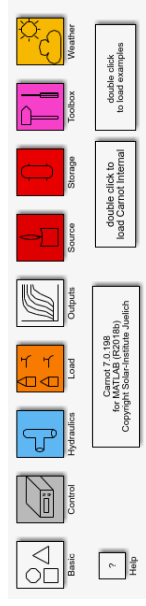


Carnot User Meeting

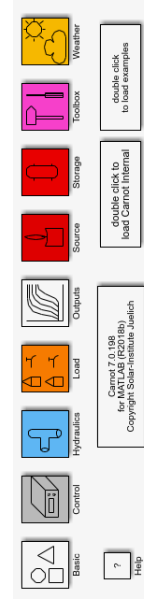
Innsbruck 01/07/2022

Bernd Hafner

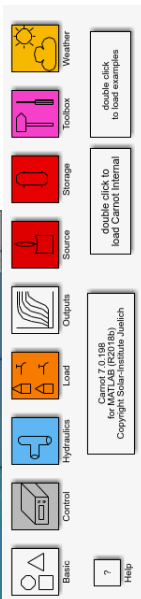
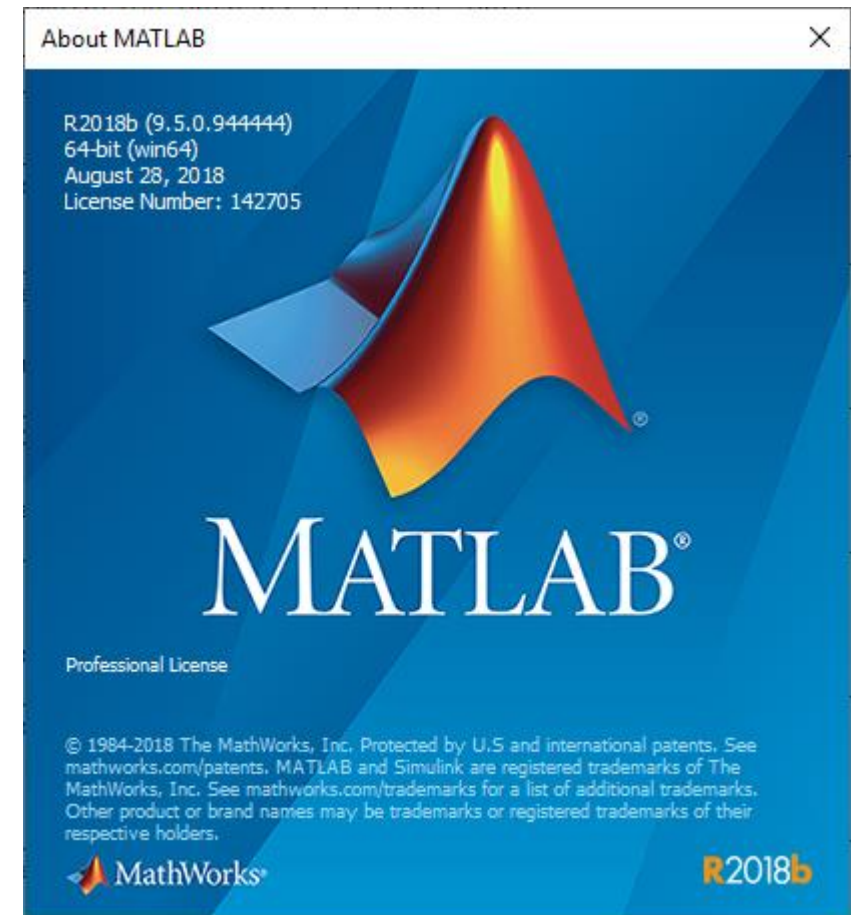
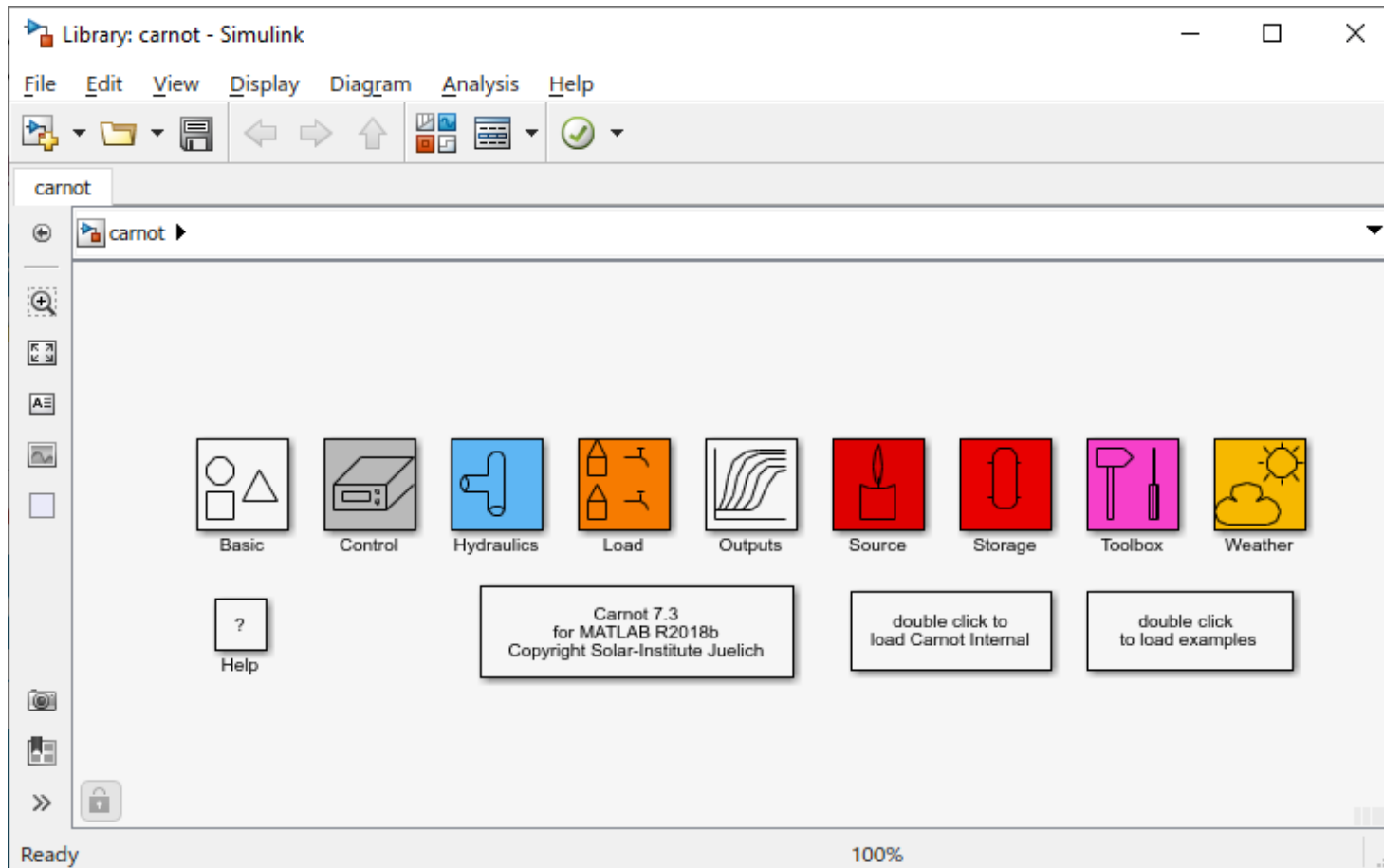


Carnot

- Current development
- Where to find it
- Major application
- Bug fixes and new features
- Next release



Carnot 7.3 for Matlab R2018b



CARNOT development group

Sorted members list:

Mara Magni, Elisa Venturi, Fabian Ochs,

Christoph Messmer, Stephan Volkmer,

Patrick Kefer, Thorsten Summ,

Jens Schaumann, Bernd Hafner,

Tobias Blanke, Joachim Götsche,

Ralf Dott, Arnold Wohlfeil,

Dennis Götzelmann

- Web-conference every 4-8 weeks
- New features
- Bug reporting
- Organize the user meeting

	Nr.	Datum	Titel	Beschreibung	Verantwortlich	Termin	Status	Aktueller St
1								1 offen, Termi
2								2 offen
3								3 erledigt
4								
341	337	24.08.2021	Matlab-Version f. zukünftige Releases	für 2021b erstellen, u.a. wg. besserem Zeitreihen-Handling	Arnold, Bernd, Dennis, Elisa, Fabian, Jens, Mara, Patrick, Sebastian, Joachim			zur Info
342	338	19.10.2021	Webconf 15 Uhr					
351	347	30.11.2021	Webconf 15 Uhr					
354	350	30.11.2021	git statt SVN	Synchronisationstool gestoppt. Bitte nur noch git verwenden, bitte testen.	Joachim		●	2
355	351	30.11.2021	verification	Schwellwerte? Wo sinnvoll, Abweichungen in % angeben. Im Einzelfall anschauen, Zahlen-Darstellung ändern (%g)	Joachim	Jun 22	●	2
356	352	21.12.2021	Webconf Nutzertreffen '22					
357	353	22.02.2022	Webconf 16 Uhr					
358	354		Neue Solver in Simulink	neue Solver ode78 und ode89 prüfen				
360	356	29.03.2022	Webconf 16 Uhr		Patrick, Fabian, Dennis, Thorsten, Elisa, Christoph, Mara, Jens, Ralf			
362	358		html-Dok zu CARNOT auf FH-Seite erneuern		Joachim	31.03.2022	●	2
363	359	03.05.2022	Webconf 16 Uhr		Mara, Elisa, Fabian, Dennis, Jens, Patrick, Bernd, Joachim			
364	360	14.06.2022	Webconf 15 Uhr		Elisa, Fabian, Thorsten, Bernd, Patrick, Jens, Joachim			
365	361		Skript zum Anpassen an aktuelle Matlab Version	Patrick erstellt Skript zum Anpassen der Toolbox an jeweils aktuelle Matlab/Simulink-Version	Patrick	01.10.2022	●	2
366	362		Prozedere zum Erstellen neuer Versionen dokumentieren	z. B. auf gitlab-Wiki	Patrick	01.10.2022	●	2
367	363	20.07.2022	Webconf 14 Uhr					
368	364							

Carnot – Where to find it?

<https://de.mathworks.com/matlabcentral/fileexchange/68890-carnot-toolbox>

File Exchange

MATLAB Central ▾ | Files | Authors | My File Exchange | Contribute | About

File Exchange badges are here.

View badges you can earn by participating in the File Exchange community.



CARNOT Toolbox

version 7.0 by Arnold Wohlfeil

The CARNOT toolbox contains models for thermodynamics/energy engineering with focus on HVAC systems.

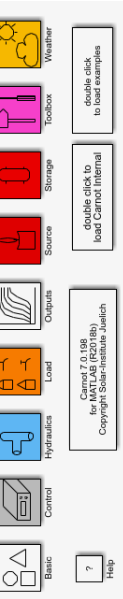
<https://fh-aachen.sciebo.de/index.php/s/0hxub0ilJrui3ED>

<https://www.fh-aachen.de/forschung/solar-institut-juelich/carnot/>

SIJ | SOLAR-INSTITUT JÜLICH CARNOT Toolbox

CARNOT is a toolbox extension for MATLAB SIMULINK. It is a tool for the calculation and simulation of the thermal components of HVAC systems with regards to conventional and regenerative elements. The CARNOT Toolbox is a library of typical components of these systems. It is organized in Blocksets like the SIMULINK Library itself. The handling of the blocks is exactly the same as in SIMULINK, so that users familiar with SIMULINK can directly use the new Blocksets in the same way.

Email: carnot@sj.fh-aachen.de



Carnot – Documentation

<https://fh-aachen.sciebo.de/index.php/s/0hxeb0ilJrui3ED?path=%2F>

The screenshot shows the sciebo file manager interface. At the top, there is a green header with the sciebo logo and a search bar containing "Hinzufügen fh-aachen.sciebo.de". Below the header, there is a navigation bar with "Alle Dateien" and a right-pointing arrow. The main area displays a list of files and folders in a table format. The columns are "Name", "Größe", and "Geändert".

<input type="checkbox"/>	Name ▲	Größe	Geändert
	CARNOT_documentation_7.1	60.4 MB	vor 2 Jahr
	Nutzertreffen	244.3 MB	vor 2 Mon
	Publikationen	24.7 MB	vor 12 Tag
	Versionsarchiv	1.2 GB	vor 2 Mon
	CARNOT_7.3.zip	222.8 MB	vor 2 Mon
	CARNOT_Anfaenger_Anleitung_ZIES_F... .pdf	1.2 MB	vor 6 Jahr
	ReleaseNotes_Carnot_7.3.txt	4 KB	vor 2 Mon






The screenshot shows the sciebo file manager interface with a list of folders. The header is green and contains "Hinzufügen fh-aachen.sciebo.de" and a right-pointing arrow. Below the header, there is a navigation bar with "Alle Dateien" and a right-pointing arrow, followed by "Nutzertreffen" and another right-pointing arrow. The main area displays a list of folders in a table format. The columns are "Name" and "Größe".

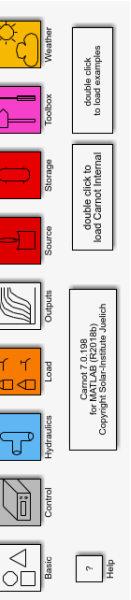
<input type="checkbox"/>	Name ▲	Größe
	2006_Duesseldorf	
	2009_Duesseldorf	
	2011_Ingolstadt	
	2012_Bayreuth	
	2013_Basel	
	2014_Juelich	
	2015_Innsbruck	
	2016_Rapperswil	
	2017_Duesseldorf	
	2018_Darmstadt	
	2019_Wels	
	2020_Biberach	
	2021_Ingolstadt	
	2021_Online_Workshop	

A vertical sidebar of utility icons on the right side of the page. From top to bottom, the icons are: Weather (yellow sun and clouds), To-Do List (pink notepad), Storage (red hard drive), Source (red folder), Origins (white wavy lines), Load (orange scale), Hydraulics (blue pipe), Control (grey control panel), Basic (white geometric shapes), and Help (white question mark). To the right of these icons are two text boxes: "double click to load examples" and "double click to load Carnot Internal". Below the icons is a copyright notice: "Copyright © 2019-2022 by sciebo GmbH".

Carnot – User Group

<https://www.gomatlab.de/carnot-toolbox-f108.html>

CARNOT-Toolbox		Themen	Antworten	Aufrufe	Letzter Beitrag
	Fragen zum Batteriespeicher (beantwortet) von Der_Simulant		4	66	20.06.2022, 15:11 Der_Simulant →
	Fragen zum Wärmeübertrager (beantwortet) von Der_Simulant		5	142	16.06.2022, 15:25 Der_Simulant →
	Schon der Start scheitert (beantwortet) von Der_Simulant		4	144	19.05.2022, 12:34 Der_Simulant →
	Entsalzung modell (offen) von nozomia		3	176	06.04.2022, 09:38 askep →
	Sim. PV Anlage - Unplausible Peaks - Solver Einstellungen? (mit Vorschlag) von Felix_RRR		2	613	12.04.2021, 12:01 DrBernd →
	Real-Time-Adapter für Simulationen mit OPAL-RT-Simulator (offen) von Steffi_T		0	500	22.09.2020, 13:50 Steffi_T →
	Parameter für die Wärmepumpe (mit Vorschlag) von Pero		1	647	14.07.2020, 18:10 askep →

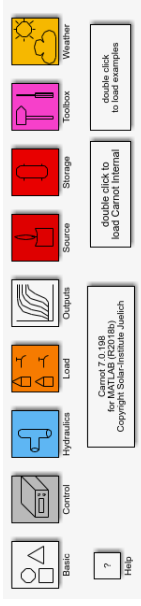


Weather
Toolbox
Storage
Source
Outputs
Load
Hydraulics
Control
Basic
Help

double click to load Carnot Internal
double click to load Carnot Internal
Copyright © 2020 (B) for MATLAB (2020B)
Copyright © 2020 (B) for MATLAB (2020B)

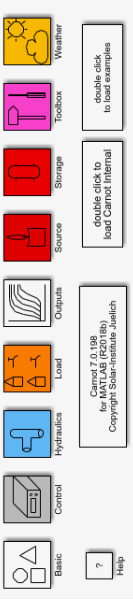
Carnot : Major Application

- Simulation of solar systems (thermal & electric)
- Simulation of HVAC systems
- Calculation of fluid properties, solar position, fluid flow and heat transfer characteristics (Reynolds, Grashof, Prandtl, ...)

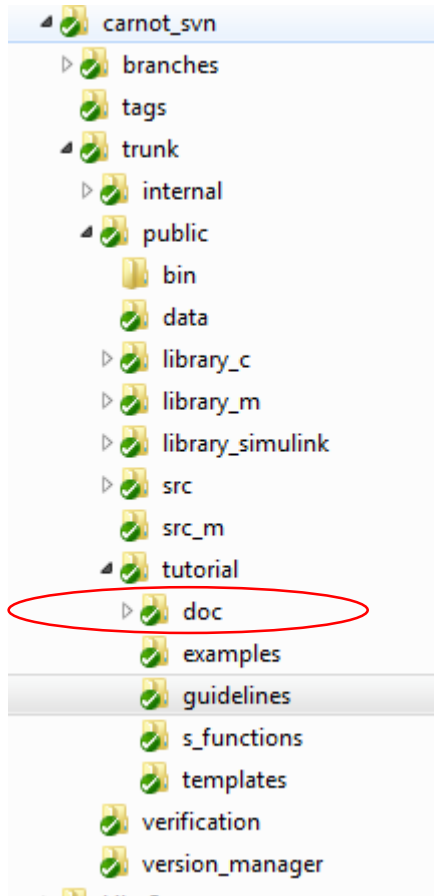


Carnot : Major Application

- Simulation of solar systems (thermal & electric)
- Simulation of HVAC systems
- Calculation of fluid properties, solar position, fluid flow and heat transfer characteristics (Reynolds, Grashof, Prandtl, ...)
- **A quite powerful tool for Model Based Development using the Matlab features for requirement engineering, MIL / HIL / SIL, code generation and testing**



Carnot folders: Tutorial



Carnot m-Functions for Blocks Overview

Contents

- [Basic / Electric](#)
- [Basic / Heat_Transfer](#)
- [Basic / Hydraulics](#)
- [Basic / Material_Properties](#)
- [Basic / Thermal_Models](#)
- [Hydraulics](#)
- [Load / General](#)
- [Load / Hot_Water_Tapping](#)

Basic / Thermal_Models

[hp_param](#)

[CarnotCallbacks_WindowWithShading](#)

Hydraulics

[CarnotCallbacks_PumpAdditional](#)

Load / General

[CarnotCallbacks_Data_from_File](#)

[createDatafile](#)

Carnot m-Functions Overview

Contents

- [carnot_library_tools](#)
- [comfort](#)
- [data_input](#)
- [economy](#)
- [hydraulics](#)
- [material_properties](#)
- [physical_units](#)
- [time_functions](#)
- [weather_and_sun](#)

comfort

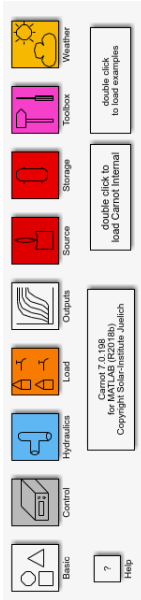
[calculate_pmv](#)

[clothing_area_factor](#)

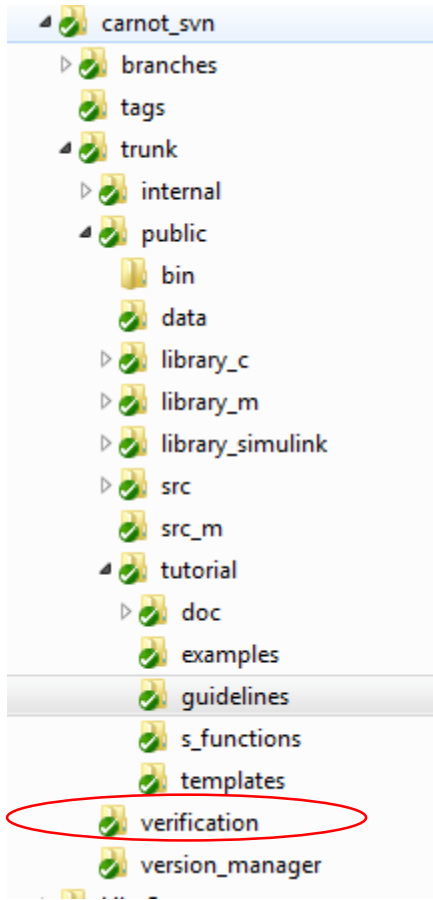
[clothing_surface_temperature](#)

[heat_transfer_clothing](#)

[calculate_ppd](#)



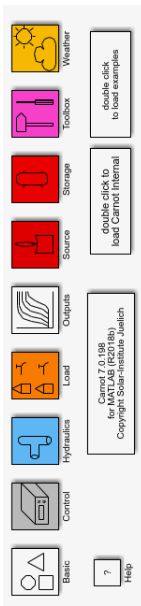
Verification



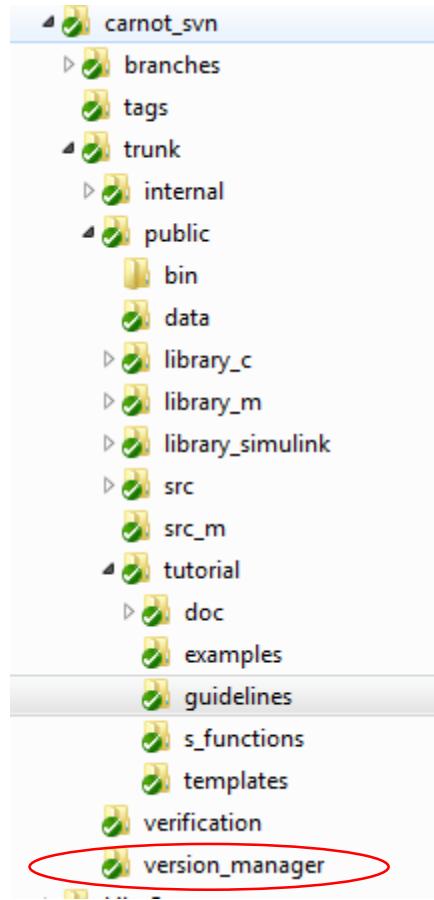
```
Command Window
>> run('C:\repos\Lib_Carnot\verification\verification_carnot.m')
--- starting verification of CARNOT library and functions ---
    density of Water OK: error 0.000
    heat_capacity of Water OK: error 0.003
    thermal_conductivity of Water OK: error 0.011
Warning in viscosity: temperature out of range!
Valid temperature range from 0°C to 160°C
Warning in viscosity: temperature out of range!
Valid temperature range from 0°C to 160°C
Warning in viscosity: temperature out of range!
Valid temperature range from 0°C to 160°C
Warning in viscosity: temperature out of range!
Valid temperature range from 0°C to 160°C
-----
    kinematic_viscosity of Water OK: error 0.007
```

```
284 of 290: RadiationOnInclinedSurface OK: error 0.030°
285 of 290: verify_Select_Weather_md1 OK: error 0.000
286 of 290: TrackedSurface OK: error 0.000
287 of 290: WDB2THB OK: error 0.000
288 of 290: verify_WeatherDatafile_md1 OK: error 0.000
289 of 290: WeatherSimpleModel OK: error 0.000
290 of 290: validating WeatherFromWorkspace OK: error 0.000
```

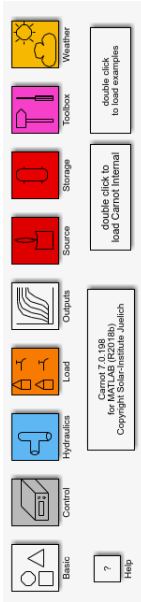
verification is correct for Matlab R2018b, R2020b and R2021b



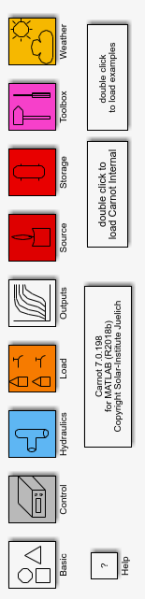
Version Manager



- AddToCarnotMDL.m
- ChangeCopyrightNotice.m
- CheckForBadBlocks.m
- CheckUpgradeAdvisor.m
- CleanUp.m
- CopyRemainingFiles.m
- CreateCarintMDL.m
- CreateCarnotMDL.m
- CreateMFileHelp.m
- MakeMEX.m
- MakeMEX_CleanUp.m
- SearchDirectory.m
- SearchFiles.m



Carnot 7.3 : Improvements



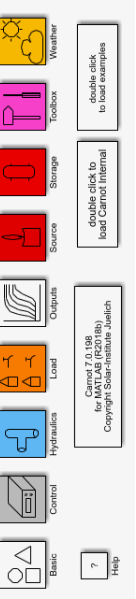
Carnot 7.3: Bug fixes

Window

- gvalue applied once to solar radiation (not twice)
- applying gvalue to the glass surface (not total window surface with frame)
- new parameter names
 - gvalue -> Solar heat gain coefficient (SHGC)
 - light transmission -> Primary solar heat gain

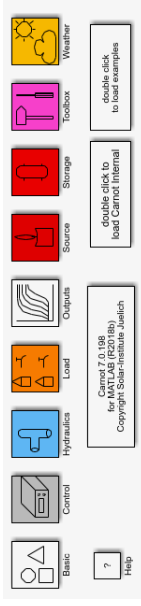
Ventilation_Window

- Corrected air exchange rate for tilted windows



Carnot 7.3: new functions and features

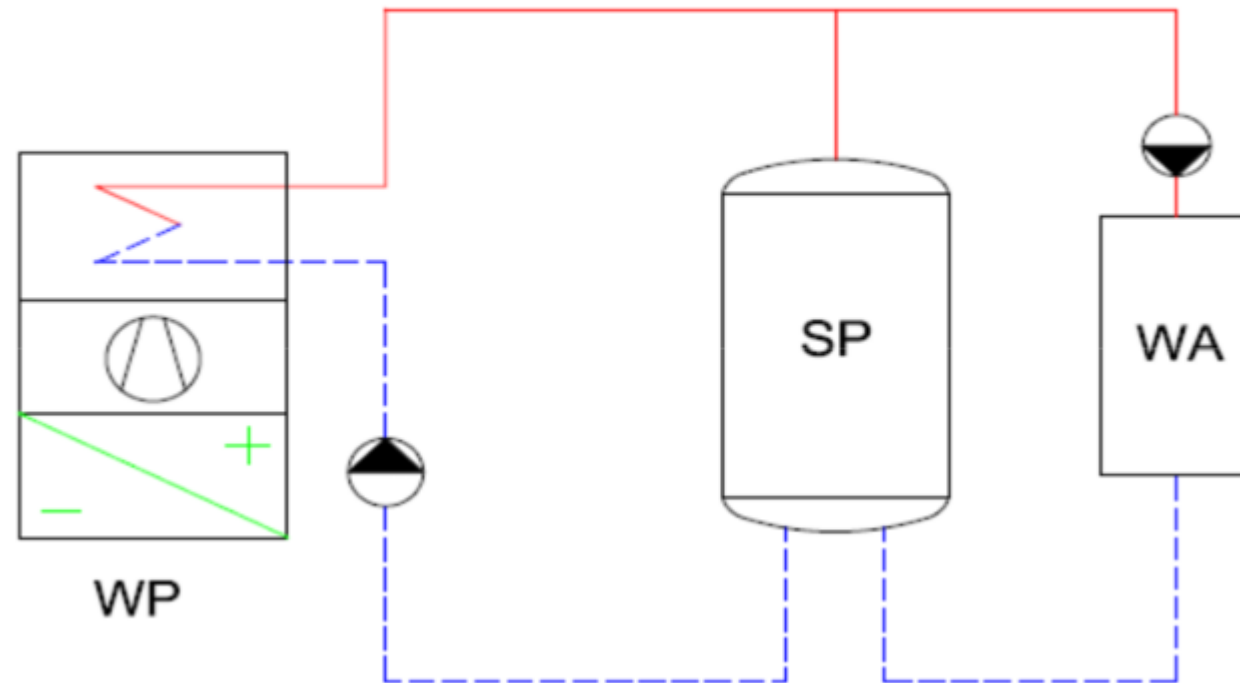
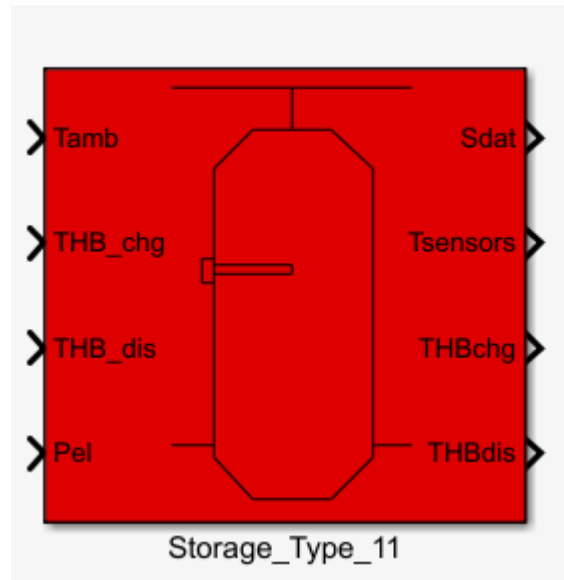
- Import filter for Meteonorm (Version 7.3)
- collectorIncidenceAngle.m : incidence angle for solar radiation
- Parameter sets for for HeatPump model



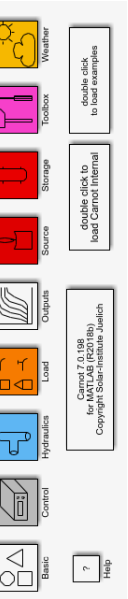
Carnot 7.3: Buffer storage „3-point connection“

Recommended for heat pump installations

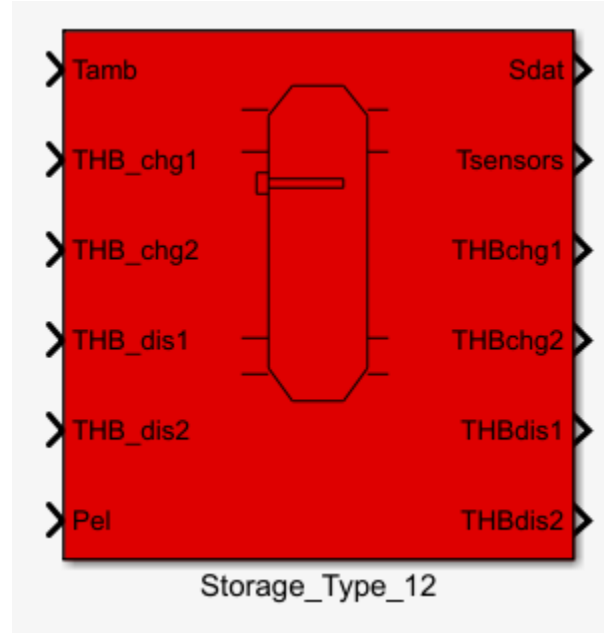
1.5 Funktionsschema mit Parallelspeicher, ohne Wassererwärmung



<https://www.wp-systemmodul.ch/de/page/InstallateurePlaner/Arbeitsunterlagen-und-Formulare-72763>



Carnot 7.3: Buffer storage with 4 ports



Weather
Turbine
Storage
Source
Outputs
Load
Hydraulics
Control
Basic
Help

double click to load examples
double click to load Carnot Internal
Copyright 2018-2020
Copyright 2018-2020
Copyright 2018-2020

Carnot 7.3: new model of a fan

untitled1 * - Simulink

File Edit View Display Diagram Simulation Ana

untitled1

untitled1

THB Air THB
GH FanDat
Fan_Const

Block Parameters: Fan_Const

Fan constant (mask) (link)

Model of a fan for air ventilation systems. Volume flowrate is constant according to the parameter Vdotmax and the control signal: $Vdot = Vdotmax * Ctrl$

Keep in mind that the flowrate in the THB is the massflowrate in kg/s whereas the parameters of the fan have different units.

$mdot = Vdot/3600 * density(Tamb, air_pressure, FluidAir, kgH2O/kgAir)$

Use the option "thermal node" if you want the pump to have thermal capacity and losses to ambient (or if you want to break an algebraic loop in the temperature signal).

Electric power is calculated $Pel = e0 + e1*mdot + e2*mdot^2$

Hydraulic Initial Values Thermal Electric

Vdotmax : volume flowrate in m³/h 1000

diameter at in- and outlet [m]

0.5

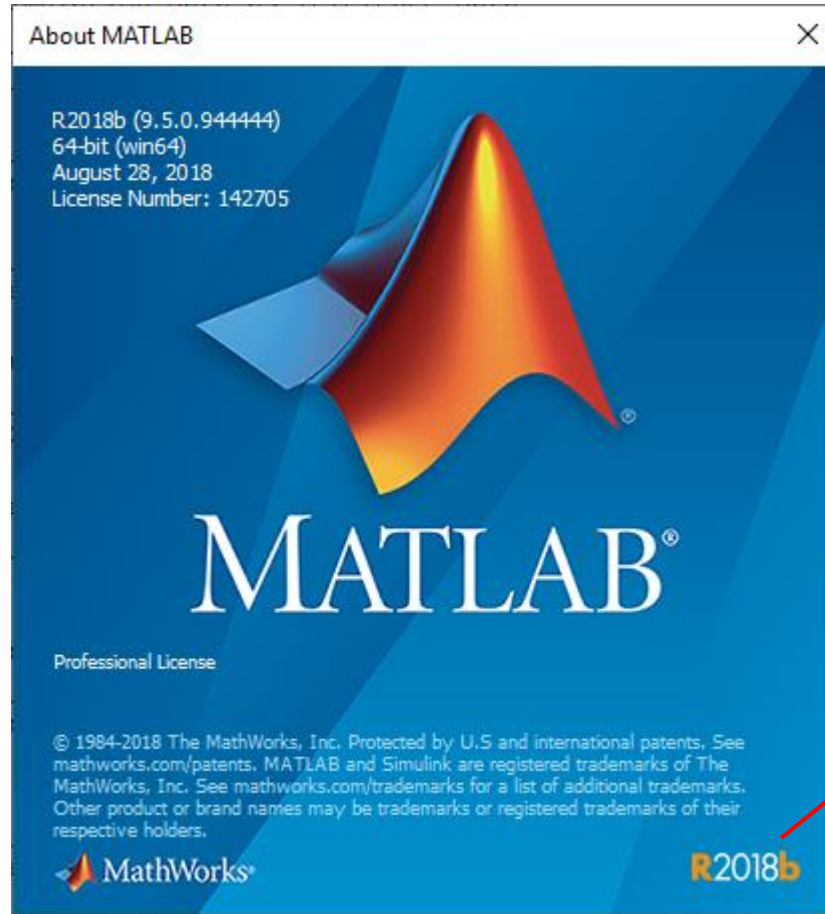
OK Cancel Help Apply

Ready 100% VariableStepAuto

Weather
Toolbox
Storage
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Hydraulics
Control
Basic
Help

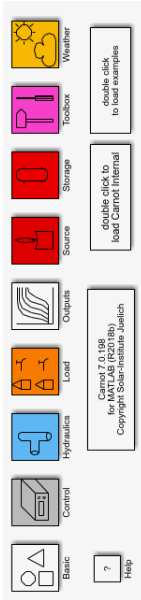
double click to load examples
double click to load Carnot Internal
Copyright 2022-2023, Carnot 7.3.189 for MATLAB (R2023B) Copyright Scharnholtz-Jaeschke

Next Version : Carnot 8.0 for Matlab R2022b



... by end of 2022 ...
... or a couple of days later ...

R2022b



Thank you for your attention

