



OPTIMAL SYSTEMS ENGINEERING SDN BHD  
ENGINEERING SUSTAINABILITY

**12**  
**CDP**

Hours Approved  
by Energy Commission

# **2 DAYS WORKSHOP**

## **MAXIMISE PROCESS THERMAL ENERGY EFFICIENCY & COST SAVINGS VIA**

# **INDUSTRIAL THERMAL ENERGY AUDIT (ITEA)**

Featuring Software:  
Pinch Analysis



MyHS00015/22-E002



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## **WORKSHOP OVERVIEW**

Up to 50% of industrial thermal energy input are finally lost as waste heat in exhaust gases, cooling water, heated surfaces and in products/byproducts (US-DoE). Thermal energy efficiency improvement typically offers among the biggest scope for energy cost saving in industry. By benchmarking process and equipment performances, identifying inefficiencies and implementing targeted measures involving optimization of operating parameters and equipment upgrades, significant cost savings and emission reduction can be achieved. Regular monitoring and maintenance of optimal operations ensure sustained energy cost savings, GHG emission reduction and compliance with regulations.

## **WORKSHOP OBJECTIVE**

This course aims to equip participants with practical concepts, principles, tools and systematic techniques to conduct energy audit, benchmark and analyse the thermal energy efficiency of industrial processes and utility systems, and effectively apply the tools and techniques for thermal energy cost saving measures.


## **WORKSHOP LEARNING OUTCOMES**

At the end of the workshop participants are expected to be able to

- Holistically perform energy audit involving process as well as the utility areas.
- Conduct process/equipment energy accounting using energy balances & Sankey diagram.
- Apply systematic procedure for macro and technical-level energy audit and analysis.
- Utilise Pinch Analysis benchmarking tool to establish energy recovery targets for process and utilities and to assess potential to maximise energy savings.
- Gain awareness on Pinch Analysis Optimal-Heat software for maximising heat recovery.
- Identify, analyse and evaluate energy savings measures covering thermal utility system such as boiler and steam system, combined heat and power (cogeneration); and processes and such as reactor, ovens, dryers, separator and heat exchangers.

## **WHO SHOULD ATTEND?**

Utility/Facility Managers and Engineers, Energy Auditors, Energy Managers, Lecturers and Researchers.





## TRAINERS' PROFILES



TRAINER 1

### **PROF IR TS DR ZAINUDDIN ABDUL MANAN**

Zainuddin Abdul Manan is a professor of chemical and energy engineering, the founding director of UTM Process Systems Engineering Centre (PROSPECT), founding Dean of UTM Faculty of Chemical and Energy Engineering, founder of UTM Sustainable Energy Management Program and the CEO and founder of the UTM spin-off company OPTIMISE Sdn Bhd. He began his career as an engineer in PETRONAS and Hume Industries and has been an academic leader, educator, researcher, consultant and professional coach for over 25 years. He completed over 100 R&D & consultancy projects serving local and multinational companies, has numerous patents and over 450 publications that include 20 books/ chapters, 230 refereed journals and 250 conference proceedings on energy and resource conservation using process integration techniques. He is a co-author of the globally referred Book on Process Integration and Intensification – Saving Energy, Water and Resources. Zain is a UK/EU chartered engineer, a Fellow IChemE (UK), Fellow of Academy of Sciences Malaysia, a professional engineer, a professional technologist, a certified energy manager, a registered electrical energy manager and a certified trainer for ASEAN energy managers. He has coached professionals from over 500 organisations and delivered over 400 invited talks in professional courses, conferences and seminars worldwide. Zain is the chair of Academy of Sciences (ASM) Energy Committee, the Chair of ASM Net Zero Task Force and the Chair of the Energy Efficiency and Conservation Act (Thermal Energy) Drafting Committee under the Ministry of Energy and Natural Resources. He founded and spearheaded the UTM Sustainable Energy Management initiative that led UTM to save over USD 7 million energy costs between 2011 and 2020, and to win the ASEAN Energy Awards.



TRAINER 2

### **PROF IR TS DR SHARIFAH RAFIDAH WAN ALWI**

Prof Ir Ts Dr Sharifah Rafidah Wan Alwi is a Professor in the School of Chemical and Energy Engineering, Universiti Teknologi Malaysia. She previously helmed as the Director of Process Systems Engineering Centre for ten years (2011 to 2021). She is an expert resource minimisation consultant for multiple industries and is among the leading researchers in resource integration technique development. Prof Sharifah is also the co-founder and Director of Optimal Systems Engineering Sdn Bhd, a UTM Spin-off company. She has been extensively involved in 80 research projects, 17 industrial based projects for various companies and government agencies and has trained engineers from more than 300 companies in the field of sustainable engineering design and management. Together with her team, they have developed 7 resource minimisation software. Sharifah has won various international and national awards such as Green Talents 2009 (Germany), IChemE Highly Commended Sir Frederick Warner Prize 2011 (UK), ASEAN Young Scientist and Technologist Award 2014, National Young Scientist Award 2015, ASEAN-US Science Prize for Women 2016 in Energy Sustainability, Malaysia Research Star Award 2016, 2018, 2019, Top Research Scientists Malaysia 2018 and Sarawak State - International Women Award 2021. She was listed as 'Asian Scientist 100' in 2017 and 'Asia's Rising Scientists' in 2020, and '8 Women Scientists from Asia You Should Know' in 2021 by AsianScientist.com. Sharifah is also the Associate Editor for Journal of Cleaner Production and UTM Sustainable Energy Management System advisor. She has also served as the Chair for the Science Leadership Working Group under Young Scientist Network, Academy of Sciences Malaysia (YSN-ASM) and Chair for Malaysia IChemE Young Engineer Group (YEG). Sharifah is also a professional engineer, a professional technologist, a UK/EU chartered engineer, a certified energy manager, a registered electrical energy manager and a certified trainer for ASEAN energy managers.

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## TRAINERS' PROFILES



TRAINER 3

### **ASSOCIATE PROF IR DR LIM JENG SHIUN**

Associate Professor Ir Dr Lim Jeng Shiun is the Director of Products and Service, Optimal Systems Engineering Sdn Bhd, a UTM spin-off company specialising in providing solutions related to energy conservation and GHG emissions reduction. He is also the Deputy Director of Process Systems Engineering Centre (PROSPECT), Universiti Teknologi Malaysia. His core expertise is in the area of innovative development and application of process systems engineering techniques for resource conservation, and energy and carbon planning. He is also a professionally Certified Energy Manager, Certified Energy Auditor, Accredited Energy Measurement & Verification Professional and a Registered Electrical Energy Manager certified by the Energy Commission of Malaysia.

He is the trainer of the Energy Management Trainer Course conducted by MGTC to certify the Energy Manager. He is also the instructor for MSc Energy Management in UTM, sharing knowledge related to energy efficiency and energy management. As an engineer in practice, he has applied the output of his research work to consultancy projects for the industrial community. He has been extensively involved in more than 35 industrial-based projects for various companies and government agencies. The key clients include local industries and multinational companies such as BERNAS, FABER MEDISERVE, SHELL, OLEON in Malaysia and PERTAMINA in Indonesia.

He has assisted those companies to identify energy-saving opportunities worth millions of dollars and GHG reduction opportunities through the use of process integration and process systems engineering approaches in the energy audit and GHG emissions accounting projects. He has shared his project experience in his co-authored book titled Pinch Analysis for Energy and Carbon Footprint Reduction, published by the Institution of Chemical Engineers (IChemE). He has been invited to share his experience on Net Zero carbon for industry and facilities, including on Net Zero Carbon for Palm Oil Industry organised by IChemE.



# COURSE SCHEDULE

| Day 1               |  |
|---------------------|--|
| 8:30 am - 9:00 am   | Attendance & Setup/Troubleshoot  |
| 9:00 am - 10:00 am  | <b>Industrial Thermal Energy Audit (ITEA) – Premise and The Big Picture</b> <ul style="list-style-type: none"> <li>• Overview of the ITEA module</li> <li>• Key terms, units &amp; conventions in ITE-System (ITES) <ul style="list-style-type: none"> <li>◦ Thermal energy, temperature &amp; heat</li> <li>◦ Thermal versus electrical energy</li> </ul> </li> </ul> <p>ITEA – Drivers for Energy Sustainability<br/>Overview of Industrial-TES (ITES)</p> <ul style="list-style-type: none"> <li>• Typical overall ITES structure</li> <li>• Energy supply – energy generation and distribution</li> <li>• Energy demand – process operations</li> </ul>  |
| 10:00 am - 10:45 am | <b>Industrial Energy Audit and Analysis – The 10 Key Steps – Part 1</b> <ul style="list-style-type: none"> <li>• The 10 key steps for plant audit analysis</li> <li>• Energy audit data collection</li> <li>• Load apportioning</li> <li>• Significant Energy User (SEU)</li> </ul>  |
| 10:45 am - 11:00 am | Break  |
| 11:00 am - 13:00 pm | <b>Industrial Energy Audit and Analysis – The 10 Key Steps – Part 2</b> <ul style="list-style-type: none"> <li>• Specific utility consumption</li> <li>• Energy baseline</li> <li>• Energy benchmarking</li> <li>• Facility level energy analysis</li> <li>• Identification and classification of energy saving measures</li> </ul>  |
| 13:00 pm - 14:00 pm | Lunch Break  |
| 14:00 pm - 15:15 pm | <b>Process and Equipment Thermal Energy Accounting – Part 1</b> <p>ITES application highlights<br/>Widely applied ITES concepts, correlations and analysis tools</p> <ul style="list-style-type: none"> <li>• The 1st Law of Thermodynamics <ul style="list-style-type: none"> <li>◦ Energy balance</li> <li>◦ Sankey diagram</li> </ul> </li> <li>• The 2nd Law of Thermodynamics <ul style="list-style-type: none"> <li>◦ Energy quality</li> <li>◦ Heat transfer means: conduction, convection, radiation</li> </ul> </li> <li>• Steam properties and steam table <ul style="list-style-type: none"> <li>◦ Sensible heat, latent heat, phase change</li> <li>◦ Temperature, pressure, specific volume, enthalpy, entropy</li> </ul> </li> </ul> |
| 15:15 pm - 15:30 pm | Break  |
| 15:30 pm - 17:00 pm | <b>Process and Equipment Thermal Energy Accounting – Part 2</b><br>(with guided working sessions) <ul style="list-style-type: none"> <li>• Performance Evaluation <ul style="list-style-type: none"> <li>◦ Direct efficiency and indirect efficiency</li> </ul> </li> <li>• Heat demands of process (direct and indirect heating)</li> </ul>   |

# COURSE SCHEDULE

| Day 2               |   |
|---------------------|---|
| 8:30 am - 9:00 am   | Review Day 1  |
| 9:00 am - 10:30 am  | <b>Thermal Energy Pinch Benchmarking and Targeting</b> <ul style="list-style-type: none"> <li>Pinch Analysis – Definition, benefit, basic, steps</li> <li>Energy targeting tools - composite curves; problem table algorithm</li> </ul>   |
| 10:30 am - 10:45 am | Break   |
| 10:45 am - 11:45 am | <b>Maximum Thermal Energy Targeting – Working Session</b> <ul style="list-style-type: none"> <li>Significance of composite curves</li> <li>Use of Optimal Heat software</li> <li>Working Session/Quiz (Understanding composite curves)</li> </ul>   |
| 11:45 am - 13:00 pm | <b>Heat Recovery Systems – Analysis, Design and Retrofit (Part 1)</b> <ul style="list-style-type: none"> <li>Grassroot vs retrofit Pinch Analysis</li> <li>Technique for correct stream data extraction</li> <li>Designing heat exchanger network using Grid Diagram – normal, stream splitting, threshold</li> </ul>   |
| 13:00 pm - 14:00 pm | Lunch Break   |
| 14:00 pm - 15:15 pm | <b>Heat Recovery Systems – Analysis, Design and Retrofit (Part 2)</b> <ul style="list-style-type: none"> <li>Concept of minimum number of units, multiple utilities, CHP and process modifications</li> <li>Economics – How to know the pinch system is feasible?</li> <li>Sample of application of Pinch Analysis case study</li> </ul>  |
| 15:15 pm - 15:30 pm | Break   |
| 15:30 pm - 17:00 pm | <b>Fuels &amp; Combustion</b> <ul style="list-style-type: none"> <li>Introduction to Fuel               <ul style="list-style-type: none"> <li>Types of fuel (solid, liquid, gas)</li> <li>Properties of fuel</li> </ul> </li> <li>Combustion               <ul style="list-style-type: none"> <li>Principles of combustion</li> <li>Types of combustion (complete, incomplete)</li> </ul> </li> <li>Combustion Reactions               <ul style="list-style-type: none"> <li>Stoichiometric equation</li> </ul> </li> <li>Combustion Heat Losses</li> <li>Analysis of furnace performance               <ul style="list-style-type: none"> <li>Air to fuel ratio</li> </ul> </li> </ul> |

# COURSE SCHEDULE

| Day 3               |   |
|---------------------|---|
| 8:30 am - 9:00 am   | Review Day 2  |
| 9:00 am - 10:30 am  | <b>Thermal Utility Analysis &amp; Improvements – Part 1</b> <ul style="list-style-type: none"><li>• Utility generation<ul style="list-style-type: none"><li>◦ Air-fuel control</li><li>◦ Economiser</li><li>◦ Blowdown</li></ul></li></ul>  |
| 10:30 am - 10:45 am | Break   |
| 10:45 am - 13:00 pm | <b>Thermal Utility Analysis &amp; Improvements – Part 2</b> <ul style="list-style-type: none"><li>• Utility distribution &amp; recovery<ul style="list-style-type: none"><li>◦ Insulation</li><li>◦ Pressure Reducing Valve vs turbine (isenthalpic vs isentropic)</li><li>◦ Condensate recovery via flash tank</li></ul></li></ul> |
| 13:00 pm - 14:00 pm | Lunch Break   |
| 14:00 pm - 15:15 pm | <b>Combined Heat and Power (Cogeneration) Systems</b> <ul style="list-style-type: none"><li>• Cogeneration system – Concepts and applications</li><li>• Optimal cogen-process integration</li></ul>   |
| 15:15 pm - 15:30 pm | Break   |
| 15:30 pm - 17:00 pm | <b>Thermal Utility Analysis &amp; Improvements</b> <ul style="list-style-type: none"><li>• The system's approach to steam system analysis</li></ul>   |
| 17:00 pm - 17:15 pm | Workshop Wrap up and Closing  |

## OPTIMISE Energy Audit, GHG Accounting and EnMS Track Records

- Co-developer of ASEAN EMGS Energy Management System Standards with MGTC.
- Led UTM to win ASEAN Energy Award and EMGS 3 Star EnMS Gold Standard.
- Led UTM to be globally ranked 1st on SDG 7 – Clean and Affordable Energy.
- Involved in certification of more than 1600 energy managers and 140 end users.
- Developer of award-winning energy audit, energy and emission monitoring software.
- Led UTM to achieve > RM 30 Million energy savings between 2011-2020.
- Over 30 years experience conducting energy audit and optimization, GHG accounting projects and professional trainings for over 500 national/multinational companies.
- Certified trainers, auditors & centre for training and certification of energy managers.

## Selected References

- Shell, Middle Distillate Synthesis
- BP – Amoco
- MLNG
- Felda Proctor and Gamble
- MIMOS Semiconductor
- Riau Pulp and Paper Mill
- Qatar LNG
- Pertamina Engineering Group
- PT Titan Petrokimia Interindo
- Pan Century, IOI Oleochemicals
- BASF – Petronas
- MTBE (Petronas)
- Huntsman Tioxide
- Malaysia Newsprint Industries
- Malaysia Palm Oil Board
- Malaysia Energy Commission
- Technip (M) Sdn Bhd
- PT Chandra Asri
- Petronas Penapisan (M) Sdn Bhd
- Petronas Gas Sdn Bhd
- Kaneka Malaysia
- UKM, UPM, USM, UM, MICET

**30+**

Years Experience in  
Thermal Energy Audit  
& Retrofit of Heat  
Recovery System

**#1**

Global Rank in Research  
'Heat Exchanger, Retrofitting  
and Design' Elsevier Scival  
Spotlight 2014

**500+**

National & Multinational  
Companies Benefitted  
from our Energy  
Training Workshops



# WHAT OUR TRAINEES *Said*



The ITEA Training was very useful for companies aiming to enhance energy efficiency of plant operations. From theory to in-depth methodology, participants learnt many new methods from OPTIMISE experienced professors and educators. I recommend those who are going for sustainability to join this training. Well done OPTIMISE!

**AZREE HAZWAN**

PROJECT MANAGER  
BECIS MALAYSIA

Industrial Thermal Energy Audit (ITEA)  
participants



I enjoyed the training so much as it allowed me to refresh my engineering calculations and link them with my industrial experience. Even though I have 15 years industrial experience in oil and gas, I learnt so much during this training.

**IZZA MAHMOD**

IMPROVEMENT EXECUTIVE  
PETRONAS CHEMICAL ETHYLENE SDN.BHD

Industrial Thermal Energy Audit (ITEA)  
participants



The course provides good guidance on conducting thermal energy audit which is very different (maybe more rigorous) than the electrical energy audit that I'm familiar with and have participated in. It's a good refresher course from what I've learnt during my undergrad years, and even more relatable since I got to apply it to an actual scale that matches my current responsibility. The step-wise details on the audit approach is also very helpful for me to get started.

**NASSYA BINTI MOHD SAID**

EXPERIENCED RESEARCHER  
SIRIM MALAYSIA

Industrial Thermal Energy Audit (ITEA) participants