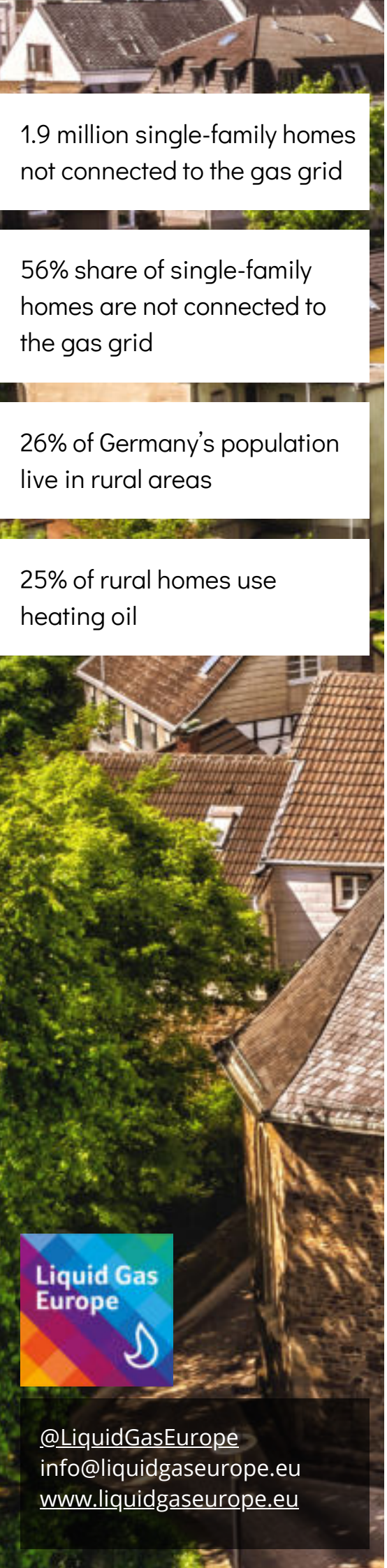


1.9 million single-family homes not connected to the gas grid

56% share of single-family homes are not connected to the gas grid

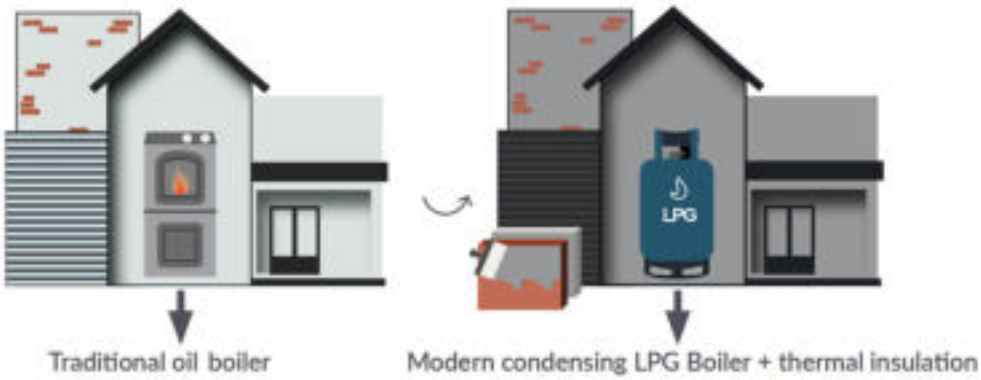
26% of Germany's population live in rural areas

25% of rural homes use heating oil

GERMANY

Case study: residential heating
#BeyondTheGasGrid

There are around 1.9 million single-family homes not connected to the gas grid in Germany.
This analysis takes a typical large detached single-family home in Germany and estimates the health and cost impact of switching from an old conventional oil boiler to a modern condensing LPG boiler. As well as changing heating systems, the household also chooses to retrofit its thermal insulation.



LPG annual CO2 savings: 63%
BioLPG annual CO2 savings: 90%

68% NOx emissions savings

66% Lifetime PM emissions savings

€933 Annual energy bill savings

Capital cost payback = 8.4 years

From 2030 onwards, it is assumed that the boiler is fuelled by bioLPG.

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Case study: residential heating
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Alternative technology options available:

The table below compares how alternative technology options compare to an existing oil boiler. The different heating systems include a new LPG boiler, an air source heat pump and a biomass boiler.

performs worse than old oil boiler

performs better than old oil boiler

Technology Options	Upfront cost*	Running cost	Lifetime CO_2 reduction	Lifetime air pollution reduction
LPG boiler: *New, condensing* + **Thermal insulation**	Similar to oil boiler	Substantially lower than oil boiler assuming that efficiency improvements are achieved (new boiler and thermal insulation)	Considerably lower than current oil boiler (over 60% using LPG, up to 90% using bioLPG)	Markedly lower than current oil boiler (60-80%)
Air Source Heat Pump + **Thermal insulation**	7-8 times more expensive than an oil boiler	Lower than oil boiler due to higher operating efficiency and thermal insulation	Lower than current oil boiler. Relatively high carbon-intensive energy mix (up to 70%)	Substantially lower than current oil boiler (up to 99%)
Biomass boiler: *New, automatic Pellet or log fuelled* + **Thermal insulation**	Up to 10 times more expensive than an oil boiler	Slightly lower than oil boiler	Substantially lower than current oil boiler (more than 90%)	PM emissions higher irrespective of wood type (more than 1000%) NOx emissions lower than oil (up to 60%)

**Upfront cost differences are case-specific; in this case the upfront cost for a heating system is modelled for an energy demand of ~20,000kWh/annual.*

Sources: Fraunhofer ISI, Building Research Establishment (BRE), European Environment Agency (EEA), VHK, Building Performance Institute Europe (BPIE), TABULA Webtool, European Commission Oil Bulletin, Eurostat, Covenant of Mayors EC, European Pellet Council, Building Research Establishment (BRE) and Deutsche Energie-Agentur (DENA)

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