

IOTI CSF Alumni Post-Graduate Scholarship Application - Research Proposal

Candidate's Details			
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Institution:	Limerick Institute of Technology	School:	Faculty of Applied Science, Engineering and Technology, Department of Electrical & Electronic Engineering
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Field of Research:	Renewable Energy Control Systems
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Award Sought:				
Master of Arts	Master of Business	Master of Engineering	Master of Science	Doctor of Philosophy ¹
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Title of Proposed Research Degree Programme :
Development of SCADA based Energy Monitoring for Production Operations

Proposed Duration of Research Programme		
Proposed Start Date: September 2016	Proposed Finish Date: September 2018	Full-time: <input checked="" type="checkbox"/> Part-time: <input type="checkbox"/>

Proposed Programme of Research
This information should be in a form of an abstract

The Direct Energy Used in production operations shows potential to be optimised based on changing operational decisions and integrating production scheduling with energy information. This opportunity requires better information, in real time, to support the decision making process. The proposed research aims to develop a structured method of using existing industrial control systems to provide energy data related to production operations.

Through the TEMPO Research Project (€1.7m) the PI has completed (May 2013) a detailed use case analysis of 6 large industrial sites in Ireland, including DePuy, Vistakon, GSK, EMC, Analog Devices and Carberry. These sites have over 7,000 employees and spent €28m on Energy in 2011. From this analysis 57% of the total energy consumed can be characterised as Direct Energy (production related) and 43% as Indirect Energy (Facilities). As these modern facilities have already addressed many of the 'low-hanging fruit' (HVAC, Lighting, VSDs, etc) the most significant opportunity for energy reduction and consequent cost and carbon impact reductions is in the production area.

This research proposal aims to collaborate with these industrial sites to investigate the Intelligent Control (PLCs/VSDs) and Supervisory Data Acquisition Systems (SCADA) deployed and to develop an effective Monitoring and Tracking Methodology (M&T) to extract significant energy and operational data. The Postgraduate Learner will have the opportunity to spend a period of time in the relevant facility, to validate their work with empirical production data from the industrial site and to work within the full TEMPO Research Team.

Proposed Supervisor:

Role:					
Principal supervisor	<input checked="" type="checkbox"/>	Co-supervisor	<input type="checkbox"/>	Mentor supervisor	<input type="checkbox"/>
Name:	John Cosgrove				
Position:	Section Head – Electrical Engineering				
Organisation:	Limerick Institute of Technology				

Candidate Comments:

Prof. John Cosgrove invited me to put him as proposed supervisor, and as he instructed me to do, I am sending now the project he forwarded to me by mail. We both expect that successful applicants will have the opportunity to modify their proposals before the submission to IOTI, so we could update this research proposal together.

Kind regards,

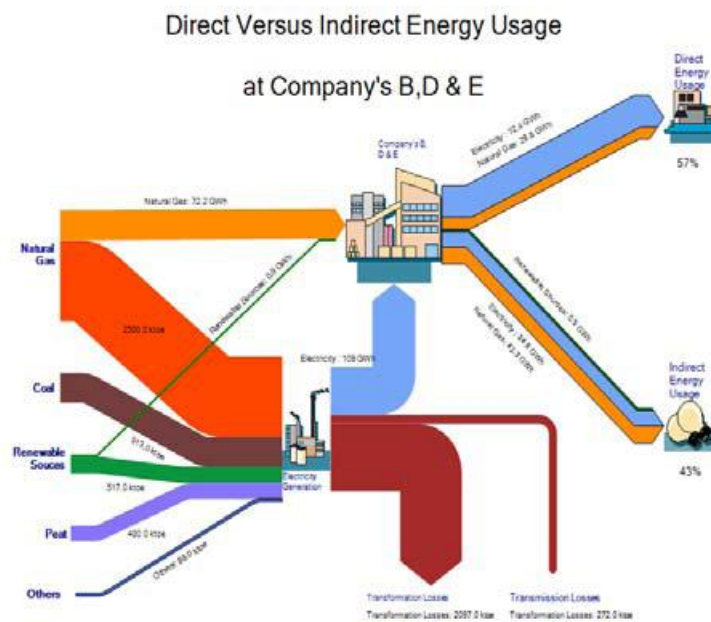


RESEARCH PROPOSAL

Through a detailed use case analysis¹ of six leading industrial sites (DePuy, Vistakon, GSK, EMC, Analog Devices and Carbery) in Ireland (May 2013) the opportunity for the proposed Postgraduate Research Project has evolved. The 6 plants employ over 7,000 people and had a combined energy spend of €28 million in 2011. Whilst significant, that €28m only represent 1% of the total spent on energy by Industry in 2011. As shown in the SanKey diagram, our studies have confirmed that in a modern Advanced Manufacturing Plant approx 57% of the total energy consumed can be characterised as Direct Energy (production related) and 43% as Indirect Energy (Facilities). As these modern facilities have already addressed all the 'low-hanging fruit' (HVAC, Lighting, VSDs, etc) the most significant opportunity for energy reduction and consequent cost and carbon impact reductions is in the production area.

Energy monitoring on Industry Sites is generally achieved through the addition of sophisticated energy monitoring solutions with wired and wireless sensors and data aggregation boxes linked back to a Server and Visualization Tool (web service).

Industrial automation systems in many factories involve distributed intelligent devices (PLCs, VSDs) that provide localized control and report back data and activity to a Server (data historian) and present the information to a Human Machine Interface (HMI). Latest generation SCADA systems can be mirrored to a Web site as required.



Main Research Question:

The key research question proposed is to develop a structured method to securely integrate key data from Sensors, PLCs, VSDs and SCADA to create a Virtual Energy Meter. The inter-operability of such systems has proved very difficult in the past however recent standardisation activities (OPC-UA), technology enhancements (Web Services) and a renewed focus on Sustainable Manufacturing presents the opportunity to develop this approach.

Additional research questions include;

- The investigation of current best practice in energy monitoring and approaches to energy modelling of production operations.
- The analysis of a number of reference industrial sites for case studies analysis.
- The deployment of advanced control systems on a lab based test rig for simulation and experimentation.

- The investigation of formal computing methods such as XML to provide a development framework for the development of Virtual Energy Meters.
- The development of a suitable visualisation and web service based approach to distribute the Energy and Carbon Data.

Methodology:

The proposed virtual meter will be coded in Structured Text Language (STL) (EN601131-3) and will be designed with a level of abstraction and encapsulation so that it can be used across different controls platforms (Siemens, Rockwell, Beckhoff) and communication channels (Ethernet, Profibus, CAN).

An initial development of a suitable ontology and XML Schema will be used to frame the code development and maintain the level of abstraction. Safety and Security concerns will have to be addressed and the final design will be verified on an industrial control rig that is modelled on an advanced industrial site. Actual production run data from the production lines in DePuy (J&J) can be used to validate the operation of the Meter.

Project Plan - See attached GANT chart.

The specific Tasks, Goals and Objectives will be re-defined in conjunction with the postgraduate Learner and tracked as the project proceeds.

WP1 – Work Package 1 – Fundamental Research

T1, T2, T3 - Structured research of current sector activities, journals and conference proceedings, in industrial automation, control systems, manufacturing, relevant EU Project Reports and interviews with end users.

Milestone M3 – Presentation of a report on the state-of-the-art as it pertains to this project.

Completion of the Research Methods Module on the Certificate in Research Practice.

T4, T5, T6 - Initiation and Training in applied control systems, monitoring and SCADA through direct tuition by the project supervisor(s) and by attendance at appropriate subject modules within the LIT or through external companies.

Milestone M6 – Presentation of a detailed project plan for the successful completion of the research.

Review (R6) - Seminar type review of progress to date and future plans. This will include participation from the student, supervisor, co-supervisor and invited participants from the sector. This may be held in conjunction with parallel projects, giving the student excellent feedback (oral and written) on their research.

WP2 – Work package 2 – Case Study Investigation

T7, T8, T9 - Liaison with industry stakeholders, system integrators and end users on standard practices and systems installed for Energy Monitoring in Industry. in procedures in the installation of small turbines. Study and development of case studies demonstrating the operation and application of existing systems. Completion of a Gap Analysis Report.

Milestone M9 –Presentation of the case study details, establishment of a web forum for discussion within the system integrator (SI) community. Completion of the Communications for Researchers Module on the Certificate in Research Practice

T10, T11, T12 - Analysis of case studies including, evaluating initial specifications of projects, Functional Requirement Specifications, User requirement Specifications, equipment used, manufacturer data, feedback on installations. Calculations on data sampling rates, bandwidth and processing speed.

Milestone M12 – Web Presentation of an analysis of operation versus design specification for specific case studies, dissemination of same amongst the SI community for feedback.

Review (R12) - Seminar type review of progress to date and future plans, including an analysis of operation versus design specification for specific case studies. This will include participation from the student, supervisor, co-supervisor and invited participants from the sector. This may be held in conjunction with parallel projects, giving the student excellent feedback (oral and written) on their

research.

WP3 – Work package 3 – Application of Techniques

T13, T14, T15 - Development and commissioning of industrial control systems, PLC platforms, SCADA interfaces, Variable Speed Drives (VSDs) and Data Historians on a Lab based Test Rig. Development of Programming Methodology for Virtual Metering.

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Milestone M15 – Web Presentation of the developed Test Rig Specification. Completion of Third Module (Elective) on the Certificate in Research Practice.

T16, T17, T18 – Development of Abstraction of code for inter-operability and platform independence. Validation through Lab tests with empirical production data.

Enhancement of HMI Visualisation of Metered Data and Integrated Carbon Calculations.

Milestone M18 – Presentation of validation analysis and video stream of operational performance.

Report on Security and Safety Considerations.

Review (R18) - Seminar type review of progress to date and final plans for completion. This will include participation from the student, supervisor, co-supervisor and invited participants from the sector. This may be held in conjunction with parallel projects, giving the student excellent feedback (oral and written) on their research.

WP4 – Work package 4 – Presentation of Results

T19, T20, T21 - Project / Thesis write up and submission for masters approval. Including the preparation and submission of a paper to appropriate conference/Journal. Completion of Business Model Analysis of system developed.

Publication of thesis findings and paper on LIT ACORN Research website.

Milestone M21 - Presentation of paper summarising the project outcomes, submission of Thesis and outline of plans for dissemination.

Review (R21) - Seminar type review of project and successful outcomes. Discussion of quality of work and potential for further research. This will include participation from the student, supervisor, cosupervisor and invited participants.

DISSEMINATION OF OUTCOMES

It is expected that the Postgraduate Learner (Masters) will submit one significant publication for peer review and 2-3 minor posters/seminar papers during their project and these milestones are tracked through the postgrad progress report forms. Numerous opportunities arise for publications in this domain. The ACORN Research centre hold its own annual colloquium (held on 14th June 2013) and co-operates in the LIT Annual Research colloquium (held in April 2013) with all Postgraduate Learners presenting aspects of their research projects for peer review.

A key target for a successful peer reviewed publication from the proposed research will be at the International Manufacturing Conference (IMC 2014 and IMC2015).

Other opportunities for dissemination will be actively pursued, these may include;

1. Publication of the case studies, industrial control platforms and Project Results in web format for learners on LIT Engineering Degree Programmes.
2. Hosting of a seminar for representatives of industrial partners to present the research outcomes.
3. Web-publication of the research outcomes of the thesis on the LIT research web-pages.
4. Submission of a paper drawn from the thesis to a journal publication such as the IEEE Transactions on ICT in Manufacturing (2014).
5. Submission of a review of the technologies used and the project outcomes to relevant industry publications.
6. Submission of further research funding applications and/or a transfer to PhD Registration application pending progress on the project.