Electrification of Industrial Process Heat and Steam

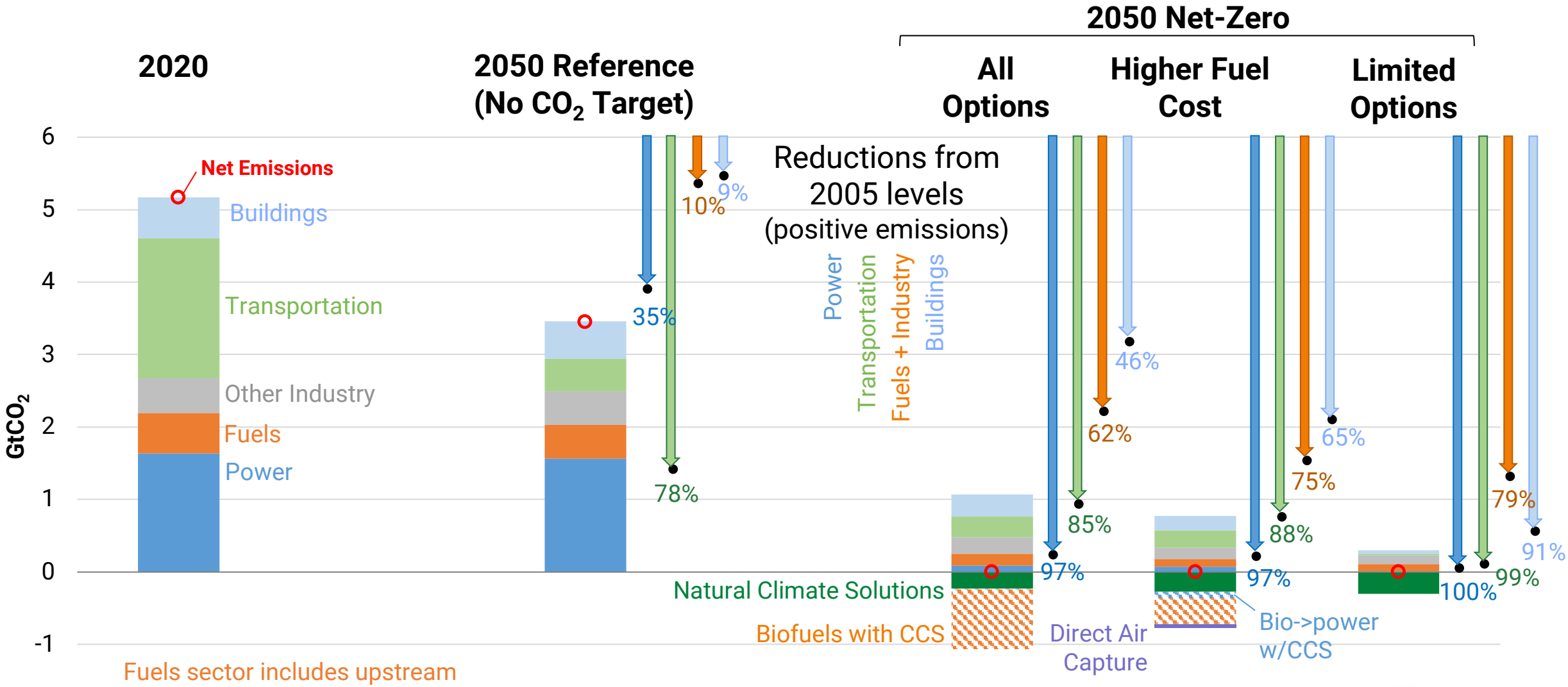
Geoffrey J. Blanford, Ph.D.
Principal Technical Executive, Energy Systems and Climate Analysis

DOE Industrial Heat Shot Summit
October 23, 2024

Key Technologies for Process Heat/Steam Electrification

- **Electric resistance boiler/furnace/heating**
- **Electrode boiler** (high voltage, high heat output)
- **Electric arc furnace** (steel-making, smelting)
- **Induction furnace** (melting, other heat treatments)
- **Infrared, microwave, RF heating** (drying, other heat treatments)
- **Heat pump, heat recovery chiller, MVR** (low-temp, pre-heating)
- **Alternative electrochemical processes** (e.g., electrolysis)

Direct CO_2 Emissions by Sector, Reductions from 2005



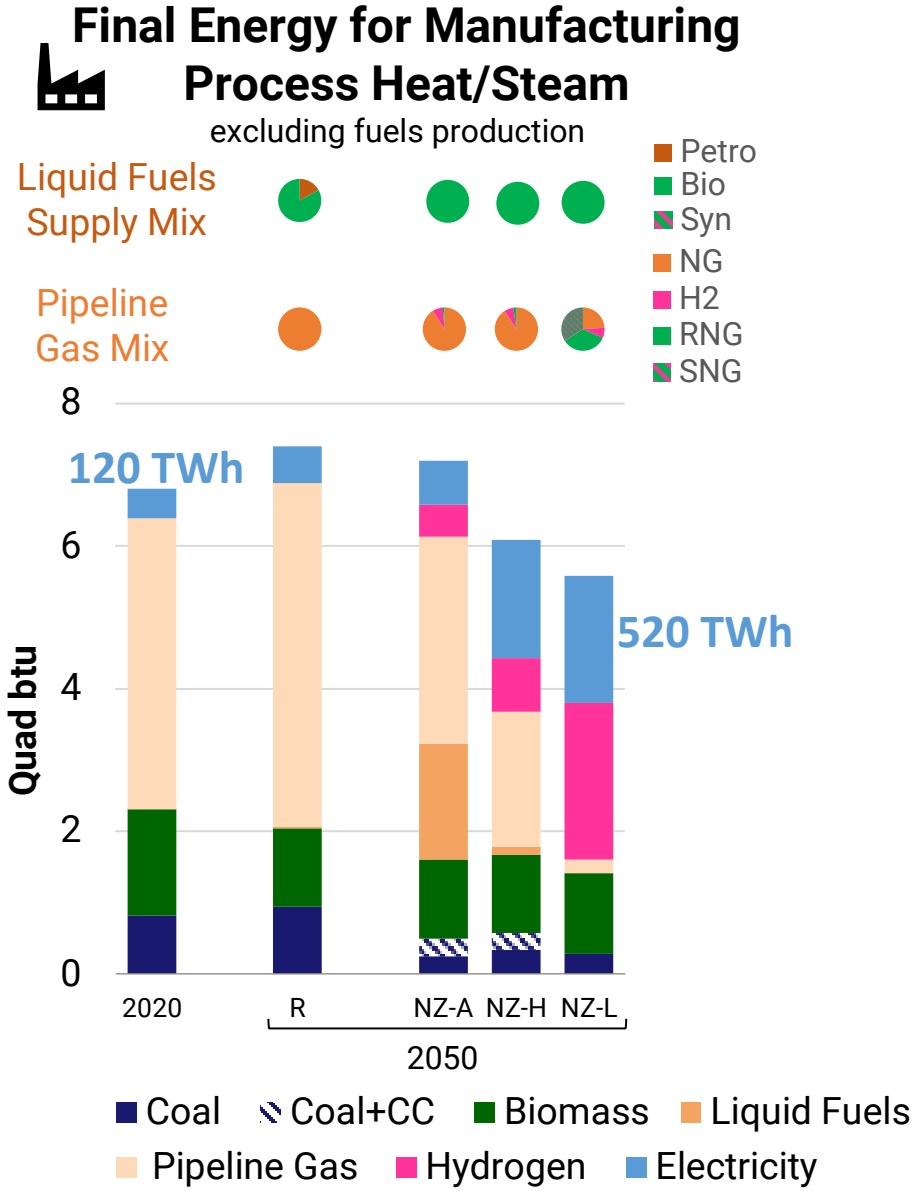
Fuels sector includes upstream production, petroleum and bio-refining, hydrogen and ammonia

Full report available at
lowcarbonlcri.com/netzero

LCRI LOW-CARBON RESOURCES INITIATIVE

EPRI

Industrial Heat Electrification in Net-Zero Scenarios



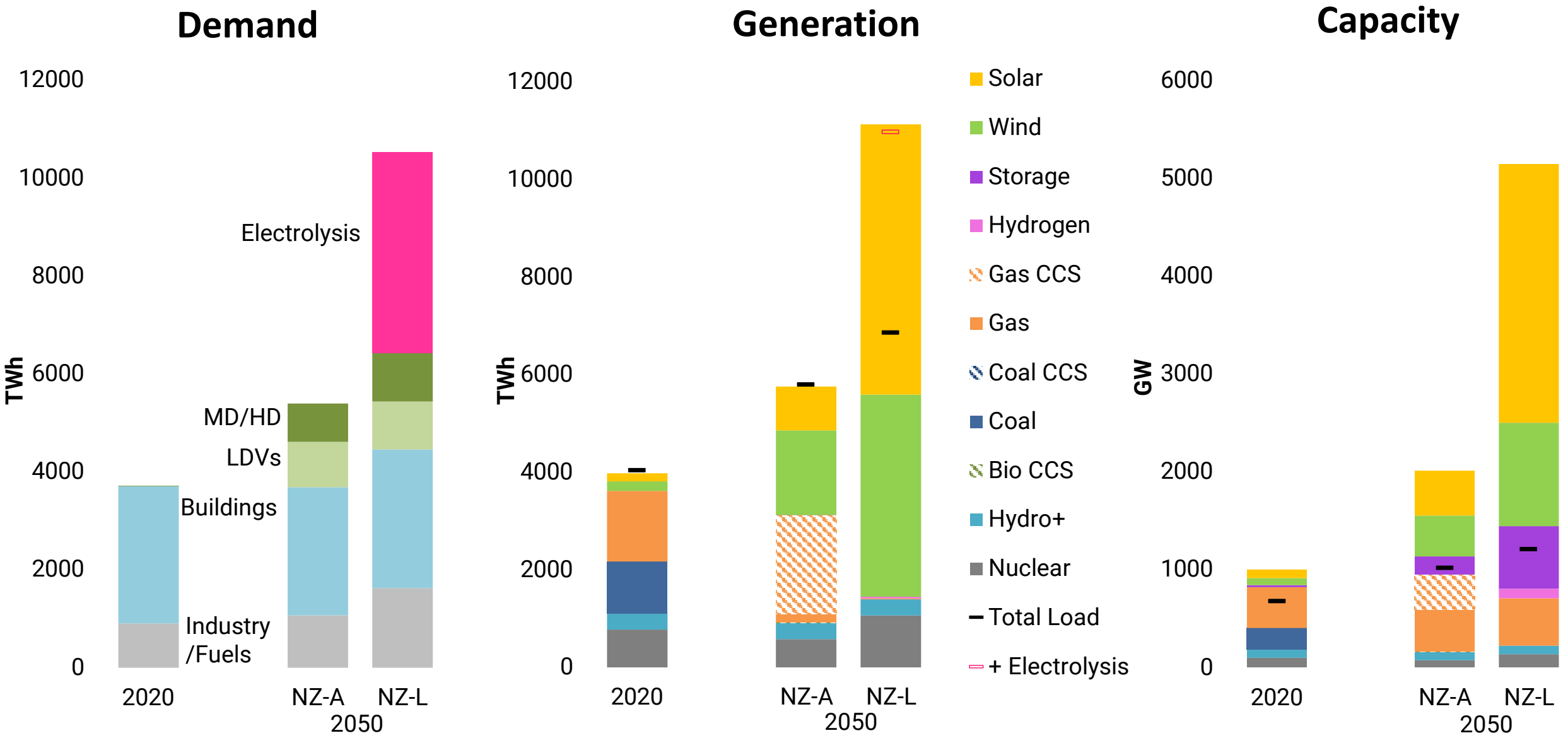
- Less than **5%** of **current** final energy use for industrial process heat and steam is **electric**
- Current electricity use for industrial process heat and steam represents around **10%** of **industrial** electricity demand and less than **3%** of **total** electricity demand

In a Net-Zero Future:

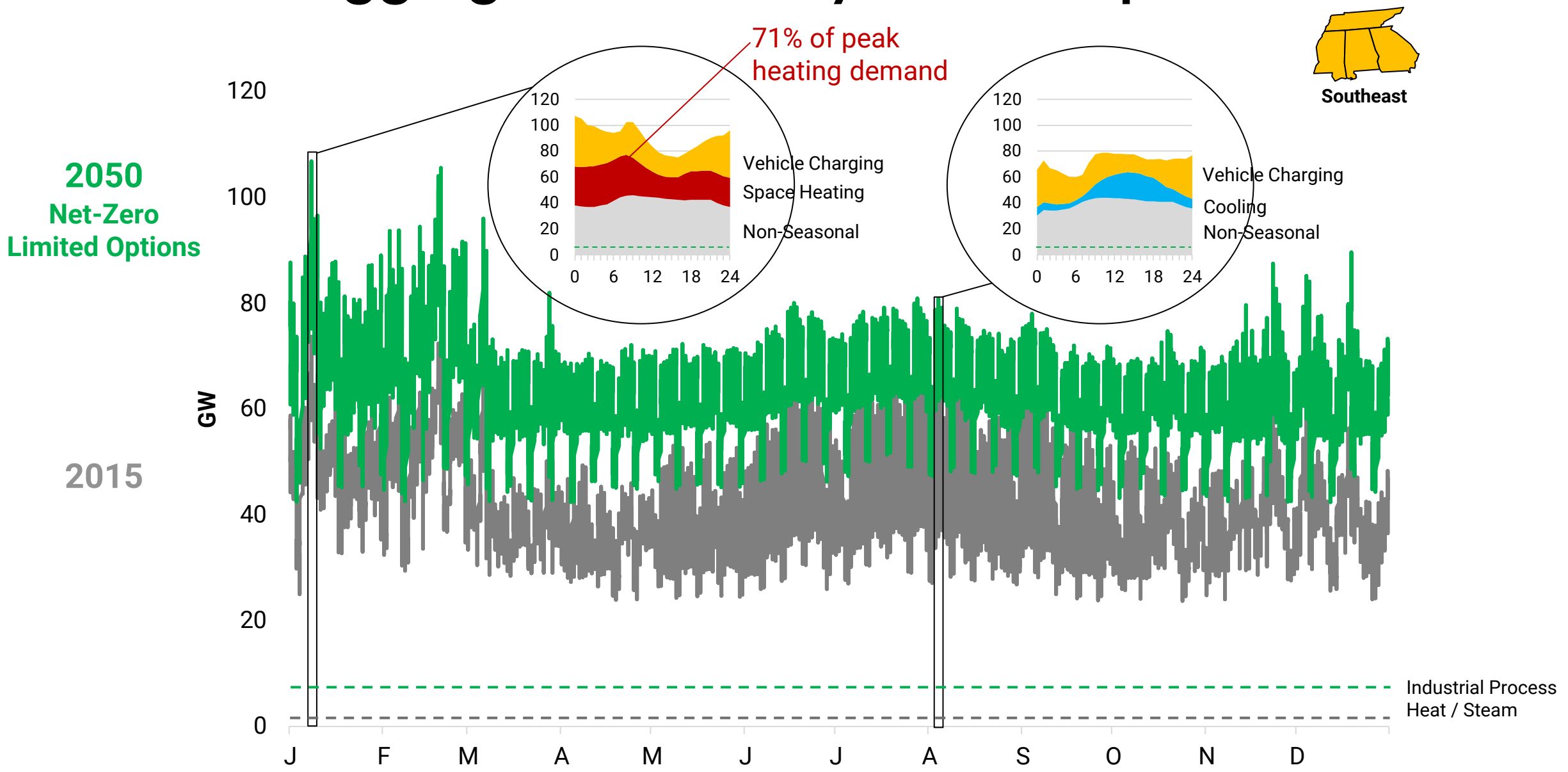
- Scale and electric share of process heat/steam energy use depends on trade-offs among **technologies**, **efficiency**, and **structural change**
- In highest share scenario, **electricity** use for process heat/steam grows by around **4-5x**, representing around a **third** of total process heat/steam final energy
- This incremental load is smaller than growth from **vehicle** electrification and (in some cases) **electrolysis** production, and peak impacts are less than for **space heating** electrification

R	Reference	**NZ-H**	Net-Zero Higher Fuel Cost
NZ-A	Net-Zero All Options	**NZ-L**	Net-Zero Limited Options

U.S. Electric System Evolution in Net-Zero 2050 Scenarios



Southeast Aggregate Electricity Load Shape



Electric System Impacts of Industrial Electrification

Bulk System

- Even with significant growth in electricity for process heat/steam, relatively small share of total demand
- High load factor limits peak impacts
- Will require new low-carbon resources, including clean firm capacity

Distribution System

- Many large industrial loads are connected to transmission system with dedicated substations
- New projects likely will require advance planning with utility to add new infrastructure

Plant Level

- Process electrification can significantly increase facility load
- May entail incremental capital costs but often operating cost savings and other benefits, including improved productivity, air quality
- Policy incentives can accelerate adoption