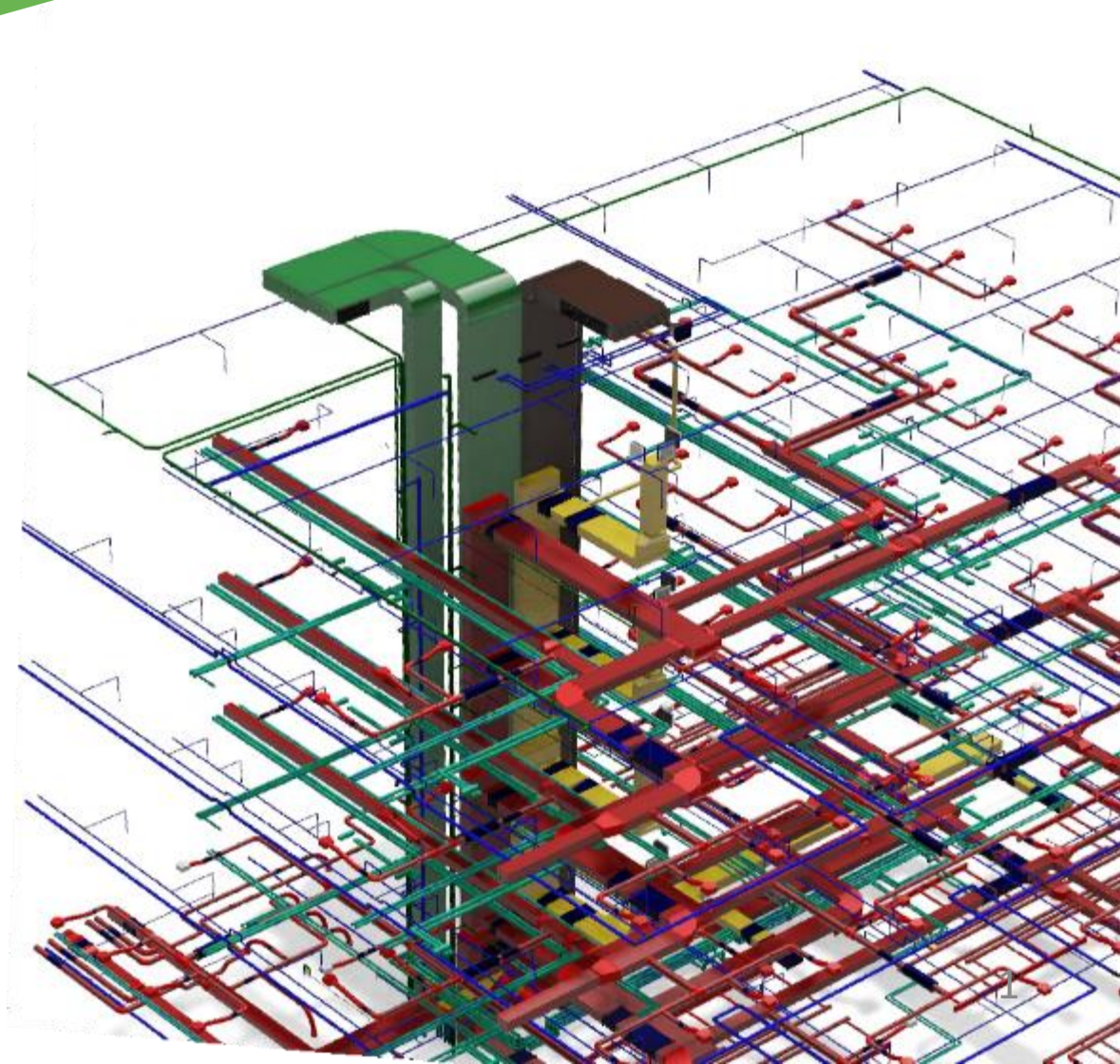
boydens engineering

Control and BMS @ Boydens

08-10-2019

Damien picard
HVAC designer
Responsible for automation
Post-doctoral researcher

Boydens Sustainable
Engineering Group



WHO WE ARE

Since 1961, Boydens Engineering has been active as technical engineering designers and consultants for construction projects from small to large scale buildings, within the public and private sectors.

We have become one of Belgium's leading independent engineering firms for technical equipment in the construction industry. With over 150 specialists from our various offices in Belgium, Luxembourg, Vietnam and Singapore (Representative Office). We work in close collaboration with key technical experts to form a team focused upon open and efficient communication. This in turn enables the exchange of ideas across the skill sectors, resulting in design solutions of quality, function, value, comfort and distinction in accordance to the highest global standards.

boydens TIMELINE

1961	Studiebureau Raymond Boydens was founded by Raymond Boydens
1989	Dirk Boydens joined the company
1990	Wim Boydens joined the company
1994	Dirk Boydens and Wim Boydens became the new directors and owners
1999	Brugge office moved to new office location
2002	The second branch office in Brussels
2008	The third branch office in Luxembourg (Bureau d'Etudes Luxembourg Sarl)
2013	The fourth branch office in Hanoi Vietnam (Sustainable Engineering Vietnam Ltd.)
2015	The fifth branch office in Ho CHi Minh city
2016	Opening of B-DNA Boydens Engineering as founding member

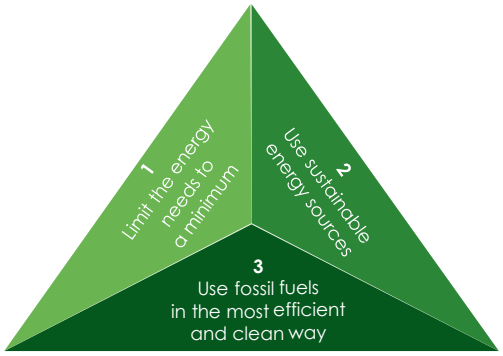
OUR VISION
AND MISSION

MISSION

Boydens Engineering is dedicated to delivering the most advanced solutions in the various technical engineering disciplines, thus providing the best solutions tailored to our clients specific needs. We focus on strengthening our position through scientific research, conducting extensive studies and applying state-of-the-art technology. We strive deliberately and with great responsibility for sustainable and low energy building solutions that minimize negative impacts on the environment

VISION

In order to make a building meet sustainability standards, we apply the strategy of the trias energetica model. A Trias Energetica is a three step directive for energy efficient design and used as a guideline to achieve desired comfort with minimal impact on the enviroment and minimum (fossil fuel) energy reliance.



HUMAN RESOURCES
BOYDENS GROUP

150
specialists

12
administration

17
project managers

33
project leaders

88
engineers

30
electrical engineer

48
mechanical engineers

10
structural engineers (structural studio in partnership with NEY + Partners)

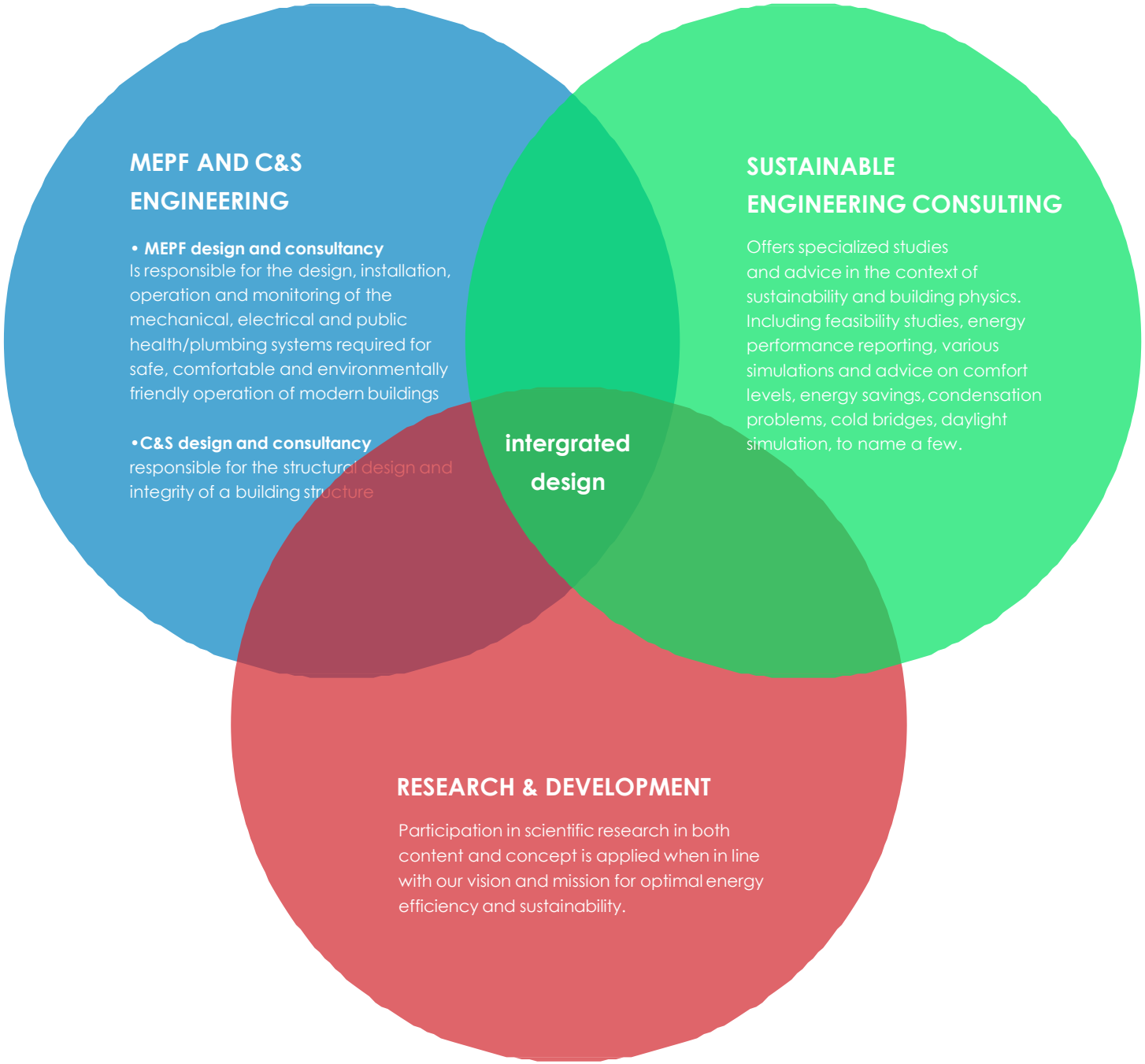
BOYDENS' SHAREHOLDERS

DIRK BOYDENS
CEO AND CO-OWNER

WIM BOYDENS
CSTO AND CO-OWNER

KURT CORVERS
COO

OUR SERVICES



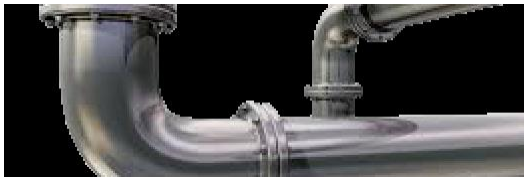
MEPF AND C&S ENGINEERING

MECHANICAL DESIGN

Design heating, ventilating, air conditioning, exhaust, heat recovery, outside air pretreatment & dehumidification, central chillers, central heating, temperature controls and energy recovery systems in compliance with international standards such as ASHRAE, European codes, British standards as well as local.

ELECTRICAL DESIGN

Design entire power distribution of high and low voltage, uninterruptible power supply (UPS), emergency backup power generators, cogeneration, lightning protection, interior & exterior lighting, sports lighting, presence light detector and dimming systems in connection and coordination with all other building system designs requiring electrical power.

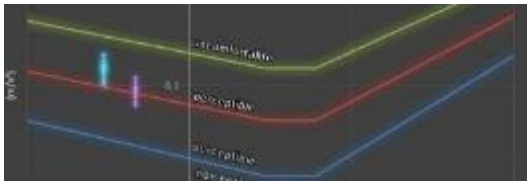


PUBLIC HEALTH DESIGN

Limiting water consumption and distribution losses has an important impact on the ecological footprint of the building. Our specialists are experienced in the various sub-domains such as water distribution, legionella control, rainwater recovery, water treatment and pumping.

FIRE ENGINEERING

Design fire safety systems including early fire detection, suppression, wet & dry control/extinguishing systems, sprinklers, fire pump designs, and smoke evacuation systems utilizing CFD model simulations.

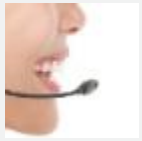


CIVIL & STRUCTURAL ENGINEERING

To achieve intricate architectural modern structures, a great deal of creativity from the structural engineer is required to ensure the design can support and resist both static and dynamic loads they are subjected to.

OTHER MEPF SERVICES

Connectivity and Data Rooms



Communi-cation technology

Security Systems

Medical Gas

Vertical & Horizontal Transport systems

Industrial Kitchens

Swimming Pools

Commissioning

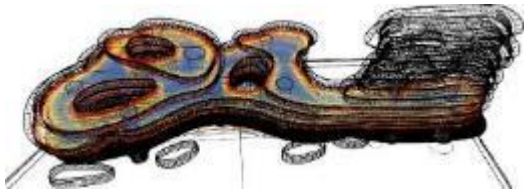
SUSTAINABLE ENGINEERING CONSULTING

CFD MODELING

Applying engineering simulations programs, is an effective way to evaluate virtual testing accurately and cost effectively. CFD modeling is used to simulate fire and smoke propagation, and help develop systems that prevent and contain fires. Projects benefit from the multidisciplinary functions of the simulation software including studying renewable resources such as wind and solar energy as well as energy reduction and efficiency.

DYNAMIC BUILDING SIMULATIONS

These programs perform hourly based simulations on buildings, whereby comfort and energy indexes can be estimated thus determining the energy efficiency generated by a specific technology or application.



DAYLIGHT AND ARTIFICIAL LIGHT SIMULATION

The intensity, uniformity, and colour rendering of indoor lighting is crucial for the safety and well-being of occupants. This simulation tool contributes significantly in reducing the need for artificial lighting, optimizing daylight harvesting without unwanted solar gains achieving significant energy savings when utilized wisely.

VGBC Vietnam Green Building Council
Hội đồng Công trình xanh Việt Nam

EPBD

BREEAM

CERTIFICATION

In addition to epbd regulations and assessment calculation E-levels & K-levels, we focus further on more holistic ecological performance labels. This includes BREEAM, Passive House Certification and Living Building Challenge.

OTHER SUSTAINABLE SERVICES

Energy Audits

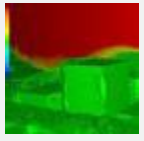
Building Certification

Epb Reporting

Building Physics

Dynamic Building Simulations

Artificial Daylight Simulation



Wind Simulation

OUR APPROACH

multi-disciplinary

Ensures an active participation on the project from the first architectural draft to the commissioning of the project. Passive design, comfort assessment, energy demand estimation, efficient MEP concept, handover and training guarantee valuable assistance over the projects life cycle.

BIM

Our teams are used to working on 3D BIM platforms that combine architectural, structural and MEP designs into the same model, and avoid inter-discipline conflict causing clash detection. On such platforms, 2D design is also possible to adapt to the project team members' practices.

masterplan optimization

Gives the client the opportunity to raise the comfort level on site while improving the energy concept at site scale. Natural resources assessment, materials thermal performance, sun exposure, shading and wind effect are assessed to enhance outdoor comfort.

passive design

Ensures an active role of the building envelope in the energy demand reduction and in comfort enhancement. Window glazing properties, walls composition, shading devices and natural ventilation opportunities are assessed to enhance indoor comfort and reduce energy needs.

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INTRODUCTION
ENERGY USE IN BUILDINGS

*"The buildings sector consumes almost **120 EJ** globally, or over **30% of total final energy consumption for all sectors of the economy** […] When upstream power generation is taken into account, the buildings sector represents nearly **30% of global CO2 emissions.**"*

*"The energy savings potential in the buildings sector is massive. Globally, the wide deployment of best available technologies and energy efficiency policies could yield annual savings in buildings' final energy use of roughly **53 exajoules (EJ) by 2050** – equivalent to the combined energy use of buildings in China, France, Germany, Russia, the United Kingdom and the United States in 2012 (IEA, 2015a)"*

From: *International Energy Agency and International Partnership for Energy Efficiency Cooperation*. Building Energy Performance Metrics - Supporting Energy Efficiency Progress in Major Economies. Technical report, IEA Publications, 2015.

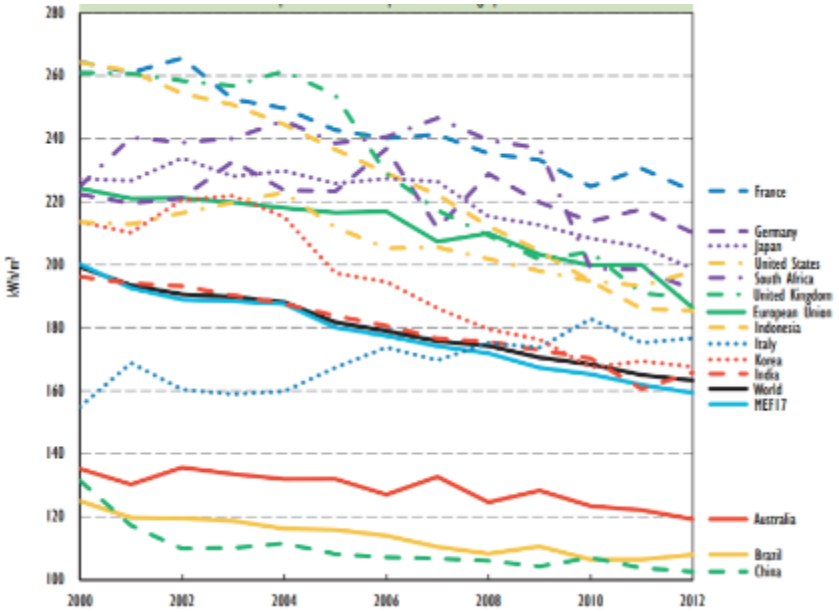


Table 3 • Historical building floor area and percent change in MEF economies, 2000-12

Economy	Floor area (million m²) in 2000	Floor area (million m²) in 2012	Change in floor area (%)
World	142 106	203 880	43.5%
MEF 17	109 176	152 477	39.7%
Australia	1 156	1 668	44.3%
Brazil	2 746	3 937	43.4%
Canada	2 106	2 644	25.6%
China	28 154	49 583	76.1%
European Union	23 127	27 917	20.7%
France	2 942	3 461	17.6%
Germany	5 057	5 133	1.5%
India	9 149	13 994	53.0%
Indonesia	2 451	4 081	66.5%
Italy	2 802	3 182	13.6%
Japan	5 868	6 674	13.7%
Korea	1 878	2 760	46.9%
Mexico	4 339	5 560	28.1%
Russia	2 785	4 189	50.4%
South Africa	737	1 209	64.0%
United Kingdom	2 938	3 609	22.8%
United States	24 680	28 263	14.5%
Remaining G20*	..	..	..

Note: m² = square metres.

INTRODUCTION : ENERGY USE IN BUILDINGS

PASSIVE DESIGN

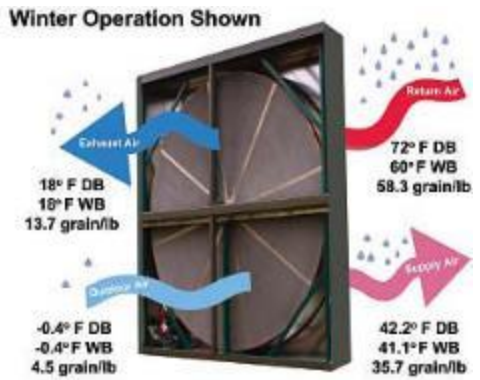
Bosco Verticale, Italy

Gare de Perpignan, France

Solarwind, Luxembourg

BCA Academy, Singapore

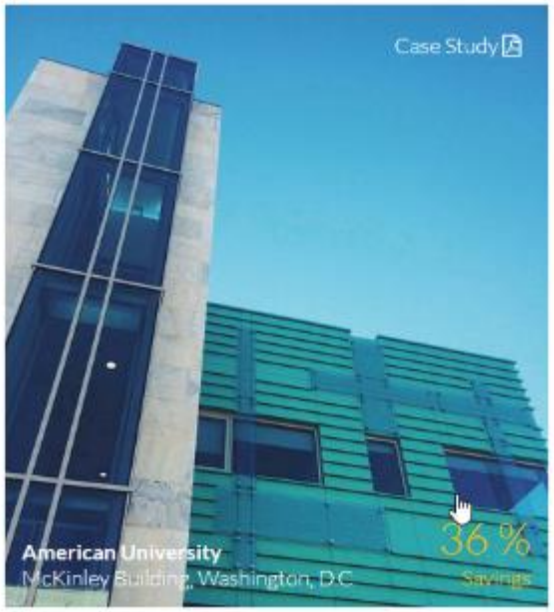
Efficient HVAC



INTRODUCTION : ENERGY USE IN BUILDINGS

Typically, improved control can reduce between 10 to > 40 % of energy use of buildings

MeteoViva



cloud ENERGY optimizer

energiebronnen, dan zet Cloud Energy Optimizer die bovendien veel effectiever in. Dit leidt tot een besparing van 15 tot 30% op uw energiekosten voor het klimatiseren van uw

Kieback&Peter

Improvement in efficiency and comfort

MPC 2.0 from Kieback&Peter optimizes control of your heating, ventilation and A/C systems. With MPC 2.0, you save about 20 percent of your energy compared to a conventional control system. And users benefit palpably from greater comfort.

MULTIPLE CHALLENGES

- Building and hydraulics complexity is increasing
  - Renewable systems in parallel to traditional one
  - More than one system to provide heat and cooling to zone (ventilation, radiator, floor heating, …)
- Increase of control degree of freedom
  - Ex: solar shading controlled depending on sun radiation, temperature, glare, lighting, …
  - Ex: ventilation controlled based temperature, humidity, CO2, …
- Large choice of products, need for coupling but different protocols + interactions between different parties (HVAC, ELEC, Integrator, …)

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Control considered from pre-design to construction phase

1. Function description
   Hydraulic scheme may need extra explanation

BEO-veld

Materiaal:
- PRBA (aandeel)
- interfacemodules
- 2x watertemperatuursensor Pt1000

Werken:
- levering en plaatsing
- PRBA-programmering

Regelingsstrategie:
- de circulatiepompen worden in cascade gestuurd (elke pomp wordt gedimensioneerd op 65 % van het piekdebiet)
- de pompen worden continu vrijgegeven
- het toerental wordt bepaald door een PI-regelaar in functie van het verschil tussen gewenst en gemeten temperatuurverschil tussen vertrek en retour
- de gewenste temperatuurverschil kan ingegeven worden als functie van de retourtemperatuur uit de bodem

Betreft:
- BEO-veld WZC

Toepassing:
- per systeem

GBS-interface (BACnet):

> Temperatuur
- AI: vertrektemperatuur BEO-veld
- AI: retourtemperatuur BEO-veld
- AV: temperatuurverschil vertrek-retour
- TLOG: vertrektemperatuur BEO-veld; interval: 5 min
- TLOG: retourtemperatuur BEO-veld; interval: 5 min
- TLOG: temperatuurverschil vertrek-retour; interval: 5 min

> Circulatiepompen (per pomp)
er zijn in totaal 2 pompen in dit systeem
- BO: vrijgave pomp (bedrijfstijdtotalisatie via eigenschap Elapsed_Active_Time)
- AO: stuursignaal pomp
- BI: foutmelding (intrinsic reporting: alarm via NC en Alarm_Value eigenschap)

> Meldingen
- NC: alarm naar GBS-server
- SCHED: anti-blokkering pomp

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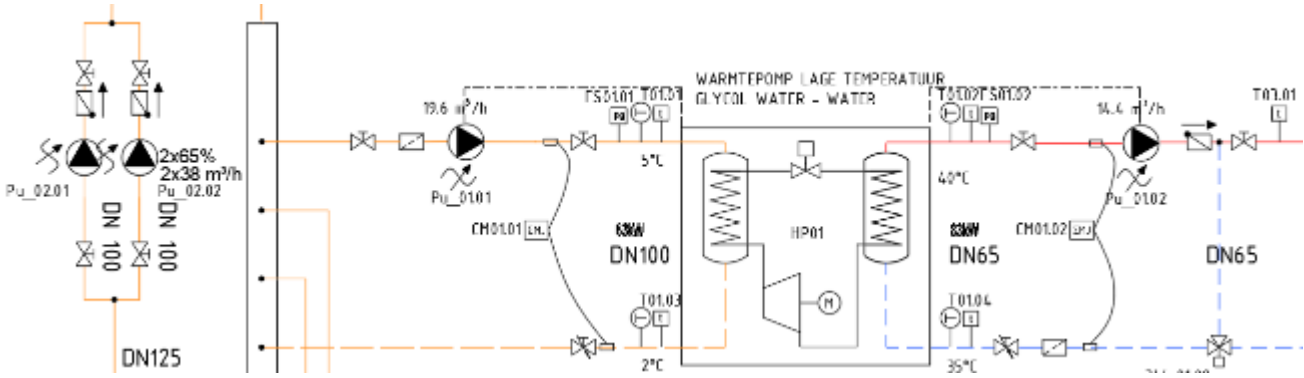
Control considered from pre-design to construction phase

2. I/O list

Type, name, description of all control/measurement points + database



HVAC: Data Point List

Project name	Ter Meeren
Project number	180-313
System Type	Verwarmings-en koelingsinstallatie
Author	PNNH
Date	4/10/2019

Name	Number	Parameter	Description	DI	AI	DO	DOX (Override)	AO	AOX (Override)	M-bus	Modbus	Block	Temperature sensor	Relative humidity sensor	Pressure sensor	Flow switch	Pump	Room motorized two way valve	Motorized two way control valve	Motorized two way valve	Motorized three way valve	Fan coil unit	Calorimeter	Watermeter	Gas meter
Binnenluchtgroep-kamers AW 5.110m³/h (LG01)	327	TERM_ThPu_15.03	Thermal alarm pump	1								AW													
	328	TERM_ConPu_15.03	Control (0-10 V)						1			AW													
	329	TERM_T15.07	Temperature sensor		1							AW	1												
	330	TERM_T15.08	Temperature sensor		1							AW	1												
	331	TERM_2W_15.09	Motorized two way valve	2					1			AW							1						
	332	TERM_StPu_06.01	Status pump	1								AW					1								
	333	TERM_CmdPu_06.01	Command of pump				1					AW													
	334	TERM_DisPu_06.01	Disparity alarm	1								AW													
	335	TERM_ThPu_06.01	Thermal alarm	1								AW													
	336	TERM_ConPu_06.01	Control (0-10 V)						1			AW													
	337	TERM_StPu_06.02	Status pump	1								AW					1								
	338	TERM_CmdPu_06.02	Command of pump				1					AW													
	339	TERM_DisPu_06.02	Disparity alarm	1								AW													
	340	TERM_ThPu_06.02	Thermal alarm	1								AW													
Buffertank 1000 l (Sanitary warm water)	341	TERM_ConPu_06.02	Control (0-10 V)						1			AW													

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Control considered from pre-design to construction phase

3. Architecture of control hardware

Use BACnet/IP, for each PLC which BACnet object available, …

Vb: Algemene specificaties

Programmeerbare regel- en besturingsapparaten (PRBA)

> BACnet stack

>> Algemeen
- BACnet toestel volgens ANSI/ASHRAE Standard 135
- getest en gecertificeerd door BACnet Testing Laboratories (BTL)
- de BACnet-stack dient op het vlak van het moederbord geïntegreerd zijn
- Data Link Layer:
  * BACnet IP, Foreign Device
  * MS/TP-master, baud rate 9600 tot 115200
- ondersteunde tekenset: UTF-8 (lengte 32 tekens)
- ondersteuning van verdeelde boodschappen (segmented messages)
- BBMD-functie (BACnet Broadcast Management Device)
- bij netspanningsonderbreking en bij de retour van de netspanning:
  * de eigenschappen van dynamische variabelen dienen minstens gedurende 72 uur te worden gebufferd; dit is van toepassing op objecten zoals Trendlog, Schedule en Calendar
  * de eigenschappen Recipient_List in Notification Class objecten worden behouden; de cliënten blijven de informaties betreffende gebeurtenissen en alarmen automatisch te ontvangen zonder zich terug te moeten abonneren
  * de eigen COV-boodschappen worden behouden
  * de COV-abonnementen tot andere BACnet servers worden automatisch hersteld
  * de connecties tussen regelaars worden geactualiseerd (geabonneerd)

>> BACnet Interoperability Building Blocs (BIBB)
- toestelprofiel: B-BC
- bijkomende geëiste BIBB (niet inbegrepen in het standaard B-BC-profiel):
  * Data Sharing: DS-COV-A, DS-COV-B
  * Alarm and Event Management: AE-N-E-B, AE-ASUM-B
  * Scheduling: SCHED-I-B
  * Trending: T-VMT-I-B, T-VMT-E-B, T-ATR-B

>> Gateway
- het toestel moet kunnen functioneren als master en BACnet/IP-gateway voor minstens de volgende communicatieprotocollen:
  * BACnet MS/TP
  * KNX (S-mode)
  * Modbus RTU
  * M-Bus
- de integratie van de bovenvermelde protocollen in het toestel gebeurt door middel van een interne driver (native support); het gebruik van een externe gateway, die het onbekende communicatieprotocol vertaalt naar een tussenliggend protocol dat door de software van de regelaar wordt ondersteund, wordt in dit geval niet toegestaan
- het updaten van de firmware moet via internet mogelijk zijn zonder dat er hardware moet vervangen worden

Vb: Luchtgroep

Luchtgroep WZC-LG-01

Materiaal:
- PRBA (aandeel)
- interfacemodules
- 5x luchttemperatuursensor Pt1000
- 2x differentieeldrukschakelaar (ventilator)
- 2x differentieeldruksensor (filter)
- 2x druksensor
- 2x servomotor aan/uit met veerteruggang (registerkleppen)
- 2x servomotor aan/uit (change-over)
- 2x servomotor 0-10 V (injectieschakeling)
- 2x watertemperatuursensor Pt1000
- 1x relatieve vochtigheidssensor
- 1x antivriesthermostaat

Werken:
- levering en plaatsing
- PRBA-programmering

Regelingsstrategie:
- werking luchtgroep volgens tijdsprogramma
- werkingsmodi: stand-by, vorstbeveiliging, verwarming, passieve koeling, actieve koeling
- werkingsmodus bepaald in functie van de buitentemperatuur
- sturing van change-over in functie van de werkingsmodus
- pulsietemperatuur afhankelijk van de werkingsmodus
- waarschuwing bij vuile filters
- pulsietemperatuurregeling d.m.v. injectieschakeling en een PI-regelaar
- bij brand automatisch uitschakelen
- constante drukregeling

Betreft:
- WZC-LG-01 bureaus

Toepassing:
- per luchtgroep

GBS-interface (BACnet):

> Algemeen
- NC: waarschuwing naar GBS-server
- NC: alarm naar GBS-server
- SCHED: werking luchtgroep
- AV: setpunt pulsietemperatuur

> Filters (per filter)
- AI: drukverschil over filter (waarschuwing via NC)

> Registerkleppen (per klep)
- BO: stuursignaal klep

> Warmtewiel
- AO: snelheid
- BI: storing warmtewiel (intrinsic reporting: alarm via NC en Alarm_Value eigenschap)

> Ventilator (per ventilatorgroep)
- BO: vrijgave motor/frequentieomvormer (bedrijfstijdtotalisatie via eigenschap Elapsed_Active_Time)
- BI: storing motor/frequentieomvormer (intrinsic reporting: alarm via NC en Alarm_Value eigenschap)
- BI: werking motor/frequentieomvormer (intrinsic reporting: alarm via NC en Alarm_Value eigenschap)
- AO: stuurfrequentie
- BI: veiligheidsschakelaar (intrinsic reporting: alarm via NC en Alarm_Value eigenschap)
- BI: differentieeldrukschakelaar
- LOOP: PID-regelaar druk/debiet

> Temperatuursensoren lucht (per sensor)
- AI: temperatuur
- TLOG: temperatuur; interval: 5 min

> Relatieve vochtigheidssensoren (per sensor)
- AI: relatieve vochtigheid
- TLOG: relatieve vochtigheid; interval: 5 min

> Druksensoren lucht (per sensor)
- AI: druk

> Change-over luchtbatterij met injectieschakeling
- LOOP: PI-regelaar vertrektemperatuur
- BO: sturing servomotor koeling (change-over)
- BO: sturing servomotor verwarming (change over)
- AO: sturing servomotor koeling (temperatuurregeling)
- AO: sturing servomotor verwarming (temperatuurregeling)

Control considered from pre-design to construction phase

4. Control should not be dictated by choice of HVAC/ELEC component
   check that devices of HVAC and ELEC can communicate with each other, check connection and location of PLC, …

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open protocol and programmable devices

1. Use BACnet/IP between controllers
   Reason: BACnet is the only protocol including semantics + EDE file enough to understand how to interact with controller

2. Controllers should be freely (re)programmable
   No dependence of control company

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Control has a large influence on energy use

1. Control should be designed by programmer with enough HVAC knowledge

   Heating/cooling curves, running average of outdoor temperature for TABS, dew point control for cooling ceiling, max ΔT on condenser and evaporator of heat pump, importance of f-controlled pumps …

2. Control design and BMS interface should have many degree of freedom for fine-tuning

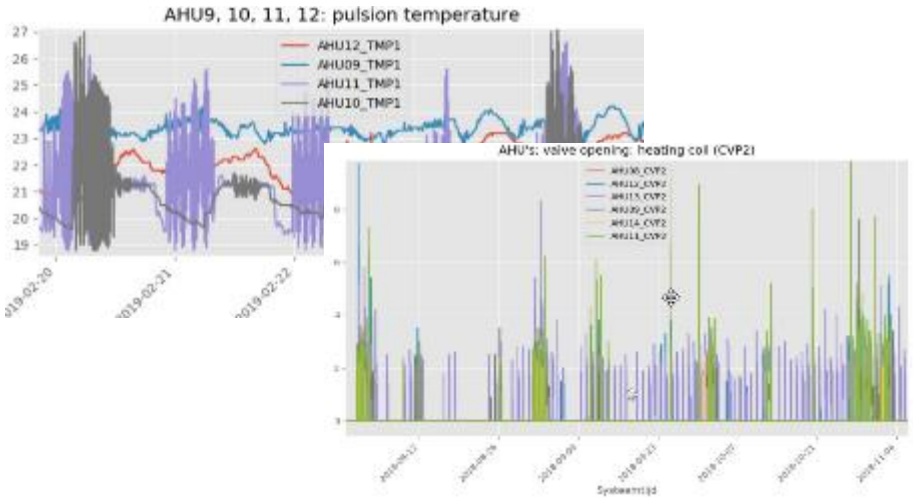
   e.g. Herman Terlinck building: heating curve and cooling curve for both supply and return temperature of TABS for each zone, heating/cooling curve per circuit, (energy) security check (no heating and cooling at the same time), …

@ BOYDENS

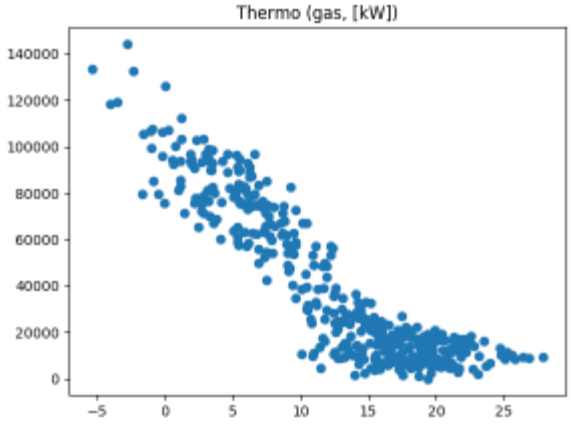
Control has a large influence on energy use

3. Good measurement, trends, and informative graphics are crucial

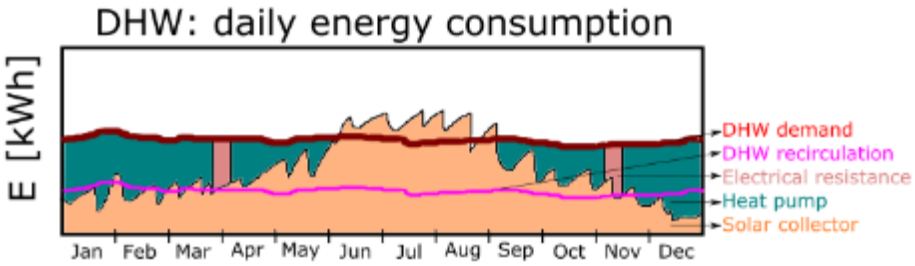
Trends: malfunctioning PID



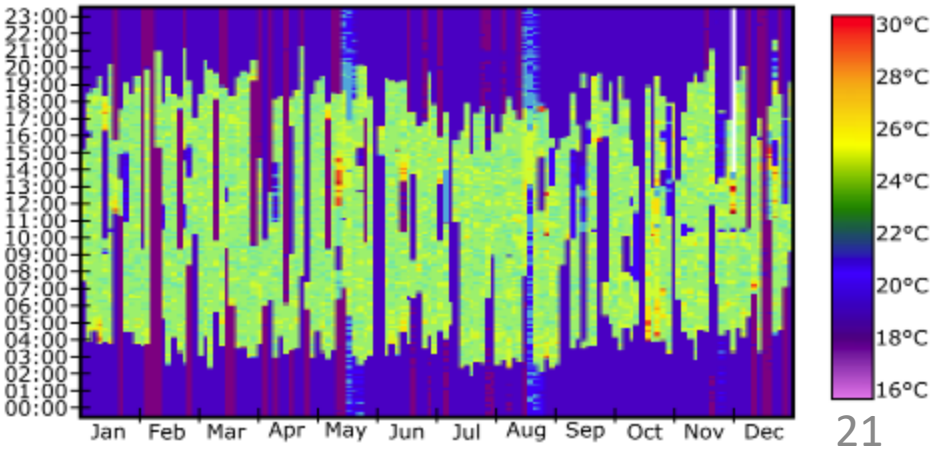
Energy consumption as function of outdoor temperature



Energy flows



Heat map



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Control has a large influence on energy use

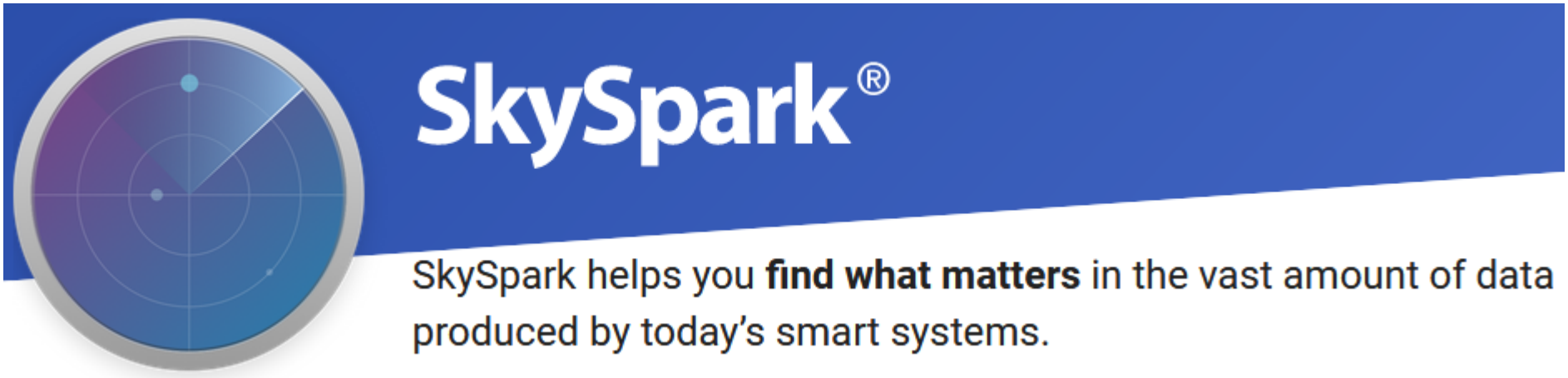
4. BMS are crucial.

   According to Energy Performance of Building Directive (EPBD), new and existing buildings equipped with > 290 kW HVAC need to have a Building Automation And Control System by 2050

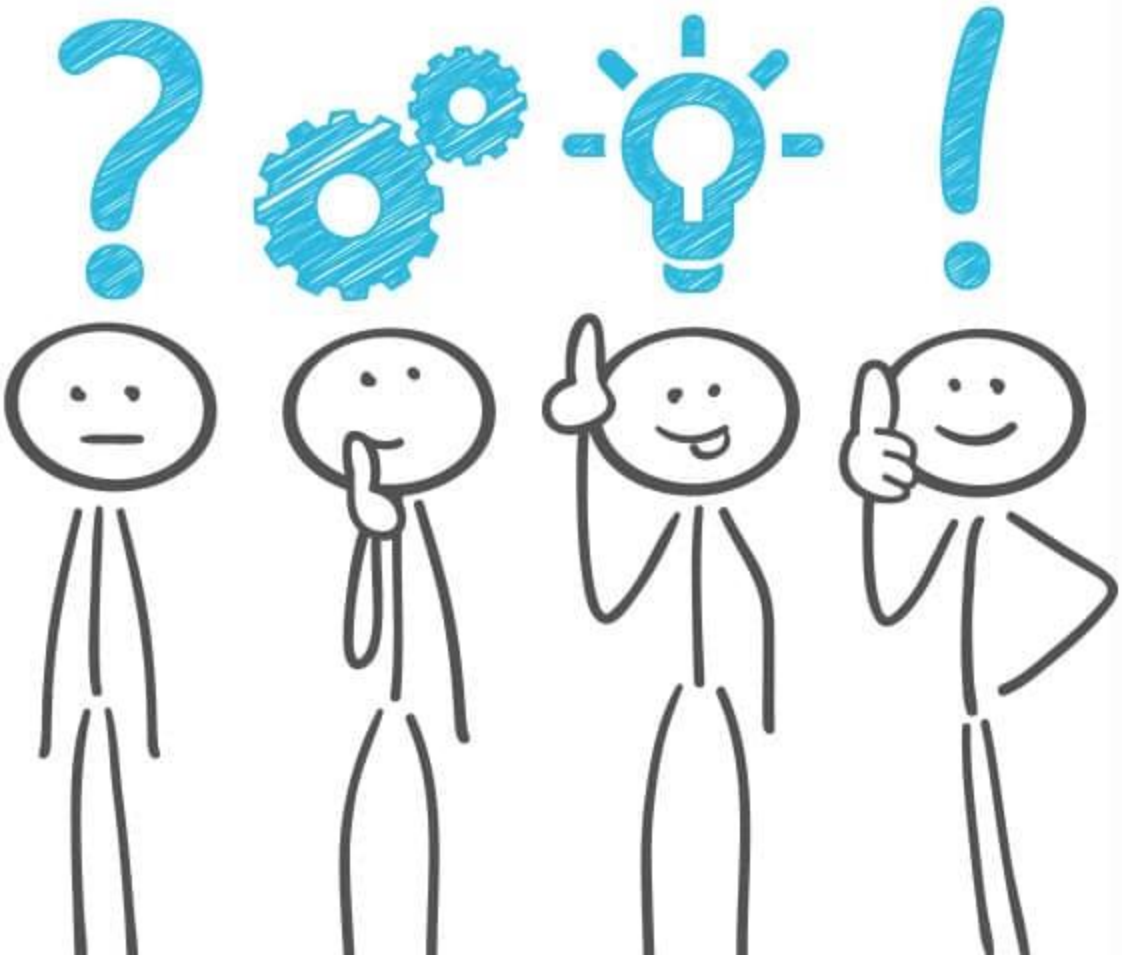
5. Commissioning is crucial

   By installer, by integrator, by engineer office

   → Need of remote access to BMS and data



THANK YOU!



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