Technische Hochschule Ingolstadt
Institute of new Energy Systems

Automatic model generation approach for local district heating networks

OREWA project

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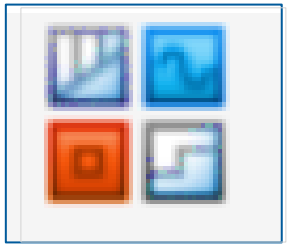
20.06.2023

AGENDA

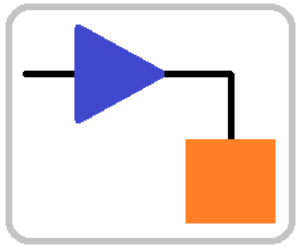
- Objective / Motivation
- Methodology
- Results

OBJECTIVE / MOTIVATION

LIMITATIONS OF CONVENTIONAL MODELLING APPROACH



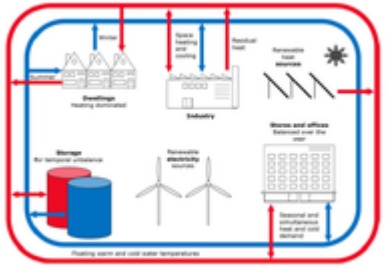
Simulink library



Simulink model

- General steps
  - Adding the blocks from library
  - Connecting the blocks
  - Parametrisation
  - Modification at multiple location

User inputs



DHN data

- Limitations
  - Time intensive
  - Risk of error
  - High effort for modification

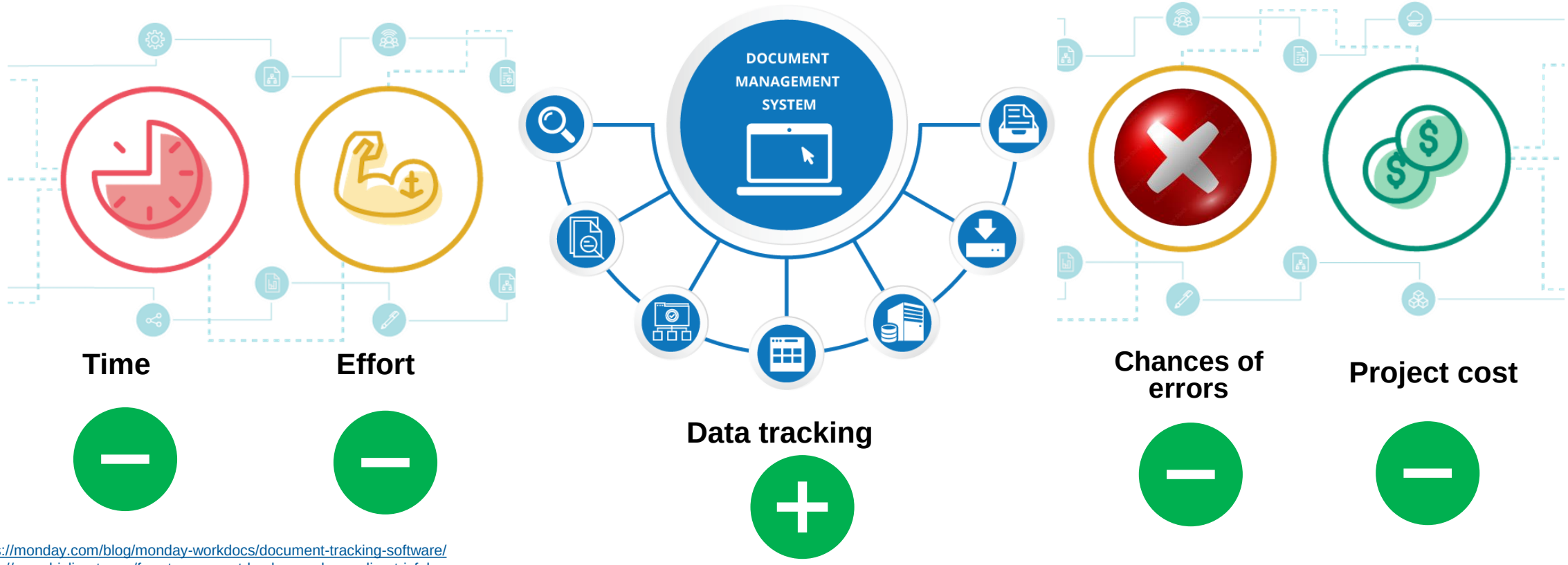
    [E.g. 93 consumer DHN model(1-2 days)]

- https://www.microsoft.com/en-us/microsoft-365/excel
- https://www.mathworks.com/
- https://en.wikipedia.org/wiki/User_(computing)
- https://en.wikipedia.org/wiki/District_heating

OBJECTIVE / MOTIVATION

OBJECTIVES OF THE AUTOMATED MODELLING APPROACH

- Improving the modelling approach of the district heating network by avoiding repetitive non analytical actions with following advantages

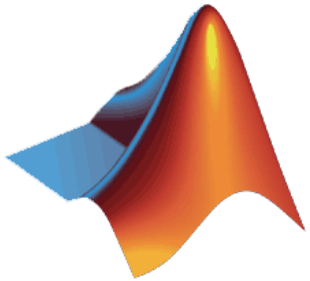


- https://monday.com/blog/monday-workdocs/document-tracking-software/
- https://www.hiclipart.com/free-transparent-background-png-clipart-iyfgb
- https://stock.adobe.com/de/images/cross-sign-element-red-x-icon-isolated-on-white-background-mark-graphic-design-round-volume-button-for-vote-decision-web-symbol-error-check-wrong-or-stop-failed-vector-illustration/140050487

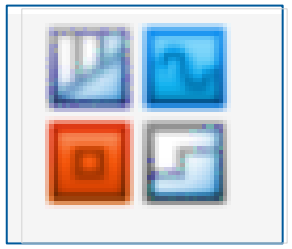
METHODOLOGY

AUTOMATED MODELLING APPROACH

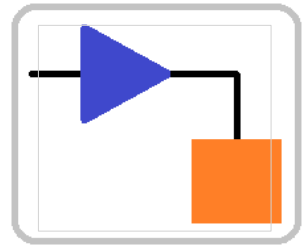
Customized Excel template



MATLAB scripts of Programmatic modelling (Model generation)

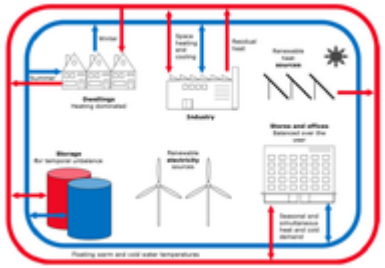


Customized Simulink Library



Simulink model

User inputs

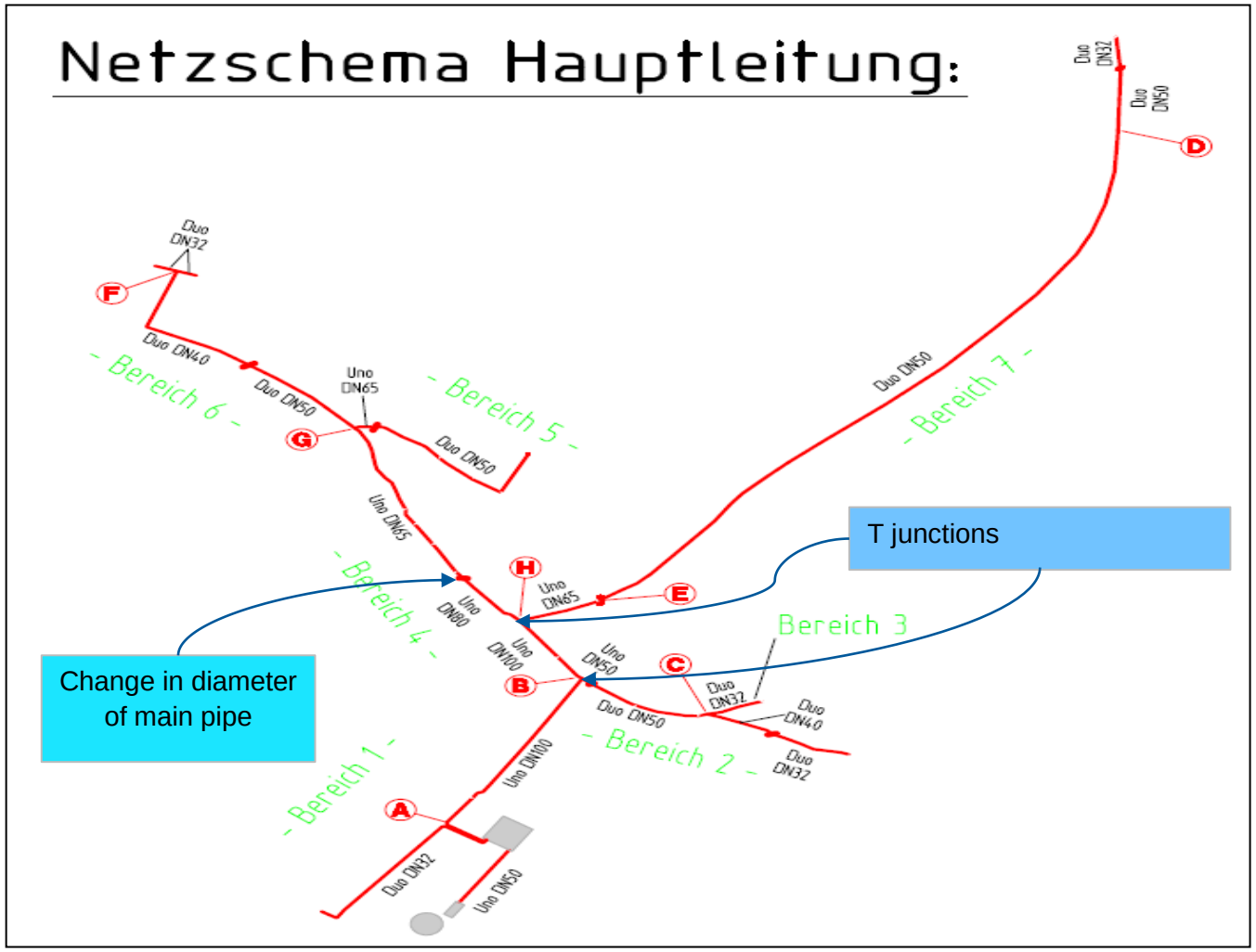


DHN data

https://www.microsoft.com/en-us/microsoft-365/excel
https://www.mathworks.com/
https://en.wikipedia.org/wiki/User_(computing)

DHN MAP:DATA COLLECTION

- Mapping the existing network
- Piping network layout
- Consumer/substations information
- Heating center information



CUSTOMISED EXCEL TEMPLATES

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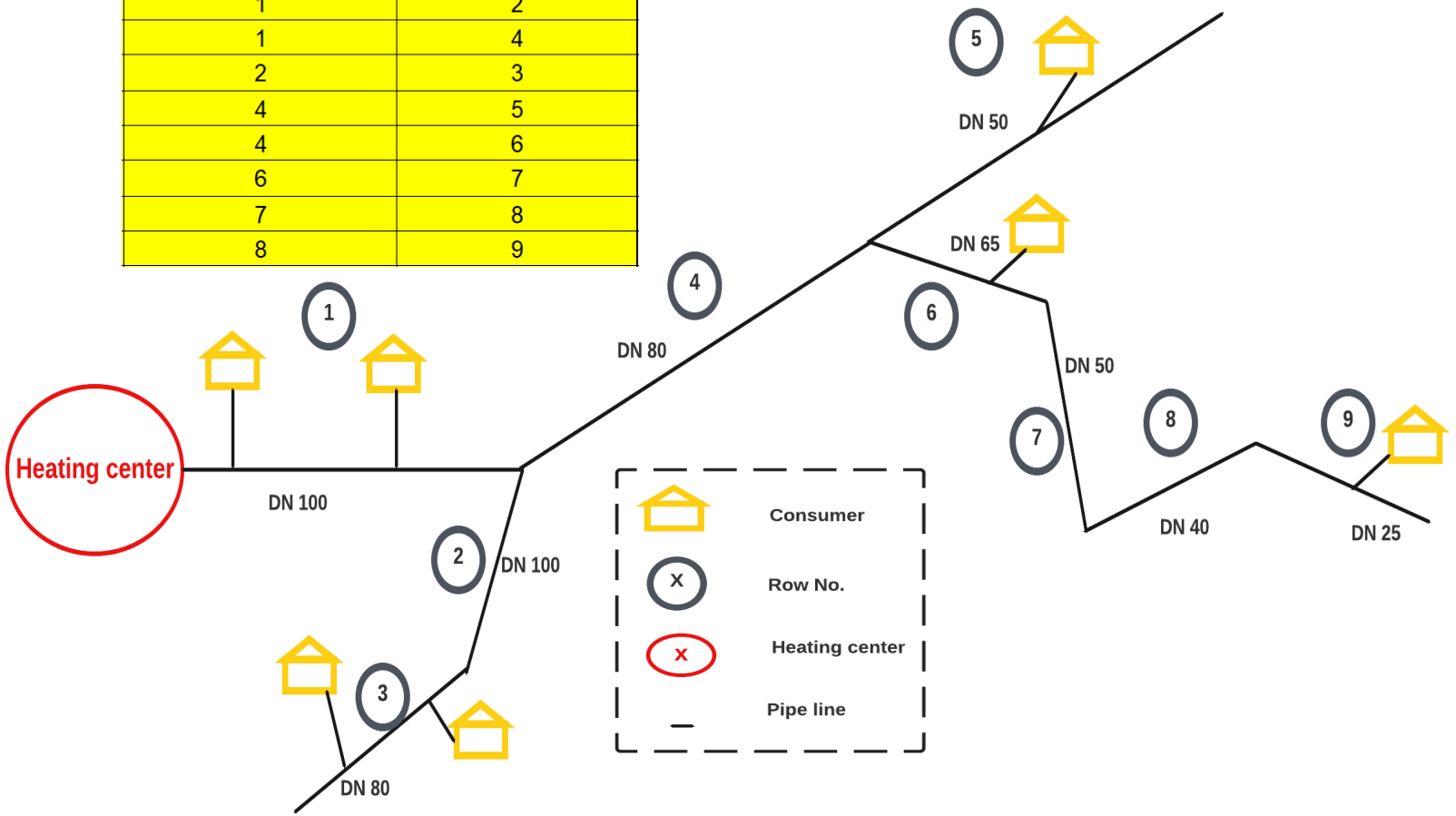
Rows	No. of consumers
1	2
2	0
3	2
4	0
5	1
6	1
7	0
8	0
9	1

Row connections (In Forward Direction from Heating center)	
Row_x	Row_y
1	2
1	4
2	3
4	5
4	6
6	7
7	8
8	9



Transforming DHN Information To Excel Template

CUSTOMISED SIMULINK LIBRARY

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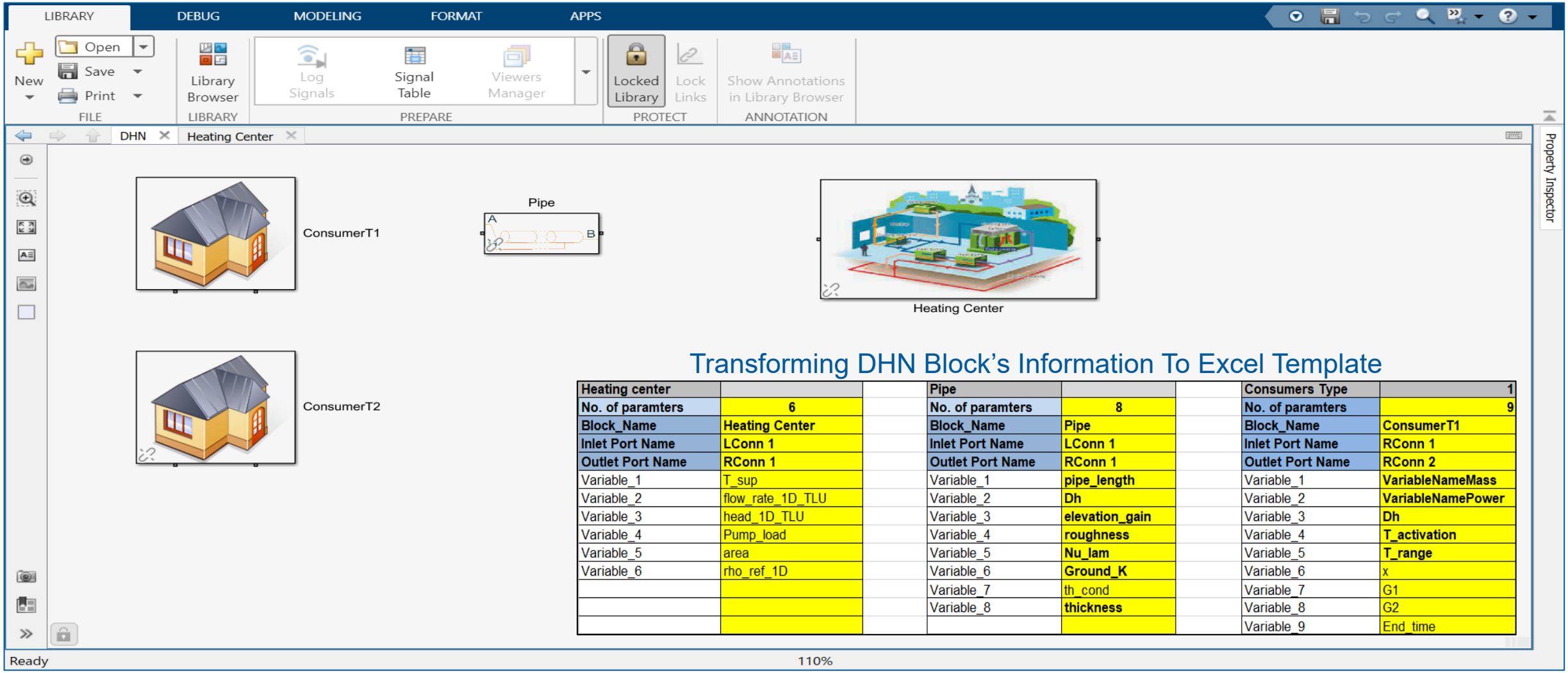

Transforming DHN Block's Information To Excel Template

Heating center			Pipe			Consumers Type	1
No. of paramters	6		No. of paramters	8		No. of paramters	9
Block_Name	Heating Center		Block_Name	Pipe		Block_Name	ConsumerT1
Inlet Port Name	LConn 1		Inlet Port Name	LConn 1		Inlet Port Name	RConn 1
Outlet Port Name	RConn 1		Outlet Port Name	RConn 1		Outlet Port Name	RConn 2
Variable_1	T_sup		Variable_1	pipe_length		Variable_1	VariableNameMass
Variable_2	flow_rate_1D_TLU		Variable_2	Dh		Variable_2	VariableNamePower
Variable_3	head_1D_TLU		Variable_3	elevation_gain		Variable_3	Dh
Variable_4	Pump_load		Variable_4	roughness		Variable_4	T_activation
Variable_5	area		Variable_5	Nu_lam		Variable_5	T_range
Variable_6	rho_ref_1D		Variable_6	Ground_K		Variable_6	x
			Variable_7	th_cond		Variable_7	G1
			Variable_8	thickness		Variable_8	G2
						Variable_9	End_time

CUSTOMISED EXCEL TEMPLATES

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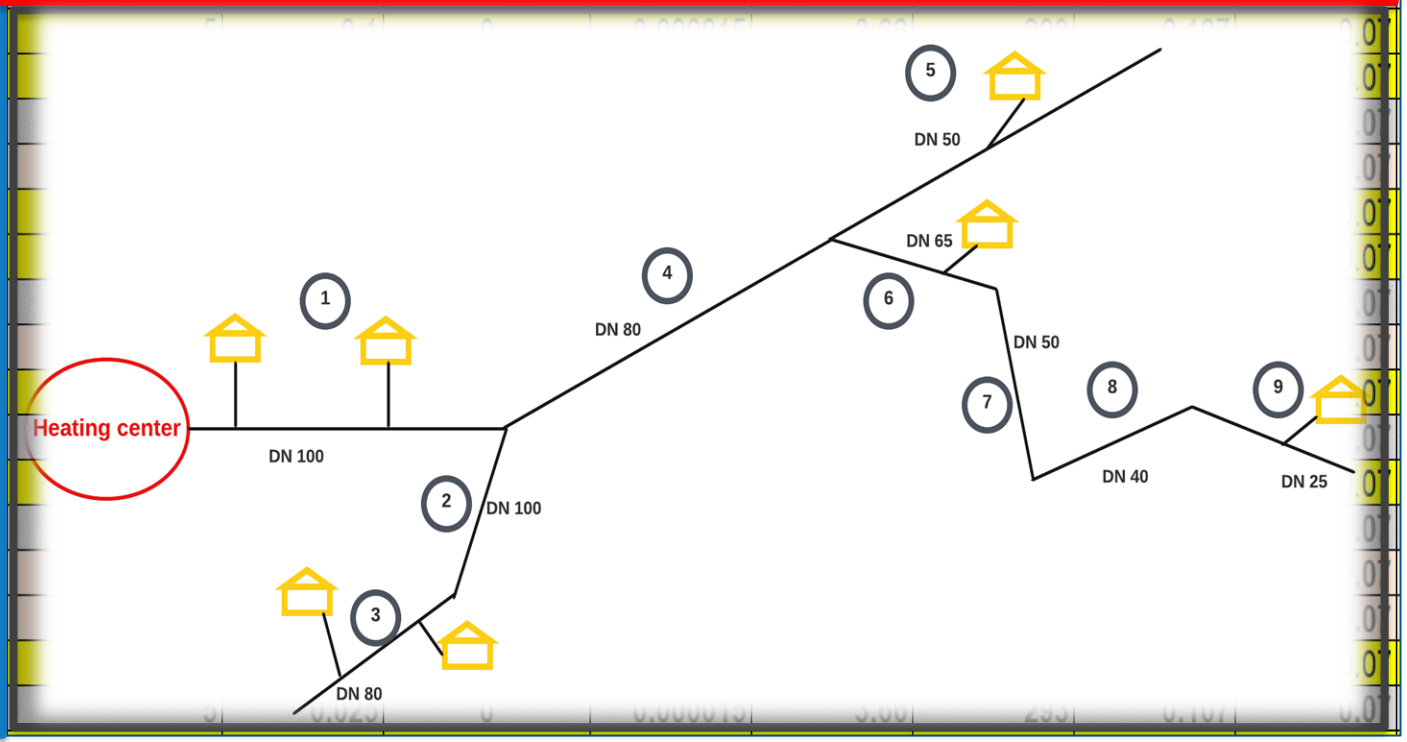
Row no.

Block Name with layout information

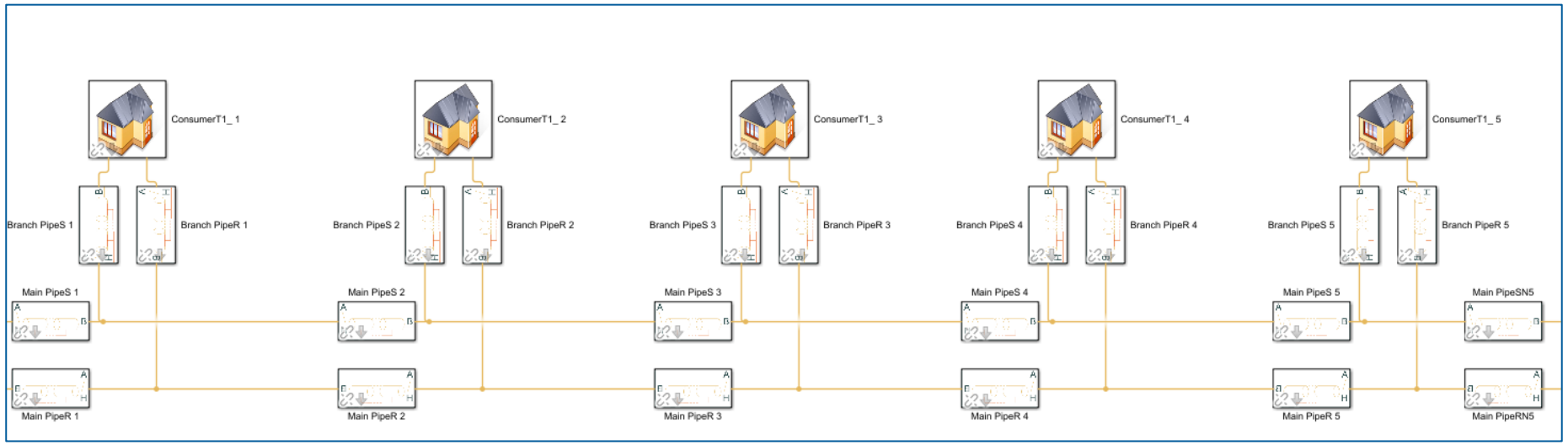
Simulink block(Pipe) mask variable names

Consumer_No._model	Row No.		Tag _Name	pipe_length	Dh	elevation_gain	roughness	Nu_lam	Ground_K	th_cond	thickness
Main Pipe1	ROW_1		Main PipeS 1								
Main Pipe2	ROW_1		Main PipeS 2								
Main Pipe3	ROW_1	Terminal Pipe	Main PipeSN2								
Main Pipe4	ROW_2	No Consumer	Main PipeSN04								
Main Pipe5	ROW_3		Main PipeS 3								
Main Pipe6	ROW_3		Main PipeS 4								
Main Pipe7	ROW_3	Terminal Pipe	Main PipeSN4								
Main Pipe8	ROW_4	No Consumer	Main PipeSN08								
Main Pipe9	ROW_5		Main PipeS 5								
Main Pipe10	ROW_5	Terminal Pipe	Main PipeSN5								
Main Pipe11	ROW_6		Main PipeS 6								
Main Pipe12	ROW_6	Terminal Pipe	Main PipeSN6								
Main Pipe13	ROW_7	No Consumer	Main PipeSN013								
Main Pipe14	ROW_8	No Consumer	Main PipeSN014								
Main Pipe15	ROW_9		Main PipeS 7								
Main Pipe16	ROW_9	Terminal Pipe	Main PipeSN7								



OUTCOMES

- **Model generation** and data handling become **faster.**
- **Easy modifications** of model parameters with **excel functions**
- Significant reductions in modelling time: **93 consumer model is generated within 5-6 minutes**
- **Generic approach** which can be extended for other applications.
- Improved **model layout (set by MATLAB SCRIPT)**



Thank you for listening!

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ENERPIPE

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