Higher Education Authority
An tÚdarás um Ard-Oideachas

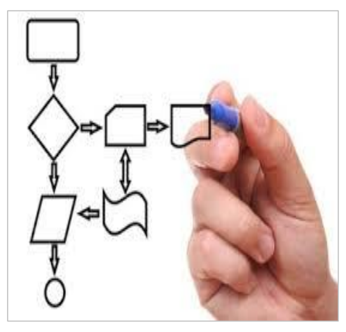
RESEARCH PORTFOLIO

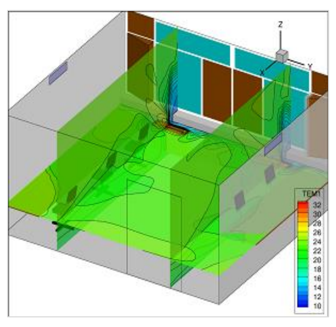
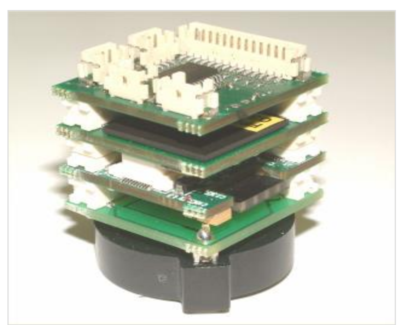




PRTLI 5

Programme for Research
in Third-Level Institutions



This certificate was presented to

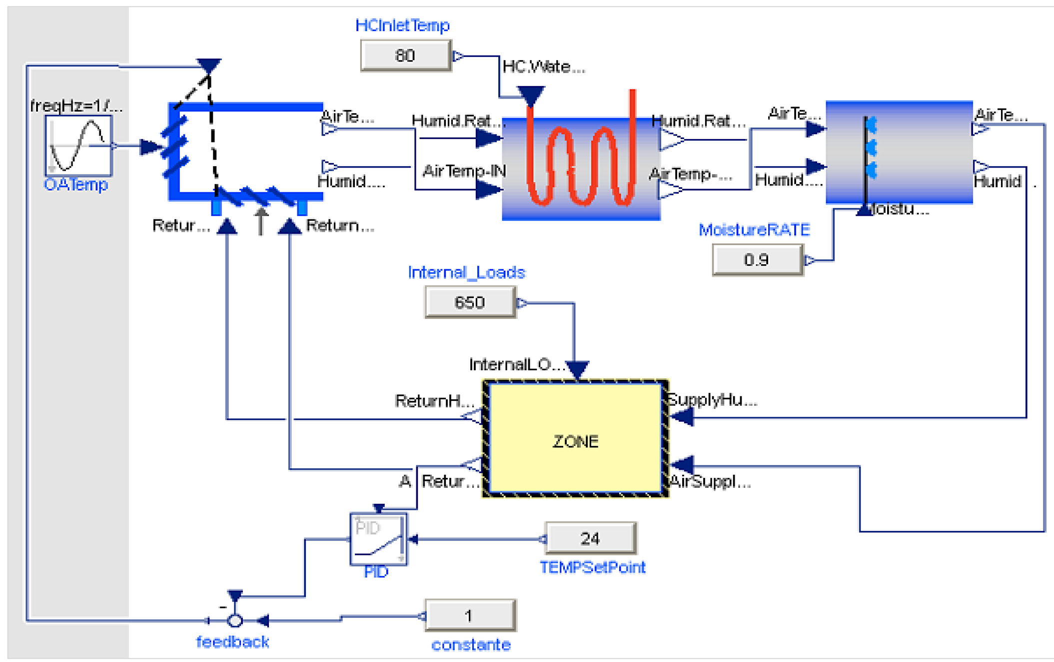
Karsten Menzel

Recognising leadership of a project in the Seventh EU Framework Programme for Research at 'Ireland's Champions of EU Research 2012'

attended by

President of Ireland, Michael D. Higgins

Dr Imelda Lambkin



BIM and Lean Management

Energy Facilities People

Smart Buildings and Big Data


University College Cork, Ireland
Coláiste na hOllscoile Corcaigh
School of Engineering

http://zuse.ucc.ie/grep

NEW BUSINESS MODELS FOR SUSTAINABLE BUILDING OPERATION

HEA
Higher Education Authority
An tÚdarás um Ard-Oideachas

Objectives

The issue of reducing primary energy demand in buildings remains a critical issue for achieving reduced carbon emissions and security of energy supply worldwide.

To date energy efficiency measures have focused on short term returns without a strategy for the buildings lifecycle.

Therefore, typical consumption (of buildings in Ireland) remains still at 220-300kWh/m2 per year compared to the target of less than 80kWh/m2

80% of buildings in Ireland predate 1991 and 75% of current stock will be in use in 2050. Besides improved insulation, the installation of advanced monitoring and control systems is one recommended retrofit action.

Therefore, this research proposes that improved integration of building services and control systems can improve building performance and especially energy performance.

Underpinning the integration approach with specially developed business models and procurement systems will achieve regular renovation cycles and develop the process of reducing energy demand in buildings.

Approach

The critical path for reducing energy consumption is through developing a culture and a framework for shorter building energy renovation cycles.

However the core problem currently is cost. This research proposes that ICT developments offer opportunities to enrich and improve building performance data for analysis and management through its lifecycle.

When coupled with a systematic process like 5D-BIM then this can improve the design construction and maintenance planning and therefore impact positively on cost control and investment returns.

With this we can confidently examine a range of renovation possibilities for the demonstrator buildings.

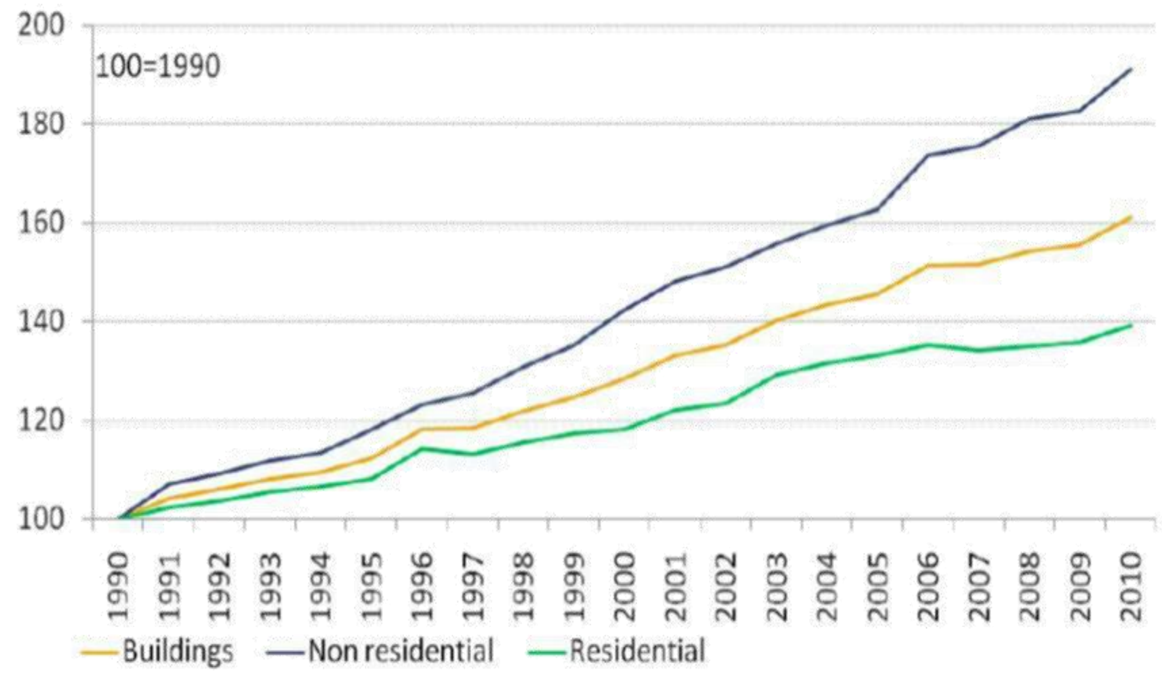


Figure 1: Electricity Trends in the Building Sector (Eurostat)

It is proposed to underpin all of the above with new business models to involve all the stakeholders for building energy management from supply and demand control to end use including maintenance and operations contractors.

New business models are needed to stimulate building stakeholders to make informed decisions and commit to sustainable building management.

For this research we will use Osterwalder's framework for business modelling.

Work on business models is complemented by a critical analysis of current procurement models. The emphasis of the analysis is on the possibility for early involvement of all stakeholders, including operators of energy and building services systems.

A second emphasis of the procurement model analysis focuses on the need for continuity in the operation, maintenance and upgrade of control and monitoring systems.

Pillar	Block	Description
Product	Value Proposition	Gives an overall view of a company's bundle of services and products
Customer Interface	Target Customer	Describes the segment of customers the company wants to offer value to
	Distribution Channel	Describes the various means of the company to get in touch with its customers
	Relationship	Explains the kind of links a company establishes between itself and its different customer segments
Infrastructure Management	Value Configuration	Describes the arrangement of activities and resources
	Core Competency	Outlines the competencies necessary to execute the company's infrastructure business model
	Partner Network	Portrays the network of cooperative agreements with other companies necessary to efficiently offer and commercialise value
Financial Aspects	Cost Structure	Sums up the monetary consequences of the means employed in the business model
	Revenue Model	Describes the way a company makes money through a variety of revenue flows

Figure 2: Osterwalder's Business Model Framework

Achievements To Date

The work carried out includes the specification and deployment of a hardware and software platform for the integrated operation of building services systems.

This is complemented by related business and procurement models, which emphasis on the provision of integrated operational, maintenance, inspection, and upgrade services. In some publications this is also called "Energy Service Provision".

Using this methodology, demonstration systems were installed and operated for a limited time period on these demonstration sites.

Lessons learned were gathered from the procurement and deployment activities of these integrated energy systems.

Currently, the second iteration of the development cycle for the above methodology is in progress. It is aimed that the final models are applicable for industry to utilise for a range of building types.

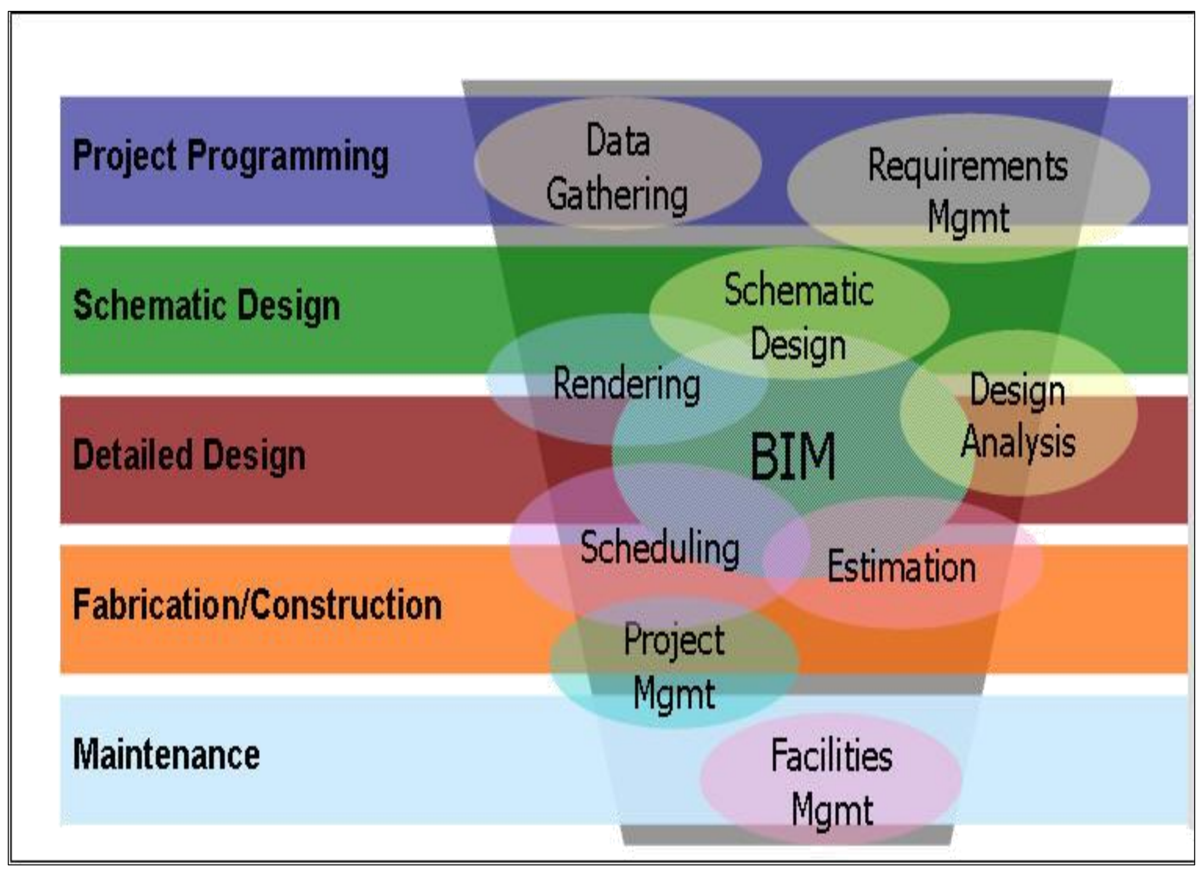


Figure 3: An Integrated Planning and Procurement Platform

Contact:

IRUSE Researchers:
Sean Sirr, MSc.
s.sirr@ucc.ie

Mentor: Prof. Karsten Menzel
University College Cork
Informatics Research Unit for Sustainable Engineering
CORK, Ireland
k.menzel@ucc.ie

UCC University College Cork, Ireland
Coláiste na hOllscoile Corcaigh
School of Engineering

http://zuse.ucc.ie/grep

BUILDING PERFORMANCE MODELLING

Higher Education Authority
An tÚdarás um Ard-Oideachas

Abstract

For Facility Management (FM) companies, Information Technology (IT) is becoming important. Clients demand that their buildings perform more efficiently and desirable FM contracts are awarded to FM companies who fulfil these requests. IT equipment is being used to monitor energy consumption within a building.

This allows a Facility Manager to analyse the data, benchmark it against similar buildings and offer the client modernisation procedures for the appropriate systems. Initial projections estimate, that for a FM company that is operating 1000 buildings, the amount of data collected after 5 years will be around 2.5 billion datasets.

Figure 1: Dimensions Derived from BIM

Objective

This research aims to deliver a standardized method to acquire the performance data of a building. It discusses the infrastructure needed to harvest data from the buildings and store it in a centralised, efficient Data Warehouse (DW) system.

The main focus will be on analysis functions that are running on top of the DW. Their objective is to support the Facility Manager with clear and understandable visualisations and process the huge amount of information for him in a convenient and non-time intensive way.

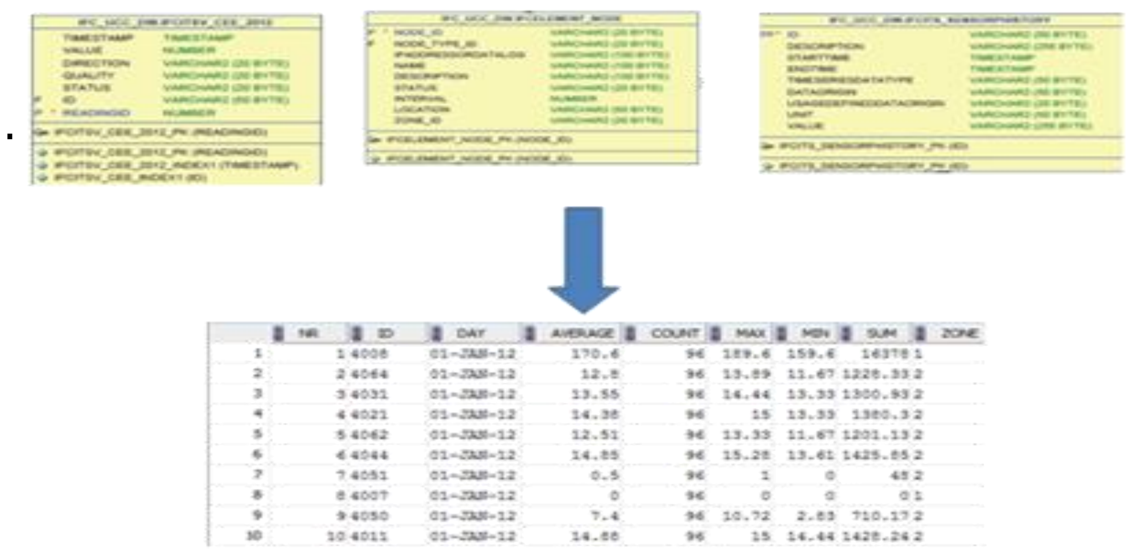
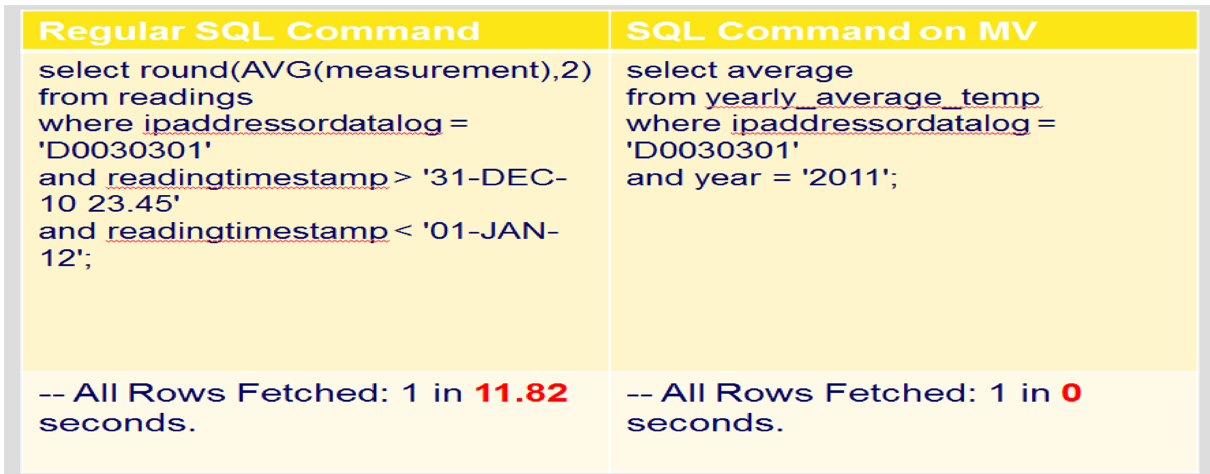


Figure 2: Amalgamating BIM and Monitoring Data

Approach

CONSOLOIDATION OF INFORMATION:

- Information is usually spread across multiple tables
- A Materialized View (MV) consolidates data
- MV's can be modelled for individual data representations
- Unneeded data gets ignored in the MV
- MV's allow to pre-calculate data for quick access



Regular SQL Command	SQL Command on MV
select round(AVG(measurement),2) from readings where ipaddressordatalog = 'D0030301' and readingtimestamp > '31-DEC-10 23.45' and readingtimestamp < '01-JAN-12';	select average from yearly_average_temp where ipaddressordatalog = 'D0030301' and year = '2011';
-- All Rows Fetched: 1 in 11.82 seconds.	-- All Rows Fetched: 1 in 0 seconds.

Figure 3: Simplification of Queries and Fast Response Times

Materialized Views & Cubes

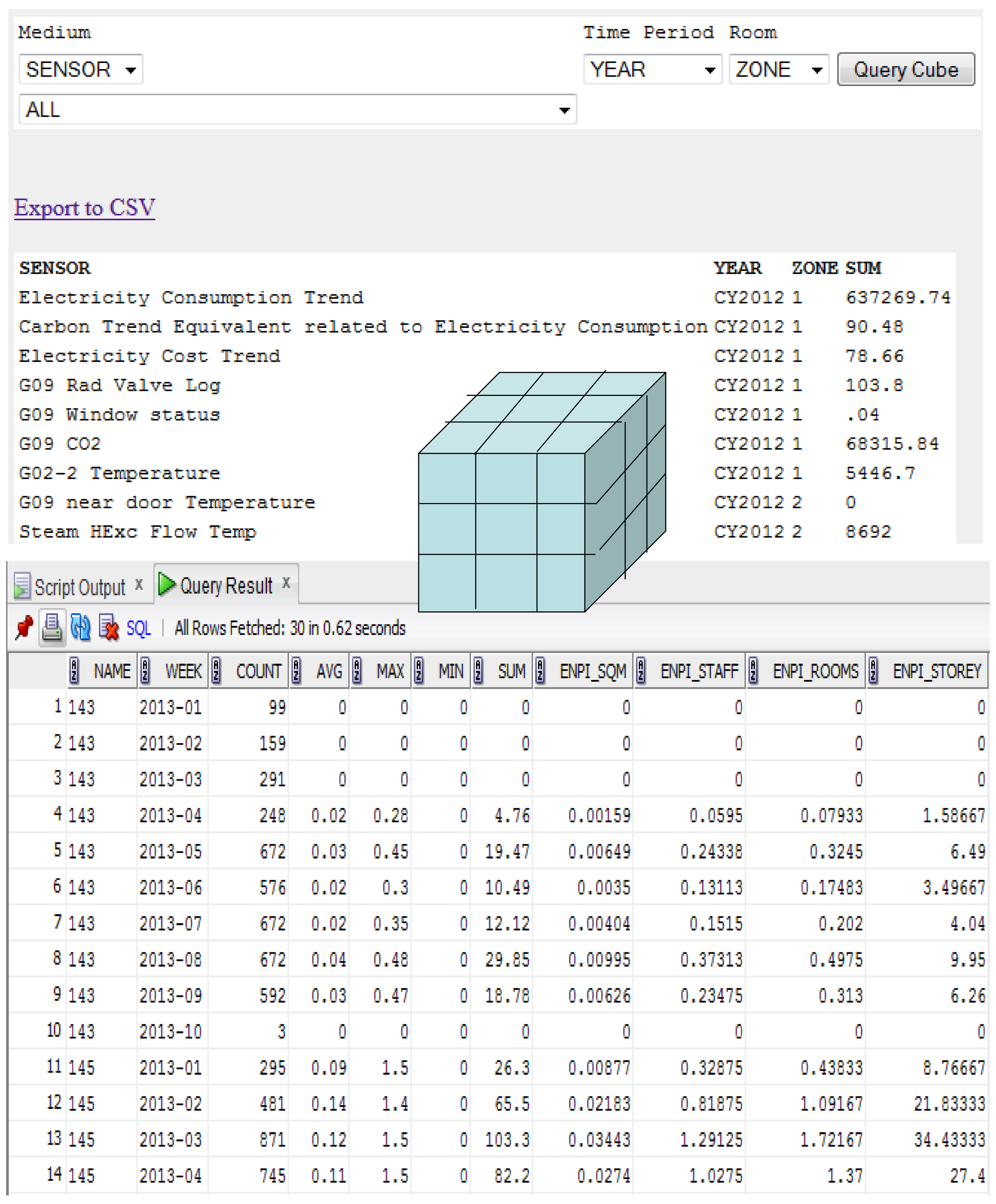
The Data Warehouse (DW) is used to pre-calculates Performance Indicators (PI) in Materialized Views.

The performance gain for using DW-technology compared to regular SQL commands is huge (cf. figure 3)

Results

Creating a Data Warehouse Cubes

- A cube consists of a fact table (w. measured data) and
- Dimensional data, e.g. time, zone, system (cf. figure 1)



SENSOR	YEAR	ZONE	SUM
Electricity Consumption Trend	CY2012	1	637269.74
Carbon Trend Equivalent related to Electricity Consumption	CY2012	1	90.48
Electricity Cost Trend	CY2012	1	78.66
G09 Rad Valve Log	CY2012	1	103.8
G09 Window status	CY2012	1	.04
G09 CO2	CY2012	1	68315.84
G02-2 Temperature	CY2012	1	5446.7
G09 near door Temperature	CY2012	2	0
Steam HExc Flow Temp	CY2012	2	8692

	NAME	WEEK	COUNT	AVG	MAX	MIN	SUM	ENPI_SQM	ENPI_STAFF	ENPI_ROOMS	ENPI_STOREY
1	143	2013-01	99	0	0	0	0	0	0	0	0
2	143	2013-02	159	0	0	0	0	0	0	0	0
3	143	2013-03	291	0	0	0	0	0	0	0	0
4	143	2013-04	248	0.02	0.28	0	4.76	0.00159	0.0595	0.07933	1.58667
5	143	2013-05	672	0.03	0.45	0	19.47	0.00649	0.24338	0.3245	6.49
6	143	2013-06	576	0.02	0.3	0	10.49	0.0035	0.13113	0.17483	3.49667
7	143	2013-07	672	0.02	0.35	0	12.12	0.00404	0.1515	0.202	4.04
8	143	2013-08	672	0.04	0.48	0	29.85	0.00995	0.37313	0.4975	9.95
9	143	2013-09	592	0.03	0.47	0	18.78	0.00626	0.23475	0.313	6.26
10	143	2013-10	3	0	0	0	0	0	0	0	0
11	145	2013-01	295	0.09	1.5	0	26.3	0.00877	0.32875	0.43833	8.76667
12	145	2013-02	481	0.14	1.4	0	65.5	0.02183	0.81875	1.09167	21.83333
13	145	2013-03	871	0.12	1.5	0	103.3	0.03443	1.29125	1.72167	34.43333
14	145	2013-04	745	0.11	1.5	0	82.2	0.0274	1.0275	1.37	27.4

Figure 4: Example for Using Cubes
(Energy Performance Indicators for one building)

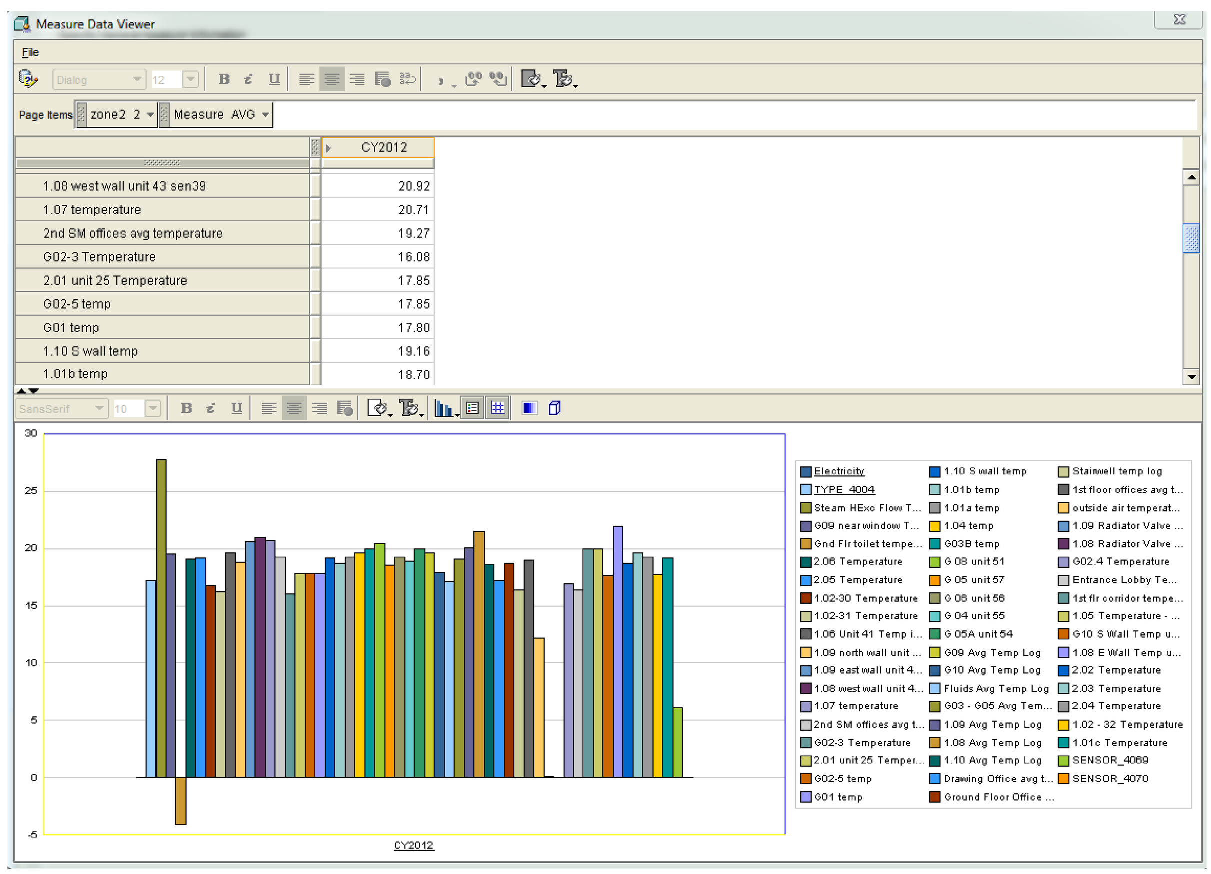


Figure 5: Complex Analysis Results
(UnderPerformance Indicator – UP_{temp} for one floor)

Contact:

IRUSE Researchers:
Stephan Hoerster, MSc.
s.hoerster@ucc.ie

Mentor: Prof. Karsten Menzel
University College Cork
Informatics Research Unit for Sustainable Engineering
CORK, Ireland
k.menzel@ucc.ie

UCC University College Cork, Ireland
Coláiste na hOllscoile Corcaigh
School of Engineering

http://zuse.ucc.ie/grep