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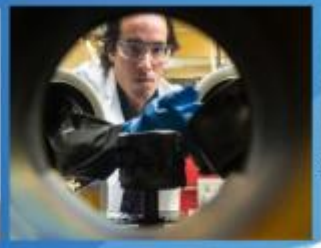


Projected growth in small-scale, fossil-fueled distributed generation: Potential implications for the U.S. Greenhouse Gas Inventory

Annika Eberle and Garvin Heath

National Renewable Energy Laboratory

EPA's International Emissions Inventory Conference

August 17, 2017

Project background

Grid Modernization INITIATIVE

Goal:

- Define a system of metrics to measure progress of grid modernization and validate with relevant stakeholders

Approach:

- Establish metrics for six categories: Reliability, Resilience, Flexibility, Sustainability, Affordability, and Security
- Engage key stakeholders to help shape development of metrics
  - Working collaborators: EPA, EIA, DHS, NERC, FERC, EPRI, APPA, NARUC, NASEO, City of New Orleans, ComED, CAISO, WA-UTC

Timeline:

- Year 1: Define initial metrics and methods
- Year 2 + 3: Implement use cases with specific partners to test the initial metrics; define additional metrics

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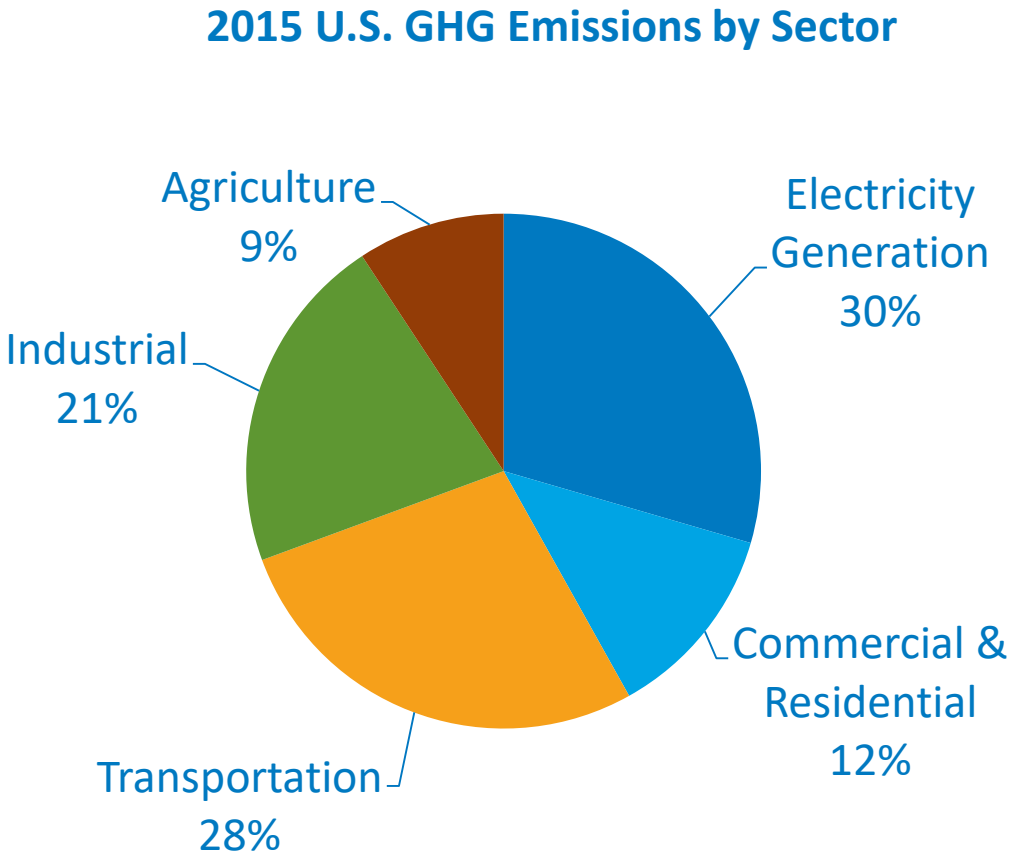
Sustainability metrics – GHG emissions



Source: EPA. 2017. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015.

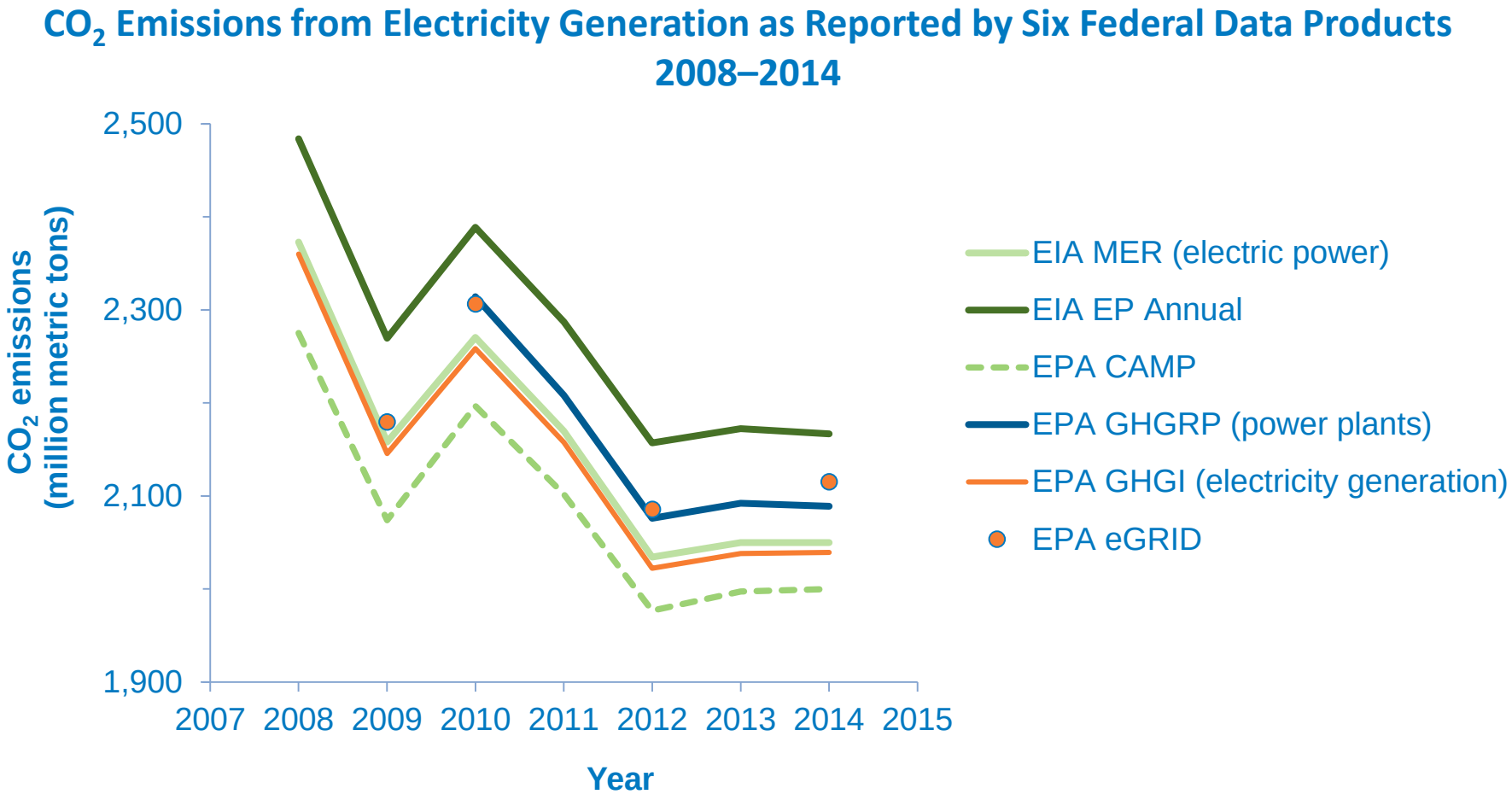
Federal data sources for electric-sector GHG emissions

Data product	Primary purpose	Lowest level of resolution		Primary estimation method
		Spatial	*Temporal*	
EIA EP Annual	Informational	State*	Annually	Fuel consumption times EF
EIA MER	Informational	State*	Monthly	Fuel consumption times EF
EIA STEO	Informational	National	Monthly	Projection
EIA AEO	Informational	Regional	Annually	Projection
EPA GHGI	Treaty obligation	National	Annually	Relies on MER data
EPA CAMP	Statutory	Boiler	Hourly	CEMS
EPA GHGRP	Statutory	Facility	Annually	CEMS
EPA eGRID	Informational	Boiler	Biennially	Relies on CAMP & MER data

*Facility-level supplements available upon request.
Abbreviations: EPA = Environmental Protection Agency; EIA = Energy Information Administration; EP Annual = Electric Power Annual; MER = Monthly Energy Review; STEO = Short-Term Energy Outlook; AEO = Annual Energy Outlook; GHGI = Greenhouse Gas Inventory; CAMP= Clean Air Markets Program; GHGRP = Greenhouse Gas Reporting Program; eGRID = Emissions and Generation Resource Integrated Database; CEMS = continuous emission monitoring system; EF = emission factor.

Federal estimates of electric-sector GHG emissions

- All data products are currently able to achieve their intended purposes
- Historical data products are aligned on discerning trends
- GHG emission estimates differ because they have different purposes and scopes



Electricity generation sources may shift as grid modernizes

Potential Changes*:

- Growth in distributed generation
  - » More on-site power generation, especially using small-scale generators
- Increased deployment of renewable energy
  - » More wind power
  - » More solar power
  - » More biopower
  - » More hybrid (renewable/conventional) power
- Greater use of combined heat and power
- Increased energy storage

*Compiled from EPRI, 2017, The Integrated Energy Network; DOE, 2015, Quadrennial Energy Review; EPRI, 2014, The Integrated Grid – Realizing the Full Value of Central and Distributed Energy Resources; Pratt et al (PNNL) 2010 – The Smart Grid: An Estimate of the Energy and CO_2 Benefits; NETL 2007 – A Vision for the Modern Grid; DOE 2003 – Grid 2030: A National Vision for Electricity's Second 100 Years; DOE 2004 – National Electric Delivery Technologies Roadmap; DOE Smart Grid Booklet

Research question

How might the accuracy and completeness of federal data products' estimates of GHG emissions from electricity generation be impacted by grid modernization?

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Focused research question for this presentation

How might the accuracy and completeness of the U.S. Greenhouse Gas Inventory's estimate of GHG emissions from electricity generation be impacted as distributed generation grows?

Scope of U.S. Greenhouse Gas Inventory

Overview

- Developed in accordance with the Intergovernmental Panel on Climate Change's (IPCC's) extensive, internationally agreed carbon accounting methods
- Accounts for all sources and sinks of GHG emissions in the U.S.
- Submitted to the United Nations in accordance with the Framework Convention on Climate Change
- Based on data from EIA's Monthly Energy Review

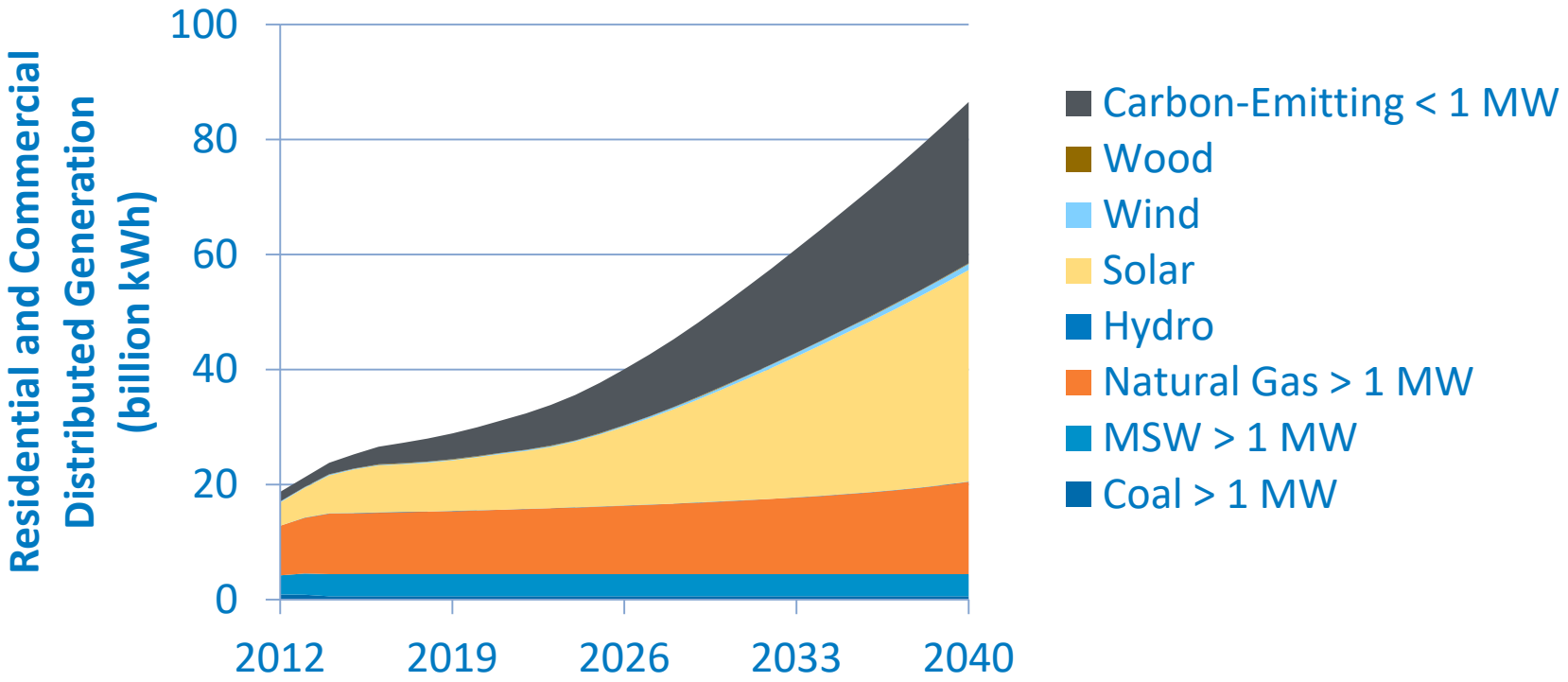
Accounting for Distributed Generation (DG)

- IPCC's methods have historically separated GHG emissions by the economic sector that generates the GHG emissions
  - For example, emissions from DG (a.k.a. autoproduction or on-site generation) are assigned to economic sector that owns the units (i.e., commercial, industrial, or residential) rather than to electricity
  - Category of electricity generation only includes GHG emissions from producers whose primary purpose is to produce electricity (IPCC Category 1.A.1.a.i)

Projected growth in distributed generation (DG)

Residential and commercial electricity from DG is projected to more than triple from 2015 to 2040

- The majority of this growth is expected to be met from renewable energy sources, which will have minimal impact on GHG emissions
- However, carbon-emitting DG is also projected to grow, particularly at scales < 1 MW



Source: Data from detailed buildings results for the 2016 Annual Energy Outlook obtained through personal communication with the Energy Information Administration (EIA).

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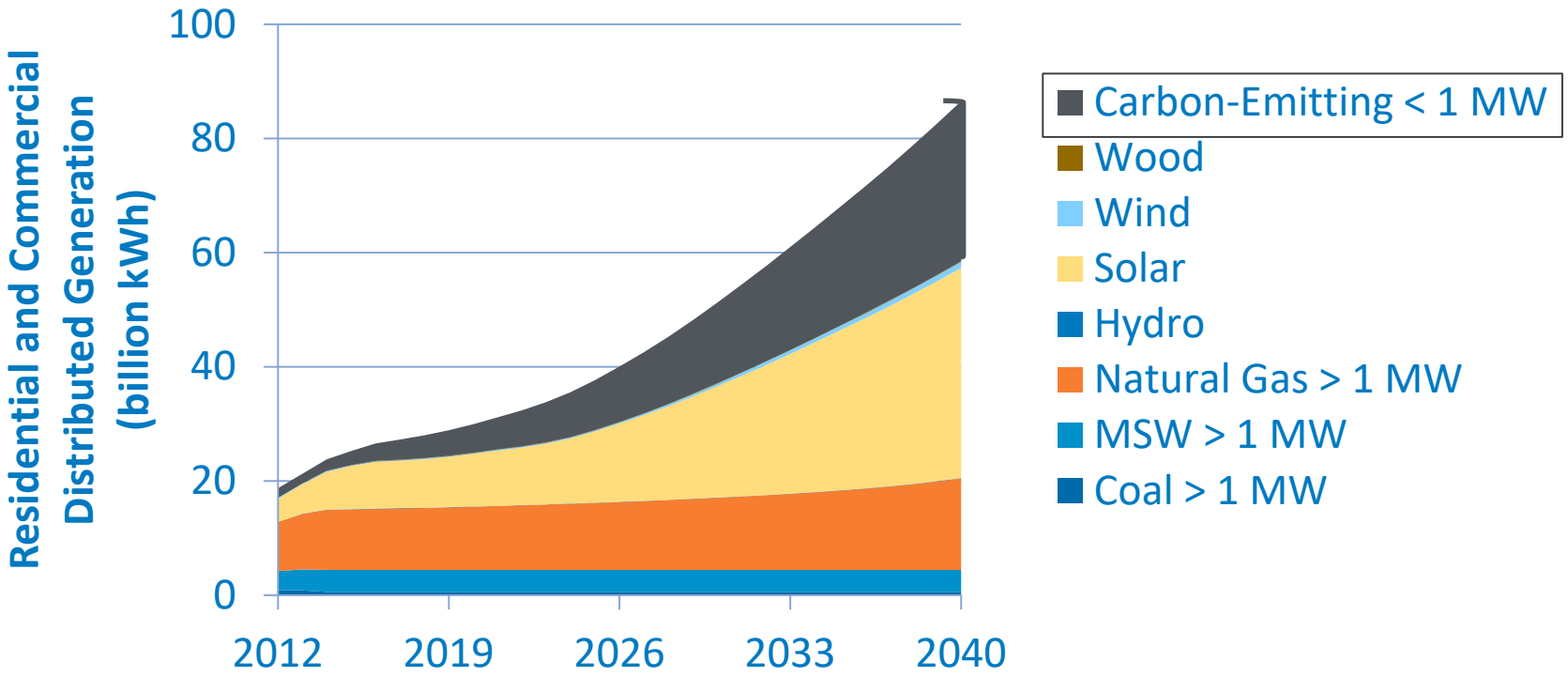
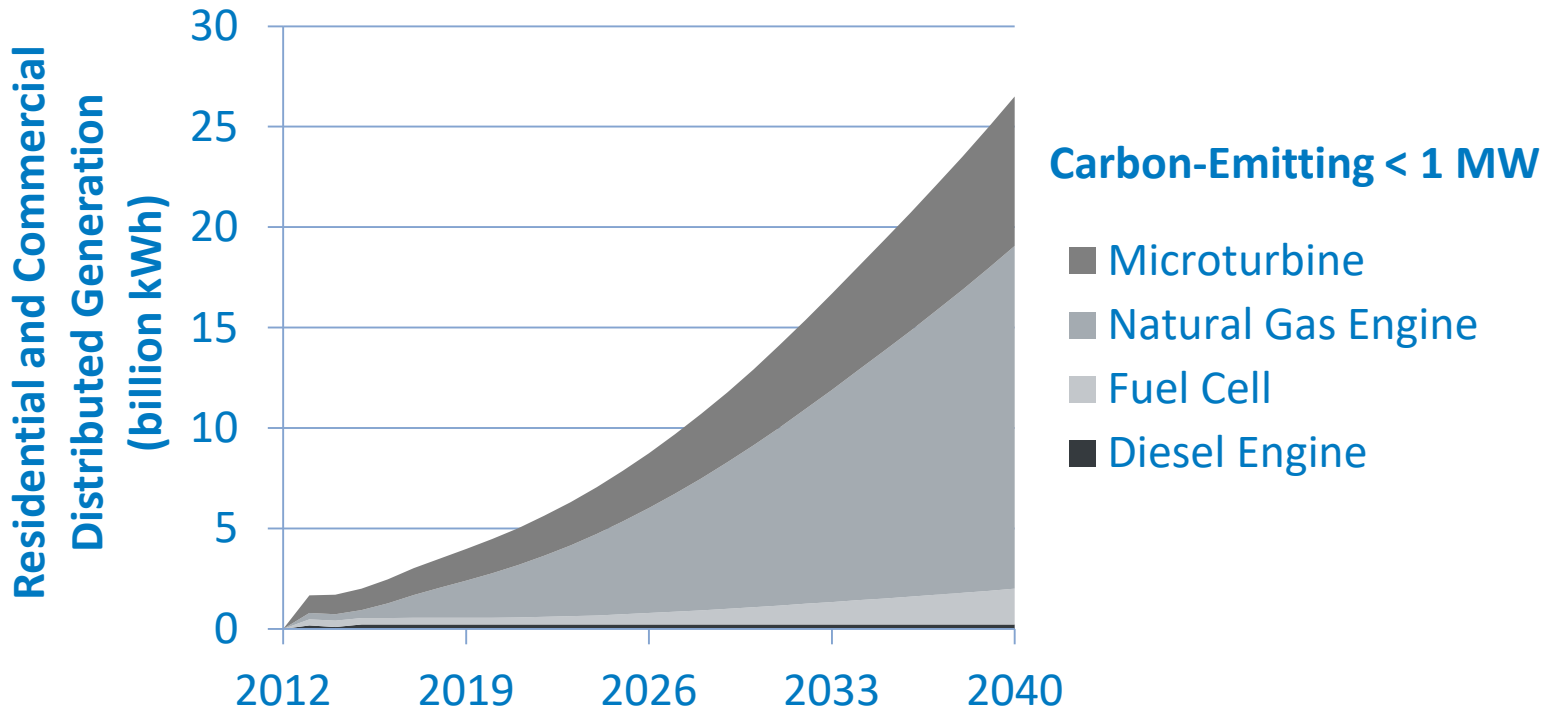


Source: Data from detailed buildings results for the 2016 Annual Energy Outlook obtained through personal communication with the Energy Information Administration (EIA).

Projected growth in small-scale, carbon-emitting DG

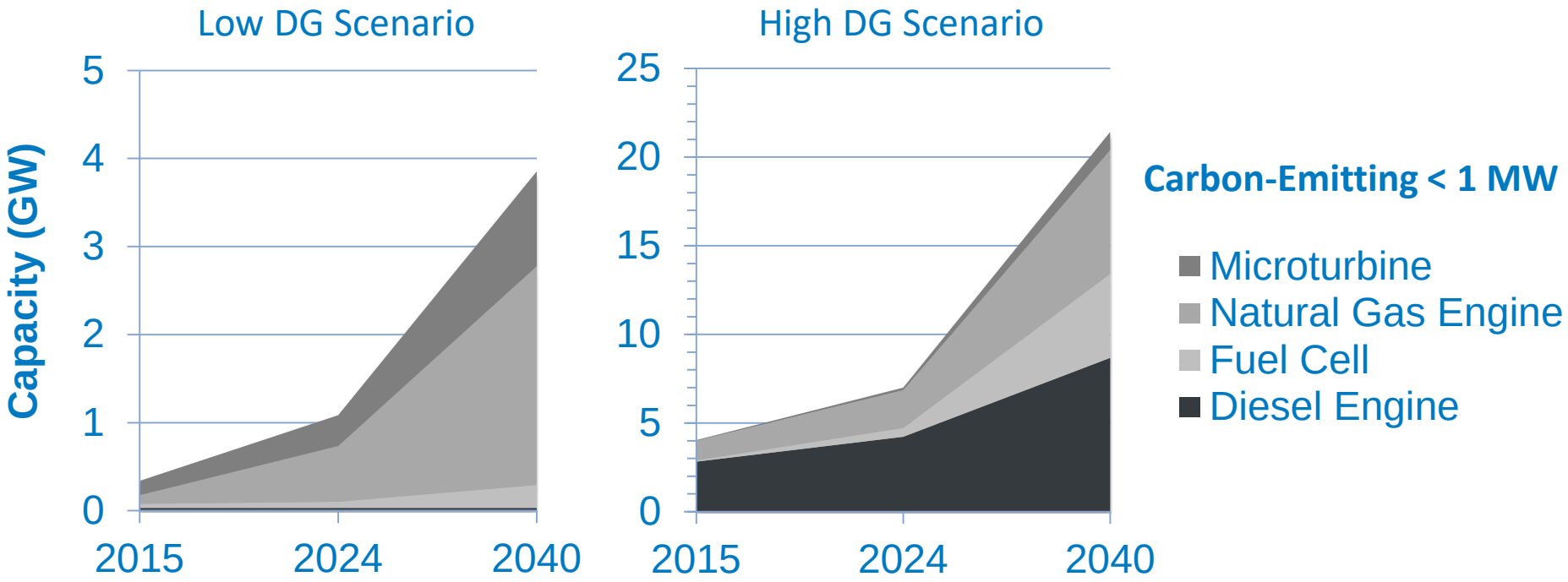
Small-scale (< 1 MW), carbon-emitting distributed generation used for commercial and residential buildings is expected to grow more than nine-fold from 2015 to 2040



Source: Data from detailed buildings results for the 2016 Annual Energy Outlook obtained through personal communication with the Energy Information Administration (EIA).

Projected growth in small-scale, carbon-emitting DG

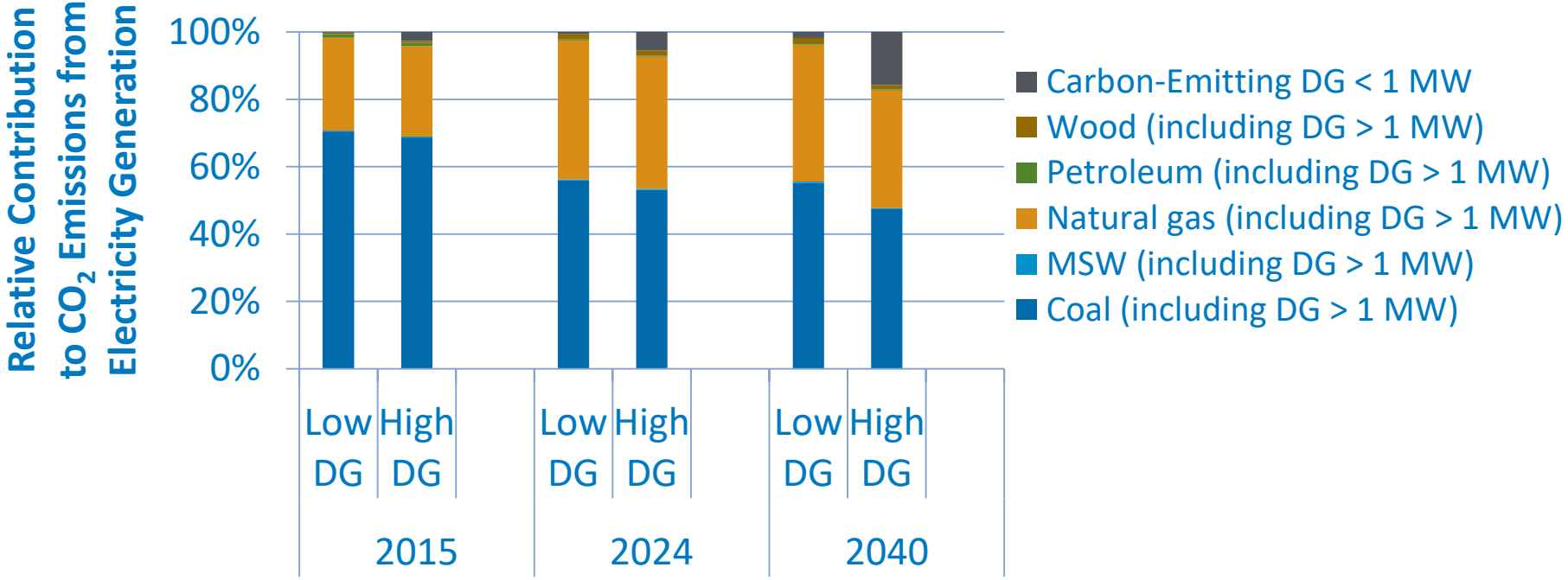
We combined literature forecasts of DG capacity (below) with literature data for capacity factors and emissions factors to develop two scenarios (low DG and high DG) to assess the potential CO_2 emissions that could result from increased use of small-scale, carbon-emitting DG



Source: Data from detailed buildings results for the 2016 Annual Energy Outlook obtained through personal communication with the Energy Information Administration (EIA) (Low DG Scenario) and Navigant capacity forecasts for DG (High DG Scenario).

Projected growth in GHG emissions from small-scale DG

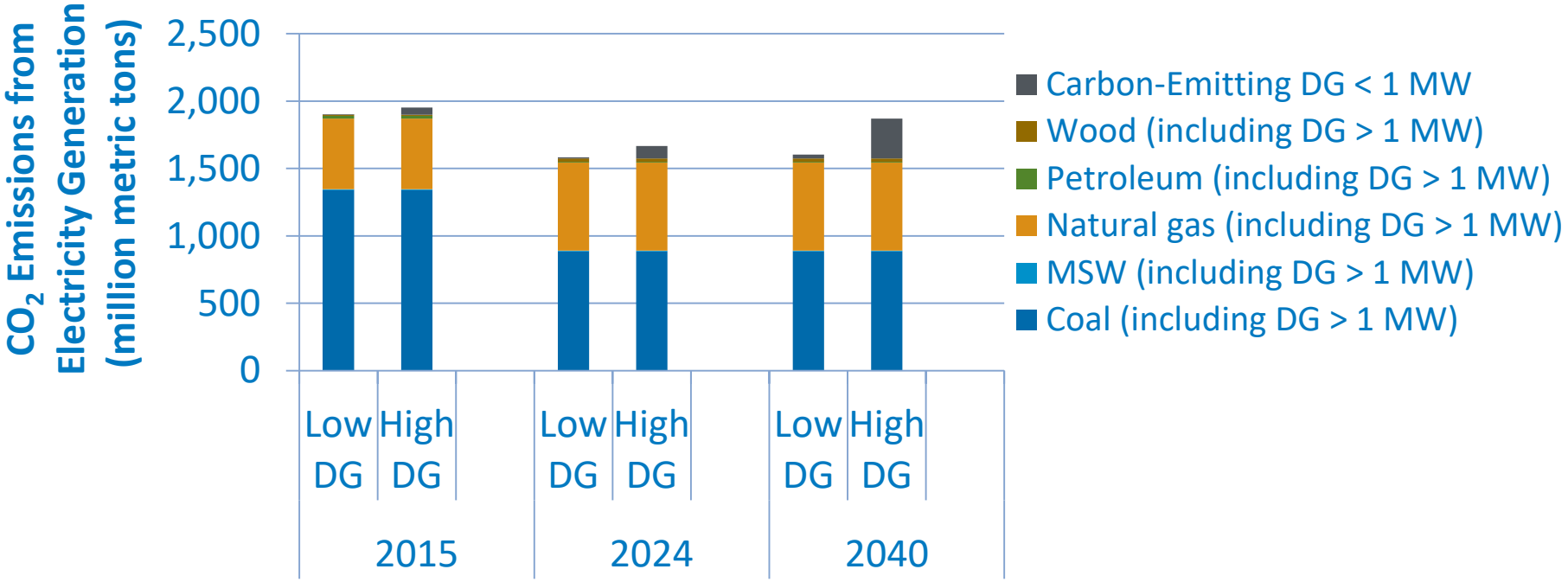
- CO_2 emissions from small-scale (< 1 MW), carbon-emitting distributed generation (DG) currently comprise less than 3% of CO_2 emissions from electricity generation
- By 2040, CO_2 emissions from small-scale DG could account for 2 to 15% of CO_2 emissions from electricity generation



Source: Eberle and Heath (in prep). Based on data from EIA's 2016 Annual Energy Outlook, Navigant's market analysis reports, documented capacity factors and emission factors.

Projected growth in GHG emissions from small-scale DG

- Absolute CO_2 emissions from small-scale (< 1 MW), carbon-emitting distributed generation (DG) are expected to increase from 2015 to 2040
- Absolute CO_2 emissions from other sources are expected to remain similar or decrease from 2015 to 2040



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Potential implications for the GHGI

How might the accuracy and completeness of the U.S. Greenhouse Gas Inventory's estimate of GHG emissions from electricity generation be impacted as distributed generation grows?

Potential implications for the GHGI

How might the accuracy and completeness of the U.S. Greenhouse Gas Inventory's estimate of GHG emissions from electricity generation be impacted as distributed generation grows?

- GHGI's autoproduction (DG) accounting method is currently sufficient
  - Small-scale DG is currently minor contributor to current electricity generation and emissions
- Methods may need to be modified to better track change in emissions from electricity generation as DG grows
  - For example, as the grid modernizes, energy production and emissions from DG are expected to increase
  - Current accounting does not allocate DG emissions to the electric power sector, which could make it difficult to accurately track changes in emissions from electricity generation and allocate mitigation resources

Acknowledgements

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Sustainability Metrics Team

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Thank you!

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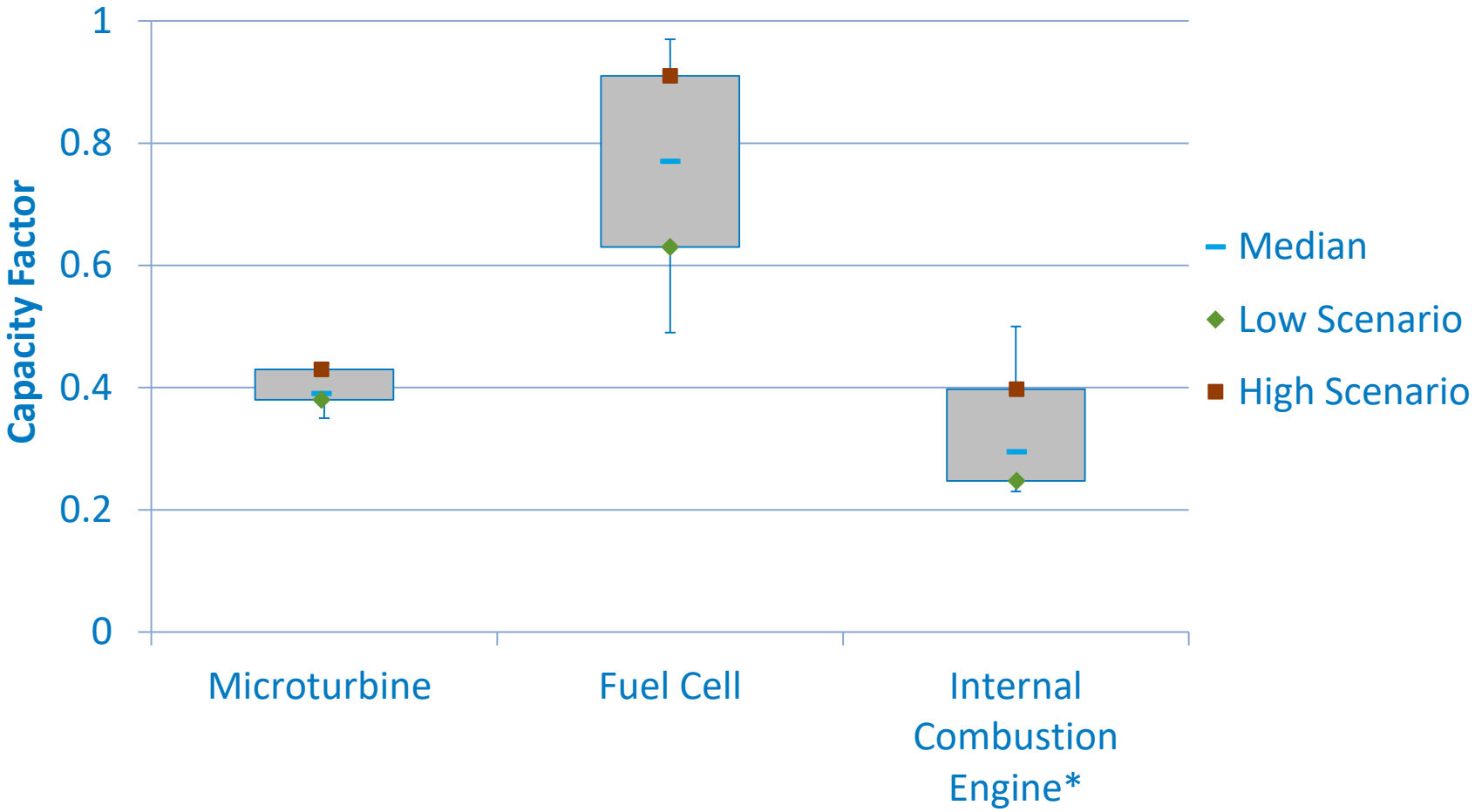
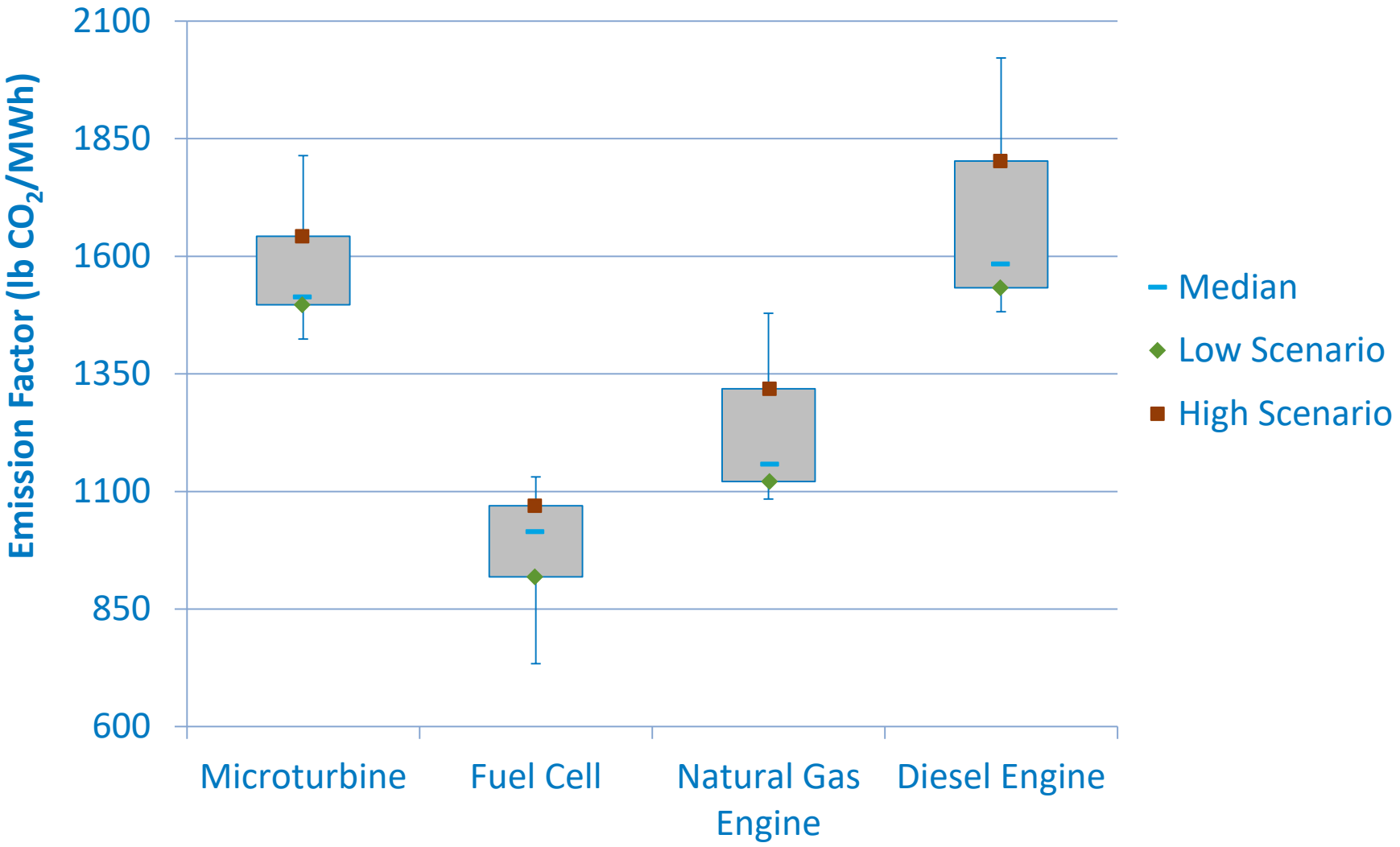
Capacity Factors



Source: Data compiled from CPUC's *Tenth Year Impact Evaluation Report*

Emission Factors



Source: Data compiled from EPA's *Catalog of CHP Technologies*