

Benchmarking IEQ and EE in Nearly Zero Energy Schools



Prof. Dr. Shady Attia

*Sustainable Building Design Lab, UEE,
Applied Sciences, University of Liège, Belgium*
shady.attia@uliege.be

 /in/shady-attia-14352a7

 /shady.attia.research

 /www.shadyattia.net

Belgian Context





THE-SCIENTIST.COM

Air Pollution Linked to Decline in Cognitive Performance

A study compares verbal and math test scores to air quality measurement...

Poor air quality in almost two-thirds of Belgian schools - Greenpeace

Wednesday, 14 March 2018 17:21

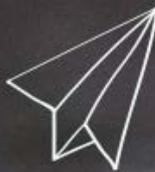


© Belga

The quality of the air in about 61% of Belgian schools is worrying and even poor, while only 3% have good air quality, Greenpeace reported on Wednesday, based on the findings of a study done in 222 schools.

PASSIEFSCHOLEN KREUNEN ONDER HITTE

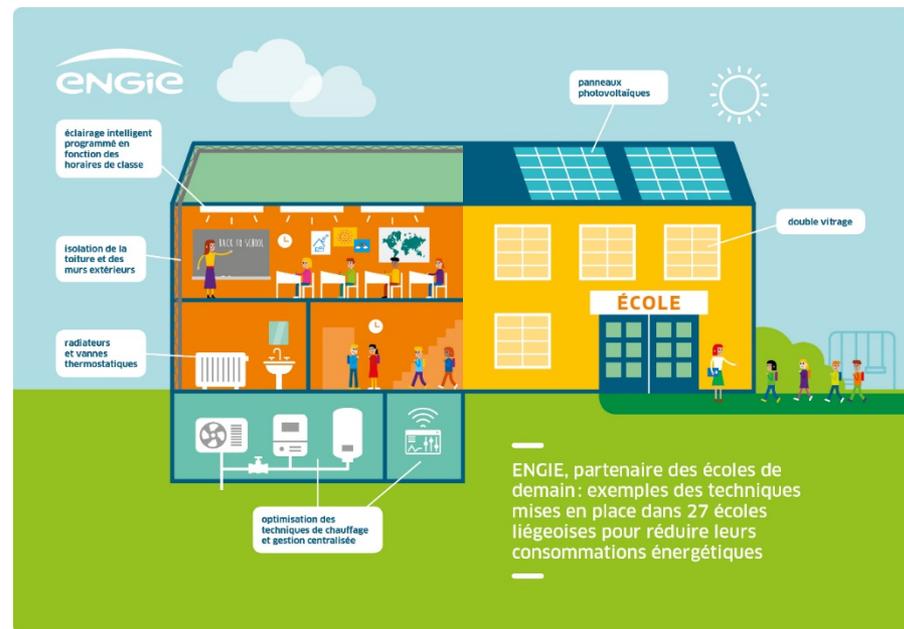




MON AIR, MON ÉCOLE

Étude sur la pollution de l'air dans 222 écoles belges

GREENPEACE



Study Context



Nearly Zero Energy Schools

IEA-SHC Task 40: Net Zero Energy Solar Buildings

IEA-EBC Annex 66: Definition and Simulation of Occupant Behavior in Buildings

IEA-EBC Annex 79: Occupant Behaviour-Centric Building Design and Operation

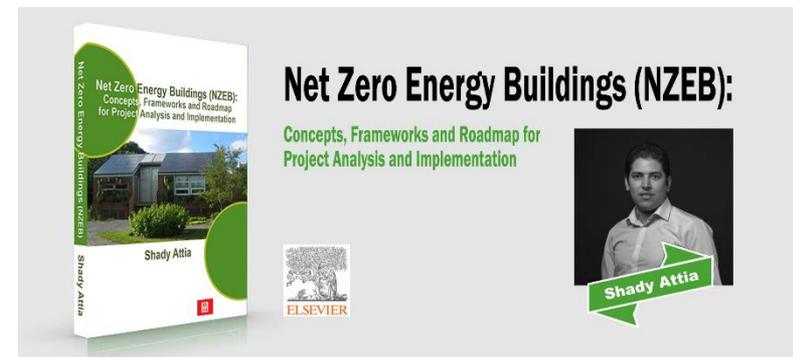
WBI: Resilience and Net-Zero Energy Buildings in Belgium and Chile

New Book

WINDSOR CONFERENCE 2018

RETHINKING COMFORT

Search



Research Question



- **Do we know how to design, build and operate nearly zero energy schools ?**

- **What is the current situation of newly built schools?**

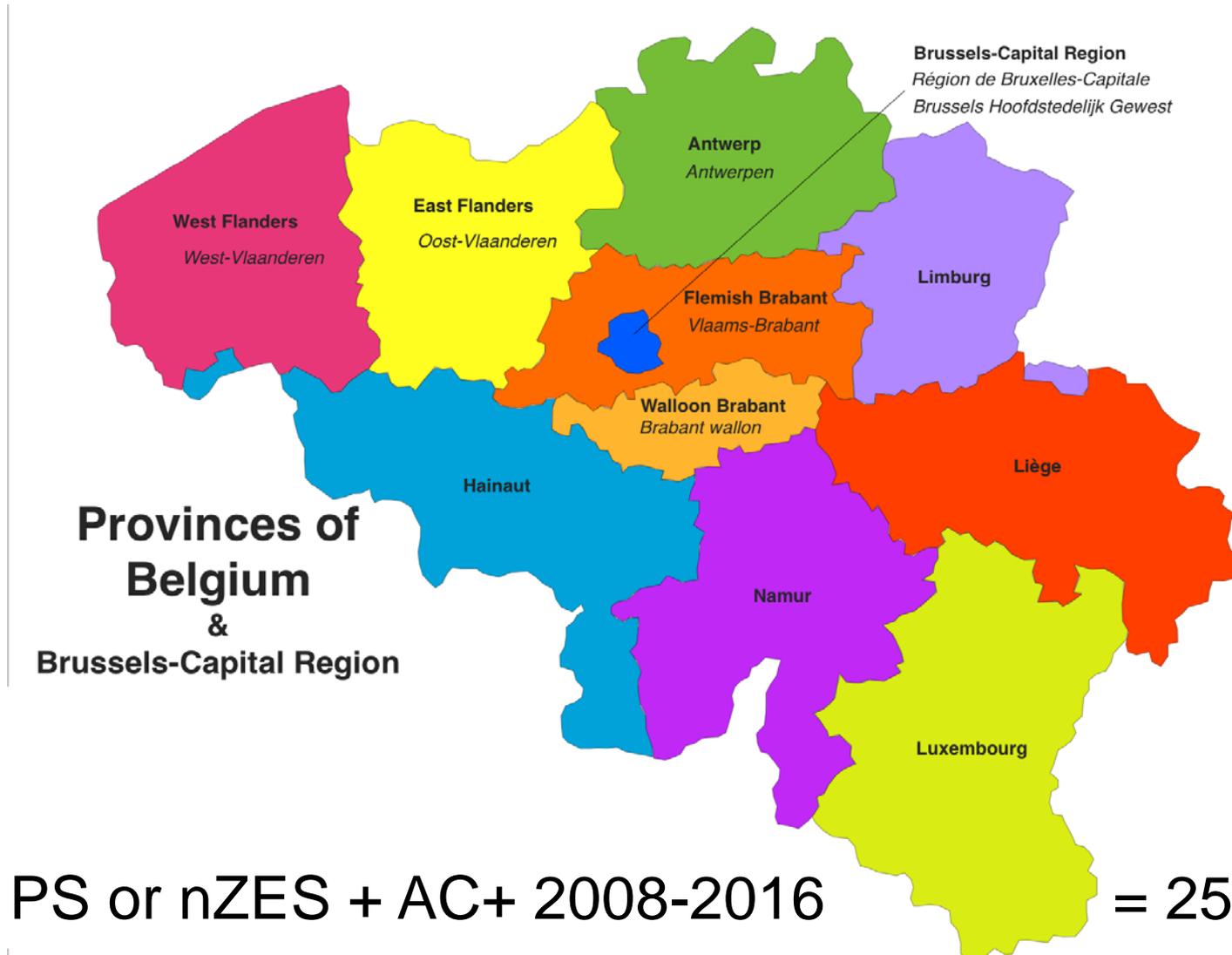
Case Studies

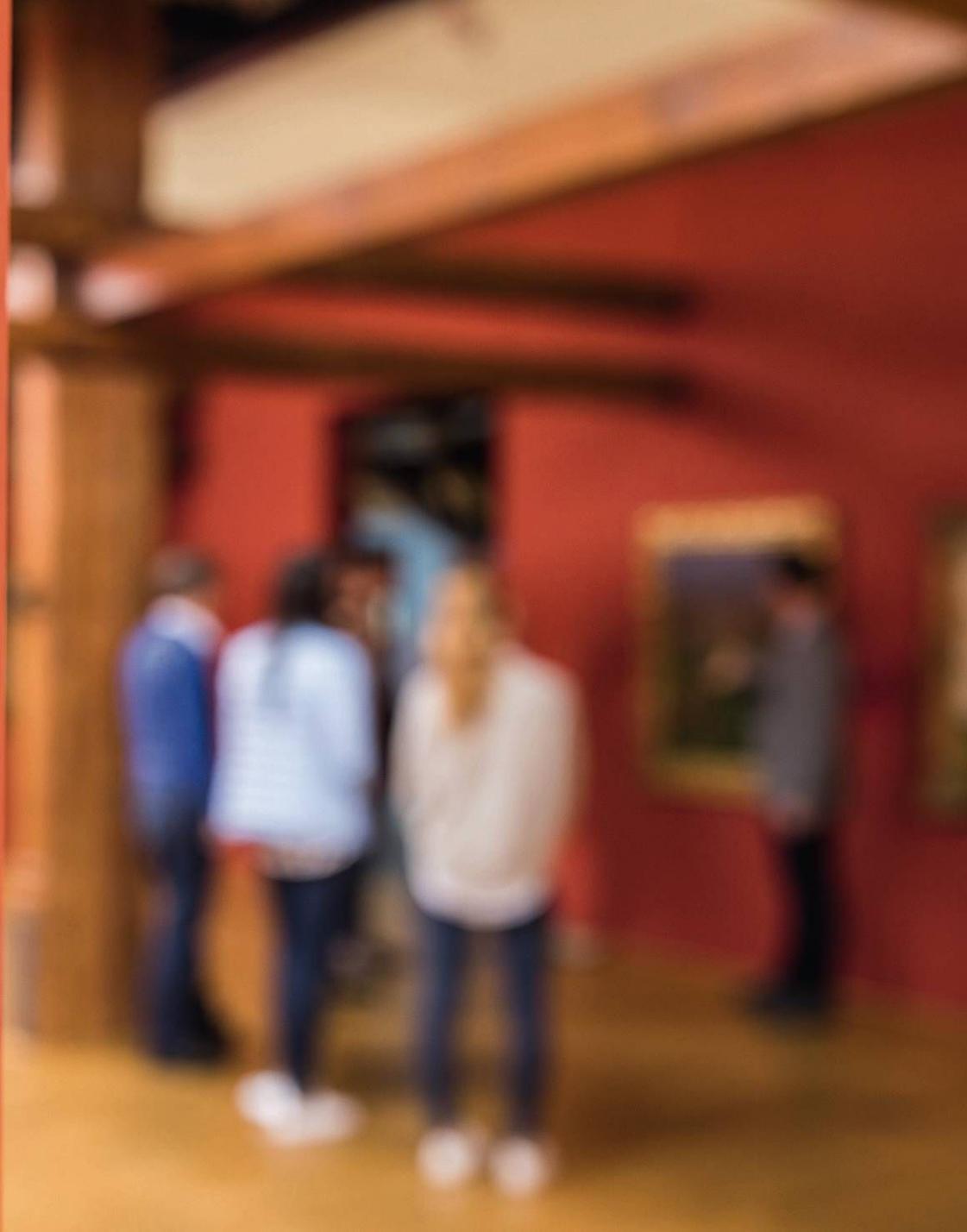


Problem Definition

- Between many schools that have been built (2008-2016) following the Passive House criteria more than 35 Passive School or nZES were built in Belgium.
- Those new schools are associated with high risk of overheating and high carbon dioxide concentration.
- However, there is no characterisations of those newly built schools regarding their EE and IEQ.

Case Studies Selection Criteria





Results and Findings



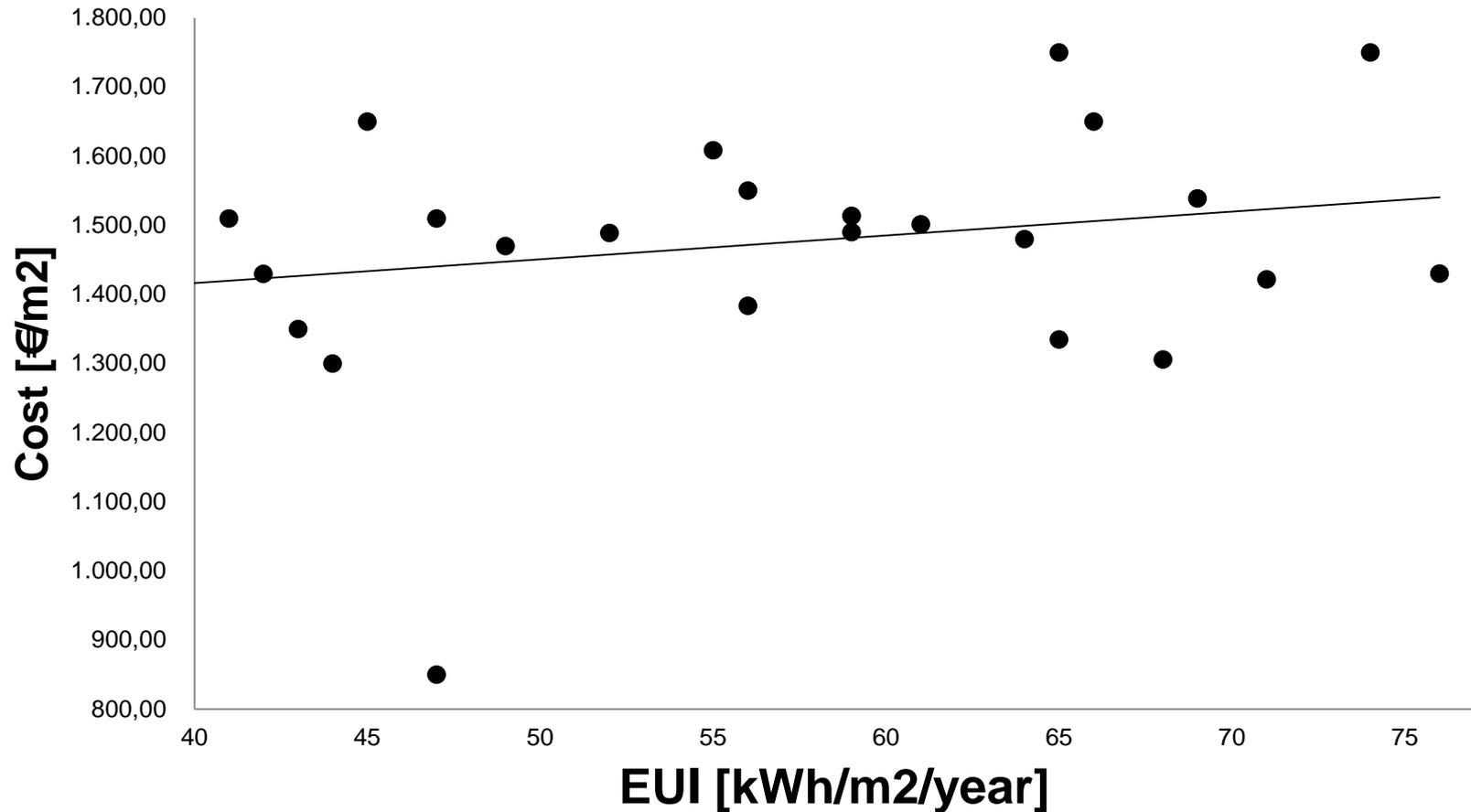
Analysis of 25 Schools

	School	Type *	Construction Date	Province	Location	Surface [m2]	Heating Energy Demand [kWh/m2*year]	Cooling Energy Demand [kWh/m2*year]	Energy Use Intensity [kWh/m2/Year]	Number of Pupils	E-level	Airtightness	Compactness	K-level	Cost [€]	Cost/mq [€/mq]	Occupancy Density [m2/student]
1	GO! De Scheepvaartschool - Cenflumarin	higher education	???	Flanders	ANTWERPEN	3863	15.23	3.53	57	120	53	0,60 fln	2.6	21	5,800,000.00	1,501.42	32.19
2	Vrije Basisschool Anzegem 'De Goede Basis'	Primary	???	Flanders	ANZEGEM	1722.55	10.85	6.07	52	???	45	0,50 fln	2.03	14	2564876.95	1489	???
3	PSBLO De Zeppelin	Primary	???	Flanders	ASSENDE	1,269	10.97	0.93	41	115	48	0,6 n50	2.46	19	1916190	1510	???
4	Vrije Basisschool 't Piepelike - School met de Bijbel	Primary and Kindergarten	???	Flanders	BILZEN	964	12.52	9.08	58	???	38	0,30 fln	2.11	14	1,842,780.11	1,306.00	???
5	De Boomhut - Basisschool Lozen	Primary	???	Flanders	BOCHOLT	412.26	16.63	13.12	69	???	52	0,50 fln	1.57	18	2,256,410.51	1,538.71	???
6	Basisschool Koninklijk Atheneum Etterbeek	Primary	???	Brussels	ETTERBEEK	1071	13.92	7.94	56	???	38	0,50 fln	2.2	18	1,522,555.02	1,421.62	???
7	Don Bosco Instituut ASO-TSO-BSO & EG	secondary	???	Flanders	GROOT-BIJGAARDEN	2176.16	14.09	0.21	41	???	27	0,50 fln	3.16	14	3,500,000.00	1,608.34	???
8	CVO De Verdieping	higher education	???	Flanders	HEUSDEN-ZOLDER	5325	12.71	3.4	42	???	45	0,60 fln	3.39	16	7,612,194.00	1,429.52	???
9	Vrije Basisschool Zonnekind	Primary	???	Flanders	KALMTHOUT	750	13.34	2.01	45	100	49	0,50 fln	1.93	18	1,237,597.50	1,650.13	7.5
11	Gemeentelijk Technisch Instituut Londerzeel	secondary	???	Flanders	LONDERZEEL	4395	9.99	0.43	38	318	47	0,30 fln	2.67	12	6,079,647.45	1,383.31	13.82
12	Campus Oude-God (Kindergarten)	kindergarten	#####	Flanders	MORTSEL	6345	14.76	5.7	56	650	48	0,50 fln	2.05	17	9834750	1550	9.76
	Campus Oude-God (Primary School)	Primary	#####	Flanders			13.37	6.84	57		49	0,60 fln	2.62	16		1430	
13	Bernarduscollege	secondary	???	Flanders	OUDENAARDE	3900	20.5	8.9	59	1400	54	0,40 fln	2.25	18	5772000	1480	2.785714286
14	Talentschool Turnhout - Campus Boomgaard	secondary	???	Flanders	TURNHOUT	3569	14.06	1.56	47	550	???	0,50 fln	2.49	19	5389190	1510	6.49
15	OLV Hemelvaart	secondary	???	Flanders	WAREGEM	4195	25.2	12.5	65	1400	???	0,30 fln	2.1	16	5600325	1335	3.00
16	Vrije Basisschool Sterbos	Primary	???	Flanders	WUUSTWEZEL	1225	13	5	59	170	35	0,40 fln	2.3	13	1,854,013.00	1,513.48	7.21
17	Leefschool 't Zandhofje	Primary	???	Flanders	ZANDHOVEN	2232	13.93	0.96	47	240	52	0,32 fln	2.33		1,663,548.72	1,250.00	9.3
18	RHIZO College Zwevegem	higher education	???	Flanders	ZWEVEGEM	1190.69	13.22	0.97	49	???	53	0,50 fln	1.71	17	1750314.3	1470	???
19	Stedelijke Bouwvakschool	secondary	Oct-15	Flanders	DILSEN-STOKKEM		25.00	0.00	63							1650	

*Age ranges are kindergarten 3-6, primary 7-12, secondary 12-18, higher education 18+

Data Collection – Meta Analysis

School Cost versus Energy Efficiency **measured**

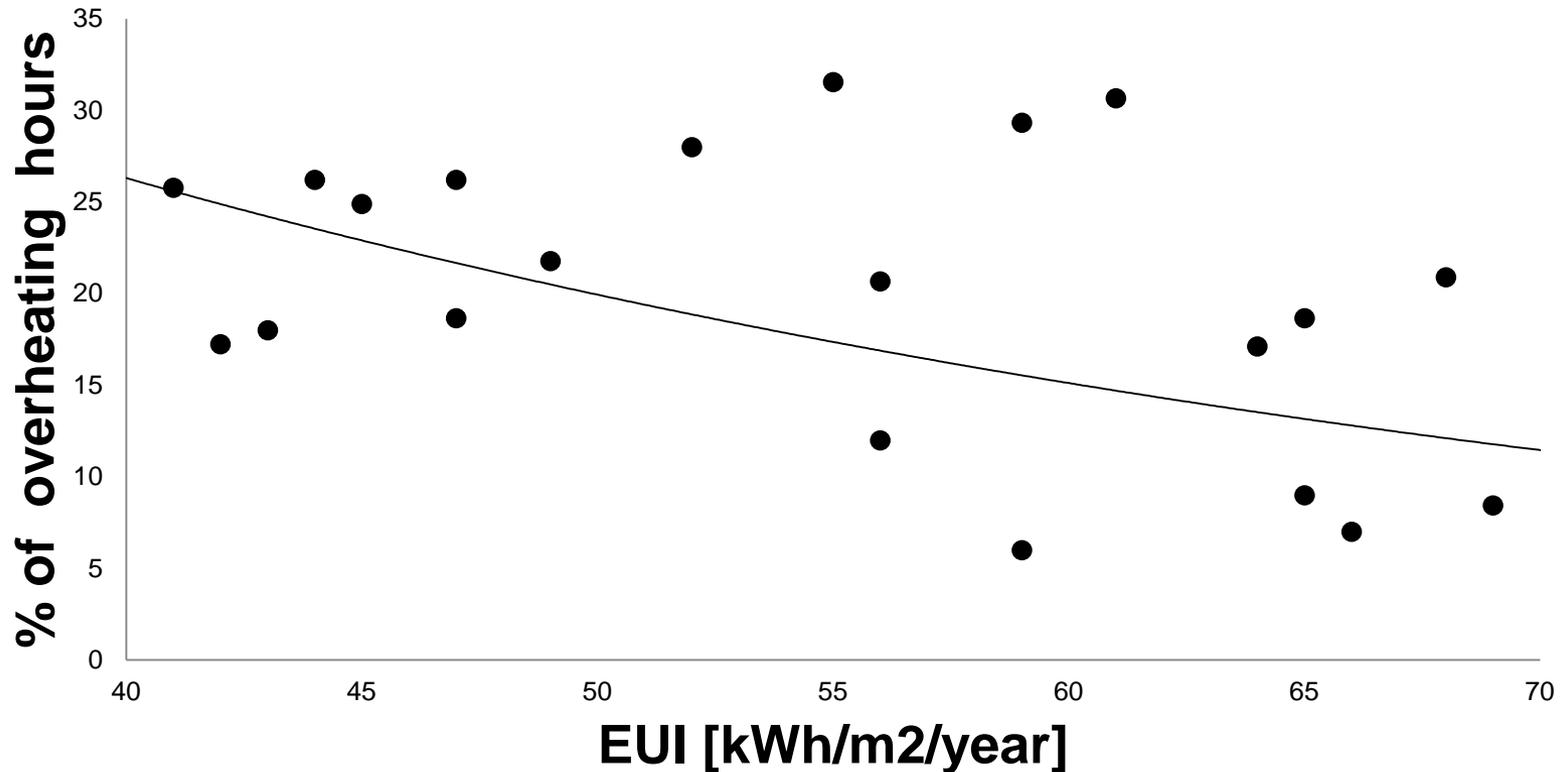


*Measured during one week in 25 classroom/school with an average of 28 pupils
19-23 June 2017 and 7-11 May 2018

Data Collection – Meta Analysis

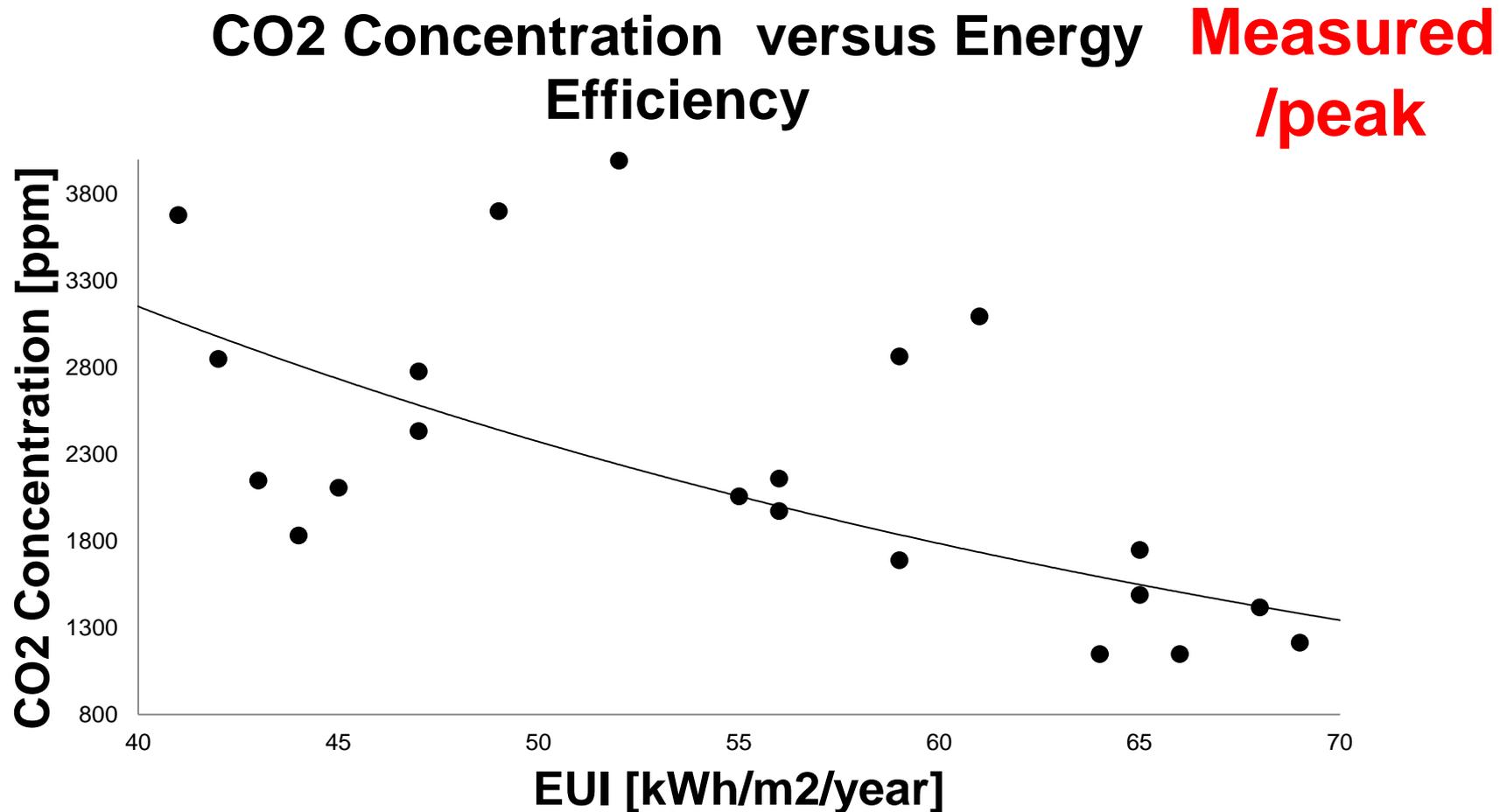
Overheating during Summer versus Energy Efficiency

measured+
calculated



*Measured during one week in 25 classroom/school with an average of 28 pupils
19-23 June 2017 and 7-11 May 2018

Data Collection – Meta Analysis



*Measured during one week in 25 classroom/school with an average of 28 pupils
19-23 June 2017 and 7-11 May 2018

Summary



Summary

- **Cognitive performance** and **acceptable IEQ** are more important than EE and budget control
- Quality assurance of design is crucial
- **Facility management and operation cost** are part of any nearly zero energy school

Conclusion



- **Do we know how to design, build and operate nearly zero energy schools ?**



What is Next?

- How can we improve IEQ taking users cognitive performance and interaction into account in design?
- Can we finance and manage schools operation?
- We need less technology and more management, funding and communication to run nearly zero energy schools.

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 /www.shadyattia.net

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