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Impact of heat pumps, rooftop PV, and hydrogen blending on gas-electricity distribution networks in Northeast US

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Abstract-

The building sector is responsible for about 7% of overall greenhouse gas emissions in the US. Cutting the emissions by electrifying heating and cooling supply through heat pumps (HPs) leads to an increase in electricity demand and potential overloading of lines and transformers in electricity distribution systems. Although many studies investigate the maximum potential for HPs in existing distribution systems in Europe, they neglect a potential relieving effect of combining HPs with rooftop photovoltaic (PV) systems as well as the consequence of coupling the electricity and gas system at distribution level. Hence, we investigate the effect of HPs and rooftop PV systems in a representative distribution system in Northeast US and the potential of coupling electricity and gas distribution systems. We show that generally no overloading in average US electric distribution systems occurs even under high realistic HP and PV adoption rates. Moreover, our results show that combining HPs and rooftop PV reduces the impact on the distribution system throughout the year with the greatest reduction in spring and fall. In contrast, the potential for injecting hydrogen on distribution level is technically very limited and not economic. Thus, electrolyzers at distribution level are not able to reduce congestion in the electricity system.

Index Terms- distribution system, heat pump, hydrogen injection, integrated energy system, synthetic networks, sector coupling

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