Simplified Thermal Model for Buildings

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1- Introduction

Le projet RESIZED dans lequel s'inscrit cette étude concerne la conception de districts "zéro énergie" ainsi que l'analyse énergétique de districts existants.
Il comporte 4 volets principaux: étude urbanistique, évaluation des consommations, production d'énergie et optimisation de l'ensemble.
Des modèles simplifiés de bâtiments (utilisant un minimum de paramètres) sont développés pour évaluer les besoins énergétiques et le confort dans ces districts.
La première étape – modèle d'un bâtiment unique – est présentée dans ce poster.

2- Methodology

- Each building has been made of a finite number of parts n, called nodes.
- Each resistance between two nodes represents the walls or windows or any other material between two different spaces.
- If resistances and capacitances are not dependent on temperature gradients then this approach is suitable for any linear thermal system.
- Thermal networks provide a systematic way to develop equations for simple and complex models.

Figure 1. Schematic simulated building in TRNSYS

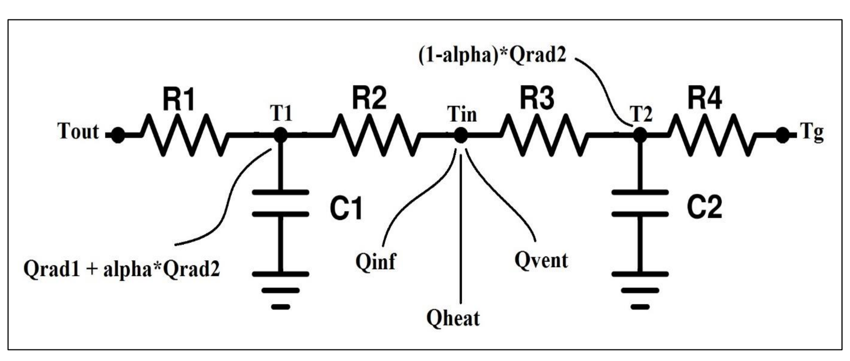

Fig 2. 4R2C thermal network to make a building simulation

3- System identification

- Model identification is the process to determine physical properties of unknown systems according to some experimental data or training data.
- Data extracted from TRNSYS software.
- More than 80% of fitness is achieved.

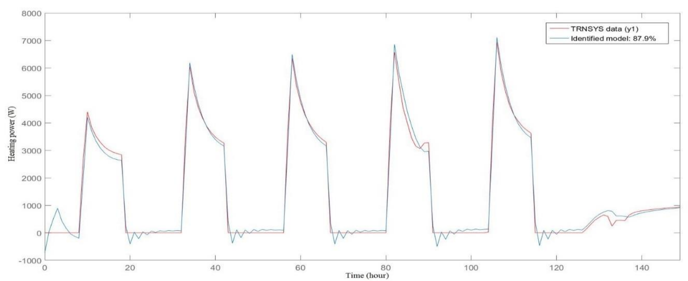

Fig 2. Model identification using 150 hours data

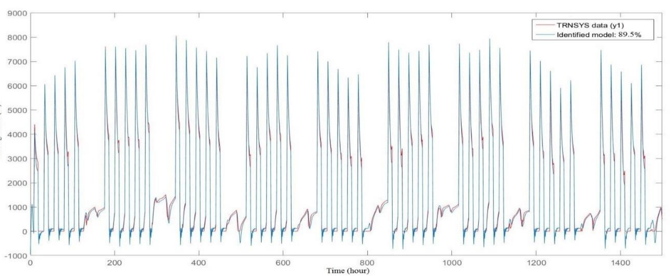

Fig 3. Model identification using1500 hours data

Table 1. Identified parameters for 3 different data sets

	TRNSYS data	150h data	1500h data	3000h data
		Fit = 86%	Fit = 89%	Fit = 89%
$R1$	0.0144	0.00046	0.00005	0.00007
$R2$		0.00286	0.01470	0.01436
$R3$	0.0067	0.00148	0.00114	0.00115
$R4$		10	0.00421	0.00436
$C1$	24259200	722000	207400	234400
$C2$	10248000	2023	4263	4221

$$C_1\frac{dT_1}{dt} = \frac{T_{out}-T_1}{R_1} + \frac{T_{in}-T_1}{R_2} + Q_{rad1} + \alpha Q_{rad2}$$

$$C_2\frac{dT_2}{dt} = \frac{T_{in}-T_2}{R_3} + \frac{T_g-T_2}{R_4} + (1-\alpha)Q_{rad2}$$

$$Q_{heat} + Q_{inf} + Q_{vent} + \frac{T_1-T_{in}}{R_2} + \frac{T_2-T_{in}}{R_3} = 0$$

4- Results

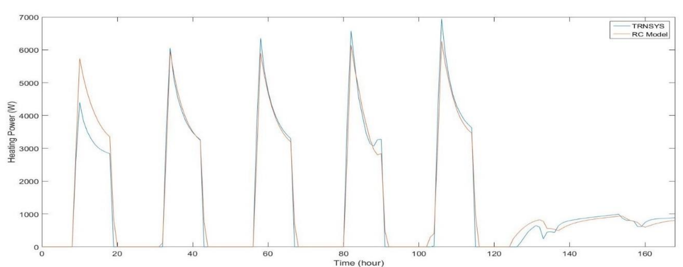

Fig 4. Heating load simulation for 1st week of the year

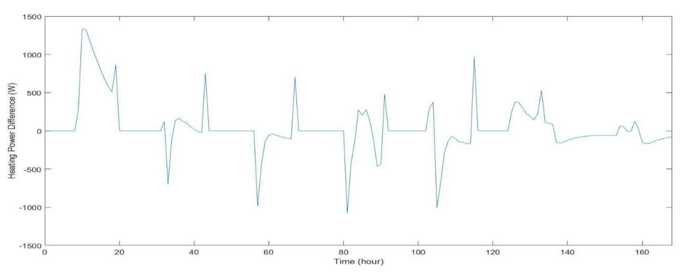

Fig 5. Heating load error for 1st week of the year

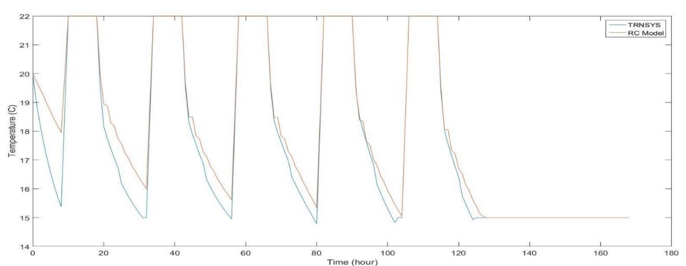

Fig 6. Temperature simulation for 1st week of the year

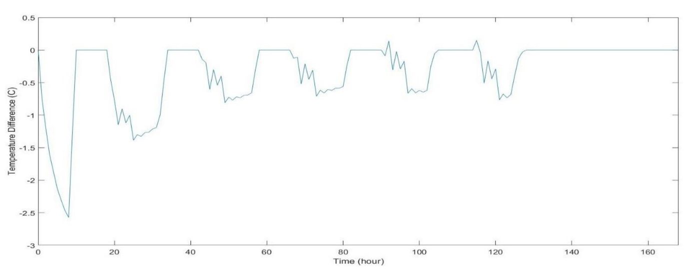

Fig 7. Temperature error for 1st week of the year

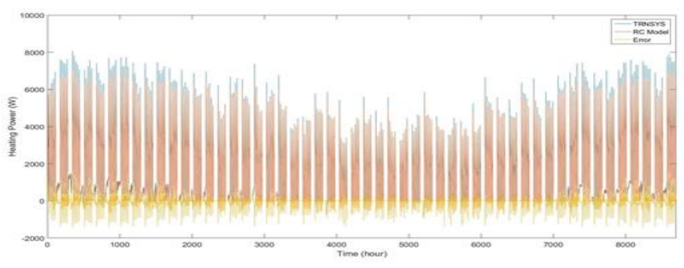

Fig 8. Heating load simulation for one year

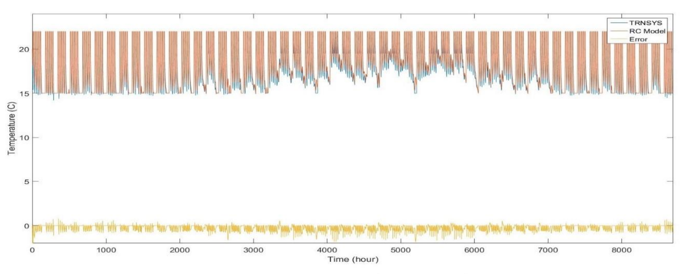

Fig 9. Temperature simulation for one year

- Using identified parameters to simulate one week and one year performance.
- The model is able to simulate building heating load with high accuracy and the mean square error is very low.

5- Conclusion

- The effectiveness of thermal networks to predict the heating load and indoor temperature in buildings is investigated.
- A "4R2C model" is used to simulate heating load and indoor temperature inside a building.
- The parameter identification has been done for 3 different sets of data (results from TRNSYS calculation).
- Data set (amount of information) can significantly impact on the accuracy of estimated parameters.
- The RC model trained with 1 month data can simulate heating load for one year accurately.

6- Bibliography

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7- Acknowledgements & contacts

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