SDAR* Journal of Sustainable Design & Applied Research

Volume 1 | Issue 1 Article 4

2012

Criminal Courts of Justice, Dublin

Jonathan Tooth
jtooth@jvtierney.ie

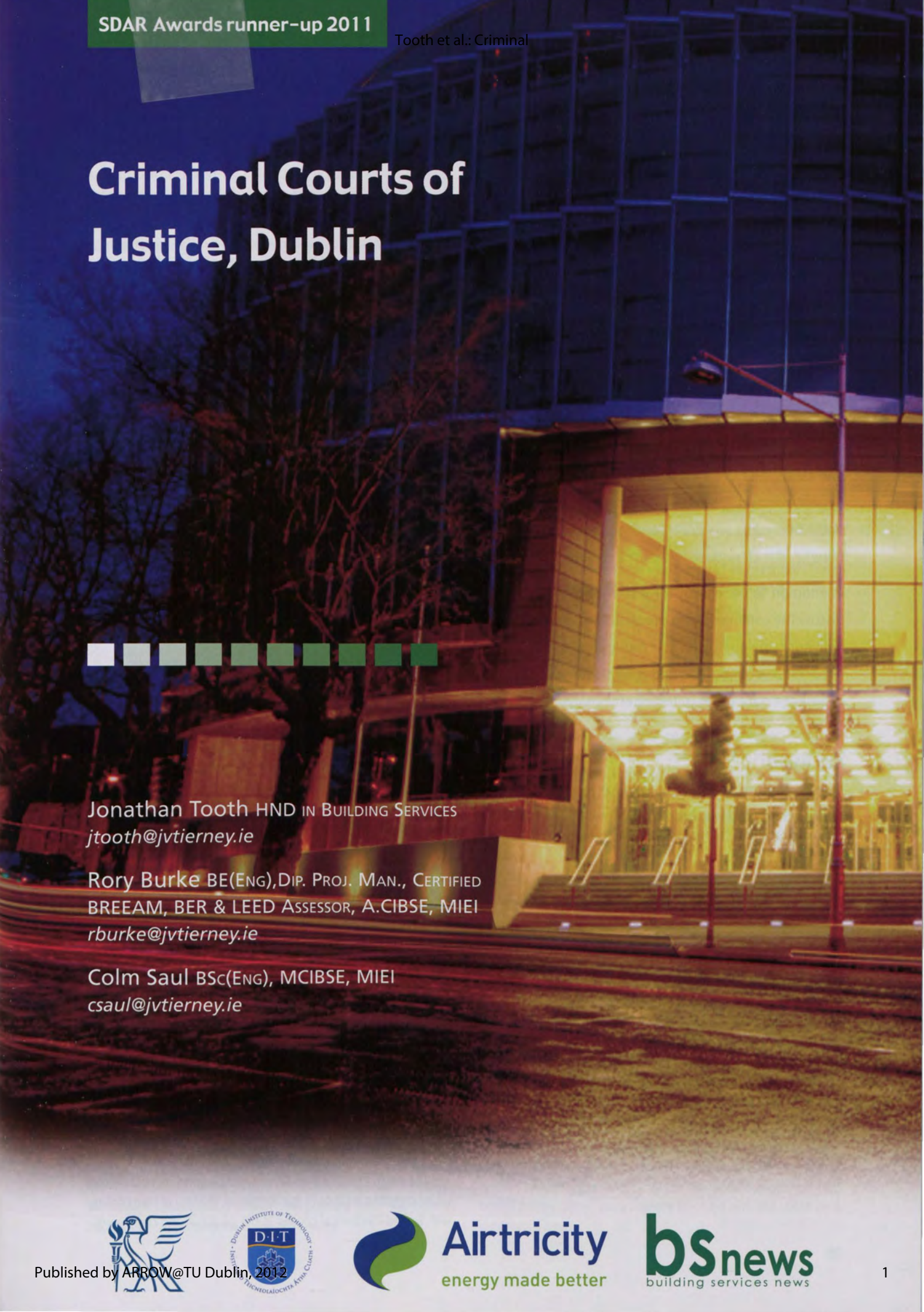
Rory Burke

Colm Saul

Recommended Citation

Tooth, Jonathan; Burke, Rory; and Saul, Colm (2012) "Criminal Courts of Justice, Dublin," *SDAR* Journal of Sustainable Design & Applied Research*: Vol. 1: Iss. 1, Article 4.
doi:https://doi.org/10.21427/D7ST78
Available at: https://arrow.tudublin.ie/sdar/vol1/iss1/4

Criminal Courts of Justice, Dublin



Jonathan Tooth HND in Building Services
jtooth@jvtierney.ie

Rory Burke BE(Eng),Dip. Proj. Man., Certified BREEAM, BER & LEED Assessor, A.CIBSE, MIEI
rburke@jvtierney.ie

Colm Saul BSc(Eng), MCIBSE, MIEI
csaul@jvtierney.ie

Abstract

The newly completed Criminal Courts of Justice (CCJ) at Parkgate Street in Dublin 8 is the largest courts project undertaken in the history of the Irish State. The design of the heating, ventilation and air conditioning (HVAC) systems was based on computer simulated modelling of the building to determine the optimum plant selection and operation based on the contract conditions and energy targets.

The report will analyse the computer simulated energy targets versus the actual energy consumption and assess the benefit of engineering solutions such as twin-skin facades and heat recovery based on real data. The report will draw conclusions on the real benefit of such systems within the built environment.

In addition to the energy targets, the report will discuss the commissioning processes involved in delivering the energy targets required and the importance of designing metering strategies to enable the data to be collected and analysed.

Key Words:

Facade, Natural Ventilation, Heat Recovery, Energy Usage Indices, Metering.

1. Introduction and project detail

The newly completed Criminal Courts of Justice (CCJ) at Parkgate Street in Dublin 8 is the largest courts project undertaken in the history of the Irish State. This landmark building provides a significant architectural addition to Dublin. Its architectural design, along with its construction, is befitting of a major civic building of national significance. The project was carried out under a Public Private Parnership (PPP) and has been awarded the RIAI Public Choice Award 2010 and RIAI Best Accessible Award 2010.

The design centralised criminal court activity in one serviced location. It is a major new state-of-art facility suited to the administration of justice in Ireland. The principal users will be the Courts Service, Judiciary, Jurors, Director of Public Prosecution, Legal Profession, Defendants, Gardai, Irish Prison Service, Facilities Management and the General Public. The building is circular in form with the 'Great Hall' at its core and is 11 storeys high over a naturally-ventilated basement car park with an area of 25,000m^2 and a construction value of €160m. It contains 22 courtrooms, jury retiring rooms, judicial chambers, custodial holding rooms and associated offices and services.

In addition to being a landmark building, the brief called for the building to be a low energy user with individually-controlled spaces; good daylight; acoustically-treated facilities protected from internal and external noise pollution; and highly-secure, including the segregation of the following users: defendants in custody, public, jurors and judiciary.

The design called for a challenging energy usage target of not greater than 240 kWh/m^2/year with a resultant carbon emission target of <86 KgCO_2/m^2/year based on the strict criteria set out in the PPP contract documents. These documents set very stringent tolerances for the internal environmental conditions and noise levels. Any deviation outside of these conditions would result in the non-availability clause being enforced.

Some of the specific features that assist in meeting these energy and environmental targets are the active double skin facade, mixed mode ventilation and use of thermal mass in courtrooms, active chilled beams, low Nox boilers, night cooling, heat recovery from the Great Hall, extensive lighting management system incorporating presence detection, and daylight sensing. In the case of the double skin facade for example, it reduces winter heat losses, reduces solar gain into the spaces and provides for solar and glare control and allows for very good levels of natural daylight.

One of the early tasks undertaken by the Building Services Design Team was to provide advice to the whole project team on the building envelope. Extensive use of Dynamic Simulation Modelling in the design phase helped to optimise the double skin facade design and the control strategy. Dynamic Simulation Modelling also allowed the thermal loads and energy consumption to be assessed whilst providing analysis of the ventilation strategy of Free cooling with limited mechanical cooling in the great hall and courtrooms.

DOI: https://doi.org/10.21427/D7ST78

A comprehensive energy strategy was produced to demonstrate and to outline compliance with the energy and carbon emission targets and outline to the client how it would be monitored, controlled and reported on.

The active double skin facade is controlled through a Facade Management System (FMS) linked to the Building Management System (BMS). The FMS is currently finishing its extensive seasonal commissioning and 12 months into occupation has demonstrated the benefit that the double skin adds to minimising energy losses.

Based on actual data, the heat loss through the courtrooms overnight during non-operational hours was exceptionally low during the cold conditions of December 2009/January 2010 and was typically around 2 degrees Celsius, thus demonstrating the benefit of the active double skin facade and overall thermal performance of the building envelope that was studied and selected using Dynamic Simulated modelling.

The courtroom design involved the use of a displacement ventilation system with highly specified acoustic baffling to meet the stringent HVAC acoustic criteria. Each courtroom has its own dedicated air handling unit (AHU) supplying air at low level and the air is returned at high level through acoustic louvers into the 'Great Hall'. The AHU's are variable speed controlled linked to temperature and CO2 control algorithms.

The Great Hall would be regarded primarily as a large transient space with a diameter of 40m and a height of 32m and is the main connecting hub to all the courts. It is the single largest space in the building representing 35% of the all public spaces. A great deal of time was spent modeling the microclimatic conditions of the space and reviewing the most energy efficient way to meet the internal environmental conditions. The system selected was a mixed mode ventilation and underfloor heating system comprising of natural ventilation openings at low and high level with the secondary air from the 22 courtrooms assisting in the ventilation and heating of the space. There are roof mounted heat recovery units that provide pre-heating to the fresh air make-up into the courtrooms.

While not in itself a low energy feature, the use of a significant metering strategy (over 150No meters) has helped to reduce the actual energy usage within the building. This strategy is in line with the guidelines set out in CIBSE's TM39 – Building Energy Metering. According to TM39 good metering/sub-metering, is a fundamental energy monitoring and targeting tool and an essential part of energy management. Sub-metering in itself does not save energy but rather the actions taken as a result of monitoring and using the data provided. All meters are connected to a dedicated monitoring and targeting software package via the BMS.

This software allows the facilities manager to actively monitor and control a significant proportion of the energy consumers in the building. The strategy developed during design, meets and exceeds the criteria set out in TM 39 and has allowed the client to verify the energy consumption within the building with the billing information supplied by the utility companies.

The environmental brief set by the client was to achieve a "Very Good" rating under BREEAM for Courts 2006 and was comfortably achieved. Particular attention was paid during construction to the impact of site activities with a specific target to reduce, recycle and reuse construction materials where possible. In this category the constructor (PJ Hegarty's) scored the maximum of four points under the construction site impacts criteria. Additionally, all timber used during construction was responsibly sourced. In relation to the Building Regulations Part L requirements the design exceeded the carbon emissions target for the notional building by 30%.

The heat recovery system installed demonstrated that by installing the equipment at an additional capital cost of £80k, the building operation would save £10k per year giving a simple payback of eight years and was deemed to be beneficial to the overall PPP operation.

The building is designed to cater for different levels of perimeter security and is provided with an integrated security management system to allow monitoring and control of all CCTV, access control, intruder alarm and call systems from a central graphical user interface. The building is provided with two security control rooms with a dedicated control room provided for the custodial area. All fixtures in the custodial area were selected to meet Irish Prison Service anti-ligature requirements including lighting, smoke detectors, ventilation grilles and sprinkler heads.

Commissioning of the CCJ formed a significant item within the construction period, an overall allowance of 16 weeks was included in the contract programme. The HVAC, security, life safety and BMS systems were commissioned in accordance with CIBSE Commissioning Codes. However, the level of approval and sign off was more stringent due to the nature of the contract. As the CCJ was a design build finance operate and maintain contract (DBFOM), there was a four level sign off for each system (contractor, building services engineer, facility management contractor and independent commissioning engineer). When completed, this was witnessed by the client's site engineering team.

The commissioning data was fundamental to the setting up of the building management system (BMS) and subsequently the energy management and reporting. The data logs collected by the control system is used in analysing actual building operation versus simulated building operation calculated during the design process. Seasonal commissioning is being carried out to maximise system performance and optimise plant operation between seasons. Adjustments are made to set points and time schedules for winter and summer conditions, based on the historical data to further enhance the building performance and ultimately the energy usage. J.V. Tierney and Co (M&E Consultants) is assisting the FM contractor in interpreting and analysing the performance of the building and its systems during the seasonal commissioning phase.

The client, the Courts Service, was fully involved through all design stages given the nature of the PPP project. The PPP company, Amber Infrastructure Group, which managed the project from design to operation, were and are involved with the client on a continuous basis.

A collaborative approach was taken by the PPP team throughout all stages of design, construction and commissioning with PJ Hegarty's taking control of the design build element of the project. This required regular monthly project workshop meetings, fortnightly design team meetings and weekly commissioning meetings during the latter stages of the project. This approach ensured minimal changes during the process and allowed the project to be delivered three months ahead of schedule.

The FM contractor G4S contract is to operate the building for 25 years and they were involved from project bid stage through design, to selection and commissioning of equipment and are fully familiar with the design and performance criteria of the building. They have a full-time team based on site including security, maintenance technicians and cleaning staff to ensure the smooth daily running of the building complex.

The PPP company made a conscious effort to beat the building energy target by at least 15% and 12 months into operation the

Fig. 1.1: Rendered wireframe image of the Criminal Courts of Justice

Criminal Courts Complex – energy model simulation summary data

Area Type	System Type	Plant Operational Profile	Estimated Occupancy	Occupancy Profile	Occupancy Diversity	Lighting (W/m²)	Lighting Profile	Lighting Diversity (%)	Equipment	Equipment Profile	Equipment Diversity (%)
Courtrooms	Displacement	08.00-17.00	As per CP RDS	09.00-17.00	67%	12	09.00-17.00	80%	Court Technology	09.00-17.00	80%
Judges Chambers (B1)	FCU	07.00-19.00	6	09.00-19.00	25%	12	09.00-19.00	25%	1 PC 1 Plasma Screen 1 Small Printer	09.00-19.00	25%
Judges Ante Rooms (B2)	FCU	07.00-19.00	3	09.00-19.00	25%	12	09.00-19.00	25%	1PC	09.00-19.00	25%
Jury Retiring Rooms (C3)	FCU	07.00-19.00	12	09.00-19.00	100%	12	09.00-19.00	80%	1 Fridge	09.00-19.00	100%
Large Consultation Rooms (A9)	FCU	07.00-19.00	6	09.00-18.00	50%	12	09.00-18.00	80%	2 PCs	09.00-18.00	100%
Consultation Rooms(10)	FCU	07.00-19.00	4	09.00-18.00	50%	12	09.00-18.00	80%	2 PCs	09.00-18.00	100%
Public Restaurant (A11[1])	AA	08.00-18.00	100 people	09.00-18.00	100% 13.00-15.00 20% other	12	09.00-18.00	80%	Catering	09.00-18.00	100% 13.00-15.00 20% other
Kitchen (A11[2])	AA	08.00-18.00	6	10.00-15.00	100%	12	10.00-15.00	80%	Catering	10.00-15.00	100%
Office Block (E8[2])	CHB	08.00-18.00	24	09.00-18.00	75%	12	09.00-18.00	80%	24 PCs 4 Lge Printers	09.00-18.00	75% Pcs 100% Printers
Office Block (E8[3])	CHB	08.00-18.00	30	09.00-18.00	75%	12	09.00-18.00	80%	30 PCs 5 Lge Printers	09.00-18.00	75% Pcs 100% Printers
Bar Area (H1)	CHB	08.00-18.00	60	09.00-18.00	50%	12	09.00-18.00	80%	22 PCs 3 Lge Printers	09.00-18.00	50% Pcs 100% Printers
Bar Area (H2)	CHB	08.00-18.00	50	09.00-18.00	50%	12	09.00-18.00	80%	50 PCs 7 Lge Printers	09.00-18.00	50% Pcs 100% Printers
Bar Area (H3)	CHB	08.00-18.00	4	09.00-18.00	100%	12	09.00-18.00	80%	3 PCs 3 Lge Printers	09.00-18.00	50% Pcs 100% Printers
Bar Area (H4)	CHB	08.00-18.00	150	09.00-18.00	50%	12	09.00-18.00	50%	150 PCs 13 Lge Printers	09.00-18.00	50% Pcs 100% Printers
Custody Area (Support)	FCU	07.00-18.00	16	09.00-18.00	100%	12	09.00-18.00	80%	6 PCs	09.00-18.00	100%
Custody Area (Cells)	AA	07.00-18.00	100	09.00-18.00	100%	12	09.00-18.00	80%	–	–	–
Jury Assembly (C1)	AA	08.00-12.00	300	09.00-12.00	75%	12	09.00-12.00	80%	2 Plasma Screens	09.00-12.00	100%
Jury Assembly (A8)	AA	08.00-12.00	97	09.00-12.00	75%	12	09.00-12.00	80%	1 Plasma Screen	09.00-12.00	100%
Jury Dining (C4)	AA	12.00-16.00	192	19.00-15.00	75%	12	13.00-15.00	80%	Catering	13.00-15.00	75%
Great Hall	UFH	06.00-17.00	–	–	–	Gallery Atrium Top Decorative	09.00-18.00 09.00-18.00 15.00-18.00	60% 60% 100%			

Unless specified otherwise, occupancies are Monday to Friday excluding public holidays.

1. Some winter months have an additional 0.30 to 1.00 warmup, e.g. courtrooms, office block, bar area. 2. Above figures are based on a typical core day of 11 hours. This gives an average building operational profile of 55 hours per week.

Fig 1.2: Assumptions used for computer simulation

https://arrow.tudublin.ie/sdar/vol1/iss1/4
DOI: https://doi.org/10.21427/D7ST78

building is projected to have an annualised reduction of greater than 25% of this target due to the quality of the design, construction and facility management operations.

The client has commented:

"It is a tribute to the design and construction teams that the completed building fully meets the complexity of the brief and during its first four months of operations has successfully dealt with the largest single transfer of criminal court business in the history of the State."

Analysis of data

As mentioned above, a computerised thermal model was produced to ascertain the predicted energy consumption of the building prior to construction. Fig. 1.1 shows a graphic of the computer model generated with IES Virtual Environment® software. The software allows actual construction details to be created within the model – a virtual wall can be created, for example, of the designed thickness, configuration and individual build element and an actual U-value can be calculated. In other words, the computer model is a virtual replica of the building. This is a powerful tool as it can be used to simulate different scenarios or construction methods etc to optimise building performance before any real building takes place.

Various data assumptions were made during the design, based on contract room data sheets and industry best practice. These are summarised in Fig. 1.2. The simulation takes these assumptions in the form of profiles and the dynamic output is achieved,and provides information on plant operation with respect of fuel type, efficiencies, weather data, occupation and internal/ external gains.

Once the model is set up and the profiles are inputted into the model, the simulation of the building takes place. The predicted fuel consumption (gas, electricity etc) can be plotted and analysed. Fig. 1.3 shows the annual energy consumptions based on the simulated computer model.

This data is represented in kWh/m² which is the unit used for benchmarking as shown in Fig. 1.4.

Actual data collected from the BMS and energy software installed at the Criminal Courts of Justice demonstrates the Year 1 energy consumption based on the metering/recording facilities and the utility companies' energy bills. These are tabulated in Fig. 1.5.

Since energy consumption for the contract year is based on energy used 24 hours a day, it was necessary to derive a factor that assesses how much energy is used between the hours of 5am and 7pm, Monday to Friday. This factor was derived from consumption data that showed how much electricity and gas was used every 15 minutes of the day. From this analysis a "2600 hours" factor (contract factor) was developed which represented how much of the 24-hour based consumption needs to be included to derive the annual Energy Usage Indices (EUI). The "2600 factors" used in this analysis are 55% for electricity and 80% for gas.

Using the consumption analysis presented in Fig. 1.5 and a treated floor area of 23,000m², Fig. 1.6 has been prepared to compare actual Contract Year One performance with target performance, for both energy and CO2.

1.2 Conclusion

Energy usage – simulated versus actual

It can be seen based on Figs 1.2 to 1.6 that the simulation software and computer model have allowed accurate assessment of the

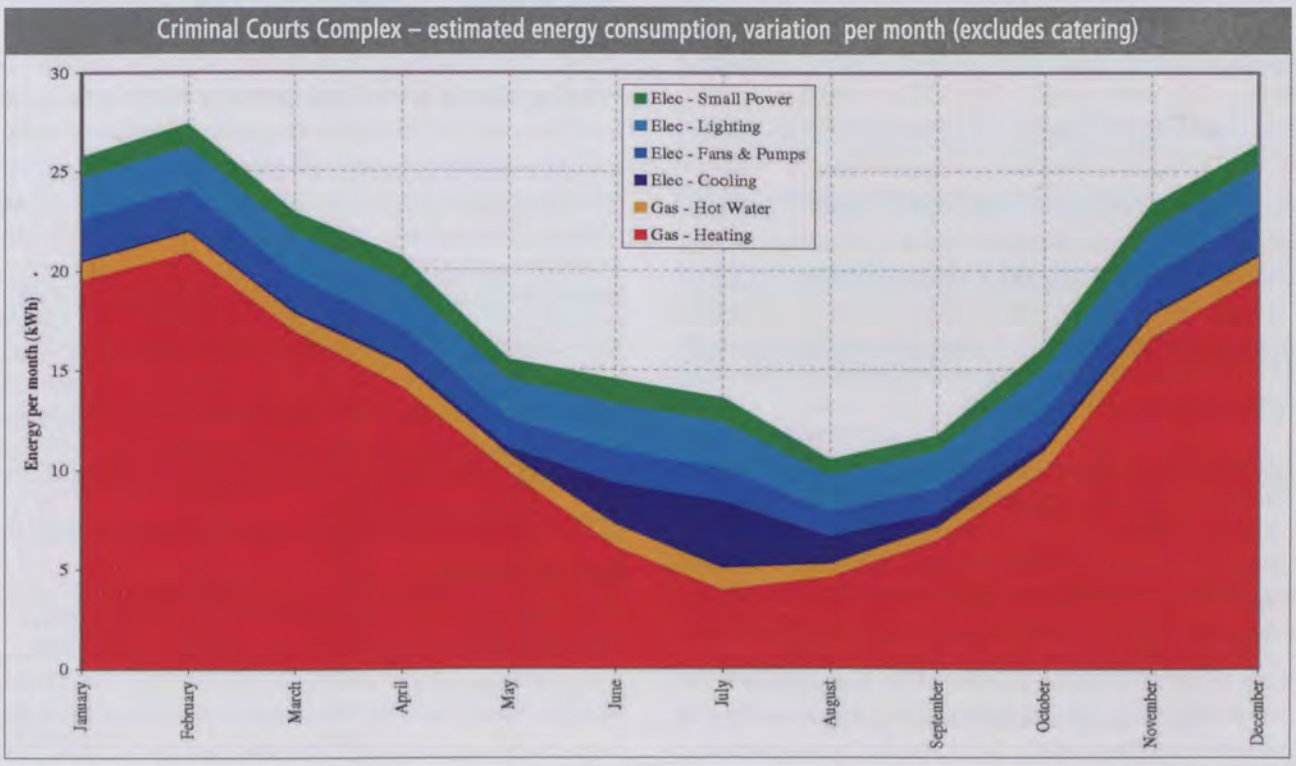


Fig. 1.3: Estimated energy consumption

Criminal Courts Complex – estimated monthly energy consumption (kW/m²)											
	Heating (kWh/m²)	Hot Water (kWh/m²)	Cooling (kWh/m²)	Fans and Pumps (kWh/m²)	Lighting (kWh/m²)	Small Power (kWh/m²)	Catering Gas (kWh/m²)	Catering Electric (kWh/m²)	Natural Gas (kWh/m²) *excluding Catering*	Electricity (kWh/m²) *excluding Catering*	Total energy (kWh/m²) *excluding Catering*
January	19.6	0.9	0.1	2.1	2.1	1.0			20.5	5.3	25.7
February	21.0	1.0	0.1	2.1	2.1	1.1			22.0	5.4	27.4
March	16.9	0.9	0.1	1.7	2.2	1.0			17.9	5.0	22.9
April	14.2	1.1	0.2	1.7	2.3	1.2			15.3	5.4	20.7
May	9.9	0.9	0.3	1.5	2.0	1.0			10.7	4.7	15.5
June	6.1	1.1	2.1	1.7	2.3	1.2			7.2	7.3	14.5
July	3.9	1.1	3.4	1.7	2.3	1.2			5.0	8.6	13.6
August	4.6	0.7	1.4	1.3	1.8	0.8			5.2	5.2	10.5
September	6.4	0.7	0.7	1.3	1.8	0.8			7.1	4.6	11.7
October	10.0	1.0	0.3	1.6	2.1	1.1			11.0	5.1	16.1
November	16.6	1.1	0.1	1.9	2.3	1.2			17.7	5.6	23.3
December	19.7	1.0	0.1	2.1	2.3	1.1			20.8	5.6	26.4
SUM	148.8	11.6	8.8	20.6	25.8	12.7	4	6	160.4	67.9	228.3
							Including Catering		164.4	73.9	238.3

Fig 1.4: Estimated energy consumption 9kWh/m²)

Notes	Invoice Month	Electricity kWh	Gas kWh	Electricity 2600hrs kWh	Gas 2600hrs kWh
From 18 Nov	Nov-09	105,354	–	57,945	–
	Dec-09	237,023	–	130,363	–
	Jan-10	254,879	–	140,183	–
	Feb-10	228,547	1,670,197	125,701	1,336,158
	Mar-10	246,592	356,631	135,626	285,305
	Apr-10	211,779	232,317	116,478	185,854
	May-10	215,477	178,585	188,512	142,868
	Jun-10	235,936	106,289	129,765	85,031
	Jul-10	247,394	131,318	136,067	105,054
	Aug-10	210,057	110,517	115,531	88,414
	Sep-10	205,921	196,955	113,257	157,564
	Oct-10	232,260	275,287	127,743	220,310
To 17 Nov	Nov-10	137,218	85,7734	75,470	68,587
	Totals	2,768,437	3,343,930	1,522,640	2,675,144

Fig 1.5: Contract year 1 energy consumption

predicted energy usage for the Criminal Courts of Justice based on continuous occupancy and internal gains used in the assumptions noted above in Fig. 1.2. In conjunction with the building services design and installation of systems that can accurately record active energy consumption, these tools provide the building user with the information to enable accurate energy prediction and management.

It can be seen that the actual energy figures are circa 25% less than predicted (Fig. 1.6). This is because the software model uses occupancy and internal gains that do not fluctuate as they do in reality. The actual energy data can be a useful 'sanity check' when

2600 hours bases EUI	Electricity	Gas	Total
Year 1 EUI kWh/m²	66	116	183
Target EUI kWh/m²	90	150	240
Vrce actual to target	**-26%**	**-22%**	**-24%**
Year 1 EUI kgsCO²/m²	41	23	64
Target EUI kgsCO²/m²	56	30	86
Vrce actual to target	**-26%**	**-22%**	**-24%**

Fig 1.6: 2600 energy usage indices

modelling buildings in the future. One thing that could be learnt from this is that the fluctuations in occupancy and internal gains could be modelled more realistically using a more complex profile, or indeed reduced from the standard figures traditionally used. In addition, installing energy meters as outlined in CIBSE TM39 has enabled the facilities manager (G4S) to monitor and control energy usage such that consumption is better than that predicted.

Historical energy data can be logged and standard energy usage profiles can be generated to allow the user to actively manage the energy consumption in a proactive, rather than reactive, way. Bench-marking energy profiles for any system can be achieved easily through data collection which can also flag issues that may occur during the building lifecycle.

Twin skin facades

The Criminal Courts of Justice was designed incorporating a twin skin facade around the majority of the building. The only exception to this is the office areas on the north facade. The computer model highlighted the benefit on energy consumption of the twin skin during the design process and along with the installed field devices and control systems working together (building management system and facade

https://arrow.tudublin.ie/sdar/vol1/iss1/4
DOI: https://doi.org/10.21427/D7ST78

Fig. 1.7: Twin skin vs single skin. Courtroom versus office area

management system) it is possible to plot the actual benefit of the twin skin vs the single skin in terms of heat loss comparison between the two systems.

To achieve this assessment, data was collected from the room thermostats in the two areas over a weekend, when building services systems are "enabled off" on the BMS time schedule (building closed over the weekend).

As an example Fig. 1.7 shows the actual temperatures plotted in the twin skin and single skin zones showing the rate of heat loss over a non conditioned time period. The relevance of this is particularly apparent when considering heat up times when the building becomes occupied (Monday morning).

It can be seen from Fig. 1.7 that the rate of heat loss over a weekend period is notably less with the twin skin than with the single skin. This may appear to be an obvious statement but it cannot be ignored in relation to overall energy consumption, plant selection and building design. Consider the difference in energy usage indices discussed earlier if the twin skin solution was not part of the building design.

(%)	Total Energy (%)	Total Electricity (%)	Total Natural Gas (%)
Jan 01-31	-7.6%	2.8%	-9.5%
Feb 01-28	-8.5%	1.1%	-10.2%
Mar 01-31	-6.7%	1.2%	-8.1%
Apr 01-30	-6.6%	0.3%	-7.9%
May 01-31	-9.9%	-0.4%	-13.3%
Jun 01-30	-8.5%	-0.2%	-13.1%
Jul 01-31	-10.2%	-0.8%	-23.2%
Aug 01-31	-21.6%	-1.7%	-32.0%
Sep 01-30	-13.9%	-1.7%	-18.3%
Oct 01-31	-11.0%	-0.4%	-14.6%
Nov 01-30	-7.0%	0.5%	-8.6%
Dec 01-31	-7.4%	2.0%	-8.9%
Summed total	-8.7%	0.3%	-11.1%

Fig. 1.8: Heat recovery predicted energy reduction (%)

Heat recovery

The Great Hall in the Criminal Courts of Justice acts as a return air path for the court rooms and ancillary spaces (underfloor heating in the great hall). The design of this space utilises six heat recovery units (run around coil) located on the roof that are enabled based on the temperature profiles within the zone. Exhaust air from the court rooms is passively extracted into the Great Hall and, depending on the conditions, is either naturally exhausted via roof vents at high level or mechanically exhausted via the heat recovery units. The useful heat built up is introduced into the court room supply air via a pre-heat heating coil in the court room supply air handling units.

The computer model was used to predict the actual real benefit of this heat recovery system with regard to energy savings. Fig. 1.8 indicates the predicted benefit of the installation of this heat recovery system in terms of reduction in energy use and associated cost saving based on electricity cost of €0.18/kWh and gas cost of €0.04/kWh.

Acknowledgements

The authors acknowledge P.J. Hegarty & Sons Ltd, G4S and the Court Services for their assistance in the preparation of this report.

References

1. CIBSE (2006) *TM39 Building Energy Metering*, Chartered Institute of Building Services Engineers, UK
2. JVT (2008) *Energy Strategy Document for the Criminal Courts of Justice*, CCJ-PPP Co., Ireland
3. CIBSE (2006) *Guide A*, Chartered Institute of Building Services Engineers, UK
4. G4S (2010) *Utilities Annual Report*, G4S Security Ltd., Ireland

https://arrow.tudublin.ie/sdar/vol1/iss1/4
DOI: https://doi.org/10.21427/D7ST78