



# Gas Company Climate Planning Tool: User Guide

Version 2.0 (June 2022)

ERM

# Overview & Contacts

**On behalf of Environmental Defense Fund (EDF) and through its development of a framework to quantify life cycle emissions of delivered natural gas, MJB&A developed the "Gas Company Climate Planning Tool," a complementary Excel-based resource.**

**This tool can provide analytical support to natural gas utilities and other stakeholders by evaluating:**

- Company-specific life cycle GHG emissions associated with delivered gas;
- GHG emissions and delivered energy demand across business-as-usual (BAU) and user-defined scenarios; and
- Impacts and changes in emissions, social cost of carbon savings, and gas demand resulting from gas company upgrades and application of supply- and demand-side strategies

**This tool does not perform an economic analysis and does not account for any economic or financial characteristics that may influence assumptions, gas demand, or the application of strategies.**

**This tool can be downloaded on our website at: https://www.sustainability.com/thinking/gas-company-climate-planning-tool/.**

**For questions and comments, please contact:**


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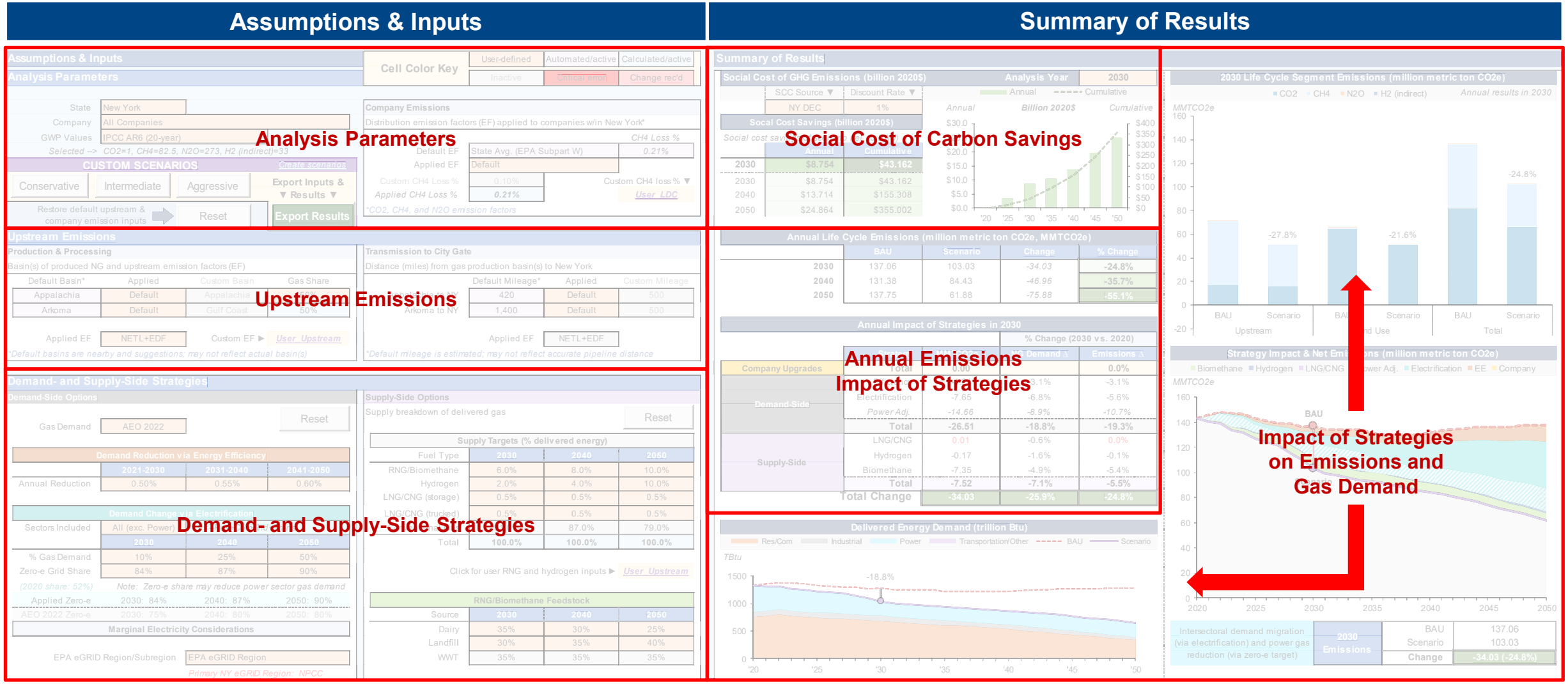
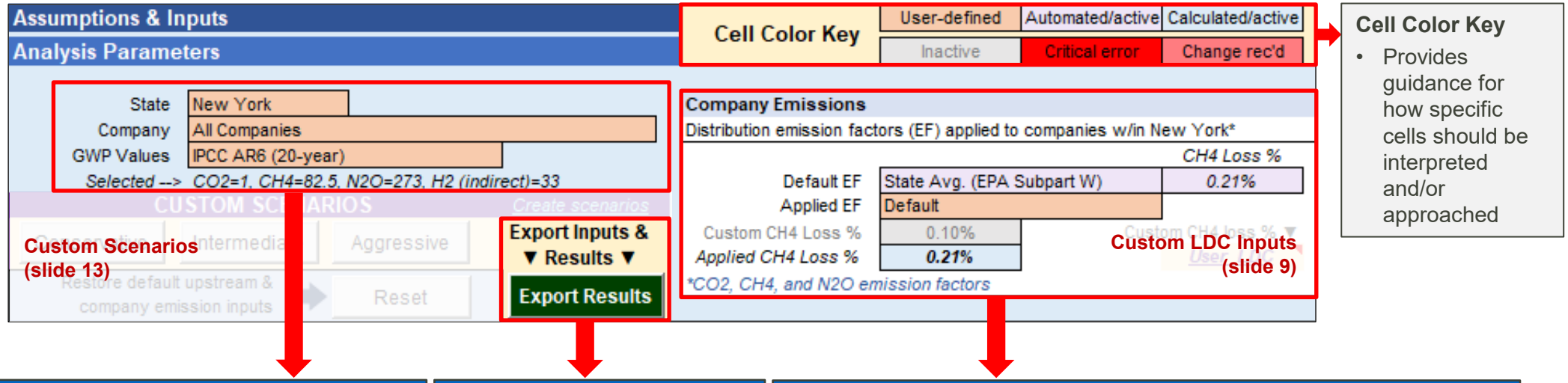
# Tool Dashboard



# Assumptions & Inputs: Analysis Parameters




**Cell Color Key**

- Provides guidance for how specific cells should be interpreted and/or approached

## Foundational Assumptions

**State**

- Select state in which company is located

**Company**

- Specify company within selected state
- Selection defines default sectoral gas delivery and emission data

**GWP Values**

- Select GWP values applied to $CH_4$, $N_2O$, and $H_2$* emissions (default is IPCC AR6 20-year)

## Data Export

- Exports data to user's computer desktop
- Includes all active assumptions and emission/energy results tables located in "Emissions_Tables" and "Energy_Tables" tabs

## Company/LDC Emissions

**Default EF**

- Recommended emission factor applied to selected company ($CO_2$, $CH_4$, and $N_2O$)

**Applied EF**

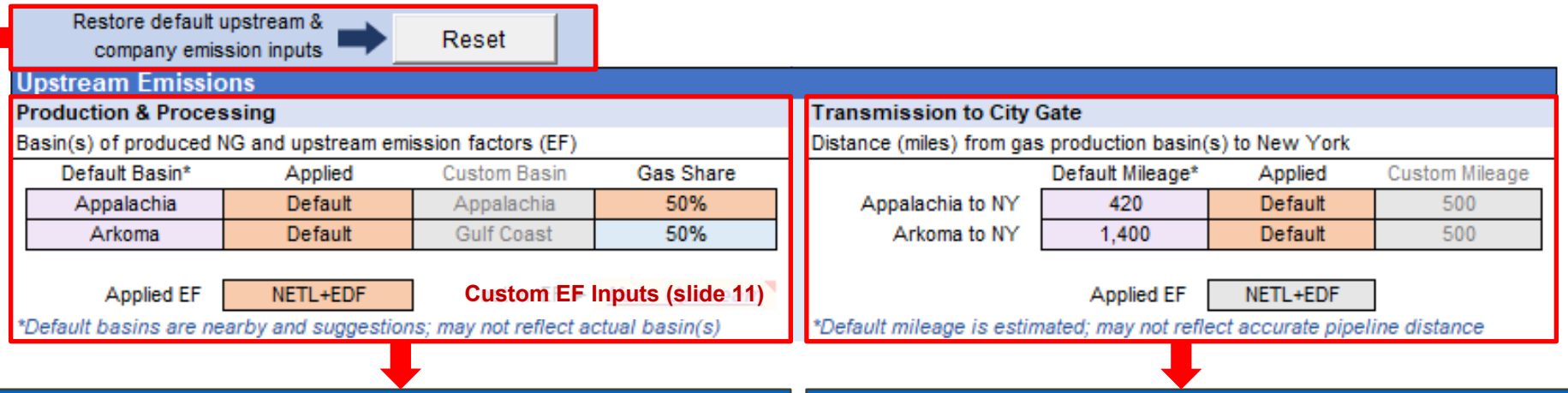
- Select default or alternative emission factor applied to selected company

**Custom $CH_4$ Loss % (if applicable)**

- If "Custom" emission factor selected, define methane loss rate (default $CO_2$ and $N_2O$ factors applied)

# Assumptions & Inputs: Upstream Emissions

**Upstream Reset**
- Resets all upstream emission inputs to default assumptions




## Production & Processing

**Default Basin**
- Nearby/suggested natural gas production basin(s)

**Applied**
- Specify whether gas originates from suggested basin(s) or user-specified, “Custom” basin(s)

**Custom Basin (if applicable)**
- If “Custom” basin selected, define production basin

**Gas Share**
- Define share of gas originating from active basin(s)

**Applied Emission Factor**
- Select source of gas production & processing emission factors (NETL factors or NETL factors adjusted using EDF methane studies)

## Transmission to City Gate

**Default Mileage**
- Estimated pipeline mileage from gas production basin(s) to selected company

**Applied**
- Specify whether pipeline mileage is calculated (“Default”) or user-specified (“Custom”)

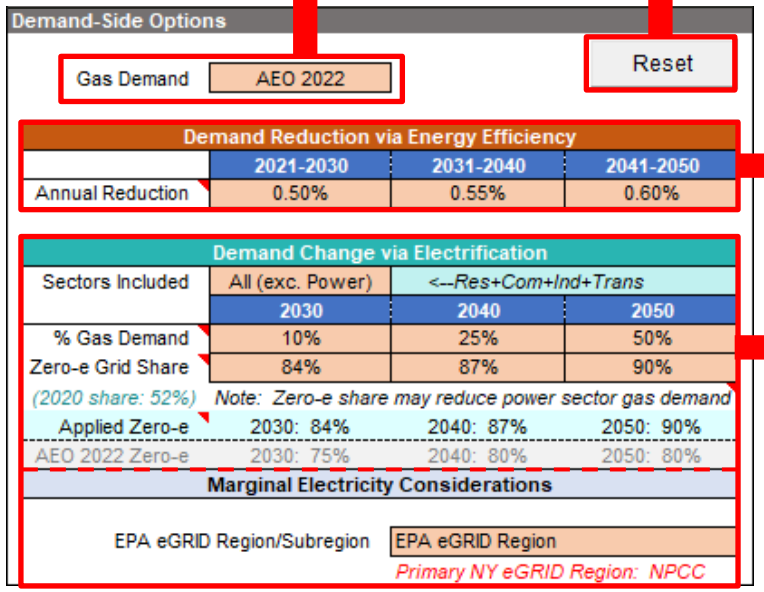
**Custom Mileage**
- If “Custom” mileage selected, define distance (in miles) from specified production basin(s) to company

**Applied Emission Factor**
- Same as production & processing (for consistency)

# Assumptions & Inputs: Demand-Side Strategies

**Gas Demand**
- Specify basis for gas demand forecasts (see slide 9 for "Custom Demand")

**Reset**
- Reset energy efficiency and electrification inputs to zero




**Notes on Electrification**
- Power sector gas demand declines proportionally to zero-emitting generation growth
- Marginal rate declines only if defined zero-e generation exceeds current zero-e grid share w/in selected region (state/NERC region)
- Electrification results in intersectoral energy demand migration and may lead to increased power sector gas demand (see slide 12)

## Demand Reduction via Energy Efficiency

### Annual Reduction
- Define year-over-year reduction in energy demand, by decade

## Demand Change via Electrification

### Sectors Included
- Define sectors to which electrification can be applied
  - Residential/commercial sectors only OR all end use sectors (excluding power sector)

### % Gas Demand
- Reduction of gas demand in defined sectors via electrification

### Zero-Emitting (Zero-e) Grid Share
- Zero-emitting electricity generation targets in selected states (linear growth to meet targets assumed in intermediate years; does not decline)

### Marginal Electricity Considerations: EPA eGRID Region/Subregion
- Select EPA eGRID region/subregion to determine marginal electricity grid emission rate applied to electricity generation required to meet demand via electrification

# Assumptions & Inputs: Supply-Side Strategies

**Reset**
- Reset energy efficiency and electrification inputs to zero

**Supply-Side Options**

Supply breakdown of delivered gas

Reset

| Supply Targets (% delivered energy) | | | |
|---|---|---|---|
| Fuel Type | 2030 | 2040 | 2050 |
| RNG/Biomethane | 6.0% | 8.0% | 10.0% |
| Hydrogen | 2.0% | 4.0% | 10.0% |
| LNG/CNG (storage) | 0.5% | 0.5% | 0.5% |
| LNG/CNG (trucked) | 0.5% | 0.5% | 0.5% |
| Conventional Gas | 91.0% | 87.0% | 79.0% |
| Total | **100.0%** | **100.0%** | **100.0%** |

Click for us… **Custom User Upstream Inputs (slide 12)**

| RNG/Biomethane Feedstock | | | |
|---|---|---|---|
| Source | 2030 | 2040 | 2050 |
| Dairy | 35% | 30% | 25% |
| Landfill | 30% | 35% | 40% |
| WWT | 35% | 35% | 35% |

## Supply Targets (% delivered energy)

### Fuel Types
- Define fuel type share of delivered gas
  - See “Biomethane Feedstock” assumptions below
  - Linear change to meet defined shares assumed in intermediate years

## Biomethane Feedstock

### Biomethane Sources
- Define feedstock share
  - Linear change to meet defined shares assumed in intermediate years

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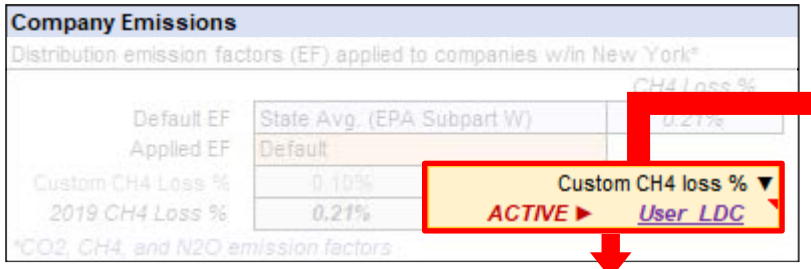
# Custom LDC Inputs: Methane Loss Rate

## Tool Dashboard




## User-Defined Company $CH_4$ Loss Rate

**2020 $CH_4$ Loss**

- Applied methane loss rate in 2020

**Applied $CH_4$ Loss %**

- Specify how $CH_4$ loss rate changes in future (no change or "Custom" change)

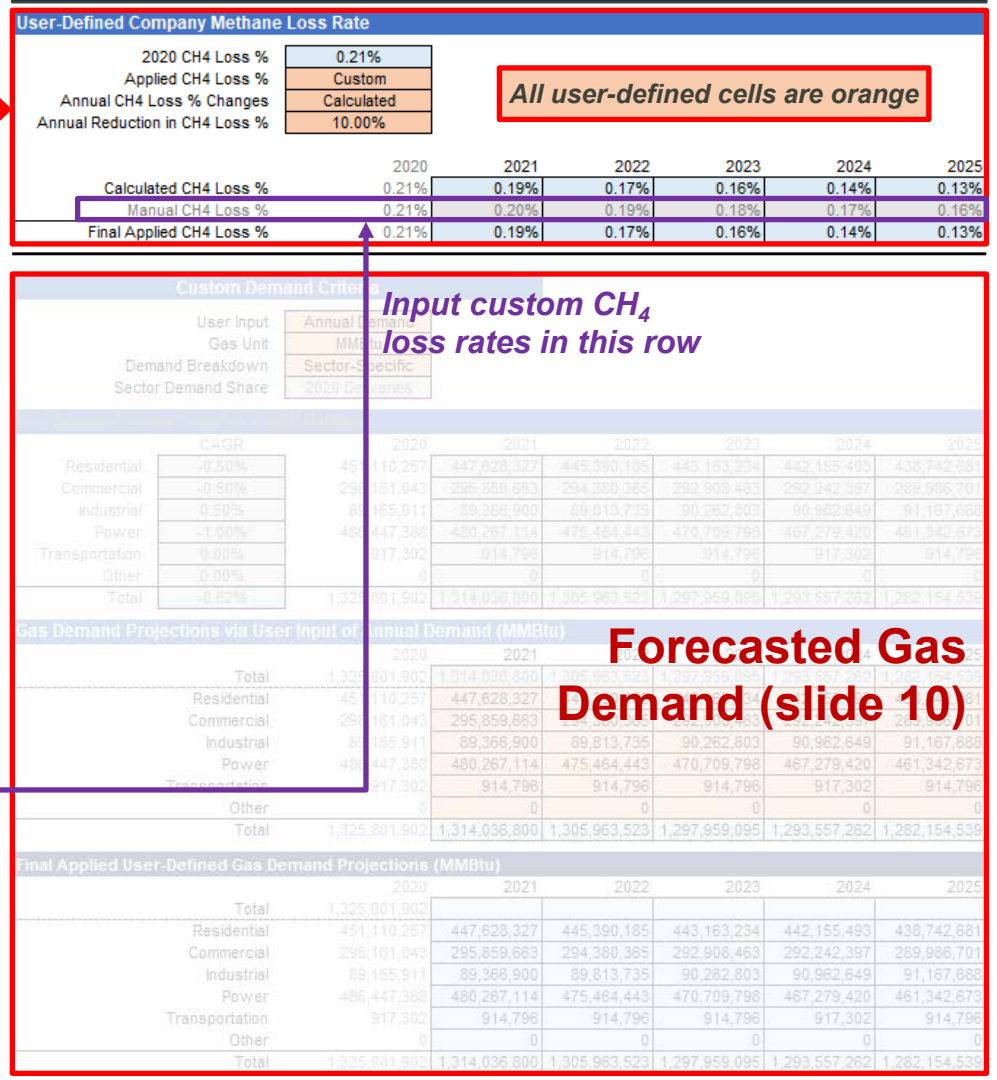
**Annual $CH_4$ Loss % Changes (if applicable)**

- If "Custom" Applied $CH_4$ Loss % selected, specify method for future year loss rates
- If "Manual" selected, specify annual $CH_4$ loss % in "Manual $CH_4$ Loss %" cells (row 16)
- If "Calculated" selected, see below

**Annual Reduction in $CH_4$ Loss % (if applicable)**

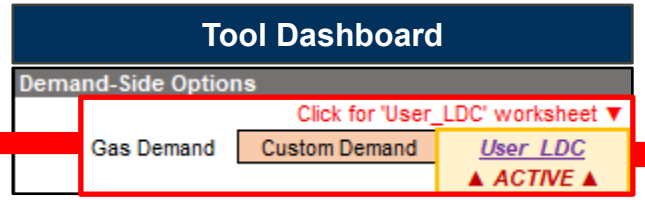
- Specify annual reduction in $CH_4$ loss %

## User-Defined Company Input Worksheet*




*Custom inputs extend through 2050; above sheet (final year 2025) for visualization purposes only

# Custom LDC Inputs: Forecasted Gas Demand




## Custom Demand

### User Input

- Specify how gas demand forecasts are calculated
  - "CAGR" applies annual growth rate to each sector
  - "Annual Demand" requires manual entry of forecasts

*Input CAGR values here*

*Input custom demand here*

### Gas Unit

- Define unit in which forecasts are calculated (mcf or MMBtu)

### Demand Breakdown (if applicable)

- If "Annual Demand" is selected as User Input, specify if manual entry will be total company demand ("Total") or broken down by sector ("Sector-Specific")

### Sector Demand Share

- If "Total" is selected as Demand Breakdown, select how total demand is distributed across sectors
  - "AEO 2022" applies AEO 2022 sector-specific demand forecasts
  - "2020 Deliveries" applies EIA-176 reported sector delivery breakdown, specific to selected company

## User-Defined Company Input Worksheet*

User-Defined Company Methane Loss Rate

| | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| 2020 CH4 Loss % | 0.21% | | | | | |
| Applied CH4 Loss % | Custom | | | | | |
| | ted | | | | | |
| Annual Reduction in CH4 Loss % | % | | | | | |
| Calculated CH4 Loss % | 0.21% | 0.19% | 0.17% | 0.16% | 0.14% | 0.13% |
| Manual CH4 Loss % | 0.21% | 0.20% | 0.19% | 0.18% | 0.17% | 0.16% |
| Final Applied CH4 Loss % | 0.21% | 0.19% | 0.17% | 0.16% | 0.14% | 0.13% |

Custom Demand Criteria

| | |
|---|---|
| User Input | Annual Demand |
| Gas Unit | MMBtu |
| Demand Breakdown | Sector-Specific |
| Sector Demand Share | 2020 Deliveries |

***All user-defined cells are orange***

Gas Demand Projections via CAGR (MMBtu)

| | CAGR | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|
| Residential | -0.50% | 451,110,257 | 447,628,327 | 445,390,185 | 443,163,234 | 442,155,493 | 438,742,681 |
| Commercial | -0.50% | 298,161,043 | 295,859,663 | 294,380,365 | 292,908,463 | 292,242,397 | 289,986,701 |
| Industrial | 0.50% | 89,165,911 | 89,366,900 | 89,813,735 | 90,262,803 | 90,962,649 | 91,167,688 |
| Power | -1.00% | 486,447,388 | 480,267,114 | 475,464,443 | 470,709,798 | 467,279,420 | 461,342,673 |
| Transportation | 0.00% | 917,302 | 914,796 | 914,796 | 914,796 | 917,302 | 914,796 |
| Other | 0.00% | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | -0.62% | 1,325,801,902 | 1,314,036,800 | 1,305,963,523 | 1,297,959,095 | 1,293,557,262 | 1,282,154,539 |

Gas Demand Projections via User Input of Annual Demand (MMBtu)

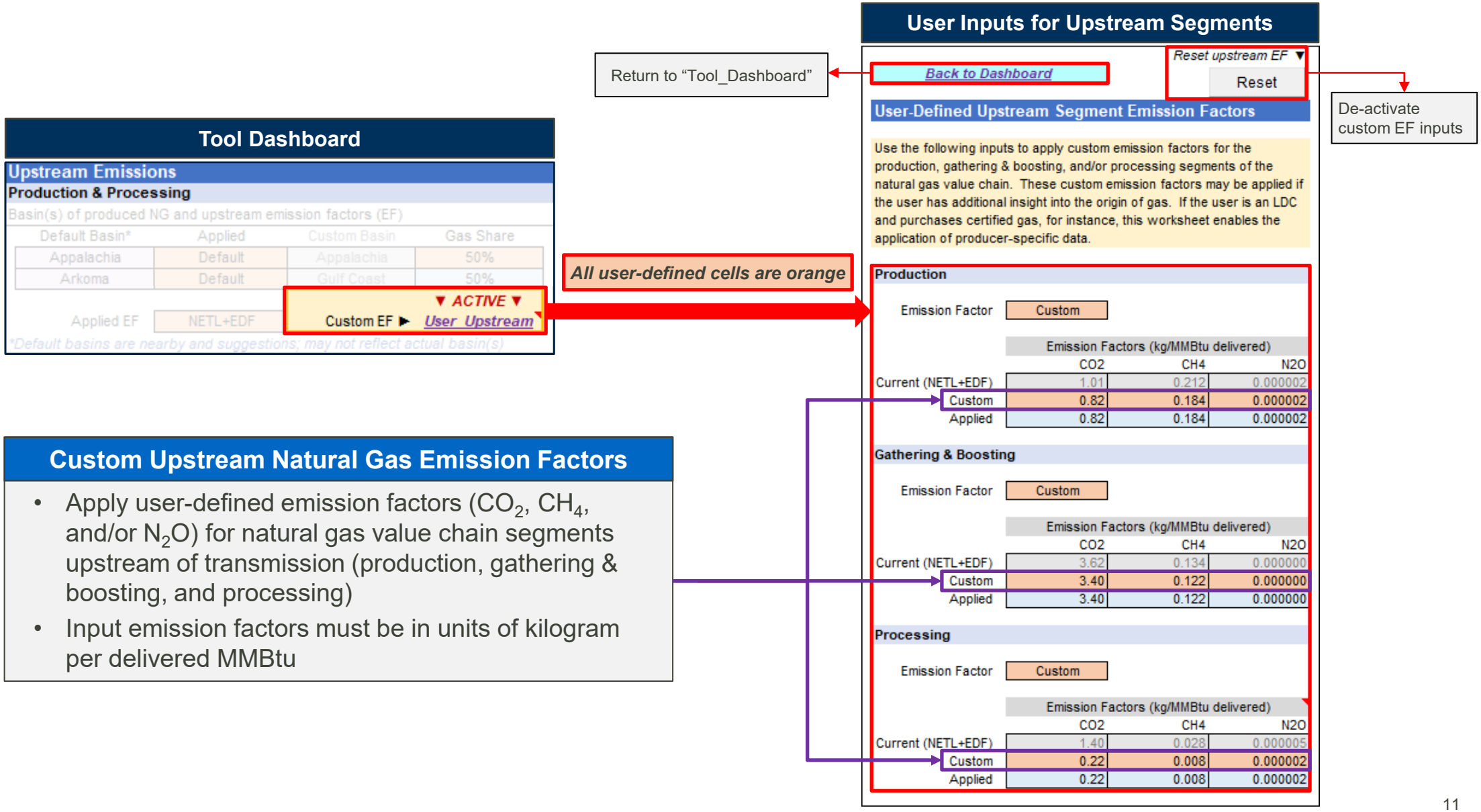
| | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| Total | 1,325,801,902 | 1,314,036,800 | 1,305,963,523 | 1,297,959,095 | 1,293,557,262 | 1,282,154,539 |
| Residential | 451,110,257 | 447,628,327 | 445,390,185 | 443,163,234 | 442,155,493 | 438,742,681 |
| Commercial | 298,161,043 | 295,859,663 | 294,380,365 | 292,908,463 | 292,242,397 | 289,986,701 |
| Industrial | 89,165,911 | 89,366,900 | 89,813,735 | 90,262,803 | 90,962,649 | 91,167,688 |
| Power | 486,447,388 | 480,267,114 | 475,464,443 | 470,709,798 | 467,279,420 | 461,342,673 |
| Transportation | 917,302 | 914,796 | 914,796 | 914,796 | 917,302 | 914,796 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 1,325,801,902 | 1,314,036,800 | 1,305,963,523 | 1,297,959,095 | 1,293,557,262 | 1,282,154,539 |

Final Applied User-Defined Gas Demand Projections (MMBtu)

| | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| Total | 1,325,801,902 | | | | | |
| Residential | 451,110,257 | 447,628,327 | 445,390,185 | 443,163,234 | 442,155,493 | 438,742,681 |
| Commercial | 298,161,043 | 295,859,663 | 294,380,365 | 292,908,463 | 292,242,397 | 289,986,701 |
| Industrial | 89,165,911 | 89,366,900 | 89,813,735 | 90,262,803 | 90,962,649 | 91,167,688 |
| Power | 486,447,388 | 480,267,114 | 475,464,443 | 470,709,798 | 467,279,420 | 461,342,673 |
| Transportation | 917,302 | 914,796 | 914,796 | 914,796 | 917,302 | 914,796 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 1,325,801,902 | 1,314,036,800 | 1,305,963,523 | 1,297,959,095 | 1,293,557,262 | 1,282,154,539 |

*Custom inputs extend through 2050; above sheet (final year 2025) for visualization purposes only

# Custom Upstream Segment Inputs: Natural Gas Emission Factors

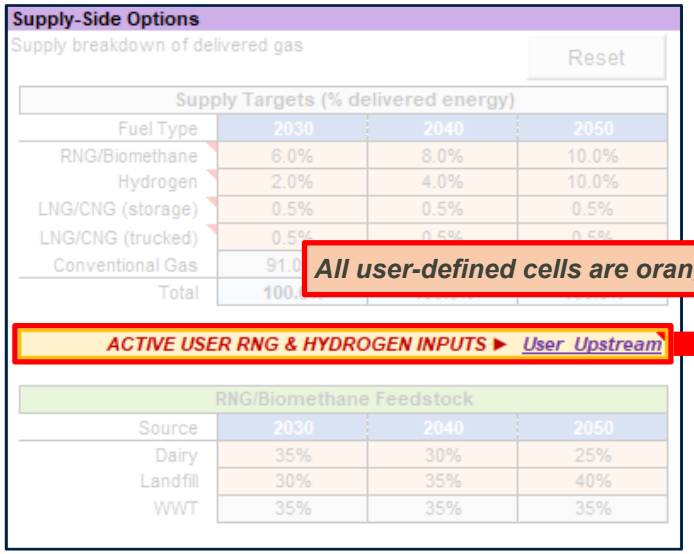



## Custom Upstream Natural Gas Emission Factors

- Apply user-defined emission factors ($CO_2$, $CH_4$, and/or $N_2O$) for natural gas value chain segments upstream of transmission (production, gathering & boosting, and processing)
- Input emission factors must be in units of kilogram per delivered MMBtu

# Custom Upstream Segment Inputs: RNG/Biomethane & Hydrogen Inputs

## Tool Dashboard



Supply-Side Options

Supply breakdown of delivered gas — Reset

Supply Targets (% delivered energy)

| Fuel Type | 2030 | 2040 | 2050 |
|---|---|---|---|
| RNG/Biomethane | 6.0% | 8.0% | 10.0% |
| Hydrogen | 2.0% | 4.0% | 10.0% |
| LNG/CNG (storage) | 0.5% | 0.5% | 0.5% |
| LNG/CNG (trucked) | 0.5% | 0.5% | 0.5% |
| Conventional Gas | 91.0% | | |
| Total | 100.0% | | |

*All user-defined cells are orange*

ACTIVE USER RNG & HYDROGEN INPUTS ► User_Upstream

RNG/Biomethane Feedstock

| Source | 2030 | 2040 | 2050 |
|---|---|---|---|
| Dairy | 35% | 30% | 25% |
| Landfill | 30% | 35% | 40% |
| WWT | 35% | 35% | 35% |

## User Inputs for Upstream Segments

*Reset RNG/biomethane and hydrogen inputs* ▼

Back to Dashboard → Return to "Tool_Dashboard"

De-activate custom RNG/bio-$CH_4$ & $H_2$ inputs ← Reset

### User-Defined RNG/Biomethane and Hydrogen Inputs

Use the following inputs to apply custom emission factors for RNG/biomethane feedstocks and hydrogen production. These custom emission factors may be applied if the user has additional insight into the origin of RNG/biomethane or hydrogen. If the user is an LDC and purchases RNG/biomethane/hydrogen from a particular project, for instance, this worksheet enables the application of project-specific data.

**RNG/Biomethane Assumptions**

Production EF: Custom

Emission Factors (kg/MMBtu; supply-weighted average through 2050)

| | CO2 | CH4 | N2O |
|---|---|---|---|
| Current | 9.40 | -0.910 | -0.004416 |
| Custom | 7.20 | -1.240 | -0.006273 |
| Applied | 7.20 | -1.240 | -0.006273 |

**Hydrogen Assumptions**

H2 Origin: Custom

*Default = SMR*

Production Emission Factors (kg/MMBtu; supply-weighted average through 2050)

| | CO2 | CH4 | N2O |
|---|---|---|---|
| Current | 42.30 | 0.064 | 0.002038 |
| Custom | 42.30 | 0.064 | 0.002038 |
| Applied | 42.30 | 0.064 | 0.002038 |

**RNG/Biomethane End-Use Customer Type(s)**

Customer type(s) to which RNG/biomethane is delivered

| Delivered to End-Use Sector? | |
|---|---|
| Residential/Commercial | Yes |
| Industrial | Yes |
| Power | Yes |
| Transportation/Other | Yes |

**Hydrogen End-Use Customer Type(s)**

Customer type(s) to which hydrogen is delivered

| Delivered to End-Use Sector? | |
|---|---|
| Residential/Commercial | Yes |
| Industrial | Yes |
| Power | Yes |
| Transportation/Other | Yes |

## Custom RNG/Bio-$CH_4$ & Hydrogen Factors

- Apply user-defined emission factors ($CO_2$, $CH_4$, and/or $N_2O$) associated with the production of RNG/biomethane and hydrogen
- Input emission factors must be in units of kilogram per delivered MMBtu

## RNG/Biomethane & Hydrogen End-Use Customer Type(s)

- Define the end-use sectors to which RNG/biomethane and hydrogen can be delivered

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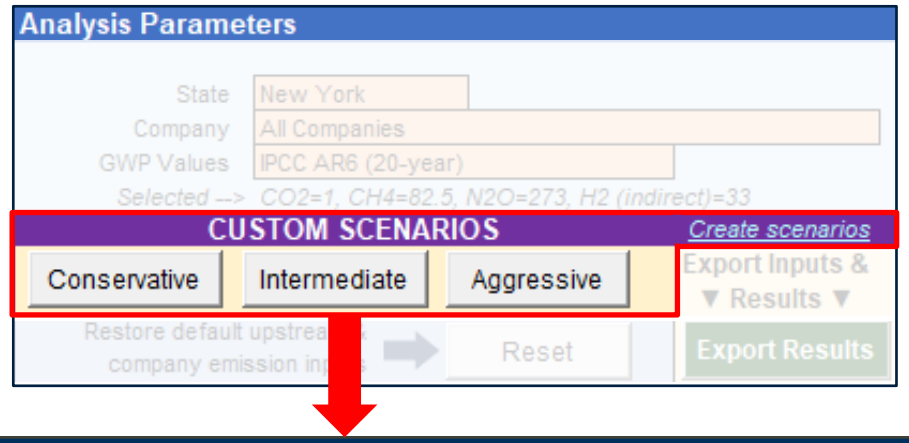
# Pre-Loaded Scenarios

## Tool Dashboard




## User-Defined Scenarios

### Conservative/Intermediate/Aggressive Scenarios

- "Pre-Loaded Scenarios" buttons in the tool dashboard apply streamlined scenarios with pre-loaded assumptions that reflect varied intensities of emission reduction strategies
- Within the pre-loaded scenarios worksheet, users can create these scenarios by defining demand- and supply-side strategies in the orange cells

## Pre-Loaded Scenarios Worksheet

**User-Defined Scenarios (CURRENTLY ACTIVE)**

**"Conservative" Scenario**

| Demand Change (year-over-year) | 2020-2030 | 2031-2040 | 2041-2050 |
|---|---|---|---|
| Efficiency Savings | 0.50% | 0.50% | 0.50% |

| Demand Reduction via Electrification | 2030 | 2040 | 2050 |
|---|---|---|---|
| % Gas Demand | 5% | 15% | 25% |
| Zero-e Grid MWh | 75% | 80% | 80% |

| Supply Targets (% delivered energy) | 2030 | 2040 | 2050 |
|---|---|---|---|
| RNG | 5.00% | 6.00% | 7.00% |
| Hydrogen | 1.00% | 2.00% | 5.00% |
| LNG/CNG (storage) | 0.50% | 0.50% | 0.50% |
| LNG/CNG (trucked) | 0.50% | 0.50% | 0.50% |

**"Intermediate" Scenario**

| Demand Change (year-over-year) | 2020-2030 | 2031-2040 | 2041-2050 |
|---|---|---|---|
| Efficiency Savings | 0.50% | 0.55% | 0.60% |

| Demand Reduction via Electrification | 2030 | 2040 | 2050 |
|---|---|---|---|
| % Gas Demand | 10% | 25% | 50% |
| Zero-e Grid MWh | 84% | 87% | 90% |

| Supply Targets (% delivered energy) | 2030 | 2040 | 2050 |
|---|---|---|---|
| RNG | 6.00% | 8.00% | 10.00% |
| Hydrogen | 2.00% | 4.00% | 10.00% |
| LNG/CNG (storage) | 0.50% | 0.50% | 0.50% |
| LNG/CNG (trucked) | 0.50% | 0.50% | 0.50% |

**"Aggressive" Scenario**

| Demand Change (year-over-year) | 2020-2030 | 2031-2040 | 2041-2050 |
|---|---|---|---|
| Efficiency Savings | 0.50% | 0.60% | 0.70% |

| Demand Reduction via Electrification | 2030 | 2040 | 2050 |
|---|---|---|---|
| % Gas Demand | 30% | 65% | 100% |
| Zero-e Grid MWh | 94% | 97% | 100% |

| Supply Targets (% delivered energy) | 2030 | 2040 | 2050 |
|---|---|---|---|
| RNG | 8.00% | 10.00% | 12.00% |
| Hydrogen | 2.00% | 5.00% | 12.00% |
| LNG/CNG (storage) | 0.50% | 0.50% | 0.50% |
| LNG/CNG (trucked) | 0.50% | 0.50% | 0.50% |

# Summary of Results: Tool Dashboard Charts

**Discount Rate**
- Select data source of social cost of carbon values
- Select discount rate applied to social cost of carbon values

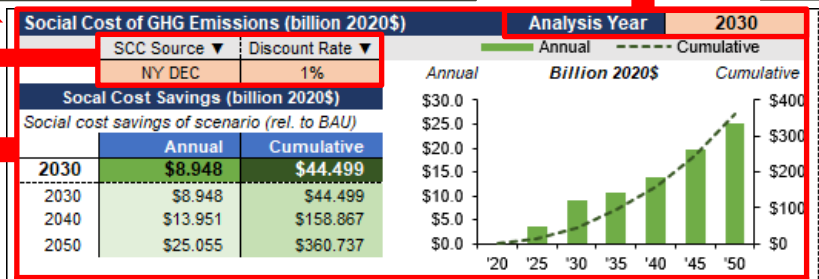
**Analysis Year**
- Define analysis year for annual results specific to selection

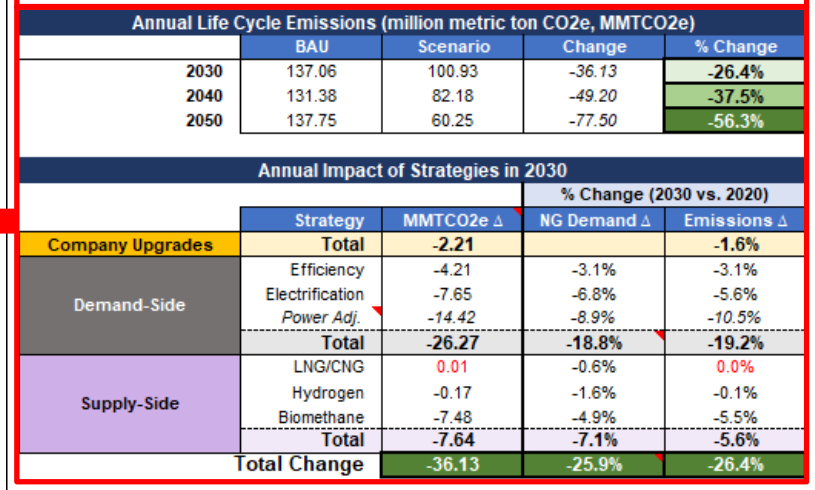
**Social Cost Savings**
- Summary of annual and cumulative social cost savings of scenario (relative to BAU)

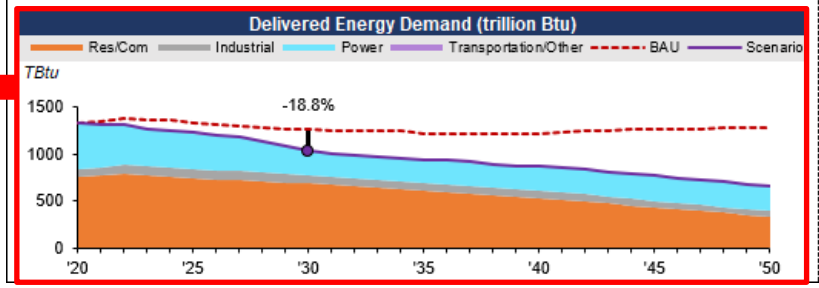
**Annual LCA Emissions**
- Analysis year emissions of BAU and applied scenario

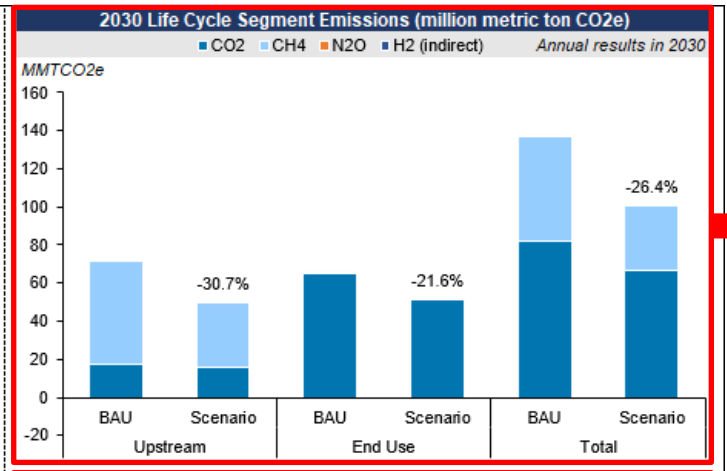
**Impact of Strategies**
- Emission reductions and effect on fossil gas demand, by strategy

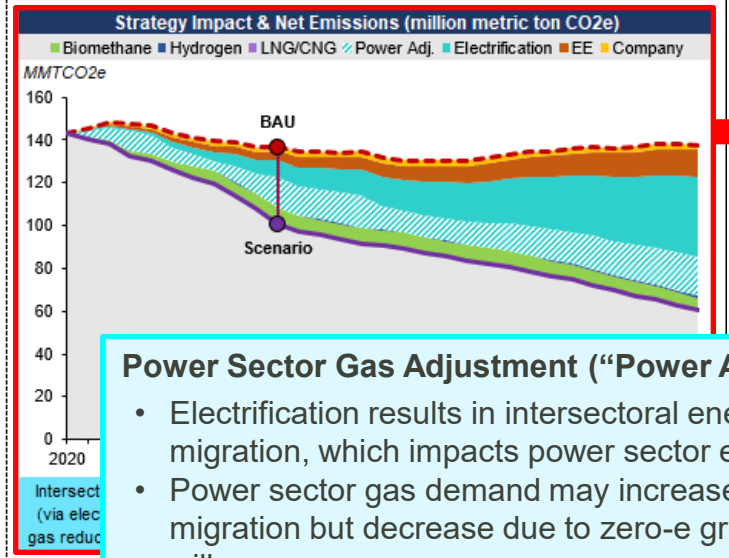
**Energy Demand**
- Forecasted gas (fossil+decarbonized) demand of selected company, by sector



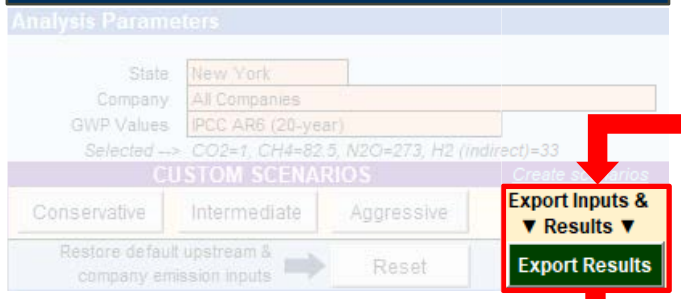

**LCA Emissions**
- GHG emissions by LCA segment and pollutant, by analysis year

**Impact of Strategies**
- Emission reductions associated with applied strategies

**Power Sector Gas Adjustment ("Power Adj.") Considerations**
- Electrification results in intersectoral energy demand migration, which impacts power sector energy demand
- Power sector gas demand may increase from demand migration but decrease due to zero-e grid targets; net impact will vary

# Summary of Results: Emissions Tables

## Tool Dashboard




## Data Export

- Exports data to user's computer desktop
- Includes all active assumptions and emission/energy results tables located in "Emissions_Tables" and "Energy_Tables" tabs

**Social Cost of GHG Emissions (billion 2020$)**

| Scenario | Metric | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|
| BAU | CO2 | $36.165 | $36.995 | $37.935 | $37.897 | $37.992 | $37.168 |
| | CH4 | $4.522 | $4.673 | $4.828 | $4.870 | $4.918 | $4.856 |
| | N2O | $0.220 | $0.226 | $0.232 | $0.232 | $0.233 | $0.229 |
| | **Total** | $40.907 | **$41.894** | **$42.995** | **$43.000** | **$43.143** | **$42.253** |
| Scenario | CO2 | $36.165 | $36.002 | $36.120 | $35.095 | $35.063 | $34.347 |
| | CH4 | $4.522 | $4.424 | $4.355 | $4.163 | $4.083 | $3.936 |
| | N2O | $0.220 | $0.213 | $0.207 | $0.196 | $0.190 | $0.181 |
| | **Total** | $40.907 | **$40.639** | **$40.682** | **$39.454** | **$39.337** | **$38.464** |
| **Savings** | **Annual** | $0.000 | **$1.255** | **$2.313** | **$3.546** | **$3.806** | **$3.788** |
| | **Cumulative** | $0.000 | **$1.255** | **$3.568** | **$7.114** | **$10.920** | **$14.708** |

**Emission Reductions Relative to 2020 Baseline, by Strategy (metric ton CO2e)**

*Negative value indicates emissions increase*

| Type | Strategy | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|
| Company Upgrades | Upgrades | 0 | 431,302 | 815,883 | 1,125,468 | 1,417,502 | 1,646,941 |
| Demand-Side | Efficiency | 0 | 418,500 | 878,332 | 1,295,131 | 1,718,433 | 2,139,911 |
| | Electrification | 0 | 162,950 | 534,665 | 1,035,970 | 1,682,172 | 2,453,152 |
| | Power Adj. | 0 | 3,470,553 | 5,920,506 | 8,851,371 | 8,218,286 | 6,555,759 |
| Supply-Side | LNG/CNG | 0 | -851 | -1,758 | -2,537 | -3,296 | -4,041 |
| | Hydrogen | 0 | 15,322 | 33,198 | 52,163 | 73,329 | 94,075 |
| | RNG | 0 | 935,097 | 1,865,846 | 2,712,999 | 3,597,642 | 4,396,241 |
| | **Total** | 0 | **5,432,873** | **10,046,672** | **15,070,565** | **16,704,067** | **17,282,037** |

**Scenario Emissions (metric ton)**

| Segment | Pollutant | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|
| Production | CO2 | 7,999,041 | 8,154,742 | 8,355,648 | 8,307,852 | 8,469,030 | 8,480,404 |
| | CH4 | 495,261 | 478,115 | 464,004 | 437,116 | 422,268 | 400,729 |
| | N2O | 9 | -28 | -64 | -97 | -132 | -163 |
| | GHG | 48,860,506 | **47,591,625** | **46,618,461** | **44,343,349** | **43,270,187** | **41,496,192** |
| Transmission | CO2 | 9,781,094 | 9,661,814 | 9,600,594 | 9,266,586 | 9,178,471 | 8,937,605 |
| | CH4 | 138,003 | 136,319 | 135,455 | 130,742 | 129,498 | 126,099 |
| | N2O | 257 | 254 | 252 | 243 | 241 | 235 |
| | H2 (indirect) | 0 | 273 | 544 | 789 | 1,044 | 1,274 |
| | GHG | 21,236,395 | **20,977,360** | **20,844,385** | **20,119,155** | **19,927,807** | **19,404,820** |
| Distribution | CO2 | 20,444 | 22,538 | 24,908 | 26,444 | 28,466 | 30,105 |
| | CH4 | 52,821 | 46,971 | 42,071 | 36,650 | 32,799 | 28,888 |
| | N2O | 0 | 0 | 0 | 0 | 0 | 0 |
| | H2 (indirect) | 0 | 101 | 202 | 293 | 388 | 473 |
| | GHG | 4,378,161 | **3,901,022** | **3,502,501** | **3,059,826** | **2,747,214** | **2,429,023** |
| End Use | CO2 | 68,102,108 | 67,272,136 | 66,806,769 | 64,396,002 | 63,677,035 | 61,874,912 |
| | CH4 | 1,353 | 1,342 | 1,336 | 1,291 | 1,277 | 1,242 |
| | N2O | 1,294 | 1,273 | 1,260 | 1,211 | 1,196 | 1,162 |
| | GHG | 68,567,124 | **67,730,346** | **67,260,900** | **64,833,152** | **64,108,997** | **62,294,502** |
| **Total** | **CO2** | 85,902,688 | **85,111,229** | **84,787,919** | **81,996,884** | **81,353,001** | **79,323,026** |
| | **CH4** | 687,438 | **662,747** | **642,866** | **605,798** | **585,842** | **556,958** |
| | **N2O** | 1,560 | **1,499** | **1,448** | **1,357** | **1,306** | **1,234** |
| | **H2 (indirect)** | 0 | **375** | **746** | **1,082** | **1,432** | **1,747** |
| | GHG | 143,042,187 | **140,209,368** | **138,244,198** | **132,381,525** | **130,088,667** | **125,666,570** |

Note: Results extend through 2050; sheet above (final year 2025) for visualization purposes only

## Result Tables

**Social Cost of GHG Emissions**

- Social cost of emissions, by year
- Social cost savings of applied scenario

**Emission Reduction Strategies**

- Emission reductions resulting from applied scenario strategies

**Scenario Emissions**

- GHG emissions, by life cycle segment of applied scenario

**BAU Emissions (not shown in screenshot)**

- GHG emissions, by life cycle segment of BAU scenario

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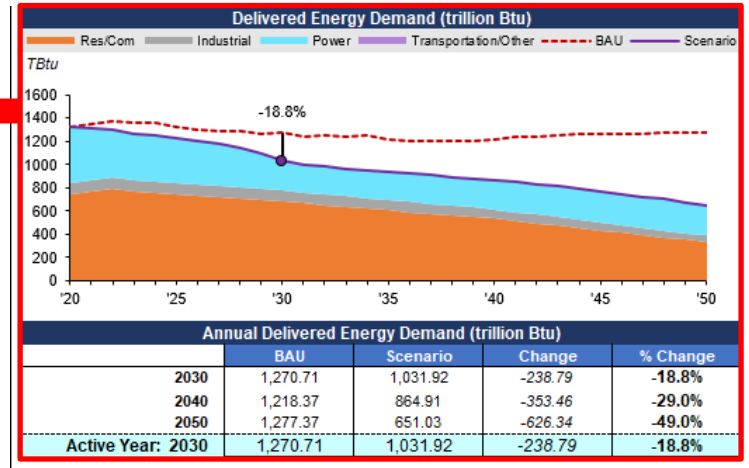
# Summary of Results: Energy Charts

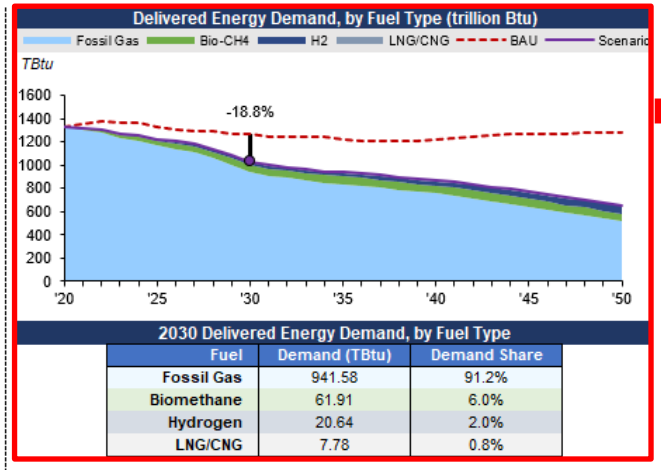
**Delivered Energy Demand**
- Delivered energy, by end-user sector of applied scenario




Annual Delivered Energy Demand (trillion Btu)

| | BAU | Scenario | Change | % Change |
|---|---|---|---|---|
| 2030 | 1,270.71 | 1,031.92 | -238.79 | -18.8% |
| 2040 | 1,218.37 | 864.91 | -353.46 | -29.0% |
| 2050 | 1,277.37 | 651.03 | -626.34 | -49.0% |
| Active Year: 2030 | 1,270.71 | 1,031.92 | -238.79 | -18.8% |

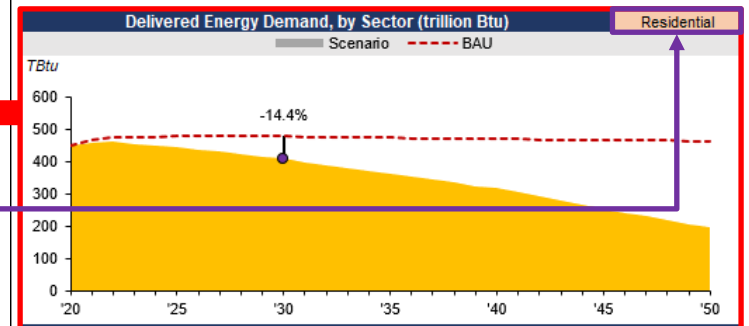
**Delivered Energy Demand, by Fuel Type**
- Delivered energy of applied scenario, by fuel type




2030 Delivered Energy Demand, by Fuel Type

| Fuel | Demand (TBtu) | Demand Share |
|---|---|---|
| Fossil Gas | 941.58 | 91.2% |
| Biomethane | 61.91 | 6.0% |
| Hydrogen | 20.64 | 2.0% |
| LNG/CNG | 7.78 | 0.8% |

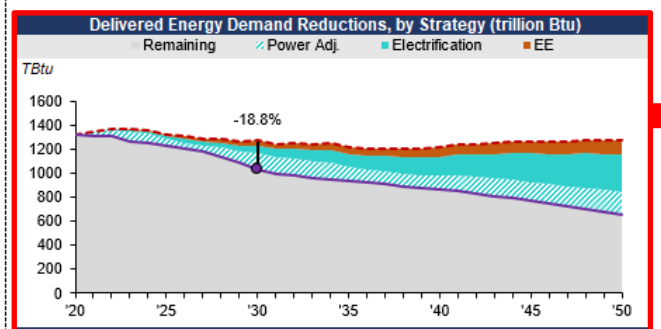
**Delivered Energy Demand, by Sector**
- Delivered energy, by user-defined sector




Delivered Energy Demand: Residential Sector (trillion Btu)

| | BAU | Scenario | Change | % Change |
|---|---|---|---|---|
| 2030 | 477.88 | 409.07 | -68.82 | -14.4% |
| 2040 | 469.85 | 317.18 | -152.68 | -32.5% |
| 2050 | 463.30 | 196.33 | -266.98 | -57.6% |
| Active Year: 2030 | 477.88 | 409.07 | -68.82 | -14.4% |

**Delivered Energy Demand Reductions, by Strategy**
- Delivered energy demand changes resulting from applied scenario strategies

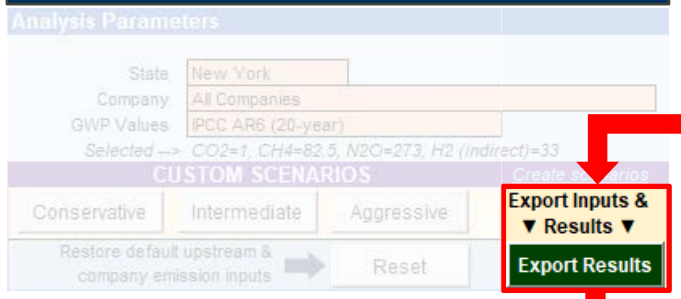



2030 Delivered Energy Demand Reductions, by Strategy

| Strategy | Reduction (TBtu) | BAU Reduction |
|---|---|---|
| Energy Efficiency | 39.05 | 3.1% |
| Electrification | 62.14 | 4.9% |
| Power Adj. | 137.61 | 10.8% |
| Total | 238.79 | 18.8% |

# Summary of Results: Energy Tables

## Tool Dashboard




## Data Export

- Exports data to user's computer desktop
- Includes all active assumptions and emission/energy results tables located in "Emissions_Tables" and "Energy_Tables" tabs

**Delivered Energy Demand Change Relative to 2020 Baseline, by Strategy (trillion Btu)**

*Positive value indicates demand increase*

| Type | Strategy | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|
| Demand-Side | Efficiency | 0 | -3.879 | -8.142 | -12.005 | -15.929 | -19.837 |
| | Electrification | 0 | -1.731 | -4.664 | -8.420 | -13.207 | -18.977 |
| | Power Adj. | 0 | -32.156 | -55.214 | -82.776 | -77.458 | -62.652 |
| *AEO 2022 Demand Projections* | | 0 | 24.215 | 48.765 | 41.024 | 34.920 | -0.656 |
| **Total** | | 0 | -13.551 | -19.254 | -62.178 | -71.674 | -102.122 |

**Delivered Energy Demand, by Fuel Type (trillion Btu)**

| Type | Fuel Type | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|
| Supply-Side | Biomethane | 0.00 | 7.87 | 15.68 | 22.75 | 30.10 | 36.71 |
| | Hydrogen | 0.00 | 2.62 | 5.23 | 7.58 | 10.03 | 12.24 |
| | LNG/CNG | 0.00 | 0.86 | 1.78 | 2.60 | 3.41 | 4.19 |
| | Fossil Gas | 1,325.80 | 1,300.89 | 1,283.87 | 1,230.70 | 1,210.59 | 1,170.54 |
| **Total** | | 1,325.80 | 1,312.25 | 1,306.55 | 1,263.62 | 1,254.13 | 1,223.68 |

**Scenario Delivered Energy Demand (trillion Btu)**

| End-Use Sector | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| Residential | 451.11 | 459.91 | 461.94 | 453.59 | 448.26 | 443.04 |
| Commercial | 298.16 | 304.34 | 329.96 | 315.00 | 306.82 | 299.50 |
| Industrial | 89.17 | 94.65 | 95.66 | 96.27 | 95.73 | 95.29 |
| Power | 486.45 | 452.20 | 417.88 | 397.70 | 402.30 | 384.86 |
| Transportation | 0.92 | 1.15 | 1.10 | 1.06 | 1.02 | 0.99 |
| Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 1,325.80 | 1,312.25 | 1,306.55 | 1,263.62 | 1,254.13 | 1,223.68 |
| GHG (MMTCO2e) | 143.04 | 140.21 | 138.24 | 132.38 | 130.09 | 125.67 |
| **GHG Intensity (gCO2e/Btu)** | 0.108 | **0.107** | **0.106** | **0.105** | **0.104** | **0.103** |

**BAU Delivered Energy Demand (trillion Btu)**

| End-Use Sector | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| Residential | 451.11 | 466.89 | 476.12 | 474.71 | 476.39 | 478.20 |
| Commercial | 298.16 | 308.96 | 340.08 | 329.67 | 326.08 | 323.26 |
| Industrial | 89.17 | 95.60 | 97.62 | 99.25 | 99.72 | 100.30 |
| Power | 486.45 | 477.40 | 459.62 | 462.11 | 457.48 | 422.34 |
| Transportation | 0.92 | 1.17 | 1.12 | 1.09 | 1.06 | 1.04 |
| Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 1,325.80 | 1,350.02 | 1,374.57 | 1,366.83 | 1,360.72 | 1,325.15 |
| GHG (MMTCO2e) | 143.04 | 145.64 | 148.29 | 147.45 | 146.79 | 142.95 |
| **GHG Intensity (gCO2e/Btu)** | 0.108 | **0.108** | **0.108** | **0.108** | **0.108** | **0.108** |

Note: Results extend through 2050; sheet above (final year 2025) for visualization purposes only

## Result Tables

**Delivered Energy Demand Change Relative to 2020 Baseline, by Strategy**

- Delivered energy demand changes resulting from applied scenario strategies

**Delivered Energy Demand, by Fuel Type**

- Delivered energy of applied scenario, by fuel type

**Scenario Delivered Energy Demand**

- Delivered energy, by end-user sector of applied scenario

**BAU Delivered Energy Demand**

- Delivered energy, by end-user sector of BAU scenario

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