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Sommario/riassunto	Long description: This thesis is about mathematical optimization for an efficient operation of gas transmission networks. The challenging question is how to expand and operate the network in order to facilitate the transportation of specified gas quantities at minimum cost. This problem is a major challenge for gas network operators. It is extremely hard to solve due to the combinatorial complexity of the active network elements such as compressors, the nonlinear physical characteristic of pipelines, and the immense sizes of the problem instances. Mathematical models and optimization techniques can result in huge gains for the network operators in terms of cost reductions and automated computations. We tackle this challenge by developing novel mathematical theory and associated innovative optimization algorithms for large scale instances. This allows us to produce solutions for a real-world instance, i.e., the largest gas network in Germany.