COURSE OVERVIEW EE0540-4D

Load Forecasting and System Upgrade

Course Title
Load Forecasting and System Upgrade

Course Reference
EE0540-4D

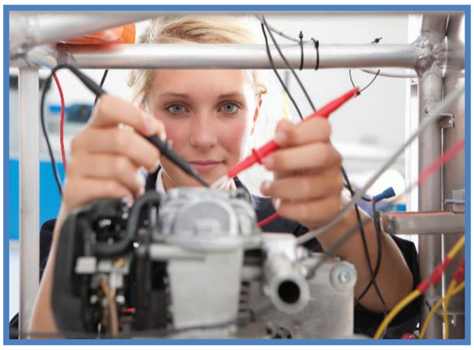
2.4 CEUs (24 PDHs) AWARD

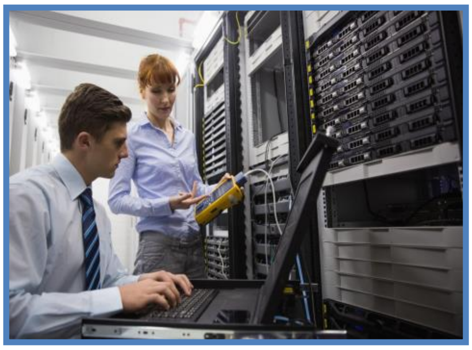
Course Duration/Credits
Four days/2.4 CEUs/24 PDHs

Course Date/Venue

Session(s)	Date	Venue
1	January 29-February 01, 2024	Jubail Hall, Signature Al Khobar Hotel, Al Khobar, KSA
2	April 15-18, 2024	Boardroom 1, Elite Byblos Hotel Al Barsha, Sheikh Zayed Road, Dubai, UAE
3	July 01-04, 2024	Cheops Meeting Room, Radisson Blu Hotel, Istanbul Sisli, Turkey
4	October 14-17, 2024	Ajman Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE

Course Description





This practical and highly-interactive course includes various practical sessions and exercises. Theory learnt will be applied using our state-of-the-art simulators.

Planning the operation in modern power systems requires suitable anticipation of load evolution at different levels of distribution network. Under this perspective, load forecasting performs an important task, allowing optimization of investments and the adequate exploitation of existing distribution networks.

Load forecasting is an essential element of power system involving prognosis of the future level of demand to serve as the basis for the supply side and demand side planning. The load requirements are to be predicted in advance so that the power system operates effectively and efficiently. It is done for planning, marketing, risk assessment, billing, dispatch or unit commitment purposes.

Further, Load forecasting can help to estimate load flows and to make decisions that can prevent overloading. Timely implementations of such decisions lead to the improvement of network reliability and to the reduced occurrences of equipment failures and blackouts.

Load forecasting may be applied in the long, medium, short, and very short term time scale. Short-term forecasts (five minutes to one week ahead) are required to ensure system stability. Medium term forecasts (one week to six months ahead) are required for maintenance scheduling, while long term forecasts (six months to 10 years ahead) are required for capital planning.

The long and medium term forecasting are used to determine the capacity of generation, transmission or distribution system additions and the type of facilities required in transmission expansion planning, annual maintenance scheduling, etc. The short-term load forecast is needed for control and scheduling of power system and also as inputs to load flow study or contingency analysis. The purpose of very short-term load forecasting (ranging from minutes to hours) is for real time control and security evaluation.

Economic and reliable operation of an electric utility depends to a significant extent on the accuracy of the load forecast. The load dispatcher at main dispatch center must anticipate the load pattern well in advance so as to have sufficient generation to meet the customer requirements. Overestimation may cause the startup of too many generating units and lead to an unnecessary increase in the reserve and the operating costs. Underestimation of the load forecasts results in failure to provide the required spinning and standby reserve and stability to the system, which may lead into collapse of the power system network. Load forecast errors can yield suboptimal unit commitment decisions.

Therefore, to reduce exposure risks, an accurate forecast is required. While system loads are predictable, they require analysis of many variables including day of the week, holidays, historical load patterns, and weather. Loads can react differently to the same weather conditions during different times of the year. Energy schedulers, portfolio managers, and grid security analysts need to understand how the load responds to weather changes during different times of the year, times of the day, and days of the week.

Different forecasting models have been employed in power systems for achieving forecasting accuracy. Among the models are regression, statistical and spatial methods. In addition, artificial intelligence-based algorithms have been introduced based on expert system, evolutionary programming, fuzzy system, artificial neural network (ANN), and a combination of these algorithms. Among these algorithms, ANN has received more attention because of its clear model, easy implementation, and good performance. Most forecasting models and methods have already been tried out on load forecasting, with varying degrees of success. They may be classified into two broad categories: artificial intelligence based techniques and classical (or statistical) approaches.

The former include expert systems, fuzzy inference, fuzzy neural models, and, in particular, artificial neural networks (ANN). The statistical methods differ from the previous approach in that they forecast the current value of a variable by using an explicit mathematical combination of the previous values of that variable and, possibly, previous values of exogenous factors (specially weather and social variables). Models that have been applied recently include autoregressive (AR) models, linear regression models, dynamic linear or nonlinear models, ARMAX models, threshold AR models, methods based on Kalman filtering, optimization techniques, and curve fitting procedures. The statistical models are attractive because some physical interpretation may be attached to their components, allowing engineers and system operators to understand their behavior. At the same time they offer relatively good performance.

This course is designed to provide participants with a good overview of the above mentioned models and the latest techniques used in forecasting electrical loads. The course will cover Electric Power Distribution load forecasting (how it is done), Planning Methods, Load Behavior and Load Growth Characteristics, Basic Theory and Mathematics of Modern Distribution Load Forecasting, Practical Forecasting, "Curve Expert" Spatial Electric Load Forecasting and user Instructions software, Accuracy and Information content requirement for evaluating the goodness and fitted estimate, Examination of T&D Planning and Forecasting needs, Short-Term Load Forecasting, Review of the Load Forecasting Techniques and guidelines for selection, Application of the Best Methods, Integrated Resource Planning, Value Based Planning, and Planning Capacity Needs of Power Delivery.

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply and gain an in-depth knowledge on load forecasting and system upgrade
- Determine distribution circuit electrical analysis, identify automated planning tools and perform its methods
- Employ T&D load forecasting methods as well as the planning and T&D planning process
- Discuss the practical aspects of T&D load forecasting as well as describe objectivity bias and accuracy in T&D planning
- Discuss the power systems, current T&D systems, distribution system reliability and carryout utility forecasting and planning
- Implement proper planning and forecasting as well as illustrate smart grid
- Perform system planning using smart grid and recognize deregulation

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides an overview of all important aspects and considerations of load forecasting and system upgrade in distribution networks. Electrical engineers and technologists, control engineers, planners and planning engineers, designers, supervisors, economists and managers in power plants and electrical utilities will find the practical aspects of this course very beneficial.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Fee

Al Khobar	**US$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Dubai	**US$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Istanbul	**US$ 5,000** per Delegate + **VAT**. This rate includes Participants Pack (Folder, Manual, Hand-outs, etc.), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.
Abu Dhabi	**US$ 4,500** per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations:-

- The International Accreditors for Continuing Education and Training (IACET - USA)

Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

Haward Technology Middle East will award **2.4 CEUs** (Continuing Education Units) or **24 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Mr. Amar Namoune, PE, BSc, is a **Senior Electrical Engineer** with over **20 years** of extensive experience within **Power & Water Utilities** and Other **Energy Sectors**. His expertise widely covers **Transformer Maintenance & Testing**, **Electrical Substation & Design**, **Power Quality** Studies & Load Criteria, LV/MV Electrical Safety (**11 KV, 415 & 220 Voltage**), **Substation Earthing System**, Emergency **Diesel Generator**, **Electrical Safety**, **Power System Equipment**, **Electrical Drawing**, **Electrical Forecasting**, **Transmission Networks**, **Substation**, **Cable & Over Head Line**, **Distribution Networks**, **Substation Automation Systems & Application**, **Electrical Control & Monitoring System**, **Protection & Control of Electric Power System**, **Power System Control**, Communication for **Power System Automation**, **Communication Technologies**, **Substation Architectures**, **Specification & Engineering**, **System Maintenance** of **Substation Automation & Control Systems**, **Power System Information Integration & Automation**, **Power System Standardization**, System Configuration Language (**SCL**), Electrical Distribution System & Single Line Diagram (**SLD**), IEC 61850-6 Engineering Process, **Power Generation**, Generators, Emergency Diesel Generators (**EDG**), **Electrical Power** Systems, Electric Submersible Pumps (**ESP**), **High Voltage Electrical Safety**, **HV Overhead Power Line** Construction & Patrolling, **Power Transmission & Distribution**, **Electrical Distribution** Systems, **Electrical Power Systems** Quality & Troubleshooting, **Protection & Relay**, **Electric & Control** System Commissioning, Practical Troubleshooting & Repair of **Electronic Circuits**, Fault Analysis in **Electrical Networks & Distribution Cables**, **Variable Frequency Drives** (VFD), **Motor Operation and Maintenance**, **Electric Motor** Protection, Testing & Maintenance, **Motors & Variable Speed Drives**, **UPS System & Battery Charger**, **Circuit Breakers & Switchgears**, **HV/LV** Switching and Isolation, HV/MV **Cable** Splicing, Jointing & Termination, Uninterruptible Power Supply (**UPS**), Supervisory Control and Data Acquisition (**SCADA**) Systems, **Introduction to SCADA**, **Distributed Control System and SCADA** Systems, **ABB SCADA**, **Advanced PLC & SCADA** Systems, AC/DC & Batteries, **GIS Substation** Maintenance, **Generator** Maintenance & Troubleshooting, **Diesel Generator** Troubleshooting, **Substation** Automation Systems & Application (IEC 61850), **Transformers** Troubleshooting & Maintenance, **Earthing**, **Bonding**, **Lightning & Surge** Protection, **Process Control & Automation**, **Compressor** Control & Protection, Practical **Industrial Data Communications & Telecommunications**, **Safety Instrumented Functions**, Explosion Protection Type of Electrical Equipment & Systems, Electricity & Wiring Fundamentals, **Fire & Gas** Detection System, **Hazardous Area Classification & Intrinsic Safety** (IEC 60079, ATEX 95/137 & API RP 500/505), **Electrical Drawings & Schematic Layouts**, HSEIA, COMAH, HAZOP, HAZID, MAXIMO, Ex Equipment, Selection, Inspection & Maintenance and Installation, Testing and Commissioning of Electrical Equipment. Currently, Mr. Amar is the **Senior Electrical Instructor & Assessor** wherein he is responsible in providing guidance and training gap analysis on safe electrical and substation automation system maintenance, methodology, installation, testing, certification and operation of electrical and substation automation equipment, plant and systems.

Mr. Amar gained his expertise and thorough practical experience through several positions as an **Electrical Instructor & Assessor**, **Electrical Instructor & Assessor**, **Technical Department Associate Manager**, **Maintenance Section Head** for various companies such as the PETROFAC & PDO, Oman, ADNOC Gas Processing, IFFCO Group and BENAMOR Mills wherein, he assists in the development of **safety systems experts** to ensure strict compliance with **OSHA regulations** and specifications, codes and standards (IEC & IEEE, NFPA 70E, Shell DEP); oversees the **development** and **implementation** of **operations/process improvement** to include planning, staging and execution; spearheads the organization to a strict compliance with the **Health and Safety processes & standards** and leads in the **development** and **implementation** of an **active safety culture**, integrating a daily behaviour-based process throughout the organization.

Mr. Amar has a **Bachelor's** degree in **Electrical Engineering**. Further, he is a **Certified Instructor/Trainer**, a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership & Management** (**ILM**) and an **IOSH** Managing Safely Certified and delivered numerous trainings, courses, seminars and workshops worldwide.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0915	***Electrical Load Forecasting & Planning*** *Planning Criteria • Basic Principles • Distribution Planning • Substation Forecast/Planning Process Diagram for a Typical Utility • Substation Forecast/Planning Process Data Collection • Substation Forecast/Planning Process Weather Normalization • Substation Forecast/Planning Process Substation & Area Forecasts • Diversified Specific Growth*
0915 – 0930	*Break*
0930 – 1100	***Planning & Forecasting*** *Four Basic Questions Must be Answered in the Planning Process • System Planners Face Numerous Complexities • Utility Development Philosophy should be Clearly Stated • Major Issues must be Addressed in Developing a Long-run Expansion Plan for the Generating System • Various Technologies are Currently Available as Candidates for Expansion of Generating Systems • The Planner must also consider Potential Future Options • A Fundamental Aspect of Any Economic Evaluation is the Time Element*
1100 – 1230	***Objectivity Bias & Accuracy in T&D Planning*** *Introduction & Purpose • Know What to Look for, & Where to Look • Focus on the Report • Objective Evaluation, Proponent Study, or Simply Poor Work? • Ways that Bias Makes its Way into a T&D Planning Study*
1230 - 1245	*Break*
1245 - 1420	***Objectivity Bias & Accuracy in T&D Planning (cont'd)*** *The "Rules" Used to Bias Planning Studies in an Unseen Manner • Areas Where Bias or Mistakes are Often Introduced into a Study • Examples of Bogus, Proponent, & Masked Studies • Guidelines for Detecting, Finding, & Evaluating Bias • Summary & Conclusion: Forewarned is Forearmed*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day One*

Day 2

0730 – 0930	***Planning & the T&D Planning Process*** *Introduction • Goals, Priorities & Direction • The Public Steward Utility • The Equipment Steward Utility • Technology-dominated Utility • The Long-Term Effects of Cost Cutting • Balance Among Priorities - The Business Utility • The Adventuresome Utility • A Utility's Mission & Values • The Short-range Plan • Long-Range Planning: Focus on Reducing Cost • The Long-range Plan • The Functions of the Long-range Plan • Uncertainty & Multi-scenario Planning • Uncertainty in T&D Growth Forecasts Cannot be Addressed by Planning for the Expectation of Load Growth*
0930 – 0945	*Break*
0945 - 1100	***Distribution Circuit Electrical Analysis***

	Standardization, Consistency & Documentability ● Performance Simulators & Decision Support Methodology ● Models of the System Versus Models of Natural Physical Behavior ● Simulators Typically Used in Distribution Planning & Engineering ● Models, Algorithms & Computer Programs
1100 – 1230	***Distribution Circuit Electrical Analysis (cont'd)*** *Constant Power, Constant Current & Constant Impedance Loads ● Phase Assignments of Load Models ● Power Factor ● Assigning Loads to Individual Nodes ● Allocation to Nodes based on Connected Transformer Capacity (TkVA) ● Allocation to Nodes Based on Customer Billing Records*
1230 – 1245	*Break*
1245 - 1420	***Automated Planning Tools & Methods*** *Introduction ● Identification, Evaluation & Selection ● Fast Ways to Find Good Alternatives ● Complicated Mathematics but Simple Concepts ● Tradeoffs in Optimization Application ● Constraints ● Integer versus Continuous ● Distinctions in Optimization Methods Applied to Distribution Systems ● Radialization of Optimal Feeder System Plans ● Typical Feeder Optimization Algorithm Structure ● Suitable Optimization Methods for Feeder System Planning ● Substation-level & Strategic Planning Tools ● The Critical Focus of "Strategic" Substation Planning ● Substation Capacity Optimization*
1420 - 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Two*

Day 3

0730 – 0930	***T&D Load Forecasting Methods*** *Spatial Load Forecasting ● Small Area Forecasting ● A Series Including Interim Years ● Load Growth Behavior ● Load Growth at the Small Area Level ● Important Elements of a Spatial Forecast ● Short-Range & Long-Range Forecasting ● Multiple Scenario Forecasting ● Load Transfer Coupling (LTC) ● Geometric & Cluster-Based Curve-Fit Methods ● Recommended Approach ● Simulation Methods for Spatial Load Forecasting ● De-Coupled Analysis of the Two Causes of Load Growth ● Land Use Customer Classes ● Overall Framework of a Simulation Method*
0930 – 0945	*Break*
0945 – 1100	***Practical Aspects of T&D Load Forecasting*** *The First Step In T&D Planning ● Weather Normalization & Design Criteria ● Weather Variables ● Hourly Measurement Data ● Causal, Peak Demand Functions ● Micro-Climates & Spatial Weather-Demand Analysis ● Four Key Technical Steps ● Analysis to Identify Weather's Impact on Peak Demand ● Setting Design*
1100 – 1230	***Practical Aspects of T&D Load Forecasting (cont'd)*** *Changes in Growth Conditions & the Need for Multi-Scenario Planning ● Ease of Explanation & Clarity of Communication ● Cost ● Data Requirements ● Documentability & Credibility ● Planning Period ● Robustness ● Spatial Resolution ● Type of Small Area Format ● Application of Spatial Forecast Methods ● Pitfalls to Avoid in Forecasting*
1230 – 1245	*Break*

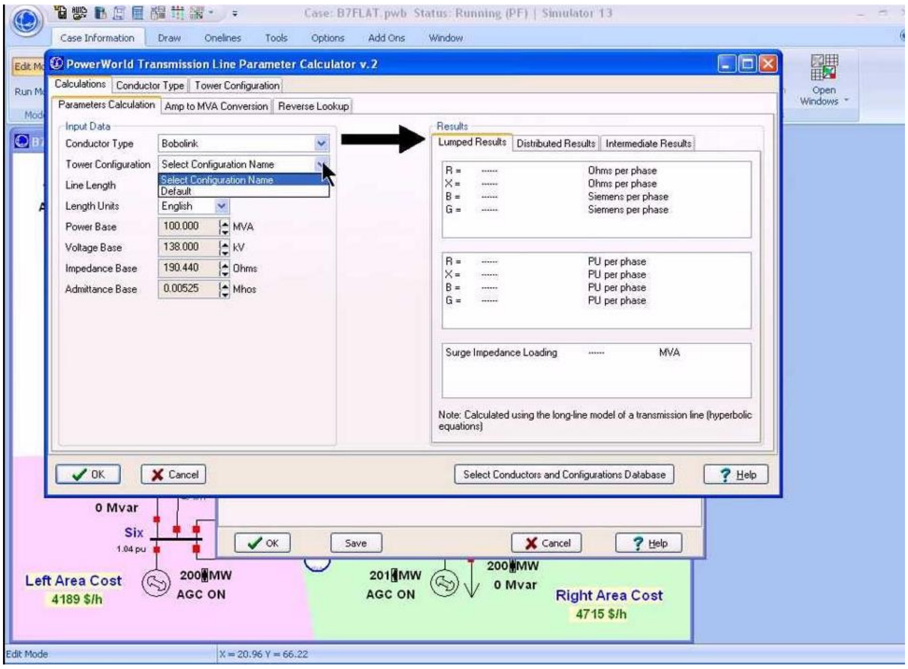
1245 – 1420	***Distribution System Reliability*** *Introduction to Distribution System • Background • When the Lights Go Out • Motivation • Strategies • Assessing System Performance • Outline of Presentation • Why Use Reliability Measures? • Quantifying Levels of Reliability • Reliability Indices (Sustained Interruptions) • Momentary Interruptions • Reliability Indices (Momentary Interruptions) • Understanding Failures • Reliability Evaluation • FMEA Method • Data Required • FMEA Method: Example • System-wide Reliability Indices • Comparative Results • Monte Carlo Simulations • Steps Involved • SAIDI & SAIFI Distributions • Effect of System Size • Some Software Tools*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Three*

Day 4

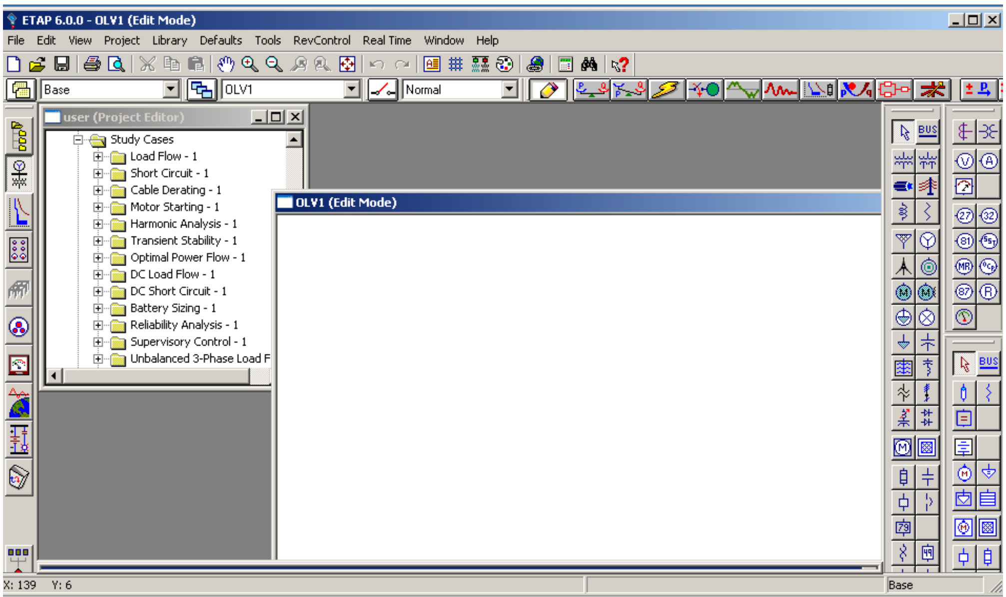
0730 – 0930	***What is the Smart Grid?*** *The Smart Grid Will • EPRI: The Intelligent Grid • Xcel Energy: The Smart Grid • FERC: The Smart Grid • The Smart Grid is Equal Parts • The Smart Grid is not a Single Thing • DOE: Key Technologies • Smart Grid Technologies Rest on Five Key Foundational Elements*
0930 – 0945	*Break*
0945 – 1100	***What is the Smart Grid? (cont'd)*** *System Integration • Operating Center Integration • More Operational Data • Telecommunications Technologies Evolving at Hyper Speed • Some Implementations • SCE's Smart Grid Activities • Energy Distribution • Integrated Distribution Operations Center*
1100 – 1230	***System Planning Using Smart Grid*** *Smart Grid Definition • Statement of Smart Grid Policy • EISA 2007 • DOE Smart Grid Characteristics • Smart Grid Interoperability Framework • Smart Grid Technologies • Smart Grid Technologies Used for Distribution System Planning • T & DEC System Planning Subcommittee*
1230 – 1245	*Break*
1245 – 1345	***Deregulation*** *Different Names • Forces Behind the Deregulation • Reasons Why Deregulation is Appealing • What will be the Transformation • What will be the Potential Problems • Deregulation Around the World • Market Rules • Capacity Payments • Problems • Spot Prices • New Electricity Trading Arrangement (NETA) in UK • The New Arrangements • California Deregulation Process • Congestion Management through Adjustment of Zonal Prices*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course*
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulators (Hands-on Practical Sessions)

Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using our state-of-the-art simulators “Power World” and “ETAP software”.



Power World Simulator



ETAP Software Simulator

Course Coordinator

Kamel Ghanem, Tel: +971 2 30 91 714, Email: kamel@haward.org