
FMU Export of CYMDIST

Release 1.0.0

LBL - Building Technology and Urban Systems Division

Nov 07, 2016

CONTENTS

| | | |
|-----------|---|-----------|
| 1 | Introduction | 1 |
| 2 | Download | 3 |
| 2.1 | Release 1.0.0 (December 01, 2016) | 3 |
| 3 | Installation and Configuration | 5 |
| 3.1 | Software requirements | 5 |
| 3.2 | Installation | 5 |
| 3.3 | Uninstallation | 6 |
| 4 | Creating an FMU | 7 |
| 4.1 | Command-line use | 7 |
| 4.2 | Output | 8 |
| 5 | Usage of CYMDIST as an FMU | 9 |
| 6 | Best Practice | 11 |
| 7 | Development | 13 |
| 8 | Notation | 15 |
| 9 | Glossary | 17 |
| 10 | Acknowledgments | 19 |
| 11 | Disclaimers | 21 |
| 12 | Copyright and License | 23 |
| | Index | 25 |

INTRODUCTION

This user manual explains how to install and use CYMDISTPy. CYMDISTPy is a software package written in Python which allows users to export the distribution simulation program *CYMDIST* version 7.2 or as a *Functional Mock-up Unit* (FMU) for model exchange using the *Functional Mock-up Interface* (FMI) standard *version 2.0*. This FMU can then be imported into a variety of simulation programs that support the import of the Functional Mock-up Interface for model exchange.

DOWNLOAD

The CYMDISTPy release includes scripts and source code to export CYMDIST version 7.2 as an FMU for model exchange for Windows 32.

To install CYMDISTPy, follow the section *Installation and Configuration*.

Release 1.0.0 (December 01, 2016)

Download [CYMDISTPy-1.0.0.zip](#).

Release notes

First release that uses FMI version 2.0 for model exchange.

INSTALLATION AND CONFIGURATION

This chapter describes how to install, configure and uninstall CYMDISTPy.

Software requirements

To export CYMDIST as an FMU, CYMDISTPy needs:

1. Python 3.4.x. 32bit
2. jinja2
3. lxml
4. pandas
5. numpy
6. cython
7. Dymola

CYMDISTPy has been tested with:

- Windows 10 64 bit Professional.
- Dymola 2017.

Installation

To install CYMDISTPy, proceed as follows:

1. Download the installation file from the [Download](#) page.
2. Unzip the installation file into any subdirectory (hereafter referred to as the “installation directory”).

The installation directory should contain the following subdirectories:

- dev/
 - parser/ (Python scripts, Modelica templates and xsd validator files.)
 - cymdist/ (Python scripts for communicating with CYMDIST.)
 - fmuChecker/ (fmuChecker binaries for running unit test)
 - bin/ (Scripts for running unit tests.)
 - fmus/ (FMUs folder.)

- `models/` (Examples models)
 - `cymdist`

3. Add following folders to your system path:

- Python installation folder (e.g. `C:\Python34`)
- Python scripts folder (e.g. `C:\Python34\Scripts`),
- Dymola executable folder (e.g. `C:\Program Files (x86)\Dymola2017\bin`)

You can add folders to your system path by performing following steps on Windows 8 or 10:

- In Search, search for and then select: System (Control Panel)
- Click the Advanced system settings link.
- Click Environment Variables. In the section System Variables, find the PATH environment variable and select it. Click Edit.
- In the Edit System Variable (or New System Variable) window, specify the value of the PATH environment variable (e.g. `C:\Python34,C:\Python34\Scripts`). Click OK. Close all remaining windows by clicking OK.
- Reopen Command prompt window for your changes to be active.

To check if the variables have been correctly added to the system path, type `python` into a command prompt to see if the right version of Python starts up.

4. Install Python dependencies by running

```
pip install -r bin/cymdistpy-dependencies.txt
```

Note: `lxml` cannot be installed using `pip`. Please download and install the executable (`lxml-3.4.4.win32-py3.4.exe`) from [PyPyi](#).

Uninstallation

To uninstall CYMDISTPy, delete the *installation directory*.

CREATING AN FMU

This chapter describes how to create a Functional Mockup Unit, starting from a CYMDIST model description input file. It assumes you have followed the *Installation and Configuration* instructions, and that you have created the CYMDIST model description file following the *Best Practice* guidelines.

Command-line use

To create an FMU, open a command-line window (see *Notation*). The standard invocation of the CYMDISTPy tool is:

```
> python <scriptDir>CYMDISTWriter.py \
  -g <path-to-grid-model-file> \
  -i <path-to-input-file> -b <path-to-buildings-lib-file> \
  -m <path-to-modelica-template-file> \
  -s <path-to-modelica-script-template-file> -x <path-to-xsd-file> \
  -r <flag-to-write-results>
```

where `scriptDir` is the path to the scripts directory of CYMDISTPy. This is the `parser/` subdirectory of the installation directory. See *Installation and Configuration* for details.

If `CYMDISTWriter.py` is run from within `scriptDir` then only the required arguments are needed as shown in the following example:

```
# Windows:
> python CYMDISTWriter.py -g C:\grid\test.sxst -i test.xml -b modelica-buildings
```

where `scriptDir` is the path to the scripts directory of CYMDISTPy. Typically this is the `parser/` subdirectory of the installation directory. See *Installation and Configuration* for details.

All file paths can be absolute or relative. For readability, the rest of these instructions omit the paths to the script and input files.

Note: If any file path contains spaces, then it must be surrounded with double quotes.

Script `CYMDISTWriter.py` supports the following command-line switches:

| option <argument> | Purpose |
|--|--|
| -g <path-to-grid-model-file> | Path to the grid model (required). |
| -i <path-to-input-file> | Path to the input file (required). |
| -b <path-to-buildings-lib-file> | Path to the Buildings library (required). |
| -m <path-to-modelica-template-file> | Path to the Modelica template file This file is in the <code>scriptDir</code> . If the script is run for the <code>scriptDir</code> then this file is not required. |
| -s <path-to-modelica-script-template-file> | Path to the Modelica script template file This file is in the <code>scriptDir</code> . If the script is run for the <code>scriptDir</code> then this file is not required. |
| -x <path-to-xsd-file> | Path to the XSD validator file. This file is in the <code>scriptDir</code> . If the script is run for the <code>scriptDir</code> then this file is not required. |
| -r <flag-to-write-results> | Flag to write results. 0 if results should not be written, 1 else. Default is 0. |

The main functions of CYMDISTPy are

- reading, validating, and parsing the CYMDIST XML input file,
- writing Modelica code with input and outputs,
- invoking Dymola to compile the Modelica code as an FMU for model exchange 2.0.

Note: In the process of creating the FMU, CYMDISTPy will rewrite the model description file generated by Dymola to include `needsExecutionTool=true` attribute in the FMU capabilities of the CYMDIST FMU. This is currently not supported by default in Dymola.

Output

The main output from running `CYMDISTWriter.py` consists of an FMU, named after the `modelName` specified in the input file. The FMU is written to the current working directory, that is, in the directory from which you entered the command.

The FMU is complete and self-contained. Any secondary output from running the CYMDISTPy tools can be deleted safely.

Note that the FMU is a zip file. This means you can open and inspect its contents. To do so, it may help to change the “.fmu” extension to “.zip”.

USAGE OF CYMDIST AS AN FMU

The following items must be observed to import an FMU that contains CYMDIST:

1. Python 3.4 must be installed.
2. CYME version 7.2 must be installed. CYME can be downloaded from www.cyme.com.
3. The CYMDIST Python API scripts directory must be added to the PYTHONPATH.

Note: The CYMDIST Python API scripts are in the installation folder of CYME. It can typically be found in `pathCYME\CYME\cympy`, where `pathCYME` is the path to the installation folder of CYME 7.2.

To add the CYMDIST Python API scripts folder to the PYTHONPATH:

- In Search, search for and then select: System (Control Panel).
 - Click the Advanced system settings link.
 - Click Environment Variables. In the section System Variables, find a variable named PYTHONPATH environment variable and select it. If the variable does not exist, create it. Click Edit.
 - In the Edit System Variable (or New System Variable) window, specify the value of the PYTHONPATH environment variable which should in our case be `pathCYME\CYME`. Note that `cympy` is not included in the name of the variable.
4. The `cymdist` utility folder must be added to the PYTHONPATH. The `cymdist` utility folder can be found in the distribution of CYMDISTPy. It is in `dev/cymdist`. To complete your set-up, add the folder `dev\cymdist` to the PYTHONPATH.

BEST PRACTICE

This section explains to users the best practice in configuring a CYMDIST XML input file for an FMU.

To export CYMDIST as an FMU, the user needs to write an XML file which contains the list of inputs, outputs and parameters of the FMU. The XML snippet below shows how a user has to write such an input file. A template named `CYMDISTModeldescription.xml` which shows such a file is provided in the `parser` installation folder of CYMDISTPy. This template should be used and modified to create new XML input file.

The following snippet shows an input file where the user defines one input and one output variable.

```
1 <?xml version="1.0" encoding="UTF-8"?>
2 <CYMDISTModelDescription
3   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
4   fmiVersion="2.0"
5   modelName="HL0004"
6   description="Input data for a CYMDIST FMU"
7   generationTool="CYMDISTPy">
8   <ModelVariables>
9     <ScalarVariable
10      name="VMAG_A"
11      description="VMAG_A"
12      causality="input">
13       <Real
14        unit="kV"
15        start="0.0"/>
16     </ScalarVariable>
17     <ScalarVariable
18      name="voltage_A"
19      description="voltage_A"
20      causality="output">
21       <Real
22        unit="V"/>
23       <Device
24        name="HOLLISTER_2104"/>
25     </ScalarVariable>
26   </ModelVariables>
27 </CYMDISTModelDescription>
```

To create such an input file, the user needs to specify the name of the FMU (Line 5). This is the `modelName` which should be unique. The user then needs to define the inputs and outputs of the FMUs. This is done by adding `ScalarVariable` into the list of `ModelVariables`.

To parametrize the `ScalarVariable` as an input variable, the user needs to

- define the name of the variable (Line 10),
- give a brief description of the variable (Line 11)

- give the causality of the variable (`input` for inputs, `output` for outputs) (Line 12)
- define the type of variable (Currently only `Real` variables are supported) (Line 13)
- give the unit of the variable (Currently only valid Modelica units are supported) (Line 14)
- give a start value for the input variable (This is optional) (Line 15)

To parametrize the `ScalarVariable` as an output variable, the user needs to

- define the name of the variable (Line 18),
- give a brief description of the variable (Line 19)
- give the causality of the variable (`input` for inputs, `output` for outputs) (Line 20)
- define the type of variable (Currently only `Real` variables are supported) (Line 21)
- give the unit of the variable (Currently only valid Modelica units are supported) (Line 22)
- give the name of the output device (Line 24)

Note: To avoid name-clash, CYMDISTPy concatenates the name of the output with the name of the device to make it unique. The new output name will have the form `outputName_DeviceName`.

DEVELOPMENT

The development site of this software is at <https://github.com/lbl-srg/cyder>.

To clone the master branch, type

git clone <https://github.com/lbl-srg/cyder.git>

NOTATION

This chapter shows the formatting conventions used throughout the User Guide.

The command-line is an interactive session for issuing commands to the operating system. Examples include a DOS prompt on Windows, a command shell on Linux, and a Terminal window on MacOS.

The User Guide represents a command window like this:

```
# This is a comment.  
> (This is the command prompt, where you enter a command)  
(If shown, this is sample output in response to the command)
```

Note that your system may use a different symbol than “>” as the command prompt (for example, “\$”). Furthermore, the prompt may include information such as the name of your system, or the name of the current subdirectory.

GLOSSARY

Dymola Dymola, Dynamic Modeling Laboratory, is a modeling and simulation environment for the Modelica language.

Functional Mock-up Interface The Functional Mock-up Interface (FMI) is the result of the Information Technology for European Advancement (ITEA2) project *MODELISAR*. The FMI standard is a tool independent standard to support both model exchange and co-simulation of dynamic models using a combination of XML-files, C-header files, C-code or binaries.

Functional Mock-up Unit A simulation model or program which implements the FMI standard is called Functional Mock-up Unit (FMU). An FMU comes along with a small set of C-functions (FMI functions) whose input and return arguments are defined by the FMI standard. These C-functions can be provided in source and/or binary form. The FMI functions are called by a simulator to create one or more instances of the FMU. The functions are also used to run the FMUs, typically together with other models. An FMU may either require the importing tool to perform numerical integration (model-exchange) or be self-integrating (co-simulation). An FMU is distributed in the form of a zip-file that contains shared libraries, which contain the implementation of the FMI functions and/or source code of the FMI functions, an XML-file, also called the model description file, which contains the variable definitions as well as meta-information of the model, additional files such as tables, images or documentation that might be relevant for the model.

Modelica Modelica is a non-proprietary, object-oriented, equation-based language to conveniently model complex physical systems containing, e.g., mechanical, electrical, electronic, hydraulic, thermal, control, electric power or process-oriented subcomponents.

MODELISAR MODELISAR is an ITEA 2 (Information Technology for European Advancement) European project aiming to improve the design of systems and of embedded software in vehicles.

PyFMI PyFMI is a package for loading and interacting with Functional Mock-Up Units (FMUs), which are compiled dynamic models compliant with the Functional Mock-Up Interface (FMI).

Python Python is a dynamic programming language that is used in a wide variety of application domains.

ACKNOWLEDGMENTS

The development of this documentation was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technologies of the U.S. Department of Energy, under contract No. xxx.

The following people contributed to the development of this program:

- Thierry Stephane Noudui, Lawrence Berkeley National Laboratory
- Jonathan Coignard, Lawrence Berkeley National Laboratory
- Michael Wetter, Lawrence Berkeley National Laboratory

DISCLAIMERS

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor The Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or The Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or The Regents of the University of California.

COPYRIGHT AND LICENSE

Functional Mock-up Unit Export of CYMDIST 2016, The Regents of the University of California, through Lawrence Berkeley National Laboratory (subject to receipt of any required approvals from the U.S. Department of Energy). All rights reserved.

xxxx fixme xxx still needed

D

Dymola, [17](#)

F

Functional Mock-up Interface, [17](#)

Functional Mock-up Unit, [17](#)

M

Modelica, [17](#)

MODELISAR, [17](#)

P

PyFMI, [17](#)

Python, [17](#)