# ELFORSK
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# Grundvandsvarmepumper og –køling med grundvandsmagasiner som sæsonlager

BILAG 6

Eksisterende beregningsmodeller i TRNSYS-programmet

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Der er gennemført en kort undersøgelse af eksisterende modeller for simulering af ATES systemer i dynamiske simuleringsværktøjer. I denne forbindelse blev fokus rettet imod TRNSYS programmet, som oprindeligt er udviklet til simulering af vedvarende energisystemer som fx solvarmesystemer. Programmet er i løbet af sin levetid blevet udvidet med forskellige modeller der kan simulere forskellige ATES systemer. Disse modeller beskrives kort i det følgende ved kopier af de information er som findes på TRNSYS's officielle hjemmeside på internettet.

I simuleringsværktøjet TRNSYS findes en række modeller som alle er relateret til forskellige konfigurationer af energi hentet fra / lagret i undergrunden. I de følgende gengives nogle af de informationer som kan findes på www.trnsys.com.

### *TRNSYS*

*TRNSYS is a well respected energy simulation tool under continual development by a joint team made up of the Solar Energy Laboratory (SEL) at the University of Wisconsin – Madison, The Centre Scientifique et Technique du Bâtiment (CSTB) in Sophia Antipolis, France, Transsolar Energietechnik GmBH in Stuttgart, Germany and Thermal Energy Systems Specialists (TESS) in Madison, Wisconsin. TRNSYS currently boasts a graphical interface, a library of 80 standard components, add on libraries offering over 300 other components, a world wide user base and distributors in France, Germany, Spain, Sweden, Luxembourg, the US and Japan.*

### *Model libraries in TRNSYS*

Through various consulting projects well over 200 TRNSYS components have been developed. The components contained in these libraries represent the best of our in-house Types. Each of the components in these libraries has been extensively tested and comes complete with on-line documentation, source code, example projects, printed reference documentation and free technical support. Each of these libraries comes in a format compatible with the Simulation Studio front-end (source code, documentation, on-line help, icon, etc.) but may also be used outside that environment. The source code is provided for each of these models so that they can be quickly and easily modified if the user wishes to make changes to the model. Each of the component libraries comes with or more Studio/TRNSYS projects that demonstrate typical uses of the component models found in that library. Screen captures from several of the example projects are included in the detailed information section for each library. With the release of Libraries version 2.0, extensive technical documentation as well as new models and new examples have been added.

## Geothermal Heat Pump Component Models

 Ground Temperature Model

This component models the temperature of the earth as a function of depth and time of year. The model is based on the Kusuda correlation and is used in geothermal heat pump applications and basement loss calculations.

 Simple Buried Pipe

This component models a horizontal pipe that is buried in the earth. This simple approach (based on the standard TRNSYS type 31 plug-flow approach) requires the user to provide the heat transfer coefficient from the fluid to the ground and the ground temperature (usually provided by the new ground temperature model). Heat storage in the ground is not considered.

 Detailed Buried Pipe (Horizontal Ground Heat Exchanger)

This component models a horizontal pipe (or horizontal ground heat exchanger) that is buried in the earth. This model relies on a finite-difference approach to solve the temperature distribution in the pipe and soil and is based on a method developed by Oak Ridge National Laboratories. Heat storage in the ground is considered, but heat exchange between several buried pipes is not considered.

 Tube-in-Tube Vertical Ground Heat Exchanger

This component represents the finest vertical ground heat exchanger model in the world today! Written by the University of Lund, Sweden, this component has been extensively tested and updated over the past several years and is available for the very first time in TRNSYS format. The model includes both tube-in-tube and U-tube vertical ground heat exchangers (both single and multiple). The models rely on both analytical and finite-difference methods to model the complex heat transfer between the working fluid and the earth in which the heat exchanger is buried. This is the only ground heat exchanger model that we'll use - it's simply the best there is.

 U-Tube Vertical Ground Heat Exchanger

This component represents the finest vertical ground heat exchanger model in the world today! Written by the University of Lund, Sweden, this component has been extensively tested and updated over the past several years and is available for the very first time in TRNSYS format. The model includes both tube-in-tube and U-tube vertical ground heat exchangers (both single and multiple). The models rely on both analytical and finite-difference methods to model the complex heat transfer between the working fluid and the earth in which the heat exchanger is buried.

 Geothermal Heat Pump

This new component models the performance of a water-source heat pump (water to refrigerant to air heat transfer). The component uses a look-up table approach to calculate the cooling and heating capacities and power based on tables of manufacturer's data. Two sample data files are included with purchase (1 heating and 1 cooling). Data files for other manufacturer's/models may be created quickly and easily by the user and incorporated into the simulations. This model includes a de-superheater option for the heating of a domestic hot water stream.