



NEW HORIZON COLLEGE OF ENGINEERING

Bengaluru - 560103



and



SRI RAMAKRISHNA ENGINEERING COLLEGE

Coimbatore - 641022



In Commemoration of the Silver Jubilee Year



Department of Electrical and Electronics Engineering

NHCE & SREC Jointly Organize Seven Days Webinar Series on



SMART GRID INTEGRATION & ENERGY STORAGE SYSTEMS



[10.07.2021 to 16.07.2021]

01

10.07.2021
10:30-11:30 AM

Mr. Thiruvallu Marban
Manager
Vi-Micro Systems, Chennai
**SMART GRID & RES
INTEGRATION**



04

13.07.2021
10:30-11:30 AM

Dr. K. Selvakumar, Assistant Professor
Department of Electrical and Electronics
Engineering
SRM Institute of Science & Technology,
Chennai
**DEMAND RESPONSE PROGRAM
IN SMART GRID**



02

11.07.2021
10:30-11:30 AM

Dr. S. U. Prabha, Professor & Head
Department of Electrical and Electronics
Engineering
Sri Ramakrishna Engineering College,
Coimbatore
**RENEWABLE ENERGY GRID INTEGRATION
TECHNIQUES AND CHALLENGES**



05

14.07.2021
10:30-11:30 AM

Mr. K. Maharaja, Lecturer
Department of Engineering
University of Technology & Applied
Sciences, Al Musannah, Oman
**ADVANCEMENT IN SMART GRID
TECHNOLOGY IN ELECTRICAL POWER
NETWORK**



03

12.07.2021
10:30-11:30 AM

Dr. A. Immanuel Selvakumar, Professor
Department of Electrical and Electronics
Engineering
Karunya Institute of Technology &
Sciences, Coimbatore
**IMPLEMENTATION OF MACHINE
LEARNING IN SMART GRID**



06

15.07.2021
10:30-11:30 AM

Mr. S. Selvakumar
Business Head
Power Project, Chennai
**FUTURE OF MICROGRIDS WITH
DISTRIBUTED GENERATION & EV**



07

16.07.2021
10:30-11:30 AM

Dr. K. Vinoth Kumar, Associate Professor
Department of Electrical and Electronics
Engineering
New Horizon College of Engineering
Bengaluru.
**CONDITION MONITORING OF
SMART SENSORS IN MICROGRID**



CONVENOR

Dr. M. Mahesh
Professor & Head, NHCE
Dr. S. U. Prabha
Professor & Head, SREC

CONTACT

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9994171297

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SRI RAMAKRISHNA ENGINEERING COLLEGE

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING (in association with **New Horizon College of Engineering, Bengaluru**)

SEVEN DAYS WEBINAR SERIES ON

Smart Grid Integration & Energy Storage Systems

10.07.2021 to 16.07.2021

EVENT REPORT

Due to this COVID'19 Pandemic situation, the **Department of Electrical and Electronics Engineering** of Sri Ramakrishna Engineering College in association with New Horizon Engineering College jointly organized a **Seven Days Webinar Series on “Smart Grid Integration & Energy Storage Systems”** during 10th to 16th July 2021. Many Participants from various institutions in and around Tamil Nadu has participated in the technical webinar.

The event commenced with a **Welcome address** by **Dr. M. Mahesh, Professor and Head**, Department of Electrical and Electronics Engineering, NHCE who elaborated on the requirement of innovative ideas to make the society smarter. He also briefed on how this kind of webinar bridges the gap between industry and Academia.

The Event Coordinator **Dr. B. Gunapriya, Associate Professor**, Department of Electrical and Electronics Engineering, NHCE elaborated about the Webinar.

On 10.07.2021, **Dr. Vijayarajeshwaran** communicated that Smart Grid is a concept and vision that captures a range of advanced information, sensing, communications, control, and energy technologies. He explained the various technical challenges along with Economic, Policy, and Regulatory Challenges. The speaker briefed about the two dominant technical challenges that can be identified with a higher penetration of RE generation: 1) managing variability and uncertainty

during the continuous balancing of the system, and 2) balancing supply and demand during generation scarcity and surplus situations. The session was impressive and interactive

On 11.07.2021, **Dr. S. U. Prabha** expressed that, Grid integration is the practice of developing efficient ways to deliver variable renewable energy (VRE) to the grid. Good integration methods maximize the cost- effectiveness of incorporating VRE into the power system while maintaining or increasing system stability and reliability. She also mentioned that most of the time, the grid will absorb all of the electricity produced by renewables because there is sufficient demand for electricity. As a result, the more renewable energy resources present on the grid, the less electricity must be generated using conventional fossil-fuel plants. The session was interactive

On 12.07.2021, **Dr. A. Immanuel Selvakumar** conducted a comprehensive study on the application of big data and machine learning in the electrical power grid introduced through the emergence of the next-generation power system-the smart grid. He mentioned big data analysis and machine learning techniques were essential to reaping these benefits. In the complex connected system of SG, cyber security becomes a critical issue; IoT devices and their data turning into major targets of attacks

On 13.07.2021, **Dr. K. Selvakumar** voiced that, Demand response is a strategy used by electric utility companies to reduce or shift energy consumption from peak hours of the day, when the demand for electricity is the greatest to leaner demand periods. He defined it as a measure for reducing energy load in response to supply constraints, generally during periods of peak demand. His focus was on the managing the DR and he concentrated more on the electric utility and system operators for which he gave two choices available:

1. Increase the size and dimension of the network which is costly and requires time to implement.
2. Utilize energy management in order to reduce the possibility of high peak demand during peak hours. The session was very informative

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Signature of the Co-ordinators	
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<p>Dr. B. Gunapriya Associate Professor/EEE, NHCE</p>	<p>Dr. A. Singaravelan Sr. Assistant Professor/EEE, NHCE</p>

Dr. S. U. Prabha
Professor & Head/EEE, SREC

EV can strengthen Grid

Hyperdrive

Why Charging Your Electric Car at Night Could Save the World

By Dan Murlaugh and Mark Chedialk
February 26, 2018, 2:30 AM GMT+5:30

Climate Changed

Parked Electric Cars Earn \$1,530 From Europe's Power Grids

By Jess Shankleman
August 11, 2017, 9:30 AM GMT+5:30 Updated on August 11, 2017, 8:13 PM GMT+5:30

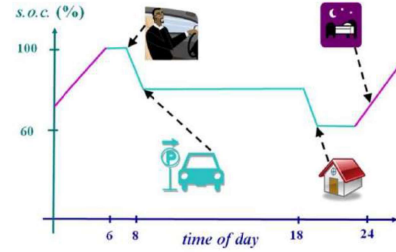
25 Jan / 2018 13:30

NEWS EVERYTHING EV NETWORKS

David Pratt
Deputy UK Editor,
Currents

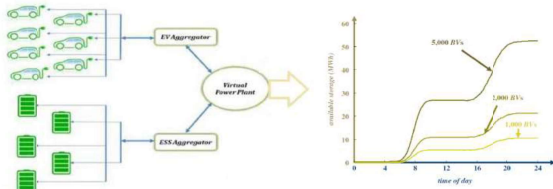
Electric vehicle to grid projects receive £30 million boost from government

EV Driving Pattern



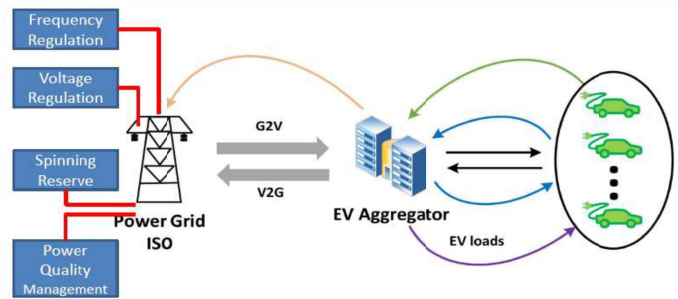
It has been revealed by some studies that most vehicles are parked almost more than 80% of their time.

EV as a Virtual Power Plant: Vehicle-to-Grid



One third of the global light-duty vehicle fleet will be electrified by 2040. That means tens of millions of batteries floating around, storing electricity while the cars aren't in use and releasing it when they are in use.

EV can provide Grid Services



Challenges for V2G

International status for the penetration of EVs	Fast charging technology and infrastructures	Robust Smart electricity grid (High reliability, flexibility & Extensibility)
EVs are expensive primarily due to their costly batteries	Battery Degradation (High price of batteries & less life time)	Fast response (Level 2 & 3 AC & DC Charging infrastructure)
EV integrated Micro-grids equipped with cyber physical systems	Attractive Govt. policies for V2G, Demand Side Management	Security (Energy & Information)

Vehicle to Grid Integration

V1G	<ul style="list-style-type: none"> • Unidirectional • Modulating the charging rate • No additional equipment for Vehicles 	Controllable Load <ul style="list-style-type: none"> • Demand Response
	<ul style="list-style-type: none"> • Bidirectional • Providing power back to grid • flexibility in providing grid services 	Storage device <ul style="list-style-type: none"> • Support Ancillary Services, • Help RE integration, • Create new revenue streams for automobile owners
Battery Swapping <ul style="list-style-type: none"> • B2G • G2B 		

V2G = Vehicle to Grid
 V2H = Vehicle to Home
 V2B = Vehicle to Building
 V2L = Vehicle to Load

Implementation of Machine Learning in Smart Grid

Dr. A. Immanuel Selvakumar
 Professor/EEE
 Karunya Institute of Technology and Sciences

Outline

- Machine Learning-Introduction
- Smart Grid – Introduction
- ML Application to SG Problem – Classification – Case Study
- ML Application to SG Problem – Regression – Case Study

15-Jul-21

1

15-Jul-21

2

Machine Learning – Definition

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. **Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.**

Traditional Programming



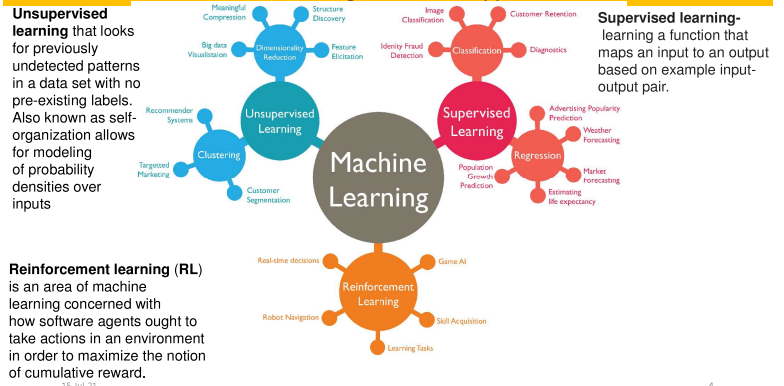
Machine Learning



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3

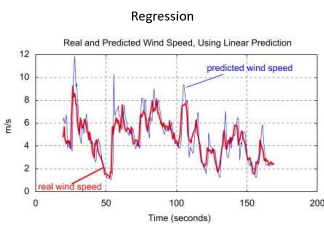
Machine Learning – Tasks and Applications



15-Jul-21

4

Machine Learning – Supervised Learning



Regression is the problem of predicting a continuous quantity output

Classification



Classification is the problem of predicting a discrete class label output.

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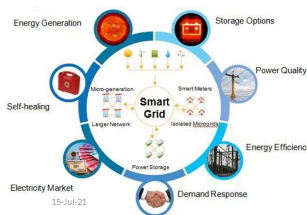
5

Smart Grid – The New and Improved Power Grid

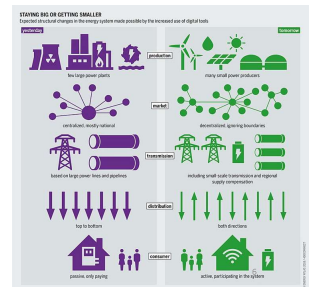
Smart grid (SG) or intelligent grid

Power Grid : an electricity system that support the following four operations: electricity generation, electricity transmission, electricity distribution, and electricity control. The Smart Grid, regarded as the next generation power grid, uses **two-way flows of electricity and information** to create a widely distributed automated energy delivery network.

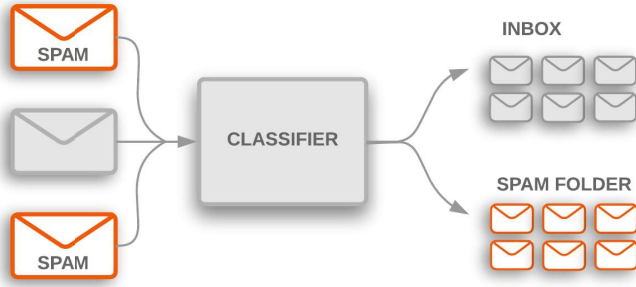
Smart Grid = Existing Power Grid + IT + Communication



15-Jul-21



Classification is a supervised learning concept which basically categorizes a set of data into classes.

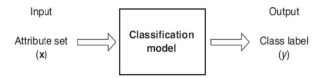


Classification is the task of *learning a target function f* that maps attribute set *x* to one of the predefined class labels *y*

Tid	Refund	Marital Status	Taxable Income	Cheat
1	Yes	Single	125K	No
2	No	Married	100K	No
3	No	Single	70K	No
4	Yes	Married	120K	No
5	No	Divorced	95K	Yes
6	No	Married	60K	No
7	Yes	Divorced	220K	No
8	No	Single	85K	Yes
9	No	Married	75K	No
10	No	Single	90K	Yes

One of the attributes is the class attribute
In this case: Cheat

Two class labels (or classes): Yes (1), No (0)



Classification as the task of mapping an input attribute set *x* into its class label *y*.

Examples of Classification Tasks

- Predicting tumor cells as benign or malignant
- Classifying credit card transactions as legitimate or fraudulent
- Categorizing news stories as finance, weather, entertainment, sports, etc
- Understanding if a web query has commercial intent or not
- Classifying a waveform as a good quality or poor quality waveform

General approach to classification

- Training set consists of records with known class labels
- Training set is used to build a classification model
- A labeled test set of previously unseen data records is used to evaluate the quality of the model.
- The classification model is applied to new records with unknown class labels

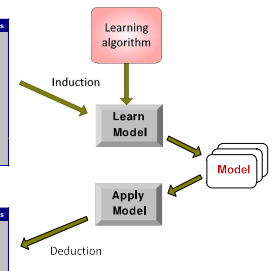
the given data set is divided into training and test sets, with training set used to build the model and test set used to evaluate it.

Tid	Attrib1	Attrib2	Attrib3	Class
1	Yes	Large	125K	No
2	No	Medium	100K	No
3	No	Small	70K	No
4	Yes	Medium	120K	No
5	No	Large	95K	Yes
6	No	Medium	60K	No
7	Yes	Large	220K	No
8	No	Small	85K	Yes
9	No	Medium	75K	No
10	No	Small	90K	Yes

Training Set

Tid	Attrib1	Attrib2	Attrib3	Class
11	No	Small	95K	?
12	Yes	Medium	80K	?
13	Yes	Large	110K	?
14	No	Small	95K	?
15	No	Large	67K	?

Test Set



Machine Learning Classification Algorithms

Logistic Regression

Naive Bayes

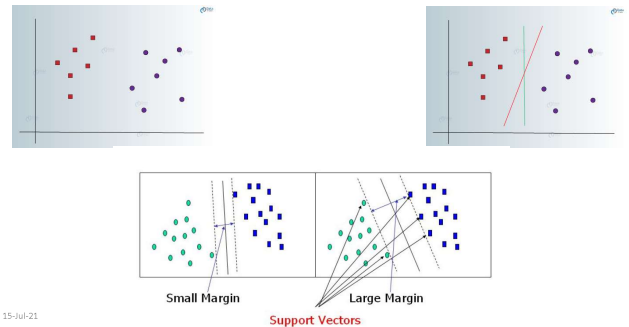
Decision Tree

Support Vector Machines

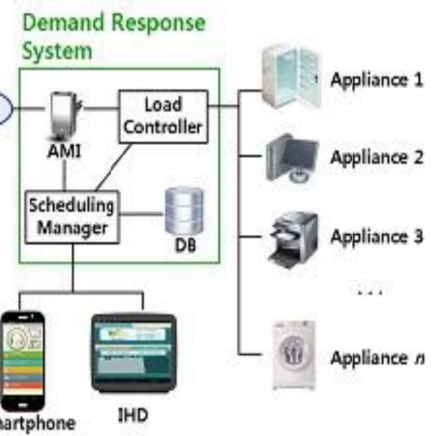
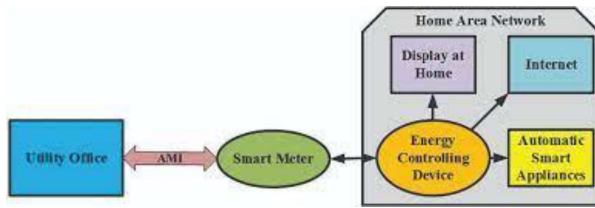
Random Forest

K-Nearest Neighbours

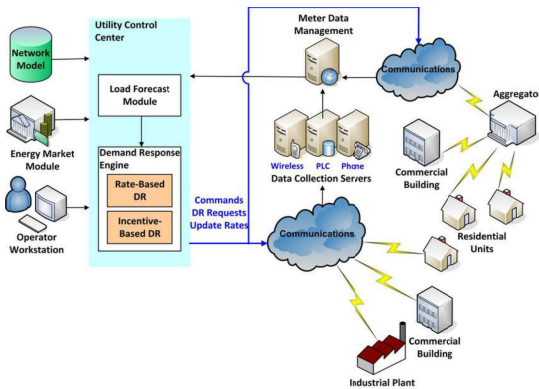
Support Vector Machines: Supervised Machine Learning Algorithm for Classification
Basic Idea: Create a hyperplane that separates the dataset into classes



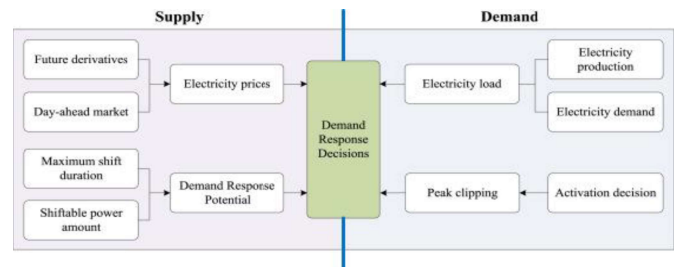
DR implementation



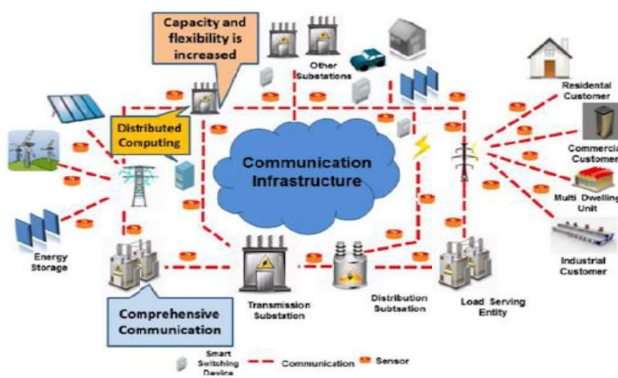
DR Implementation



Residential electricity pricing in DR



DR in smart grid



- The electricity tariffs that the end use customers depend on the average electricity expenses and allow little relaxation to the load pattern in flexible electricity price.
- DR is a tariff or program designed to achieve changes in electricity use by end-utilize customers because of difference in the cost of electricity after some other time period, or to encourage lower power usage now and again of high market costs or low network unwavering quality.
- The main reason behind utilizing DR programs is the way that decreases electricity use in peak time periods makes benefits in the short run by decreasing the level of generation and transmission resources required to give electric power system.
- The following figure gives a realistic illustration of the DR types that gives support to the system for load management.

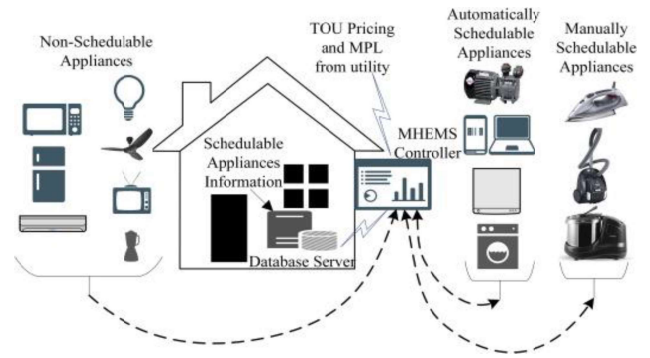
Time of Utilizing Tariff(TOU)

- These tariffs are built on a model where the **price varies within a predetermined time interval** that is defined as high or low peak hours.
- The customer knows beforehand what the price will be in a certain hour or time.
- Time tariffs can also be combined with a **separate price for high peak load consumption**; this would somewhat compensate for the drawbacks of inaccurate pricing compared to RTP.
- The simplest rate of TOU is to have two price levels, one peak price and one off-peak price.

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TOU - DR Management



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Critical Peak Pricing (CPP)

- CPP uses **maximum electricity price all through peak hours**.
- This price is pre-determined and **communicated to the customer some time ahead of the event**.
- CPP prices are used in a restricted number of hours or days per year.

7/14/2021

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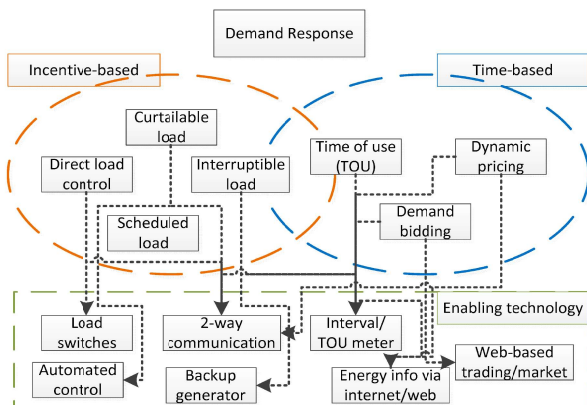
Real-Time Pricing (RTP)

- This program makes the **customer pay a real-time price for their electricity**.
- The price varies in time which creates an economic incentive to shift the demand.
- **Customers receive price information a day-ahead or an hour-ahead** depending on the market.
- An important aspect to consider is when to inform the customer about the price if it is too near the actual time of use it could be difficult for the customers to act in time.
- Many economists argue that RTP programs are the most efficient ones and that policymakers should focus on this type of programs.

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DR implementation



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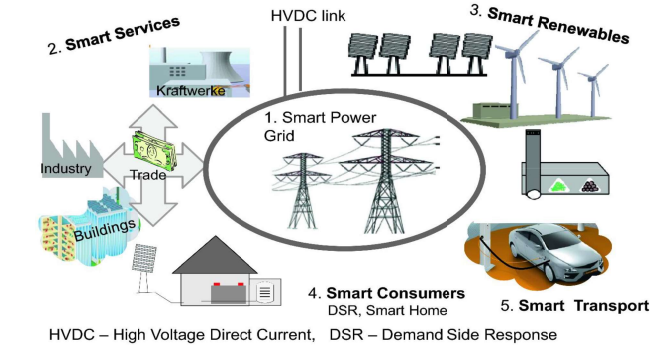
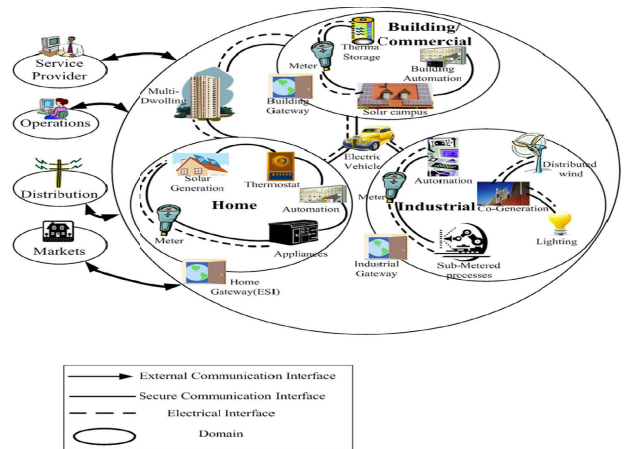
Benefits of DR



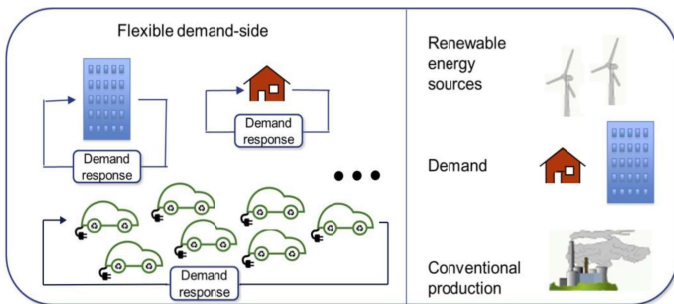
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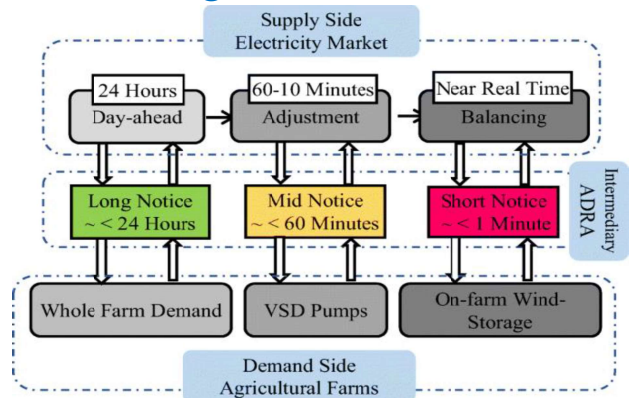
Overview of the customer domain



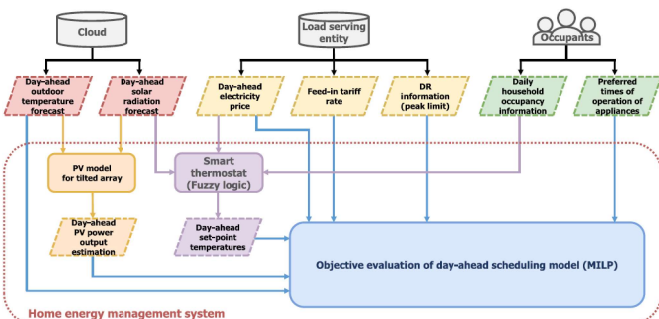
Various Loads for DRM



Agricultural DR



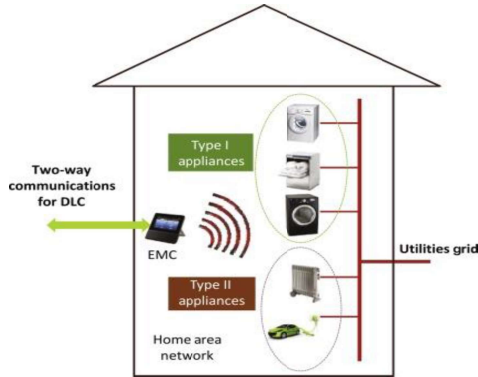
The workflow of the HEMS



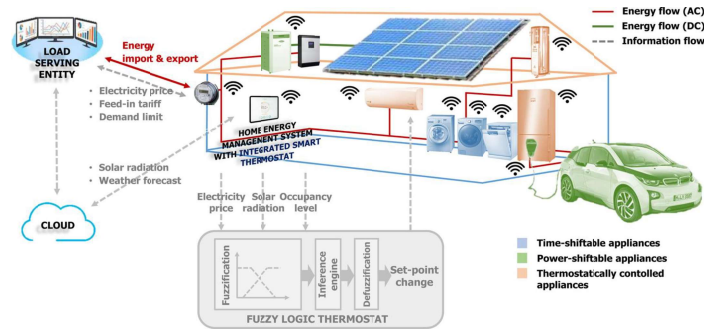
Smart Appliances



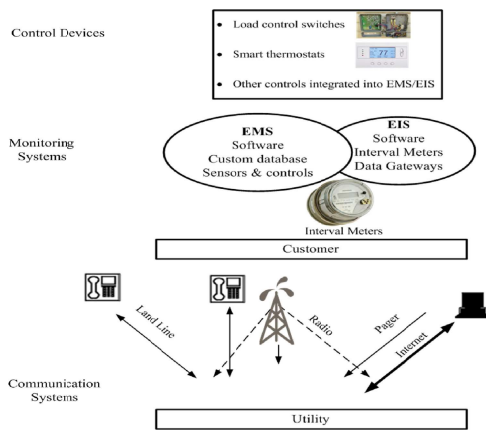
Smart Homes(HEMS)



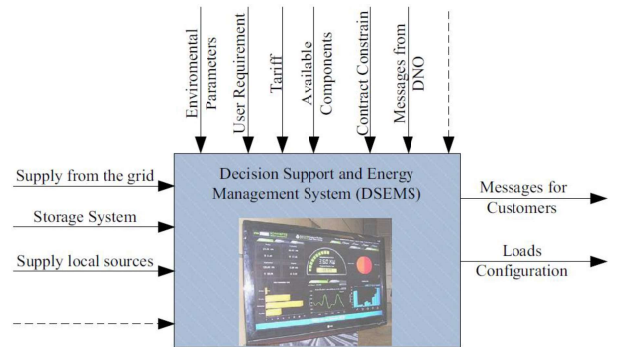
The framework of the HEMS architecture



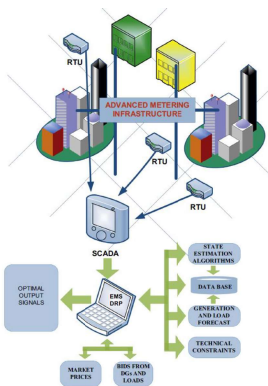
Categories of DR Technologies



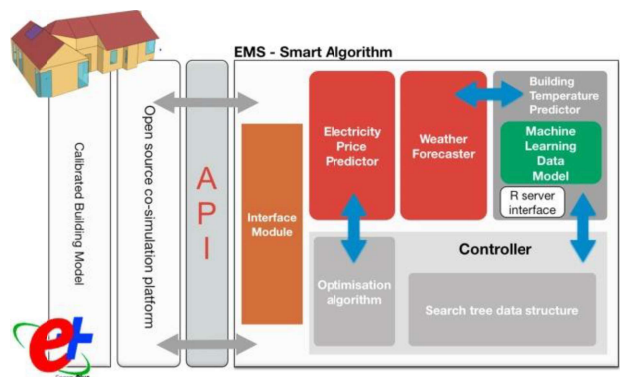
Decision support and energy management system



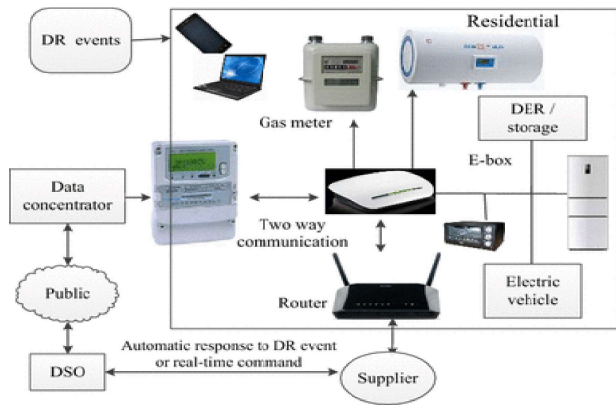
Energy management system in the smart grid infrastructure



EMS smart Algorithm

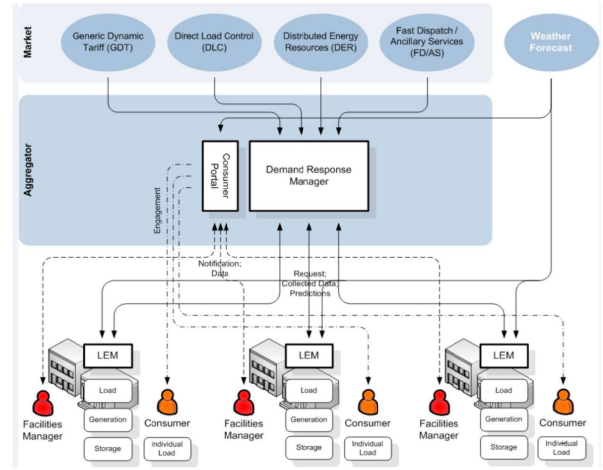


DRM in Future



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Thank You

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VATTAMALAIPALAYAM, N.G.G.O. COLONY POST, COIMBATORE – 641 022.



DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING (in association with New Horizon College of Engineering, Bengaluru)

SEVEN DAYS WEBINAR SERIES ON

Smart Grid Integration & Energy Storage Systems

10.07.2021 to 16.07.2021

AGENDA

DAY 1 (10.07.2021)		
10:30 AM – 10:35 AM	Welcome Address	Dr. M. Mahesh Professor & Head/EEE, NHCE
10:35 AM – 10:40 AM	About the Programme	Dr. B. Gunapriya Associate Professor/EEE, NHCE
10:40 AM – 11:30 AM	Smart Grid and RES Integration	Mr. Thiruvallu Marban Manager Vi-Micro Systems, Chennai.
DAY 2 (11.07.2021)		
10:30 AM – 10:35 AM	Chief Guest Introduction	Mrs. I. Abinaya Assistant Professor/EEE, SREC
10:35 AM – 11:30 AM	Renewable Energy Grid Integration Techniques and Challenges	Dr. S. U. Prabha Professor & Head Department of Electrical and Electronics Engineering Sri Ramakrishna Engineering College, Coimbatore.
DAY 3 (12.07.2021)		
10:30 AM – 10:35 AM	Chief Guest Introduction	Mrs. I. Abinaya Assistant Professor/EEE, SREC
10:35 AM – 11:30 AM	Implementation of Machine Learning in Smart Grid	Dr. A. Immanuel Selvakumar Professor Department of Electrical and Electronics Engineering Karunya Institute of Technology and Sciences, Coimbatore

DAY 4 (13.07.2021)		
10:30 AM – 10:35 AM	Chief Guest Introduction	Mrs. I. Abinaya Assistant Professor/EEE, SREC
10:35 AM – 11:30 AM	Demand Response Program in Smart Grid	Dr. K. Selvakumar Assistant Professor Department of Electrical and Electronics Engineering SRM Institute of Science and Technology, Chennai.
DAY 5 (14.07.2021)		
10:30 AM – 10:35 AM	Chief Guest Introduction	Mr. M. Karthik Assistant Professor/EEE, SREC
10:35 AM – 11:30 AM	Advancement in Smart Grid Technology in Electrical Power Network	Mr. K. Maharaja Lecturer Department of Engineering University of Technology and Applied Sciences, Al Musannah, Oman.
DAY 6 (15.07.2021)		
10:30 AM – 10:35 AM	Chief Guest Introduction	Mr. M. Karthik Assistant Professor/EEE, SREC
10:35 AM – 11:30 AM	Future of Microgrids with Distributed Generation & EV	Mr. S. Selvakumar Business Head Power Project, Chennai.
DAY 7 (16.07.2021)		
10:30 AM – 10:35 AM	Chief Guest Introduction	Dr. B. Gunapriya Associate Professor/EEE, NHCE
10:35 AM – 11:20 AM	Condition Monitoring of Smart Sensors in Microgrid	Dr. K. Vinoth Kumar Associate Professor, Department of Electrical and Electronics Engineering New Horizon College of Engineering, Bengaluru.
11:20 AM – 11:25 AM	Discussion & Feedback	
11:25 AM – 11:30 AM	Vote of Thanks	Dr. A. Singaravelan, Sr. Assistant Professor/EEE, NHCE

On 14.07.2021, **Mr. K. Maharaja** explained the different technologies used in smart grid communication like Programmable Logic Controller (PLC), wireless, cellular, SCADA (Supervisory Control and Data Acquisition), and BPL. He also mentioned that by 2020, the cumulative smart grid technology market is expected to surpass the \$400 billion mark, with a compound annual growth rate of 8% worldwide. In the United States alone, the market is expected to continue growing by double digit to reach \$26.7 billion by 2017. He mentioned that communication infrastructure for smart grid should meet requirements for time synchronization, reliability, latency, criticality of data delivery, and support for multicast. The session was informative

On 15.07.2021, **Mr. S. Selvakumar** stated that, Smart grid (SG), an evolving concept in the modern power infrastructure, enables the two-way flow of electricity and data between the peers within the electricity system networks (ESN) and its clusters. He mentioned that the SG is intended to replace the fossil fuel-rich conventional grid with the distributed energy resources (DER) and pools numerous existing and emerging know-hows like information and digital communications technologies together to manage countless operations. With this, the SG will be able to “detect, react, and pro-act” to changes in usage and address multiple issues, thereby ensuring timely grid operations. The session was informative.

On 16.07.2021, **Dr. K. Vinoth Kumar** articulated that there are various approaches regarding the meaning and added value of the Smart Grid concept. He mentioned that, the digital technology that allows for two-way communication between the utility and its customers, as well as sensing throughout the transmission and distribution systems, is what makes the grid “smart”. He told that, at present, monitoring energy consumption and flow, actuating automatic rerouting when equipment fails or outages occur for quicker restoration of electricity after power disturbances, and improving integration of customer-owner power generation systems, including renewable energy systems. He explained that the final objective is more efficient transmission and distribution of electricity and increased reliability, a fundamental contribution can be provided by implementing advanced techniques for diagnostic and condition monitoring of electrical apparatus, in order to achieve

dynamic information on electrical apparatus health conditions and their optimum operation. The session was more informative.

Finally the day ended with a discussion and collection of feedback of the seven days webinar series. Event Coordinator Dr. A. Singaravelan, Sr. Assistant Professor/EEE, NHCE, delivered the Vote of Thanks.

We are glad that, many students and faculty members were benefited out of this technical webinar.

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Smart Grid Integration & Energy Storage Systems

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