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Support to Safety Analysis of Hydrogen and Fuel Cell Technologies

Report on Dissemination Seminar



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1. Introduction

WP7 aimed to raise awareness of the project in the hydrogen safety and wider community using various dissemination routes. WP7 also aimed to make the results of the project deliverables available and to gather feedback early in the project to ensure that the outcome was fit for purpose. Feedback from the hydrogen safety and wider community was sought at an early stage through an experts' workshop, which is described in Deliverable 7.1 "Experts and stakeholder workshop". Dissemination through publications is listed in Deliverable 7.3 "Publications list". This deliverable describes the dedicated dissemination seminar which was organised near the end of the project to present the detailed project outcomes to the hydrogen and wider safety communities.

2. Planning

Several options were available to the consortium for holding the dissemination seminar. These were:

- To hold a stand-alone event at one of the partner's institutions or alongside an existing conference
- To hold the seminar as a session within an existing conference
- Partnering with another organisation to host a dedicated seminar

The above options each have their advantages and disadvantages. A stand-alone event may not attract the same level of participation as attendance at a large international conference. Furthermore, there was anecdotal evidence that seminars held alongside (but not within) international conferences (such as World Hydrogen Energy Conference) would not be well attended. The option of booking a session at an existing conference was considered, but the audience would be limited to those attending the particular session, potentially 20-30 attendees. Furthermore, the possibility of webcast would not be available for this option and attendees would also be required to pay and register for the conference, which would be a significant expense. Partnering with another organisation to host the seminar would benefit from promotion among their membership, but would require that organisation to be relevant to SUSANA.

The HSL contribution to the SUSANA project is part-funded by HSE as part of an internal project. At a steering committee meeting of this project, the suggestion was made to hold the SUSANA dissemination seminar in collaboration with the Fire and Blast Information Group "FABIG"¹ as one of their regular technical meetings.

During a SUSANA General Assembly meeting it was decided that, for practical purposes, the seminar should be held sufficiently near to the end of the project to allow the various deliverables to be sufficiently complete, but before the summer holiday period in July/August.

The various options for the seminar were discussed within the SUSANA consortium at a web meeting in early 2016 and at the 4th General Assembly meeting in Brussels. Following these meetings, it was decided to use the FABIG technical meeting option.

¹ <http://www.fabig.com/> (accessed 8th July 2016)

2.1 The Fire and Blast Information Group

FABIG is a UK based not-for-profit organisation whose mission is to “disseminate knowledge and best practice, and to develop guidance on the prevention and mitigation of fires and explosions and the protection of people and facilities from such hazards.” Although UK based, FABIG membership is internationally based and covers areas such as design of floating production facilities, LNG, hydrogen, human factors, integrity management, and life extension. FABIG hold regular technical meetings on various topics, where the meetings are generally of a two-day format:

- A technical meeting at Aberdeen University
- The same meeting, held in London and also via webcast

FABIG meetings and newsletters have previously been used for dissemination of model evaluation [1, 2] and hydrogen related [3] activities. Dissemination meetings for special topics have also taken place [4].

It was felt that the meeting would be an appropriate forum to disseminate the SUSANA project. The webcast facility would also increase outreach to interested parties who may be unable to attend the meeting in person, such as those predominantly based outside the UK.

2.2 Detailed plan

The seminar dates were fixed as the 22nd and 23rd June, 2016 and the content of the seminar was planned around these dates (Appendix A). The seminar was organised jointly by FABIG and HSL and all partners were involved in setting the agenda and contributing the presentations for the various work packages.

3. Promotion

Several channels were used in the promotion of the seminar. FABIG promoted the event to their membership (approximately 110 organisations in 17 countries) via an email communication (Appendix B). In addition to this, a project flyer was created (Appendix B) which was taken to the Hazards 26 conference². This flyer was also included in a direct email communication (appendix B) to the persons contacted for the expert workshop. The event was also promoted on the Fuel Cells and Hydrogen Joint Undertaking website³ and the NERGHY website⁴ and to the H₂FC email list.

4. Agenda

A draft agenda was prepared at the 4th General Assembly meeting in Brussels. This was subsequently refined in collaboration with FABIG. The main agenda items were arranged to include all aspects of the HYMEP and to include introductory and summary presentations. At the end of the meeting in

² <http://www.icheme.org/events/conferences/past-conferences/2016/hazards-26.aspx> (accessed 8th July 2016)

³ <http://www.fch.europa.eu/event/susana-project-webinar> (accessed 8th July 2016)

⁴ <http://www.nerghy.eu/dissemination-webinar-ensuring-the-adequacy-of-cfd-modelling-in-hydrogen-safety-engineering-23-june-2016/> (accessed 8th July 2016)

London, there was a panel session to encourage discussion between the audience and the members of the consortium. The final agenda is given in Appendix C.

5. Seminars

The events were well attended, with attendees from a wide variety of backgrounds including academia, companies and consultants from the hydrogen, nuclear and oil and gas sectors and regulators/government bodies. Approximately 180 delegates including international organisations registered for the meetings and the webcast and a list is given in Appendix D. The Aberdeen event on the 22nd June was chaired by Guillaume Vannier from the Steel Construction Institute (SCI) and the audience mainly comprised companies and consultants from the oil and gas sector. The London event and webcast was chaired by Vincent Tam from DNVGL, who has a large amount of experience in carrying out and commissioning modelling and experiments and has taken part in numerous model evaluation studies. This event had a larger audience, from a wide range of backgrounds. Following the introduction, webcast presentations were given by the SUSANA consortium as set out in the agenda (Figure 1).

Where time allowed, questions were taken following each presentation. At the end of the meeting in London, time was allocated for a panel session to enable discussion on the project as a whole.



Figure 1 Webcast and seminar in London

5.1 Panel session

The session was initiated by Sava Medonos (Petrellus Engineering Ltd). In the late 1960's, an initiative was set up within solid modelling to encourage best practice and information sharing within the finite element analysis community. The question was raised whether anything similar exists in the CFD community. In answer, it was noted that this is a common problem and the SUSANA project would be a step towards providing more integration in the CFD modelling community. It is acknowledged that various organisations exist within the CFD community who disseminate knowledge and best practice, but nothing exists specifically for hydrogen safety.

There was discussion on how the MEP and its supporting documents would be disseminated, i.e. if it is not used then there is a danger of it being forgotten. Part of the SUSANA project, including the seminar, is to carry out dissemination through various channels and this is one method for encouraging uptake. It was noted that users cannot be forced to apply a protocol, unless it is written

in law (as in the United States for modelling LNG dispersion and for fire modelling in some instances). However, providing a freely available procedure, useable databases and best practice guidance is a way to build “momentum” in the use of the MEP.

The intended audience for the MEP was discussed. This was in response to a point made that the user of the MEP may need to be quite advanced. While the MEP is aimed at a wide audience, the consortium emphasised that users cannot become experts overnight and the MEP and supporting documents are intended to assist users where possible. A suggestion made at the Aberdeen meeting was that the best practice guidance and the worked examples would make a good educational tool as they could be accessed relatively easily from the website. A related point was that there seemed to be three potential groups of users of the MEP; model developers, model users and commissioners of work. It was suggested that this last group had been left out as there was nothing specifically aimed at commissioners of modelling work. In response, it was shown that the MEP itself would provide a structured method or “checklist” for those commissioning CFD modelling to be assisted in making an assessment of the quality of the modelling, i.e. is the modelling scientifically robust?, has it been verified? Has it been validated?

Discussion on the validation database focussed on gaps in the experiments and availability of the material after completion of the project. It was acknowledged that gaps exist in experimental data but this will always be a problem and the users were encouraged to contribute to the update of the database if possible. There was also a suggestion about possible routes for preservation of the database once the project was finished, such as the ERCOFTAC website. Accessibility of the website was questioned. It was explained that the website was frequently hacked but the issue would be resolved in due course.

6. Post event activities

6.1 Presentations

Presentations from the meetings are available on the project website and additionally on the FABIG website (<http://www.fabig.com/video-publications/OtherPublications> - accessed 31-08-2016). The webcast of the London event was made available to those who had registered for the event.

6.2 Newsletter

A summary of the project has been written for circulation in the FABIG newsletter which is sent out to their members.

7. References

- [1] European Communities Directorate-General XII Evaluation of Models –Gas Explosions (MEGGE) FABIG Newsletter issue 10, article R150, September 1994.
- [2] Tam, V., Explosion model evaluation, FABIG Newsletter issue 22, article R320, May 1998.
- [3] Hydrogen safety activities at the University of Ulster, FABIG Newsletter 51, article R621, July, 2008.
- [4] FABIG technical meeting 72, Carbon Capture & Storage: The Safety Issues.

8. Appendix A: Dissemination seminar planning

Task	Activity	Who	Due	April				May				June			
				8	15	22	29	6	13	20	27	3	10	17	24
A. Venue	A1. Find a host venue	HSL	Completed												
	A2. Set dates for dissemination	HSL	Completed												
	A3. Book venue for general assembly for 24 June	HSL	Completed												
	A4. Disseminate accommodation options	HSL	Completed												
	A5. Disseminate travel options	HSL	Completed												
	A6. Finalise contractual arrangements/costs	FABIG/HSL	Completed												
B. Seminar	B1. Set agendas	ALL	Completed												
	B2. Inform HSL of speakers for each venue	ALL	Completed												
	B3. Generate list of invitees	ALL	Completed												
	B4. Send draft presentations to HSL	ALL	Completed												
	B5. FABIG review of presentations	FABIG	Completed												
	B6. Finalise presentations following feedback from FABIG	ALL	Completed												
C. Marketing	C1. Produce promotional flyer	FABIG/HSL	Completed												
	C2. Produce promotional email	FABIG/HSL	Completed												
	C3. Send invites to invitees	ALL	Completed												

Completed

Not started

In progress

Period of activity

Extended period of activity

9. Appendix B: Promotional emails and flyers

9.1 Invitation email and flyer

Dear Colleague,

ENSURING THE ADEQUACY OF CFD MODELLING IN HYDROGEN SAFETY ENGINEERING

Development of a CFD Model Evaluation Protocol for Hydrogen Safety Applications

Dissemination seminar on 22nd and 23rd June 2016.

Our forthcoming event will be a one-day technical meeting and will be held on Wednesday 22nd June in Aberdeen, UK, and repeated on Thursday 23rd June in London & via webcast. It is expected that the meeting will run between 10 am and 4 pm.

ABOUT THE MEETING:

For this event, the consortium of the EU funded research project SUSANA (SUpport to SAfety aNAlysis of Hydrogen and Fuel Cell Technologies) will present the results of the project. The consortium has partnered with the Fire and Blast Information Group (FABIG) for this seminar, which will form one of their technical meetings.

The objective of the SUSANA project is to support the use of CFD analysis in safety engineering in relation to Hydrogen and Fuel Cell Technologies through the development of a Model Evaluation Protocol (MEP). The MEP is a key tool in ensuring that models are fit for purpose in safety applications.

Although the focus of the SUSANA project is hydrogen safety, the research results and the methodology used for the development of the MEP are relevant to all CFD modelling applications in safety engineering and will be of value to CFD analysts as well as those involved in the interpretation and application of CFD analysis results.

For more information the project, please see the attached flyer and for information on the meeting and how to register your interest for the Aberdeen, London or webcast events, please contact Simon Coldrick (simon.coldrick@hsl.gsi.gov.uk).

We look forward to seeing you at the event

The SUSANA consortium

Ensuring the Adequacy of CFD Models for Hydrogen Safety Applications

Key project benefits:

- Improved deployment of CFD to hydrogen safety applications due to access and use of MEP and supporting documents
- Improved understanding of critical influences for models of physical phenomena related to safety in FCH technologies
- Improved capability of CFD users in applying CFD codes through access to best practice guidance
- Improved quality of CFD models due to opportunity to access benchmarking information through database

For more information, contact:
Simon Goldrick
Simon.Goldrick@dtg.gov.uk



Project Partners:



STAMBA is funded by the Fuel Cell and Hydrogen Joint Undertaking (Grant Agreement FCH-JU-123036)

Energy Innovation

SUPPORT
SUSANA

Ensuring the Adequacy of CFD Models for Hydrogen Safety Applications

Development of a CFD Model Evaluation Protocol (MEP) for Hydrogen Safety Applications



Ensuring the Adequacy of CFD Models for Hydrogen Safety Applications

The aim of the EU funded research project SUSANA (Support to Safety aNalysis of Hydrogen and Fuel Cell Technologies) is to support the use of Computational Fluid Dynamics (CFD) analysis in safety engineering relating to Hydrogen and Fuel Cell (FCH) Technologies through the development of a Model Evaluation Protocol (MEP).

Hydrogen and fuel cell technologies play a significant role in clean energy provision for a carbon neutral future. There are however uncertainties and unquantified risks that need to be understood and overcome to harness the full potential of the technologies.

- CFD is increasingly used to perform safety analyses of potential accident scenarios (production, storage, distribution of hydrogen and its use in fuel cells) and provides data as an alternative to experimental testing
- CFD is a powerful numerical tool that can provide data and understanding of hydrogen behaviour. However, it requires a high level of competence and knowledge in order to yield meaningful results. The principal output from this project has been a protocol for the effective use and accurate deployment of CFD
- Although the project was focused on hydrogen safety, the work carried out and the methods used for the development of the MEP are relevant to many other CFD analysis applications. As such they will benefit and interest a much broader audience of safety engineers



Key elements of project

Critical review of physical and mathematical models

Models of physical phenomena related to safety in FCH technologies have been reviewed, and their strengths and weaknesses explored. This review covered the following phenomena: gaseous and liquid hydrogen releases, dispersion of permeated hydrogen, dispersion of hydrogen in the open atmosphere and ventilated enclosures, spontaneous ignition, jet fires & microflames and deflagrations & detonations.

Best practice guide in numerical simulations

This guide brings together knowledge on best practice in the application of CFD to safety engineering design of FCH systems from all of the SUSANA partners. It addresses the issue of users' capability in correctly applying CFD codes for each of the phenomenon that had been explored in the critical review. User education and training is also covered.

The CFD MEP refers to the guide as a knowledge base beneficial to all CFD users, providing a learning tool for newcomers in the area of FCH technology as well as safety.

Verification and validation database

Organisational and technical frameworks to demonstrate the credibility of models and codes for their intended use have been developed. The completion of a database of suitable verification problems and validation data applicable to FCH technologies has been created. This database is freely available to all stakeholders through the SUSANA website.

Simulation benchmarking

The Project partners have simulated selected examples from the validation database to quantify predictive capabilities of models/codes. These results are available for future reference through the project website for anyone wishing to benchmark their CFD model.

Project Website

The key elements of the project will be publicly available, see www.support-chl.eu

Figure 2 Promotional flyer

9.2 FABIG invitation email to members

Dear Colleague,

ENSURING THE ADEQUACY OF CFD MODELLING IN SAFETY ENGINEERING
Illustration through the Development of a Model Evaluation Protocol for Hydrogen Applications

Full-day UK FABIG Technical Meeting on 22nd & 23rd June 2016

Our forthcoming event will be a **full-day** Technical Meeting and will be held on **Wednesday 22nd June in Aberdeen** and on **Thursday 23rd June in London & via Webcast**. It is expected that **the meeting will be held between 10.00am and 16.00pm**.

You can already go to www.fabig.com/events for **registration**.

ABOUT THE MEETING:

For this Technical Meeting, **FABIG is partnering with the consortium of the EU funded research project SUSANA** (SUpport to SAfety aNalysis of Hydrogen and Fuel Cell Technologies), the results of which will be presented during this full-day event.

The objective of the SUSANA project is to support the use of CFD analysis in safety engineering in relation to Hydrogen and Fuel Cell Technologies through the development of a Model Evaluation Protocol (MEP).

Although the focus of the SUSANA project is hydrogen safety, the research results and the methodology used for the development of the MEP are relevant to all CFD modelling applications in safety engineering and will be of value to CFD analysts as well as those involved in the interpretation and application of CFD analysis results.

The programme for the event is currently being finalised and more information will be provided very shortly on the FABIG website.

10. Appendix C: Agenda

Time	Presentation	Comments	Speaker(s)
10.00	Registration and Coffee		London (Aberdeen in italics if different)
10:30-10:45	Introduction: Challenges in the Use of CFD Modelling in Safety Engineering	<i>This would include 2min for the chairman to go through the usual announcements, followed by an introduction to the meeting on the importance and challenges of CFD Modelling in safety engineering.</i>	Vincent Tam (DNVGL) Rosemary Whitbread (HSL)
10:45-11:00	SUSANA Project – To support the use of CFD analysis in safety engineering related to FCH technologies throughout the development of a Model Evaluation Protocol	<i>This presentation would provide some background to the SUSANA project, describe the project structure, its partners and its objectives.</i>	Olaf Jedicke (KIT)
11:00-11:15	HYMEP – Hydrogen Model Evaluation Protocol for safety applications	<i>This presentation would describe the HYMEP, what it actually consists of and how to use it. This presentation would be based on Work Package 6 of SUSANA but would be structured to act as an introduction to the following presentations which will provide detailed information on the work carried out for the development of the MEP.</i>	Daniele Baraldi (JRC) Simon Coldrick (HSL)

Time	Presentation	Comments	Speaker(s)
11:15-11:50	Review of Physical and Numerical Models for Hydrogen Releases, Dispersion, Ignition, Fires and Explosions	<i>This presentation would describe the work carried out under Work Package 2 of SUSANA but would need to be differentiated from the next presentation covering the best practice guidance.</i>	Dmitriy Makarov (UU) Volodymyr Shentsov (UU)
11:50-12:20	Best Practice Guidance for CFD Analysts Working in Hydrogen Safety	<i>This presentation would describe the work carried out under Work Package 3 of SUSANA but would need to be differentiated from the previous presentation covering the review of the state-of-the-art in physical and numerical models.</i>	Alexandros Venetsanos (NCSRD) Ilias Tolias (NCSRD)
12:20-13:20	Lunch		
13:20-13:50	Procedures for Verification of Software Implementation of Mathematical Models	<i>This presentation would describe the work carried out under Work Package 4 of SUSANA in relation to verification procedures.</i>	Shane Slater (EE)
13:50-14:20	Development of Validation Procedures & Model Validation Database	<i>This presentation would describe the work carried out under Work Package 4 of SUSANA in relation to validation procedures. It will cover validation procedures and the development of the model validation database. It should however be differentiated from the next presentation.</i>	Alexei Kotchourko (KIT) Audrey Duclos (AREVA)

Time	Presentation	Comments	Speaker(s)
14:20-14:40	Statistical Analysis Procedures for Model Validation & Methodology for Sensitivity Analysis and Assessment of Uncertainties.	<i>This presentation would describe the work carried out under Work Package 4 of SUSANA in relation to statistical analysis of CFD results for validation purpose, sensitivity analyses and assessment of uncertainties.</i>	Simon Coldrick (HSL)
14:40-15:05	Break		
15:05-15:40	Benchmarking Results and Quantification of Predictive Capabilities of CFD Models	<i>This presentation would describe the work carried out under Work Package 5 of SUSANA.</i>	Alexandros Venetsanos (NCSRD) Ilias Tolias (NCSRD)
15:40-15:55	Summary and Conclusions	<i>This short presentation will summarise the key information disseminated throughout the day and provide a list of references for those looking for more detailed information.</i>	Rosemary Whitbread (HSL)
15:55 – 16:10	Panel session		

11. Appendix D: Delegate list

Abbott Risk Consulting	Dean Simrick
Abercus	Steve Howell
ABS	Daniel Son
	Gary Fitzgerald
	Linda Ezeigwe
	Gloria Umeadi
	Greg Knight
	Oliver Yeo
Advisian	Chun Chien Bong
	Krishna Moorthy
Amec Foster Wheeler	Ayo Adeagbo
	Happiness Okafor
	Jack Vamplew
	Mark Anderson
	Swagat Gaikwad
	Tola Akinmade
Apollo Offshore Engineering	Alasdair Thom
AREVA	Audrey Duclos
	Harald Dimmelmeier
Aston Frame	Peter Cox
Atkins Global	Will Sharpe
	Alasdair McLeod
	Daniel Mahoney
	Ian Lines
	Marco Buonfiglioli
	Matt Westcott
Baker Risk	Robert Magraw
	Roger Stokes
	Peter Smith
	Phillip Hodge
BG Group	Marcelo Mendes
BMT Fluid Mechanics	Kejia Wu
BP	Chris Savvides
	Franklin Salazar
	Fraser Munro
	Hollie Harton
	Horacio Galea
	Jackeline Rothwell

	Kieran Glynn
	Lee Pua
	Mark O'Connor
	Mei Wang
	Rhian Drath Morgan
Bureau Veritas	Kate McCombe
	Kehinde Makinde
	Adrien Aubert
	Fanny Coulon
	Julia Carval
	Pierre Alvarez
	Sundara Cholan Kalyan
Case Western Reserve University	YeongAe Heo
CB&I	Eduardo Aja
	Ritesh Chhabra
	William Marsh
Chevron	Fiona Aoun
	John Ironta
	Justin Schmeer
	Lina Hall
	Ossai Opene
	Richard Opene
	SreeRaj Nair
Cobra Advice	Charles Lefevre
Computit	Kjell Erik Rian
ConocoPhillips	Toby St Leger
	Jennifer Miller
ConocoPhillips/DNV GL	Tanweer Khan
DNV GL	Asmund Huser
	Gabriele Ferrara
	Roman Shavansky
	Tahir Bhola
	Tim Coates
	Yongfu Xu
	Vincent Tam
Element Energy	Shane Slater
ENGIE	Pierre Quillatre
	Vincent van den Hoogenband
Eni	Antonello Miscimarra

	Mahmoud Gawish
ERM	Angela Ku
	Mohammed Seid Ali
	Widya Siswanto
	Jones Wan
ESR Technology	Andy Rushton
	Folake Abass
	Heather Cook
	Shamsudeen Hassan
	Zhixin Hu
European Commission	Daniele Melideo
	Daniele Baraldi
Fluidyn	Amita Tripathi
Genesis Oil & Gas	Filipa Gomes
	Kevin Banks
GexCon	Christopher Coffey
	Helene Hisken
	Josue Quilliou
	Khairunnisa Khairunnisa
	Lars Pesch
	Robert Brewerton
	Teguh Cahyono
Health & Safety Executive	Alexander Stacey
	Conrad De Souza
	Karen Fearon
	Matthew Ivings
	Michael Wu
	Vernon Martin
	Rosemary Whitbread
	Simon Coldrick
Ineris	Emmanuel Leprette
	Jerome Daubech
Karlsruhe Institute of Technology	Alexei Kotchourko
	Olaf Jedicke
Lloyd's Register	Espen Stodle Gaserud
	Hellen Mello

	Olav Roald Hansen
MMI Engineering	Chris Pinkney
	Enrico Munoz-Garcia
	Tony Liu
	Saffron Wyse
NCSR Demokritos	Alexandros Venetsanos
	Ilias Tolias
Petrellus	Sava Medonos
Petrobras	Marcelo Amaral
	Renato Mendes
Petrofac	Ayham Al Jawabra
	Steven Chapple
Presenta	Laurence Frewer
	Mark Jiggins
Quantra	Stephen Hall
Regional Safety Organisation Rotterdam-Rijnmond	Maarten van Abeelen
Risktec	Baptiste Ellias
	Frank Hart
	Rosario Nobile
RIVM	Piet Timmers
Safe Sight Technology	Sirous Yasseri
Safetec	Knut-Arne Vik
Safetec Group	Lerisna Kassie
	Steve Kilshaw
SBM Offshore	Sudeep Karumathil
SCI	Guillaume Vannier
Shell	Alvin Ho
	Callum McKenna
	Chris Dixon
	Magnus Ekekwe
	Pratap Sathiah
	Wojciech Rudy
	Paul Bailey
	Pratap Sathiah
	Terry Rhodes
Solent Composites	Ashley Alvares
Statoil	Ole Kristian

	Sommersel
Technip	Laurent Paris
	Victor Estrada
Total	Antonio Ron-Pedrique
	Els Depraetere
	Phil Shorrock
University of Aberdeen	Fei Pan
	Ilia xypolia
	Marilyn Marilyn
	Mohamed Alane
University of Ulster	Dmitriy Makarov
	Donatella Maria Chiara Cirrone
	Vladimir Molkov
	Volodymyr Shentsov
Wild Well Control	Alistair Gill
	John Eddie
Wood Group	Adewole Aderibigbe
	Ameya Bhate
	Darren Randell
	Eniola Odunuga
	Eseorhe Igbelokotor
	Jide Okwujiako
	Jonathan Rumble
	Nurudeen Momodu
	Richard Hunter
	Ugoeze Emmanuella Queensley Uzor
	John Audu
	Omomagiowawi Osemwinyen
	Pankaj Kumar
	Romanus Eze
Woodside Energy	Simon Bugg
	Linda Ezeigwe