

## Software MYNTS

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# Simulation, analysis and optimization of networks for gas, H<sub>2</sub>, CO<sub>2</sub>, and electricity

In the future, thousands of kilometers of new grids will be built in Germany to make greater use of electricity from renewable energies. These new “intelligent networks” (smart grids) increase complexity, costs, and vulnerability. Fraunhofer SCAI has developed a software tool to analyze and optimize transport networks for gas, electricity, and water using numerical simulations as early as the planning stage. This makes conversion and expansion more flexible for network operators, saves energy and expenses, and increases the security of the energy supply.

Efficient transport networks for gas, electricity, and water are essential. One example: studies show that around three percent of the total electrical energy consumed is used for water supply - primarily for pumps. Optimized control has great economic potential: even small percentage savings significantly contribute to the environment and help save costs.

### Improved network planning and optimized use of stored energy and costs

Another example is the massive expansion and restructuring of the power grids in Germany that is needed to cope with the switch to renewable energies. The software is also interesting regarding smart grids, the expansion of which is being promoted by the German government. After all, the

intelligent networking and control of power generators, storage facilities, consumers, and grid resources are major economic and environmental challenges. Local solutions can also make important contributions: improved timing and savings, especially for energy-intensive companies, can reduce peak consumption and match electricity and gas consumption with supply.

### Flexible planning of gas, electricity, and water networks

The simulation software MYNTS (Multiphysical Network Simulator), which Fraunhofer SCAI developed jointly with the University of Cologne, helps operate and plan complex networks. The program models the networks as a system of algebraic differential equations so users can flexibly analyze and better draft them by numerical simulation. Above all, the simulation immediately shows the effects of changes in various factors. For example, MYNTS can be used to calculate how temperature fluctuations change flow rates and how the failure of subnetworks affects the remaining network components.

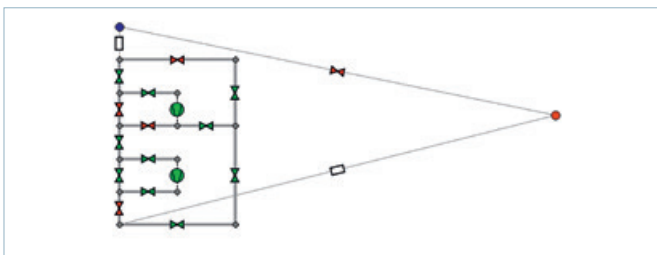
MYNTS takes advantage of the fact that the simulation of transportation networks for gas, electricity, and water and the simulation of electrical circuits are always based on the



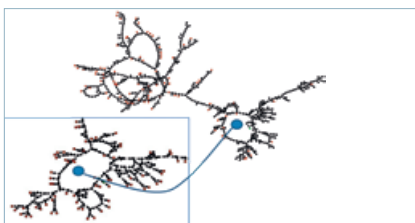
same numerical core. Nevertheless, each application field has its particularities. The software is therefore available in special versions for different areas of application. Combinations are also possible, for example, for investigations of power-to-gas scenarios. When simulating gas networks, users can use MYNTS to create and control subnetworks, for example, compressor stations or mixing chambers. Fraunhofer SCAI continuously develops MYNTS in close cooperation with industrial users (e.g., Open Grid Europe, Essen). Combined with the software tools "net'O'graph" and "DesParO," which were also developed by SCAI, tasks for graph analysis and comparison, statistical analyses, and parametric optimization tasks can be handled.

### New developments in MYNTS:

- templates (programmable assemblies) for reusable subnetworks
- more flexible modeling
- sector coupling (gas-electricity-heat)
- network viewer (Open Street Map)
- hydrogen share up to 100 percent (modeling according to GERG-2008)
- extension to liquid phases (e.g., for CO<sub>2</sub>-transport)
- free MYNTS reader for viewing and searching energy grids and scenarios



*Schematic illustration of a compressor station as a multi-use subnet for MYNTS gas*



*Graph representation of two gas subnets matched employing net'O'graph ("graph matching")*

### Software: MYNTS

- **Tasks:** Simulation, analysis, and optimization of transport networks for gas, electricity, water and CO<sub>2</sub>
- **Special features:** programmable subnetworks and elements, open modeling, steady-state, and time-dependent calculations; efficient numerical kernels, suitable for multi-processor computers; visualization
- **Availability:**
  - MYNTS-Gas: Windows, Linux
  - MYNTS-CO<sub>2</sub>: Windows, others on request
  - MYNTS-Water: for research purposes
  - MYNTS-Electricity: under development
- **[www.scai.fraunhofer.de/mynts](http://www.scai.fraunhofer.de/mynts)**

### Software: net'O'graph

- **Tasks:** Network and graph analysis, matching, layout
- **Special features:** extensive C++ library for analysis and optimization; drivers for various formats; efficient routines even for large networks
- **Availability:** Windows, others on request
- **[www.scai.fraunhofer.de/netograph](http://www.scai.fraunhofer.de/netograph)**

### Software: DesParO

- **Tasks:** Metamodeling, parametric analysis, and optimization
- **Special features:** efficient interpolation over response surfaces with adaptive model building, Pareto optimization, extensive statistical analysis, Python API networks
- **Availability:** Windows and Linux
- **[www.scai.fraunhofer.de/desparo](http://www.scai.fraunhofer.de/desparo)**

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