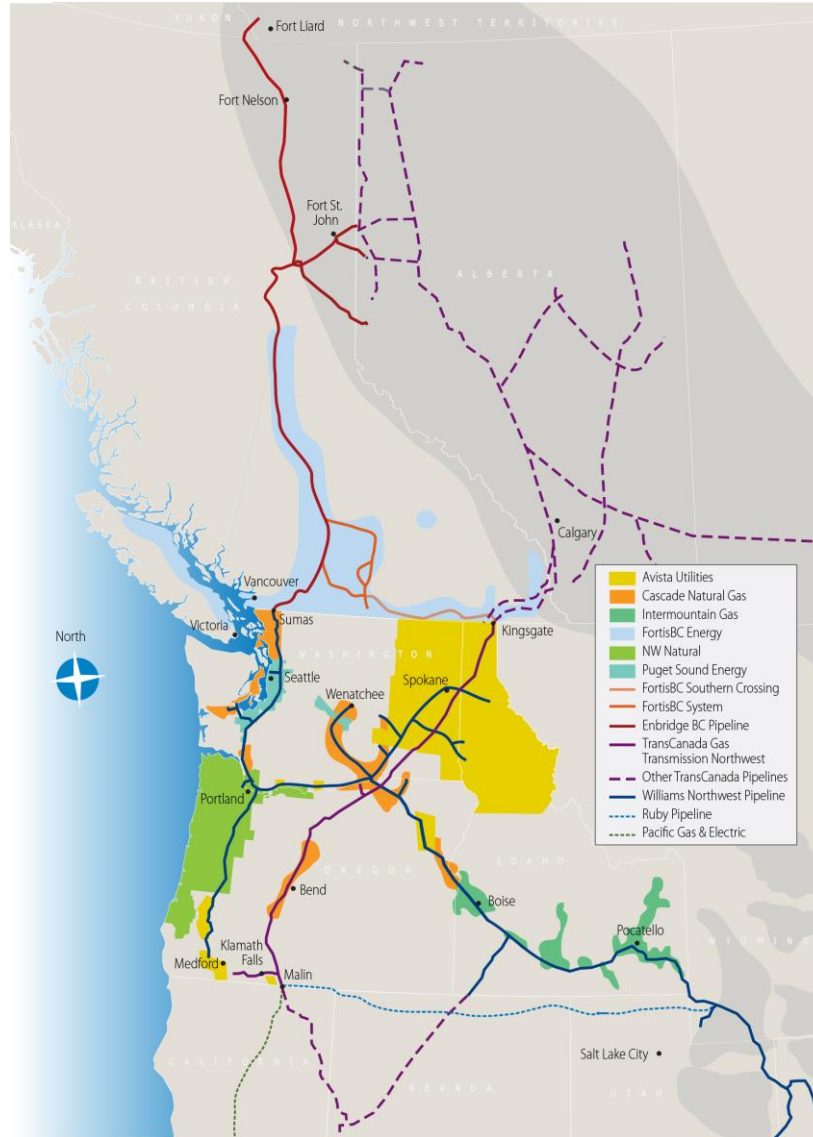


PNWER Utility of the Future

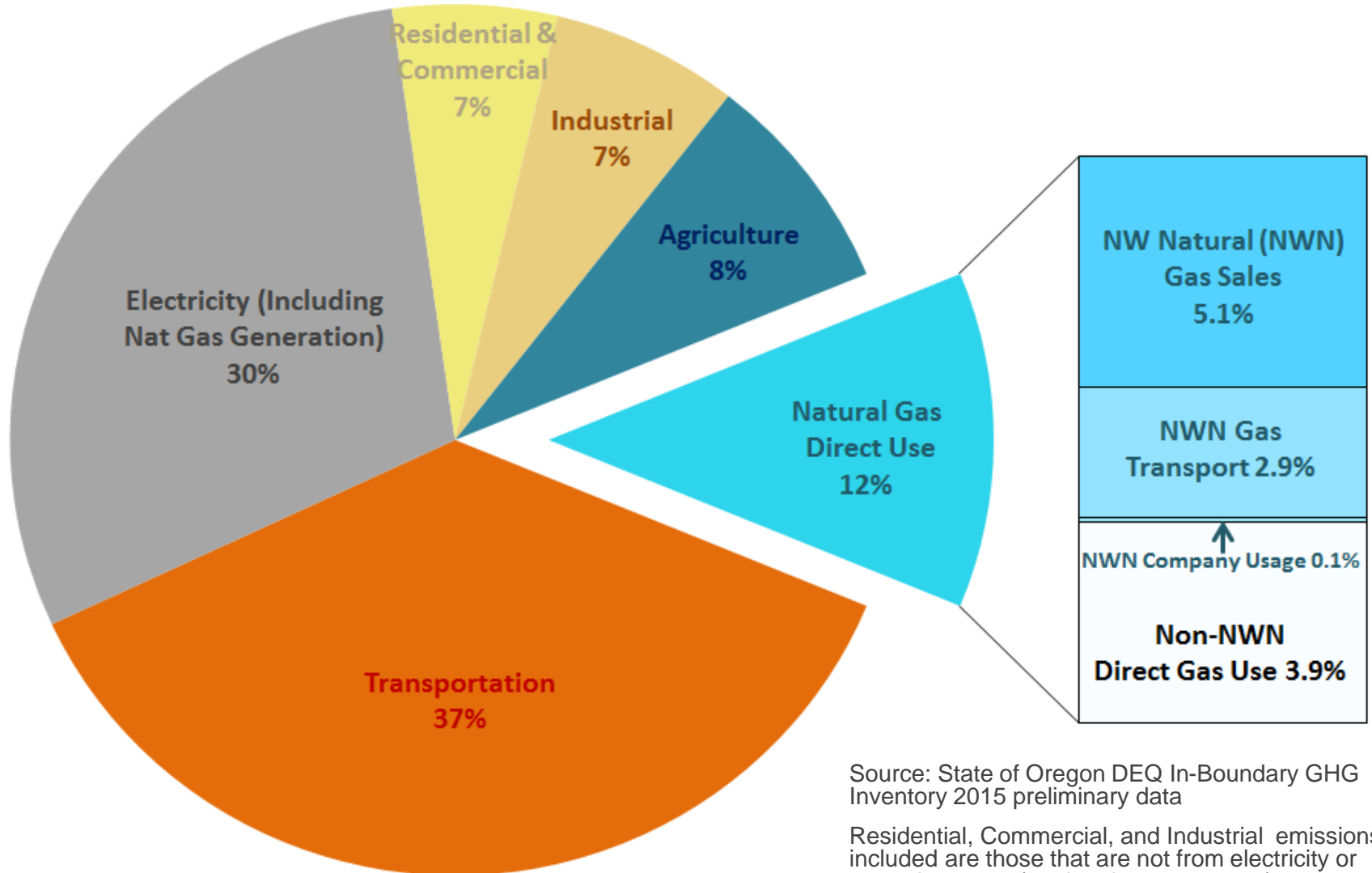
Gary Bauer
Government Affairs
July 25, 2017



Pacific Northwest Natural Gas Utilities



NW NATURAL CUSTOMERS: 8% OF OREGON'S GHG EMISSIONS

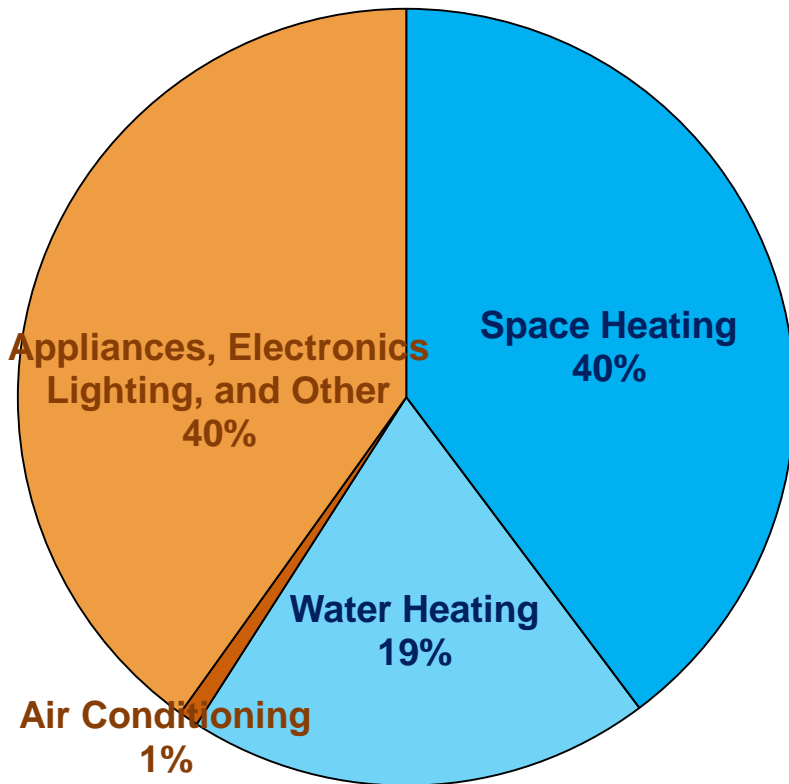


Source: State of Oregon DEQ In-Boundary GHG Inventory 2015 preliminary data

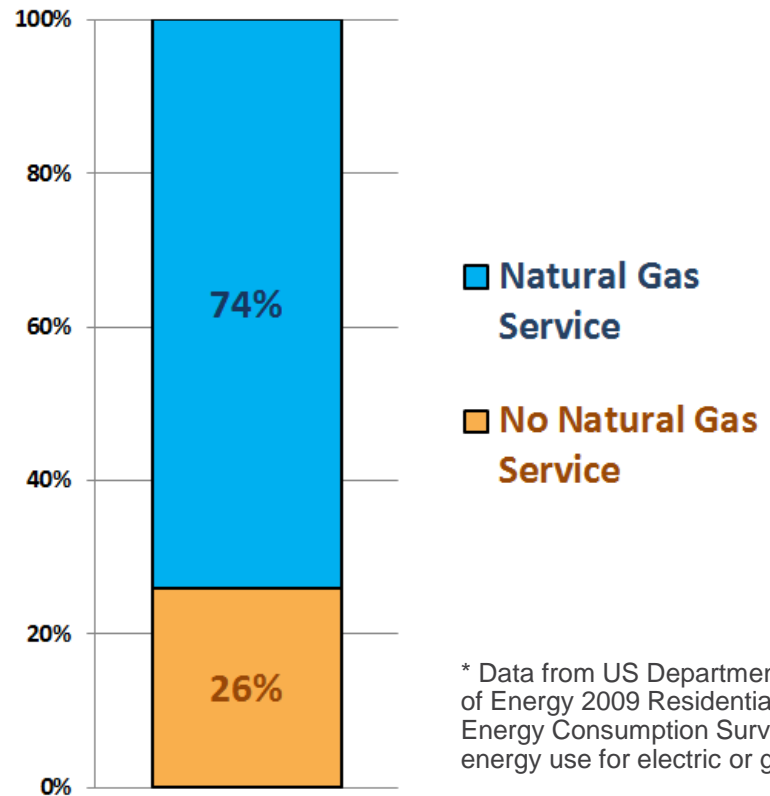
Residential, Commercial, and Industrial emissions included are those that are not from electricity or natural gas use (trash, other waste, etc.).

RESIDENTIAL ENERGY USE

Pacific Northwest Residential Annual Energy Use*



Share of Residential Square Footage in NWN Service Area with Natural Gas Service**



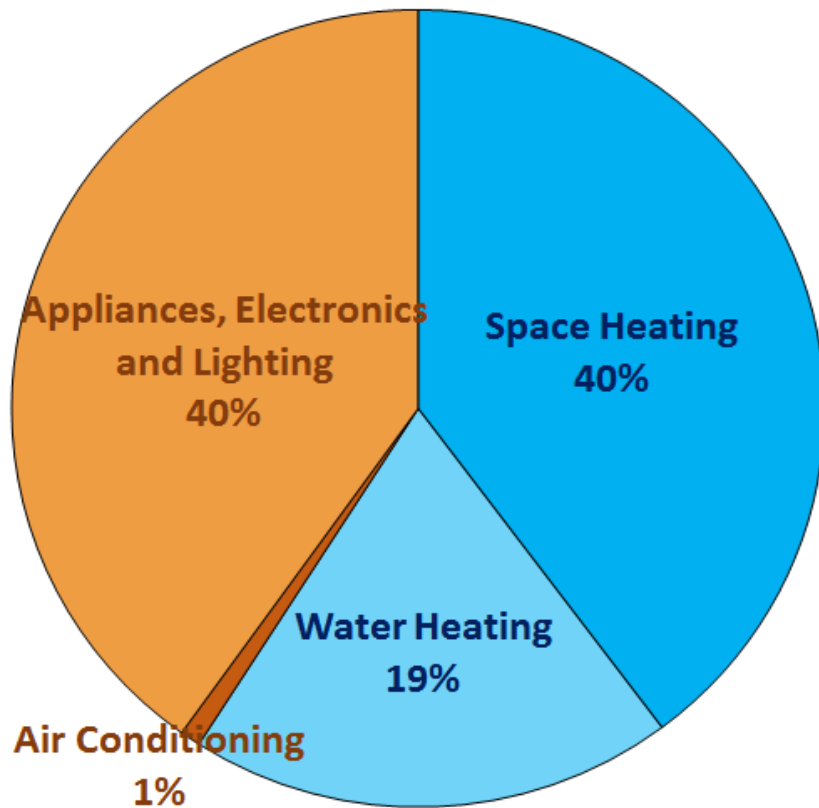
* Data from US Department of Energy 2009 Residential Energy Consumption Survey; energy use for electric or gas.

**Data from 2014 Residential Sites Database; Residences on or near NW Natural main service

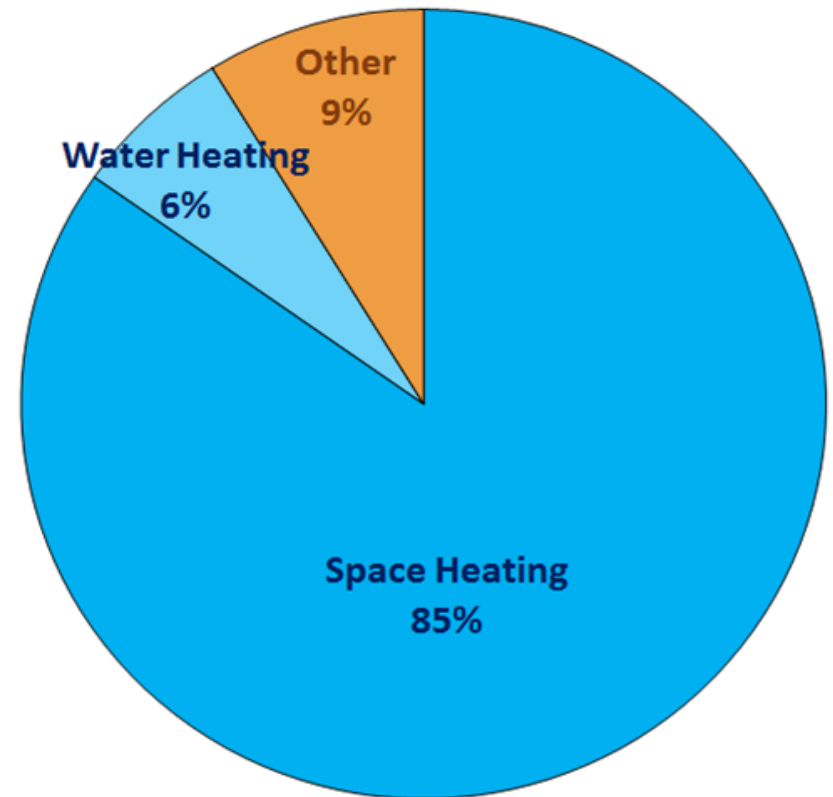
SPACE AND WATER HEATING: 90% OF PEAK HOUR ENERGY USE

PNW Household Usage: Annual vs. Peak Hour

Annual Usage



Winter Peak Hour Usage**



**Based on kWh usage of a home with a 9.0 HSPF heat pump and standard electric water heater for the 7am hour in the winter with a temperature of 7°F.

DIRECT USE TAKEAWAYS

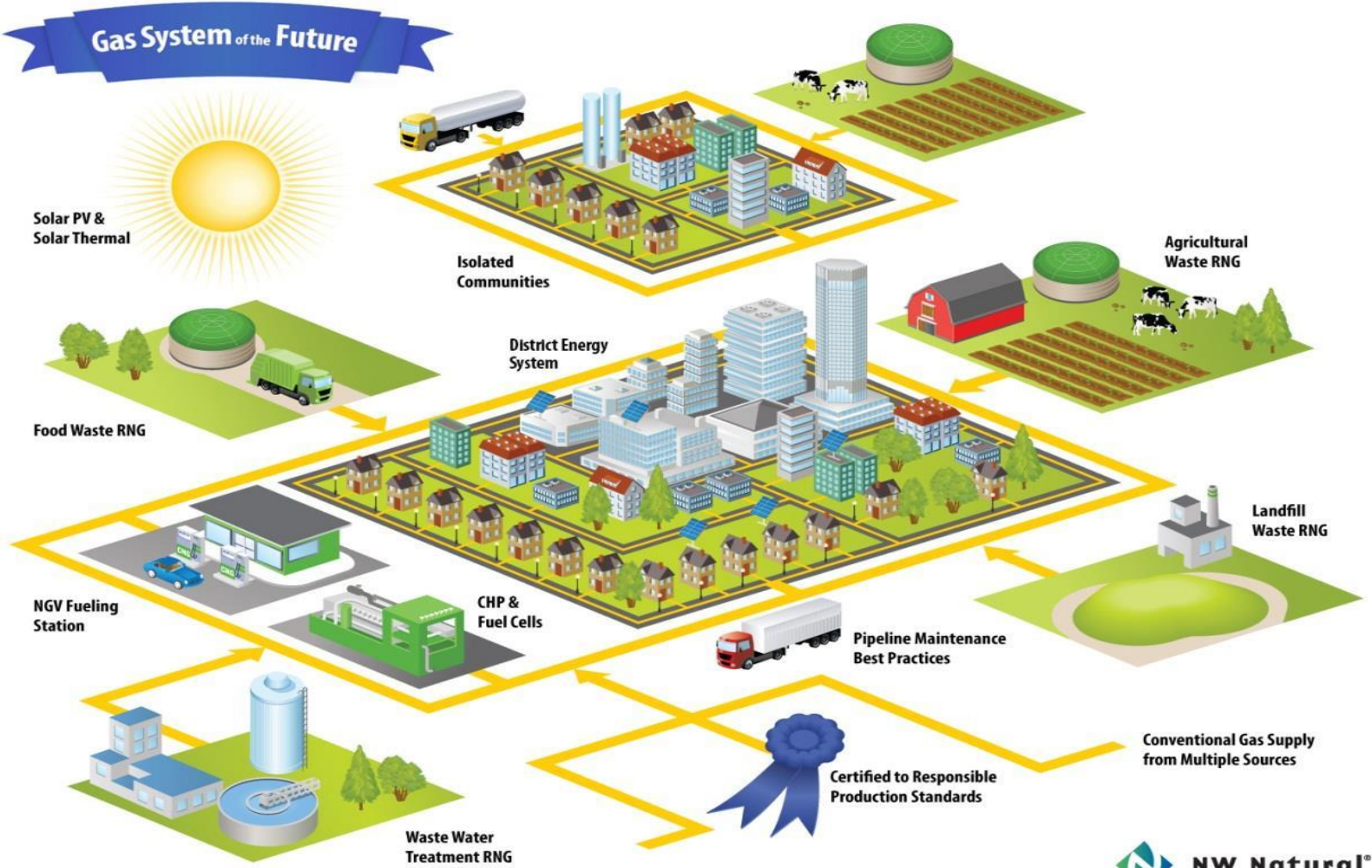
NW Natural's system is a highly efficient way to serve winter peak energy needs.

- **Heats 74%** of residential square footage in the areas we serve
- **Provides 90%** of peak day energy needs for our residential space and water heat customers
- **Serves 60%** of total peak hour energy use of buildings in the areas we serve
- **NW Natural's emissions account for 8%** of state's total carbon emissions

For perspective; to serve the current gas peak load with electricity, the Northwest's winter peak electric load would roughly double (increase by ~25GW).

- Assumes comprehensive adoption of high efficiency heat pumps for space and water heating.
- Assuming adoption of today's commonly purchased heat pumps, the electric winter peak load would roughly triple (increase by ~50GW).

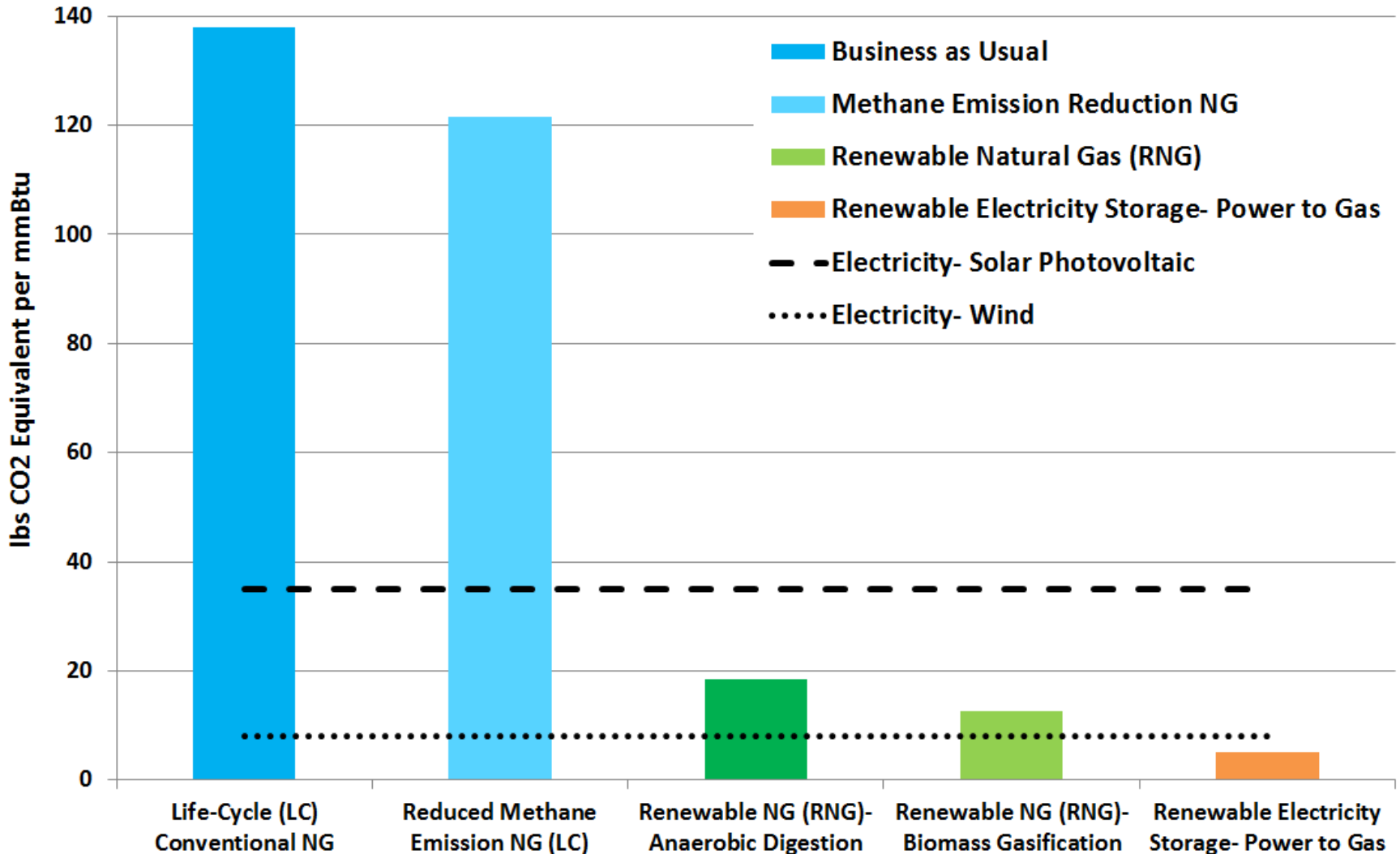
Gas System of the Future



LOWER EMITTING GAS



Relative Life-Cycle (LC) Natural Gas Carbon Intensities



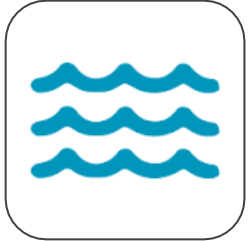
TRANSPORTATION



Near Zero Emission (NZE) Natural Gas Vehicles (NGVs):
Cleanest available technology for heavy duty applications.

- Transportation is the largest contributor to emissions and growing.
- In Oregon, nearly 50% of NOx emissions (air pollution) in the transportation sector come from heavy duty vehicles.
- Heavy duty vehicles account for the bulk of transportation emissions and air quality impacts.
- There are limited electric alternatives for heavy-duty use.
- New NGVs emit 90% less smog-forming pollutants than the cleanest diesel.
- NGV's deliver about a 20% reduction in carbon emissions
- Allows for drop-in renewable natural gas - provides for 80% or more reduction in GHGs.

POWER TO GAS (P2G)



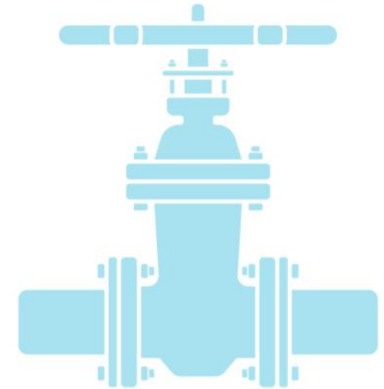
EXCESS
RENEWABLE
GENERATION



ELECTROLYSIS



H₂



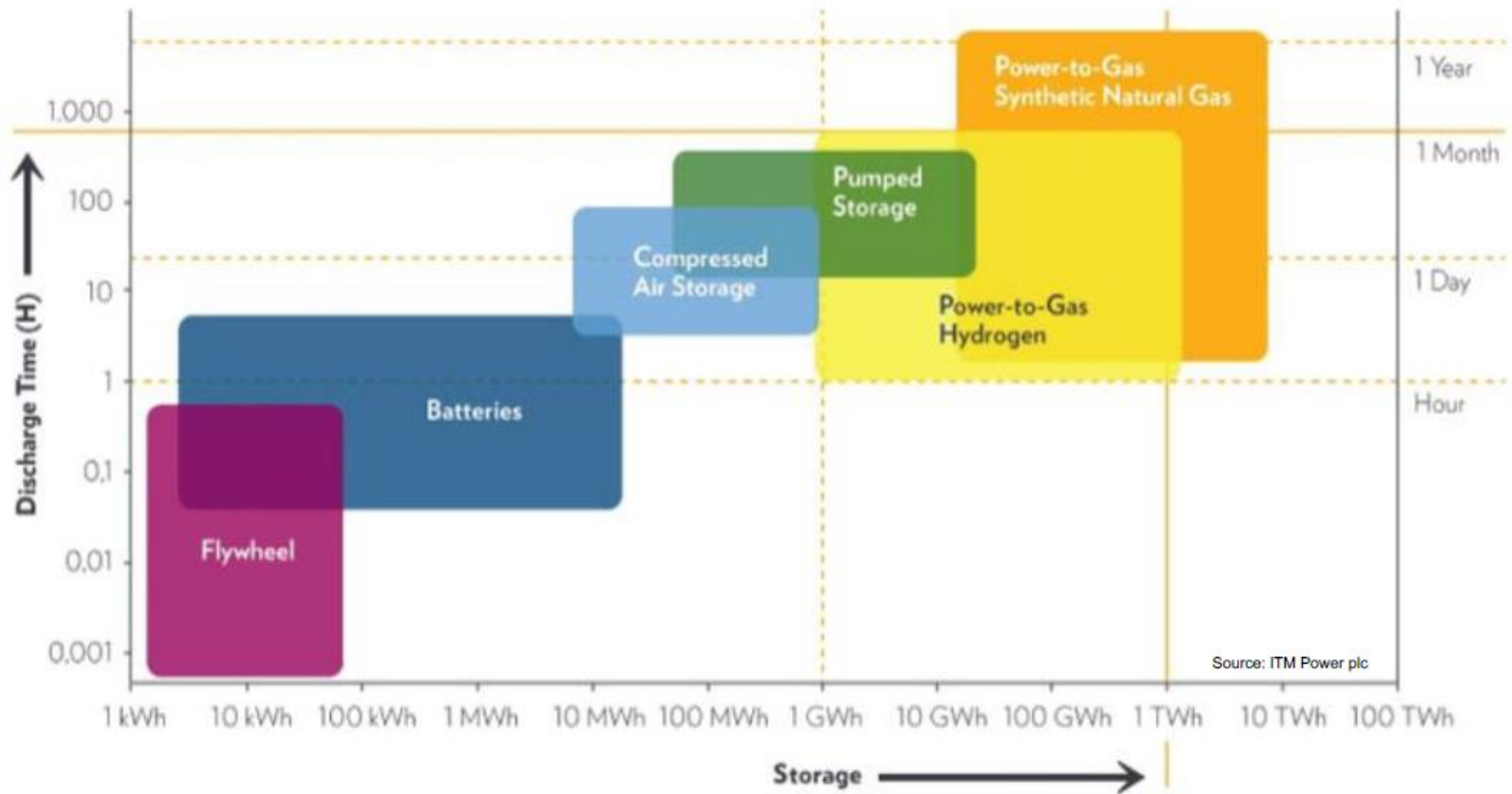
RENEWABLE
STORAGE ON
DISTRIBUTION
SYSTEM

Viable Seasonal Renewable Storage Solution

- Create hydrogen and blend up to 15% into the natural gas pipeline system without any impacts on end-use equipment, as we work toward 100% hydrogen utilization.

ENERGY STORAGE TECHNOLOGIES

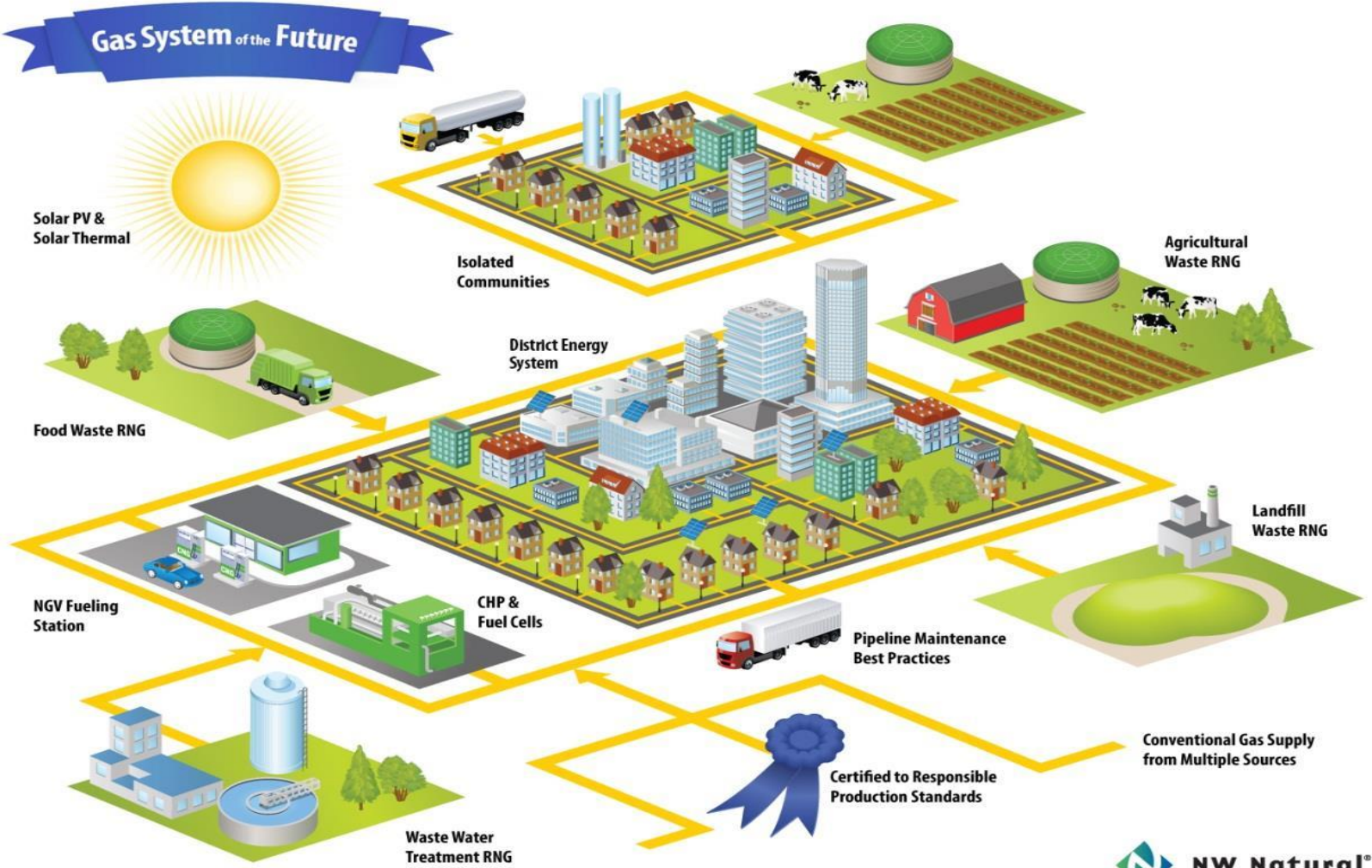
Power-to-gas is efficient | long term | low energy cost



ENERGY STORAGE TECHNOLOGIES

ENERGY STORAGE | CLEAN FUEL

Gas System of the Future



Questions

