%. The factor affects the angle of the slope, with a lower factor having a lesser slope. See examples below:



Efficient Rooftop Units: Sources

Sources

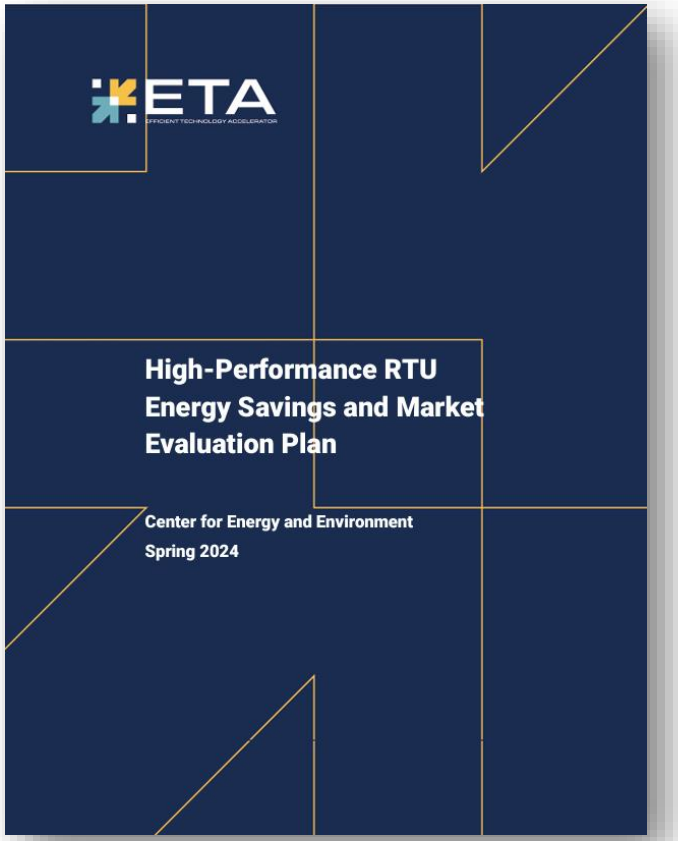
1. CEE (MN). *High-Performance RTU Energy Savings and Market Evaluation Plan.* May 2024. Link
2. GTI. *Characterization of Existing and New/Replacement RTUs on Buildings.* (Available upon request).
3. IL SAG. *Illinois Technical Reference Manual, Version 12.0.* September 2023. Link
4. MEEA. *Illinois Benchmarking Policies.* September 2023. Link
5. NEEA. *Review of Market Share Forecast and Key Assumptions for Efficient Rooftop Units.* August 2022. Link
6. NREL. *Long and Winding Road to Higher Efficiency—The RTU Story.* 2021. Link
7. St. Louis MO Gov. *Building Energy Performance Standards. 2024* Link
8. US DOE. *Commercial Building Heat Pump Accelerator. 2024* Link
9. WSDC (Washington State Department of Commerce). *Clean Buildings Performance Standard. 2024* Link

High-Performance RTU Energy Savings and Market Evaluation Plan

Source: Minnesota CEE released their Market Transformation plan for High-Performance RTUs

NMB Input: The source was used as a comparison to the Nicor Gas NMB.

Date: Spring 2024

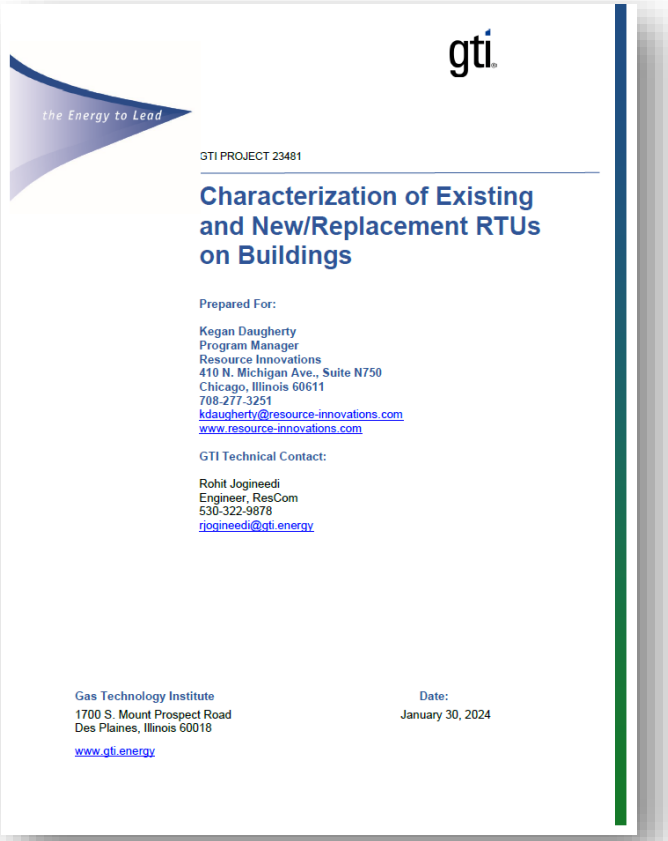


Characterization of Existing and New/Replacement RTUs on Buildings

Source: GTI market research characterization of the existing and new/replacement rooftop units.

NMB Input: The source gave insight into the current state of Nicor Gas's service territory and efficient equipment. The market research helped inform the initial market share.

Date: January 2024


gti

the Energy to Lead

GTI PROJECT 23481

Characterization of Existing and New/Replacement RTUs on Buildings

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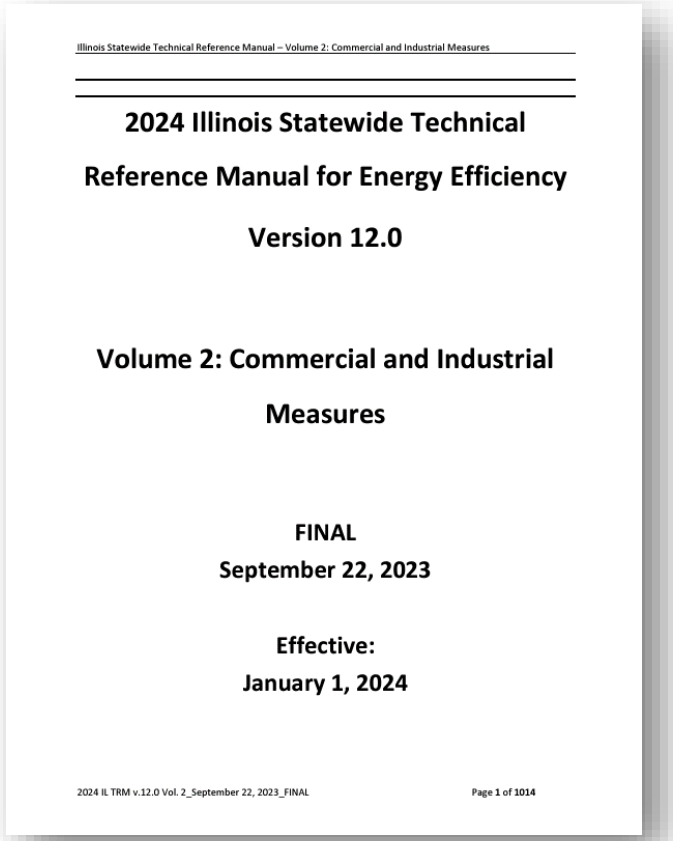
Date:
January 30, 2024

Illinois Technical Reference Manual

Source: Illinois Technical Reference Manual

NMB Input: The source was used to inform the measure life of rooftop units which contributed to the ramp period and the start of hypergrowth variables.

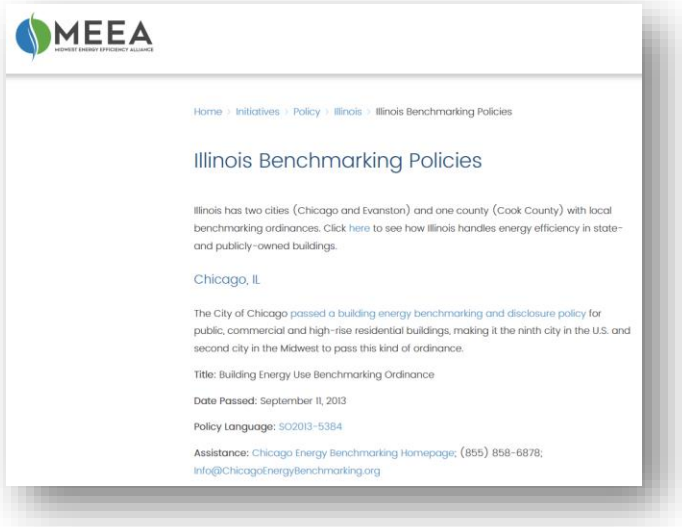
Date: January 2024



Illinois Benchmarking Policies

Source: MEEA article on Illinois benchmarking policies.

NMB Input: The source was used to inform the hypergrowth and ramp period variables.



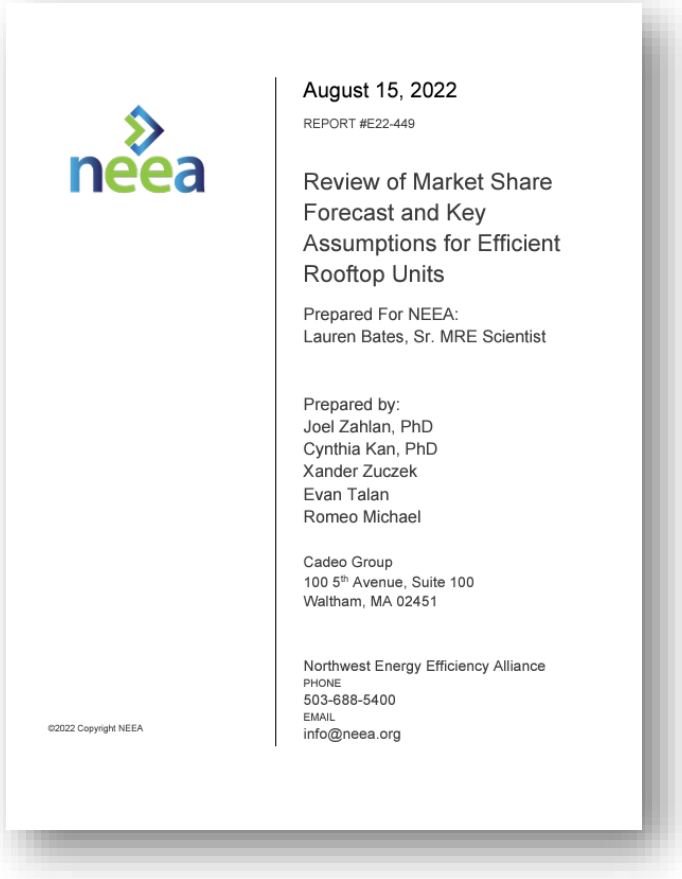
Date: September 2023

Review of Market Share Forecast and Key Assumptions for Efficient Rooftop Units

Source: Report by Cadmus Group for NEEA evaluating their NMB.

NMB Input: The source was used as a comparison to the Nicor Gas NMB.

Date: August 2022



August 15, 2022

REPORT #E22-449

Review of Market Share Forecast and Key Assumptions for Efficient Rooftop Units

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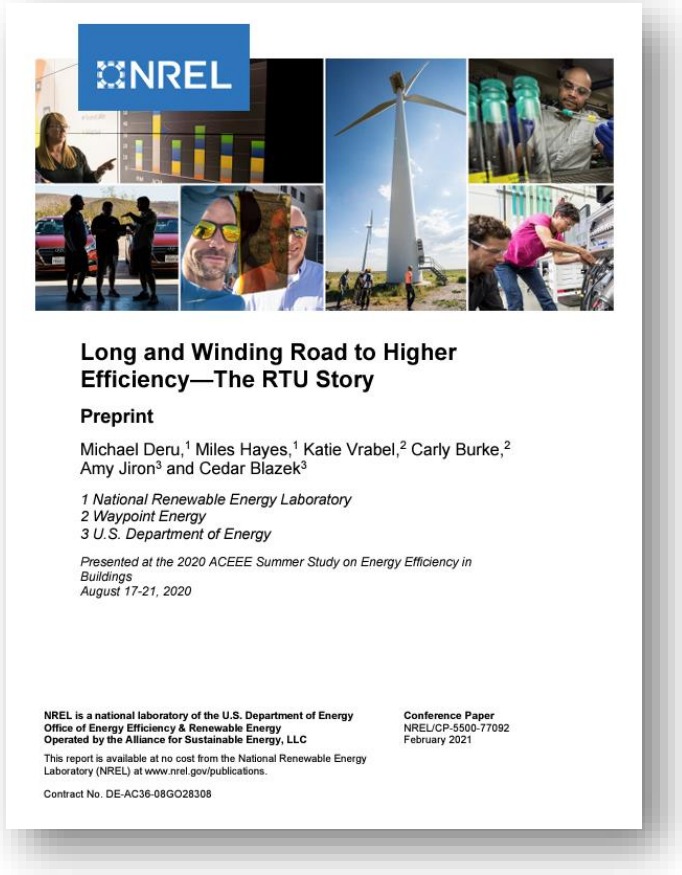
Long and Winding Road to Higher Efficiency

Source: NREL report on the barriers to improving RTU efficiency.

NMB Input: The source was used to inform the hypergrowth and ramp period variables.

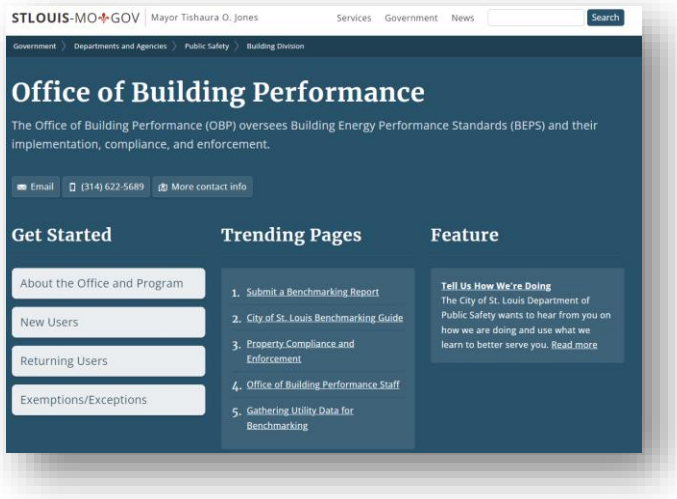
Date: August 2021



Building Energy Performance Standards

Source: St Louis Missouri government benchmarking site.

NMB Input: The source was used to inform the hypergrowth and ramp period variables.



Date: May 2024

Building Energy Performance Standards

Source: Department of Energy heat pump accelerator.

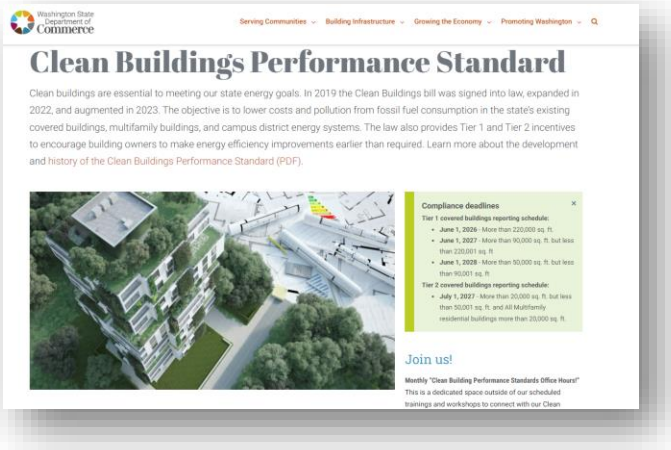
NMB Input: The source informed the start of hypergrowth, ramp period, and maximum market share.

Date: May 2024

Building Energy Performance Standards

Source: Washington State government benchmarking site.

NMB Input: The source informed the start of hypergrowth and ramp period.



Date: May 2024

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