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About The Journal

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Sincerely,

ITSJ Team

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SUSTAINABLE FLY ASH CONCRETE MIXTURES WITH SYNTHETIC FIBERS

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Abstract

This study explores the feasibility of replacing large quantities of Portland cement in concrete with Class C fly ash. The influence of structural synthetic fibers on the concrete performance was also explored. A total of 11 fibrous and plain concrete mixtures were designed and evaluated. The results showed that the concrete mixtures with 30% fly ash replacements experience compressive and flexural strengths comparable with companion control mixtures. The compressive and flexural strengths of the mixtures with 60% fly ash replacements were impressive despite the fact that these values are lower than their comparable values in companion control mixtures. The results revealed that replacing up to 60% of the cement in concrete with Class C fly ash is still feasible. The added fibers resulted in significant post-cracking residual strength and reduction in the drying shrinkage. Adding 5 lb/yd3 (3 kg/m3) of the structural synthetic fibers to the mix resulted in about 150 psi (1.0 MPa) residual strength compared with about 80 psi (0.55 MPa) for 3 lb/yd3 (1.8 kg/m3) of synthetic fibers. It was interestingly found that for the used water to cementitious materials (W/CM) ratio of 0.40, the mixtures with total CM of 650 lb/yd3 (390 kg/m3) experienced comparable performance as the mixtures with 750 lb/yd3 (450 kg/m3).

Keywords: Sustainability, Fly ash, Synthetic fibers, Shrinkage, Toughness

Introduction:

Fly ash is a byproduct of coal consumption and typically used in concrete to replace portion of the cement. Production of cement contributes about 4% to the total CO_2 released to the environment. Replacing substantial portion of the cement in concrete with fly ash is considered a sustainable and economical application since it: 1) reduces the impact of coal production and

CO_2 emission on the environment when manufacturing cement; 2) cuts on the amount of fly ash that goes to landfills; and also 3) lowers the concrete cost by reducing the amount of cement needed. On the other hand, incorporating structural synthetic fibers into concrete enhances its structural performance and increases its durability through minimizing the potential for shrinkage cracking and providing crack-arresting mechanism (Alhassan and Ashur, 2012 and 2011, Alhassan 2010, and Issa et al., 208). The enhanced performance combined with the cost reduction and minimized environmental impact are highly desirable for the infrastructure facilities such as highway pavements and bridge decks. These facilities often experience immature cracking and deterioration due to their large surface area that is exposed to the environment and to the effects of cyclic traffic loading conditions.

The use of large quantities of fly ash in concrete has some concerns, especially in terms of the early age strength gain. There is a general notion that fly ash reduces the strength gain at early age. Nevertheless, previous experience with concrete mixtures having 25% fly ash of the total cementitious materials (CM) content showed no such concern about the early age strength (Alhassan and Ashur, 2012 and 2011). Additional research is needed to investigate the effect of using high quantities of fly ash in concrete. On the other hand, incorporating synthetic fibers in fly ash concrete is pioneering since fly ash concrete is typically used in highway structures that experience aggressive environmental exposures, high drying shrinkage, and heavy live loading and impact. Synthetic fibers are noncorrosive, alkali resistant, and typically added in small quantities due to their low density, therefore, a substantial number of uniformly distributed fibers are added.

This study is conducted to obtain reliable experimental results about key-aspects of the performance of fibrous fly ash concrete in terms of strength, shrinkage, toughness, and constructability. It is expected that the availability of such data be of significant interest to many U.S. transportation agencies and researchers. This area of research is fundamental in terms of using special types of fibers and high percentages of fly ash to produce durable sustainable concrete with high resistant to cracking. Such high performance concrete mixtures are in need in many applications. For example, there are major cracking and deterioration problems in the highway pavements and infrastructure systems way before they reach their service lives due to the use of inadequate mix designs and inappropriate construction practices (Soroushian and Ravanbakhsh, 1998 and Ozyildirim et al., 1997). Extending the durability of such systems provides huge life cycle cost savings due to the huge cost of repair. Infrastructure systems with enhanced performance are safer and provide better riding quality.

Mix Designs and Parameters of Investigation:

A total of 11 concrete mixtures were designed to investigate the influence of major parameters on their performance mainly in terms of strength, shrinkage, and toughness. The mixtures were designed to allow for studying the effects of three major parameters as outlined in Table 1. The studied parameters are: 1) the fly ash content: 0, 30%, and 60% of the total CM content, 2) the fiber content: 0, 3 lb/yd^3 (1.8 kg/m^3), and 5 lb/yd^3 (3 kg/m^3), and 3) the total CM content: 650 lb/yd^3 (390 kg/m^3) and 750 lb/yd^3 (450 kg/m^3). The W/CM ratio was fixed at 0.40 for all mixtures. The coarse and fine aggregate contents were comparable for all mixtures. The mixing, finishing, curing, and testing practices were consistent for all mixtures and conducted according to the American Society of Testing and Materials (ASTM) standards. Similar dosages of superplasticizer and air-entraining admixtures were added for all mixtures to achieve comparable workability and air content values. The slump values ranged from 6 – 8 in. (150 – 200 mm), the air content values ranged around 6 ± 1%, and the unit weight was around 146 lb/ft^3 (2370 kg/m^3) for all mixtures. The specimens were covered with wet burlap and plastic sheets for 24 hours before being demolded and moist-cured in a standard moisture room for seven days.

The synthetic fiber type and dosage were selected so that notable performance enhancement is achieved while maintaining adequate constructability. The used fiber type is a 1.55 in. (40 mm) long polyolefin fiber with monofilament configuration and has aspect ration of 90, specific gravity of 0.92, elastic modulus of 1,378 ksi (9.5 GPa), tensile strength of 90 ksi (620 MPa), and high alkali, acid, and salt resistant. The constructability aspects of the fibrous mixtures were monitored during the fresh concrete state to evaluate whether the fibers jeopardize the mixing or the finishing practices. Within the used fiber types and dosages, the fibrous mixtures had a reduction in the slump of about 1-2 in. (25-50 mm) compared with the companion plain mixtures. The mixtures with 3 lb/yd3 (1.8 kg/m3) of fibers were easily constructable while the mixtures with 5 lb/yd3 (3 kg/m3) required some precaution to avoid complications during mixing, compacting, and finishing such as fiber remains in the mixer, clumps, and balling.

Table 1 Mix Designs and Parameters of Investigation

Ingredient	Quantity, lb/yd^3										
	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5	Mix 6	Mix 7	Mix 8	Mix 9	Mix 10	Mix 11
Total CM	650	750	650	650	650	650	650	650	750	750	750
Type I cement	650	750	455	455	455	260	260	260	300	300	300
Class C fly ash	0	0	195	195	195	390	390	390	450	450	450
% Fly ash	0	0	30%	30%	30%	60%	60%	60%	60%	60%	60%

Course	1,620	1,520	1,600	1,600	1,600	1,590	1,590	1,590	1,490	1,490	1,490
Fine aggregate	1,620	1,520	1,600	1,600	1,600	1,590	1,590	1,590	1,490	1,490	1,490
W/CM	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Synthetic fiber	0	0	0	3	5	0	3	5	0	3	5

* 1.0 lb/yd^3 = 0.601 kg/m^3

Compression tests were conducted for all mixtures at 7 and 28 days according to ASTM C39. Flexural performance tests were conducted at 90 days according to ASTM C 1609. A digitally controlled universal testing machine was used to test the compressive strength and the flexural performance. Unrestrained drying shrinkage tests were conducted for each mixture according to ASTM C157. The shrinkage measurements were taken over a 90 period. The average results are presented in the following sections. The results were then analyzed to evaluate the effects of the three major parameters of investigation of this study.

The plain mixtures Mix 3 and Mix 6 have 30% and 60% fly ash, respectively with a total CM content equivalent to the plain mixture Mix 1 that does not include fly ash. The plain mixture Mix 9 has 60% fly ash with a total CM content equivalent to the plain mixture Mix 2 that does not include any fly ash. Therefore, the effect of the fly ash content can be evaluated through comparing the results of Mix 3 and Mix 6 with Mix 1 as well as Mix 9 with Mix 2. The effect of the fiber content can be evaluated through comparing the results of the fibrous mixtures Mix 4 and Mix 5 with the plain mixture Mix 3, the fibrous mixtures Mix 7 and Mix 8 with the plain mixture Mix 6, and the fibrous mixtures Mix 10 and Mix 11 with the plain mixture Mix 9. The effect of the total CM content can be evaluated through comparing the results of Mix 1 with Mix 2 and Mix 6 with Mix 9.

Compressive Strength:

Figure 1 shows the average compression test results at 7 and 28 days. The compressive strengths of Mix 3 and Mix 6 were lower than Mix 1 by 13.7% and 31.4% at 7 days and 6.9% and 17.1% at 28 days, respectively. The compressive strength of Mix 9 was 34.1% and 13.5% lower than Mix 2 at 7 and 28 days, respectively. In spite of the reduction in the compressive strength when replacing the cement with 30% and 60% fly ash, Mix 3 that includes 30% fly ash achieved a compressive strength greater than 4000 psi (28 MPa) at 7 days and greater than 6000 (41 MPa) at 28 days. Mix 6 and Mix 9 that include 60% fly ash both achieved about 3500 psi (24 MPa) at 7 days, and about 5500 (38 MPa) and 6000 psi (41 MPa) at 28 days, respectively. The compressive strength development was better for the mixtures with the fly ash compared with the mixtures without fly ash.

Comparing the results of the fibrous mixtures that have 3 lb/yd^3 (1.8 kg/m^3) fibers with their control plain mixtures shows that the compressive strength of Mix 4 is 23.4% and 21.8% higher than Mix 3 at 7 and 28 days, respectively. The compressive strength of Mix 7 is 12.7% lower than Mix 6 at 7 days and 3.6% higher at 28 days. The compressive strength of Mix 10 is 3.1% higher than Mix 9 at 7 days and 2.3% lower at 28 days. Comparing the results of the fibrous mixtures that have 5 lb/yd^3 (3.0 kg/m^3) fibers with their control plain mixtures shows that the compressive strength of Mix 5 is 3.1% higher than Mix 3 both at 7 and 28 days. The compressive strength of Mix 8 is 7.2% lower than Mix 6 at 7 days and 2.2% higher at 28 days. The compressive strength of Mix 11 is 11.1% and 17.9% lower than Mix 9 at 7 and 28 days, respectively. The fibrous mixtures with 3 lb/yd^3 (1.8 kg/m^3) experienced higher strength than the companion fibrous mixtures with 5 lb/yd^3 (3.0 kg/m^3). The results do not show a general trend on whether the fibers increase or decrease the compressive strength; however, addition of fibers to concrete was never intended to increase its compressive strength. The failure modes of the compression test specimens revealed significant advantage for the fibrous additives. The fibrous specimens remained intact after failure due to the internal confinement provided by the fibers, while the plain specimens crushed at ultimate.

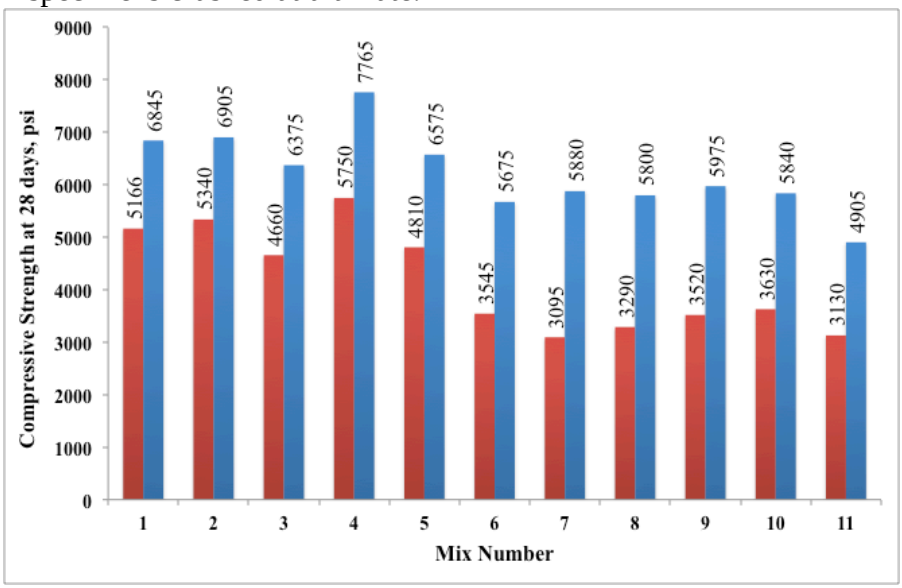

Figure 1 Compressive strengths at 7 and 28 days (1000 psi = 6.895 MPa).

Comparing the compressive strength of Mix 1 with Mix 2 shows that Mix 1 experienced approximately similar compressive strengths at 7 and 28 days as Mix 2 although Mix 1 has 13% less cement. Mix 6 also has 13% lower cement than Mix 9, and experienced almost similar compressive

strength as Mix 9 at 7 days and just 5% less at 28 days. These results are very interesting and reveal that for a W/CM of 0.40, the use of 650 lb/yd^3 (390 kg/m^3) of CM in concrete results in almost similar compressive strength as the use of 750 lb/yd^3 (450 kg/m^3) of CM. One of the reasons might be that the course aggregate content in the mixtures with 650 lb/yd^3 (390 kg/m^3) of CM is around 6% higher than the mixtures with 750 lb/yd^3 (450 kg/m^3).

Shrinkage:

The drying shrinkage measurements were taken for each mixture over a 90-day period following 7-days of moist curing. The shrinkage-time responses were plotted for the companion mixtures as shown in Figure 2 to allow for clear analysis of the results. It is important to recall that all mixtures have the same W/CM ratio. Comparing Mix 1 with Mix 2 shrinkage results shows that Mix 2 experienced slightly higher shrinkage, which can be attributed to its higher CM content. Comparison between Mix 1, Mix 3, and Mix 6 shows that Mix 6 that has 60% fly ash experienced almost similar shrinkage as Mix 1, while Mix 3 that has 30% fly ash experienced noticeably higher shrinkage that Mix 1 and Mix 6. Comparing Mix 9 that has 60% fly ash with Mix 2 shows that Mix 9 experienced slightly lower shrinkage.

The effect of the fibers on the shrinkage is evaluated through comparing Mix 4 and Mix 5 with Mix 3, Mix 7 and Mix 8 with Mix 6 and Mix 10 and 11 with Mix 9. Inspection of the plots shown in Figure 2 shows that the fibrous mixtures experienced lower shrinkage than the companion plain mixtures. The fibrous mixtures with 3 lb/yd3 (1.8 kg/m3) experienced almost similar shrinkage as the companion fibrous mixtures with 5 lb/yd3 (3.0 kg/m3). At 28 days, the average shrinkage of Mix 4 and Mix 5 was about 18% lower than Mix 1, the average shrinkage of Mix 7 and Mix 8 was about 15% lower than Mix 6, and the average shrinkage of Mix 10 and Mix 11 was about 13% lower than Mix 9. These results show that the used dosages of the structural synthetic fibers resulted in significant reduction in the drying shrinkage of concrete. This is considered a desirable enhancement in the concrete performance increases resistant to cracking.

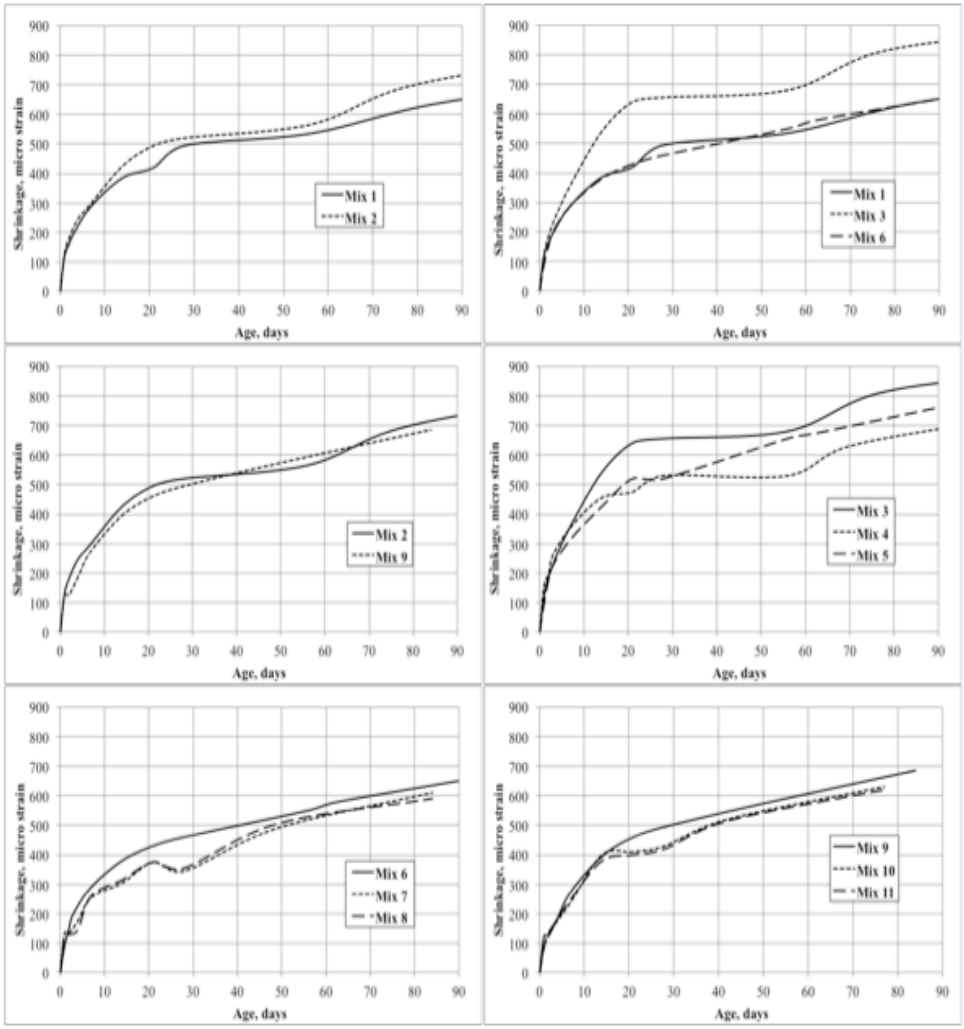

Figure 2 Shrinkage-time responses.

Flexural Performance:

Toughness and post-cracking residual strength evaluation were conducted for the fibrous mixtures according to ASTM C1609 using a servo-controlled testing machine. All specimens were tested at age of 90 days. Figure 3 shows the ultimate flexural strengths and the post-cracking and residual strengths (f D150) for each mixture as obtained from the flexural performance tests. The obtained results are the average of two to three specimens. As expected, all the plain mixtures failed suddenly without any residual strength after reaching the ultimate flexural strength. This is the major reason for adding fibers to concrete that is to arrest cracks at any location where the ultimate tensile strength is reached.

The residual strengths of Mix 4, Mix 7, and Mix 10 that include 3 lb/yd3 (1.8 kg/m3) of fibers were respectively 80 psi (0.55 MPa), 75 psi (0.52 MPa), and 80 ksi (0.55 MPa) with an average of 78 psi (0.54 MPa), which is about 11% of the average flexural strength of the previous three fibrous mixtures that is 727 psi. The residual strengths of Mix 5, Mix 8, and Mix 11 that include 5 lb/yd3 (3 kg/m3) of fibers were respectively 160 psi (1.1 MPa), 120 psi (0.83 MPa), and 190 ksi (1.3 MPa) with an average of 157 psi (1.1 MPa), which is about 21% of the average flexural strength of the previous three fibrous mixtures that is 735 psi (5.1 MPa). The results also show that the fibrous additives do not affect the flexural strength for the two used dosages of the synthetic fibers. Some fibrous mixtures experienced slightly higher flexural strengths than the companion plain mixtures, while others experienced slightly lower flexural strengths.

In terms of the influence of the total CM on the flexural strength, Mix 1 and Mix 2 almost experienced similar flexural strengths. Also Mix 6 and Mix 7 experienced almost similar flexural strengths. These interesting results were consistent with the compressive strength results for the same mixtures indicating that for W/CM = 0.40, the use of 650 lb/yd3 (390 kg/m3) of CM in concrete results in almost similar flexural and compressive strengths as the use of 750 lb/yd3 (450 kg/m3) of CM. In terms of the influence of the fly ash content on the flexural strength, Mix 3 that has 30% fly ash experienced higher flexural strength than Mix 1 by 8%, which is impressive. Mix 6 that has 60% fly ash experienced lower flexural strength than Mix 1 by 14.6%, and also Mix 9 that has 60% fly ash experienced 13.8% lower flexural strength than Mix 2. In spite of the reduction in the flexural strength when replacing the cement with 60% fly ash, Mix 6 and Mix 9 both achieved flexural strength above 650 psi (4.5 MPa).

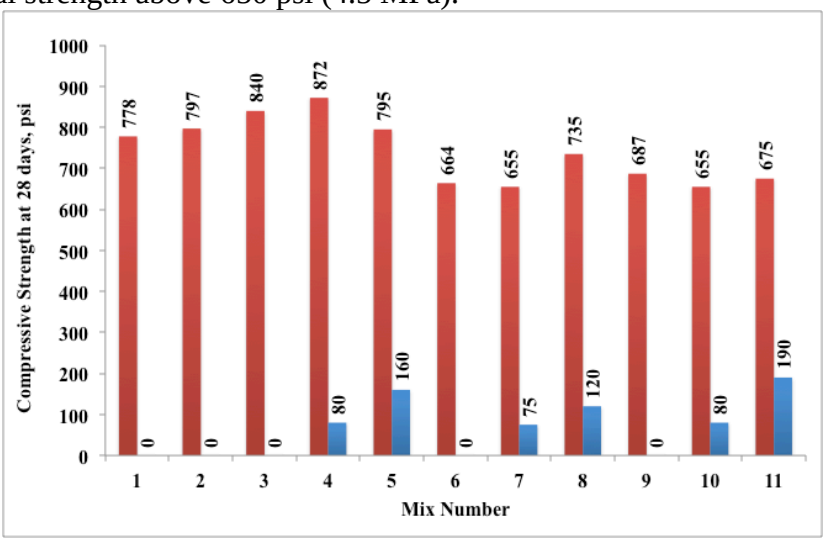

Figure 3 Flexural and residual strengths (1000 psi = 6.895 MPa).

Conclusion:

Based on the results, it can be concluded that replacement of 60% of cement in concrete with Class C fly ash is a feasible-sustainable measure resulting in large savings in the cost of concrete, lowering CO2 emission, and recycling effectively coal-consumption byproduct. The compressive and flexural strengths of the mixtures with 60% fly ash replacements were impressive, but lower than the companion mixtures. Replacement of 30% of the cement with Class C fly ash results in nearly comparable performance characteristics. Addition of 5 lb/yd3 (3 kg/m3) of the structural synthetic fibers to concrete results in about 150 psi (1.0 MPa) residual strength; while addition of 3 lb/yd3 (1.8 kg/m3) results in about 80 psi (1.0 MPa) residual strength. For similar W/CM of 0.40, the mixtures with total CM of 650 lb/yd3 (390 kg/m3) experienced comparable performance as the mixtures with 750 lb/yd3 (450 kg/m3).

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SURVEILLANCE OF MODERN GASOLINE – ENGINES AND CATALYST BEHAVIOR

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Abstract

In the last two decades an integral and continuous development of the two most important engine systems, i.e. the mixture preparation system and the ignition system, was achieved. This development is due to several factors such as to minimize the exhaust emissions, to reduce the fuel consumption, to increase the intervals between successive engine services, and to insure an easy motor operation into these intervals. Furthermore, a significant improvement of the driving system in order to better drivability and regular car kinematic was obtained. Therefore, a full diagnosis of the operation condition of all new engine systems isnecessary to prevent their possible malfunction or to restore them in the case of damages. In the course of modern engines diagnosis, measurements were taken on a Matiz Daewoo car which belongs to the Internal Combustion Engines laboratory of the Dept. of Mechanical Engineering TE, TEI of Thessaly, by using of an appropriate control program. The influence of transient load condition to the catalyst behavior also was studied and the response of the λ-sensors signals was explained.

Keywords: Gasoline, engines

HISTORICAL

The application and the evolution of the On Board Diagnosis system (OBD) is due to the so called main USA Organizations :

a. **The California Air Resourse Board – CARB and**
b. **The California Air Protection Agency – CAL EPA**

The CAL EPA restrictions and his policy enforcement have given the possibility to the CARB to apply air quality programs which were used as a direction for likely legislation in several countries, even the EU.

OBD I system has been applied in California since 1988. In accordance to this simple system the mission of the Engine Control Unit

(ECU) was the surveillance of the motor systems affecting the exhaust emissions and the creation of an optical warning signal, when an engine malfunction occurred. This signal was produced either from a LED lamp upon the ECU or from a Malfunction Indicator Lamp (MIL) on the driving board. According to the OBD I system only the λ–sensor, the EGR system, the fuel system and the ECU was supervised.

The most important two disantvages of the OBD I system were:

1. MIL activation occurred only after an engine damage, without any possibility of searching a malfunction in progress so as to prevent a total engine system destruction.

2. There were not provided any formality instructions between manufacturers.

Since 1996, the OBD II engine surveillance system has been applied in the whole USA. According to the OBD II system MIL is activated at any time as the CO, HC and NOx emissions exceed over 50% the Federal Test Procedure (FTP) standards depended on year model. These errors might result due to the following factors:

1. Random abnormal ignitions which cause increase in HC emission
2. Catalyst efficiency reduction
3. Air leak into fuel supplying and/or fuel distribution system
4. Defective sensor

The driver is responsible for immediate system malfunction check and repair. In other case, when the car is checked, a tester could be used to read out and display the stored malfunctions, even the total emissions not exceed the acceptable mandated standards and thereafter a penalty could be inflicted.

The second significant improvement of the OBD II system against OBD I system is the fact that specific standards for all manufacturers and all models have been legislated :

1. 16-pin Data Link Connector – DLC, Figure 1
2. Electronic protocols
3. Detection Troubles Codes (DTC)
4. Terminology

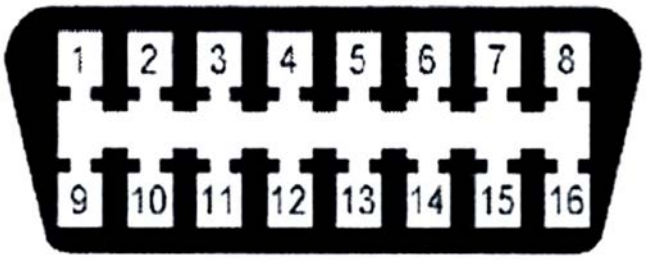

Figure 1 : 16-pin data link connector

The OBD II Diagnosis system also includes a truly most unfolded management system improved up today. This logistic comprises :

1. Two lambda oxygen sensors (λ–sensor), usually heated, upstream and downstream of the catalytic converter (HO_2S).

2. More powerfull Electronic Control Module (ECM) with Electronic Erased Programmized Read Only Memory (EEPROM) which permits the ECM to be reprogrammized with the latest logistic improvement.

3. Evaporative emissions control system with activated charcoal filter.

4. Exhaust Gas Recirculation system (EGR).

5. Serial fuel injection system instead of the Multi–Point Injection system (MPI) or the Mono–Jetronic system.

6. Manifold Absolute Pressure sensor (MAP) and Mass Air Flow sensor (MAF) to engine load monitoring.

7. Cut–off engine operation calculated from throttle valve position, engine speed and cool water temperature.

Since June 1994, SAE has published the J1978 «OBD II Diagnosis» direction and since July 1996 the J1979 «Diagnosis Control Operations» direction. So, three main protocols have been formed :

a. The Chrysler models, all european models and the most of asiatic models use the ISO 9141 communication wiring.

b. All cars and light–duty trucks of General Motors use Variable Pulse Wide (VPW) communication form according to the SAE J1850 direction.

c. All Ford cars use the so named Pulse Wide Modification (PWM) communication form in accordance to the SAE J1850 direction.

The Detection Troubles Codes (DTC) are formulated according to the SAE J2012 direction. These codes consist from five (5) symbols, shown in Figure 2. The code P0261, e.g., related to the injector 1 damage – low pressure circuitry.

Since 2000, the OBD II Diagnosis engine management is obligatory applied to all European vehicles.

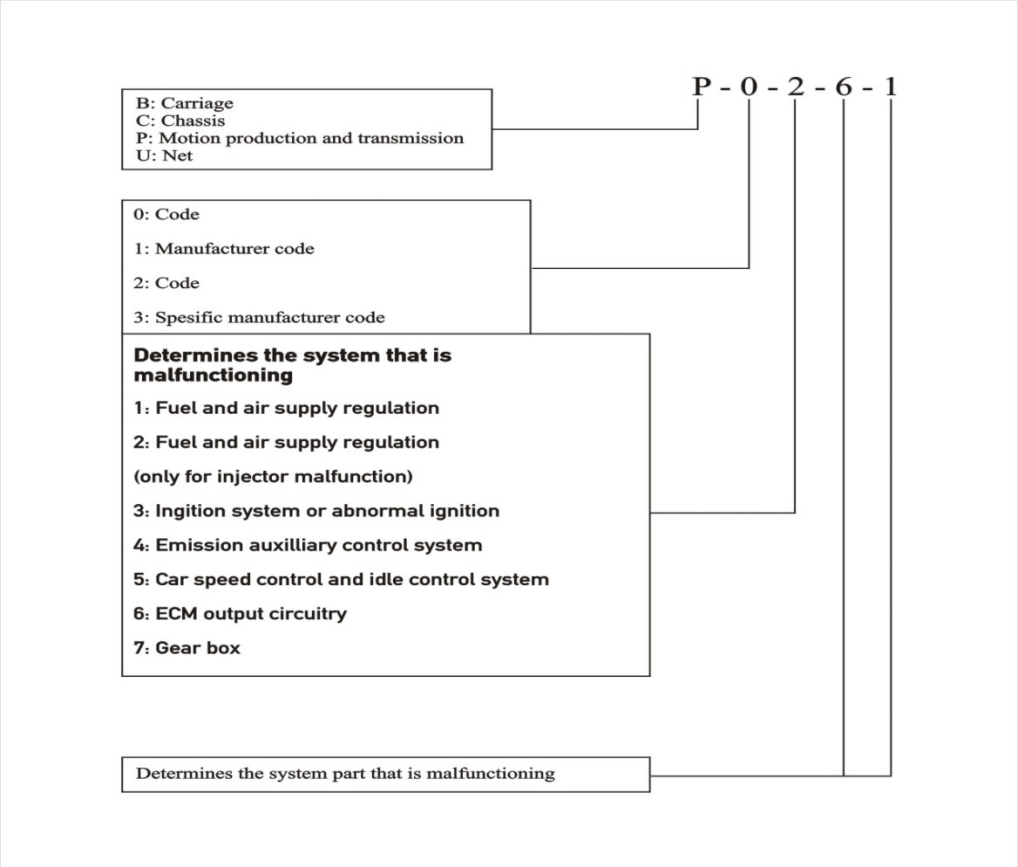

Figure 2 : Detection Troubles Codes (DTC)

EXPERIMENTAL METHOD AND RESULTS

In the year 2009 in the laboratory of Internal Combustion Engines, Dept. of Mechanical Engineering TE, TEI of Thessaly, a motor self – Diagnosis test was conducted using a Matiz II Daewoo car with a modern gasoline powered engine, 796 cc engine displacement, Figure 3. A self– Diagnosis unit was used named Autoexplorer 1, Figure 4, with an appropriate logistic program EURO 935 developed by the AVS Automotive company. This logistic system provides many possibilities, as below :

1. Supported controls presentation, Figure 5
2. MIL condition verification (check engine)
3. Troubles codes reading and cancelation
4. Troubles historical
5. Freeze Data
6. Appearance of the motor operation parameters (current values), Figure 6.
7. Sensors oszilogram
8. λ–sensors signals

Figure 3 : The Matiz II Daewoo motor

Figure 4 :Motor self – Diagnosis unit Autoexplorer 1 with 16–pin data link connector

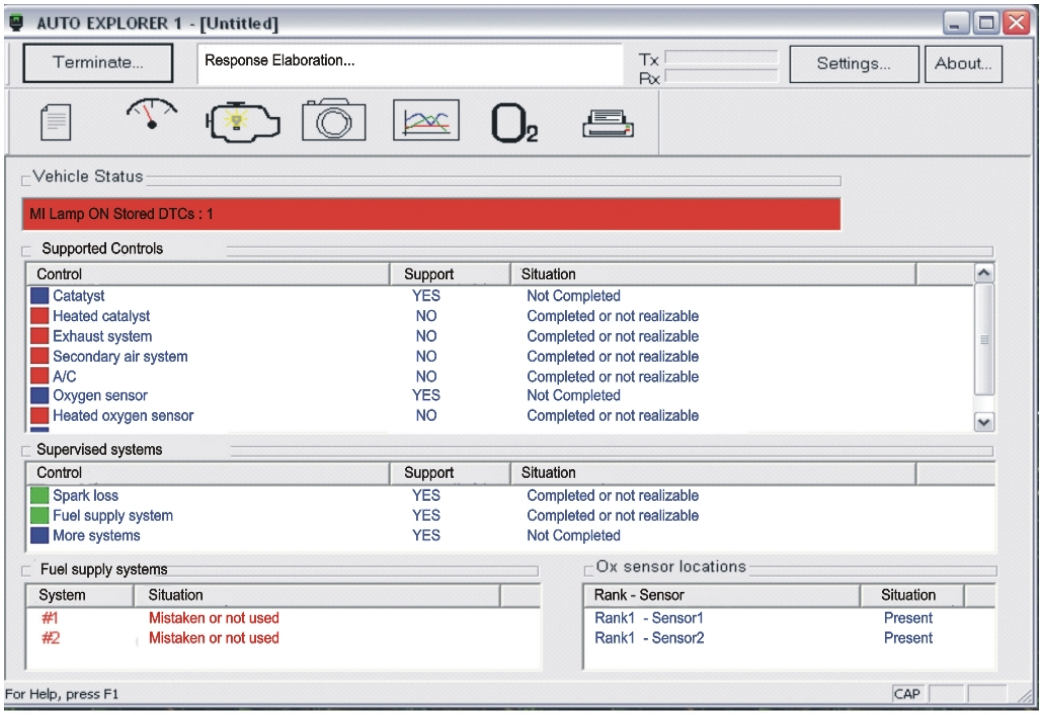

Figure 5 : Supported controls by the EURO 935 motor self–Diagnosis program

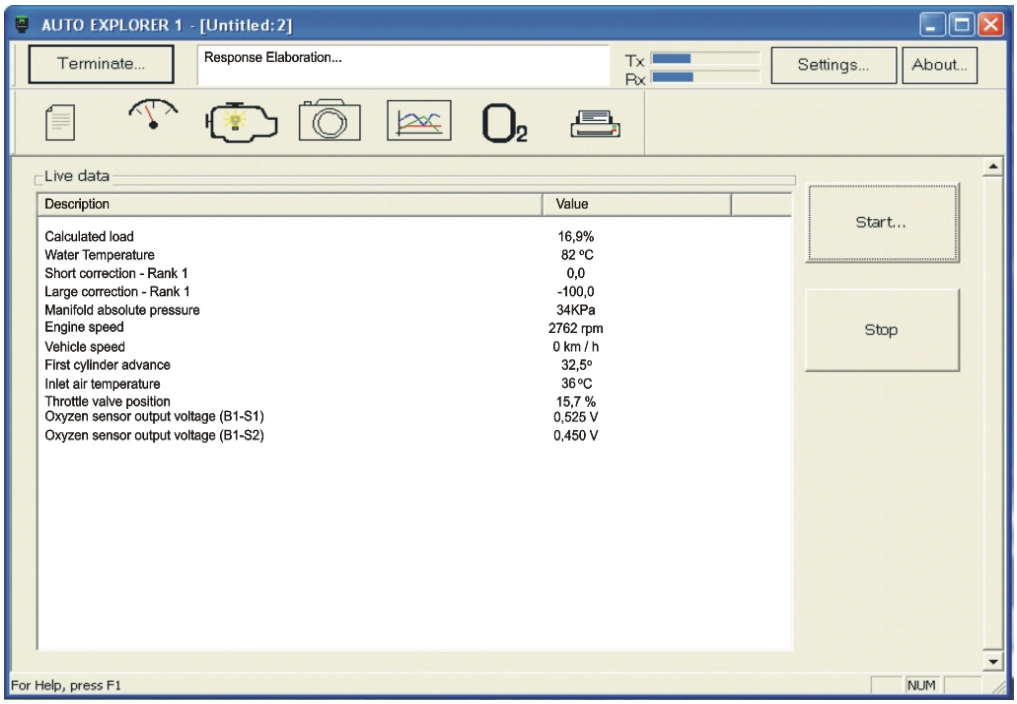

Figure 6 : Current values of motor operation parameters

Figure 7 shows the voltage variation of the two oxygen sensors at engine speed 965 rpm (idle). The voltage of the first oxygen sensor upstream of the catalytic converter (green color) goes continuously up and down, between two limited values, this means that a permanent correction of the injected fuel quantity is obtained which results to a maintained stoichiometric air–fuel mixture and therefore a full potential performance of the catalytic converter is achieved. The voltageof the second oxygen sensor downstream of the catalytic converter (blue color) remains constant. This means that the catalyst operates at the highest efficiency so that the oxygen concentration after the catalyst is constant.

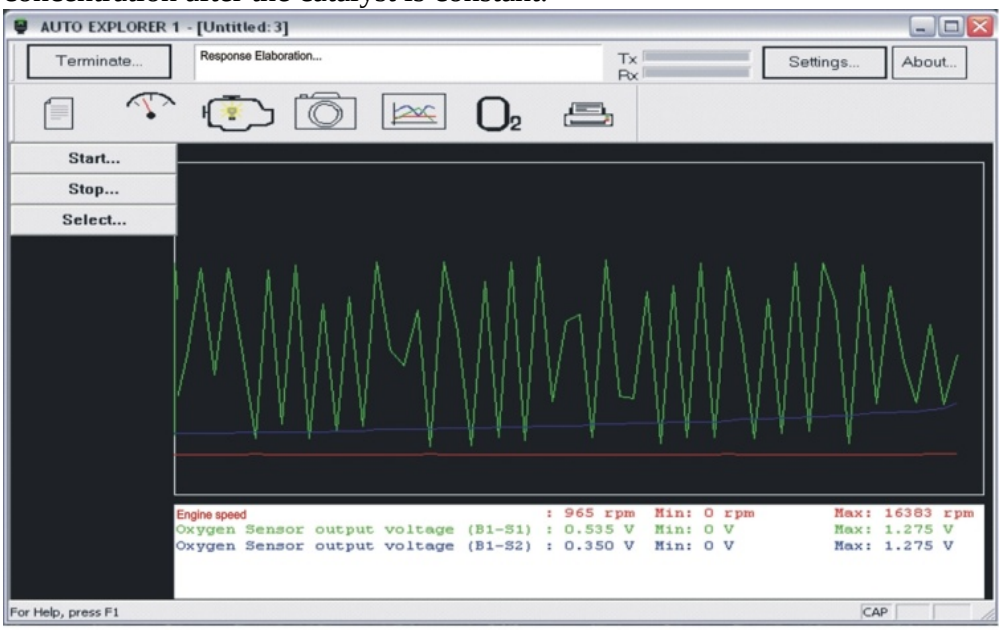

Figure 7 : Voltage variation of the two oxygen sensors at idle

Figure 8 shows the corresponding voltage variation when the motor operates at increased idle (2218 rpm). The voltage drop of the second oxygen sensor downstream of the catalyst (blue color) is due to the fact that at the same time the catalyst reaches its correct operative temperature.

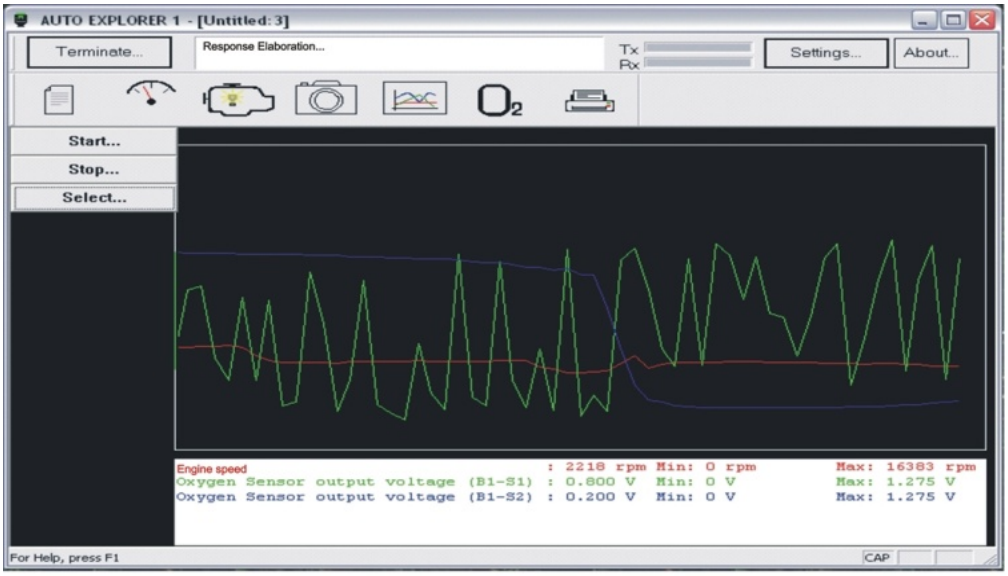

Figure 8 : Voltage variation of the two oxygen sensors at increased idle

Apart from the motor steady–state operating condition study, the car was driven at real driving conditions on a small road about 1 km long in the greater area of TEI of Thessaly. For these registrations a laptop and an appropriate monitoring software were used as well as the Autoexplorer 1 unit for the communication between the laptop and the ECM unit.

Figure 9 shows the load variation, Figure 10 shows the manifold absolute pressure variation and Figure 11 shows the advance variation depended on the engine speed. On these pictures the speed changes are obvious as well as their influence on mentioned variables.

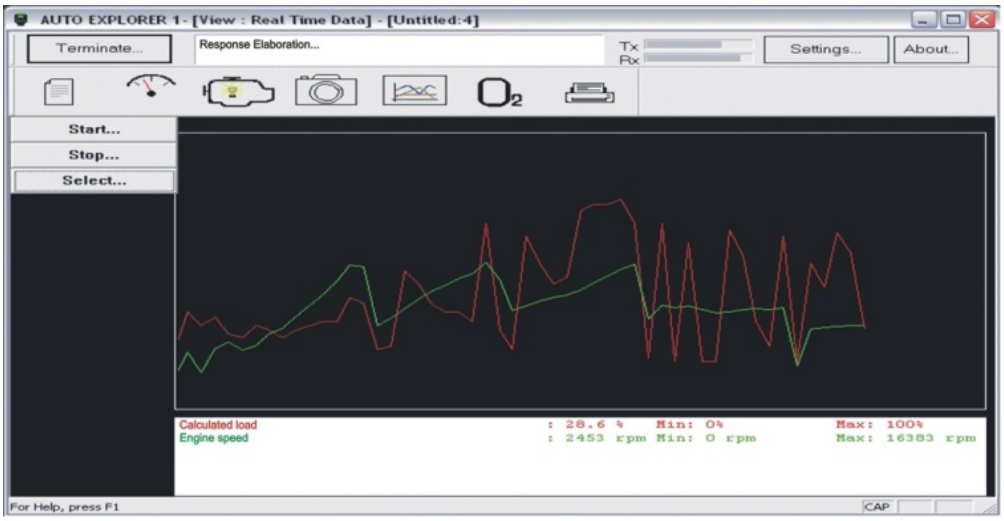

Figure 9 : Load variation as a function of the engine speed at real driving conditions

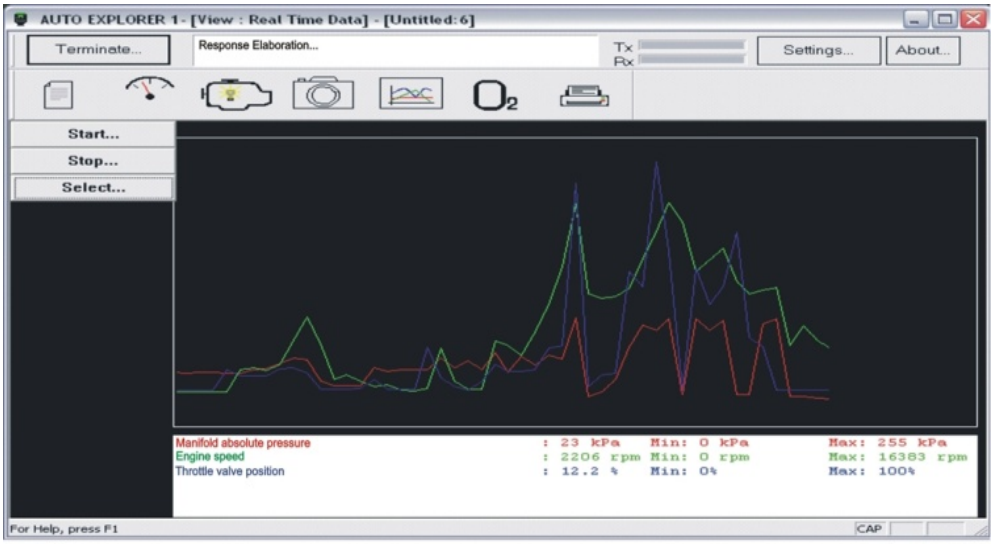

Figure 10 : Manifold absolute pressure variation as a function of the engine speed at real driving conditions

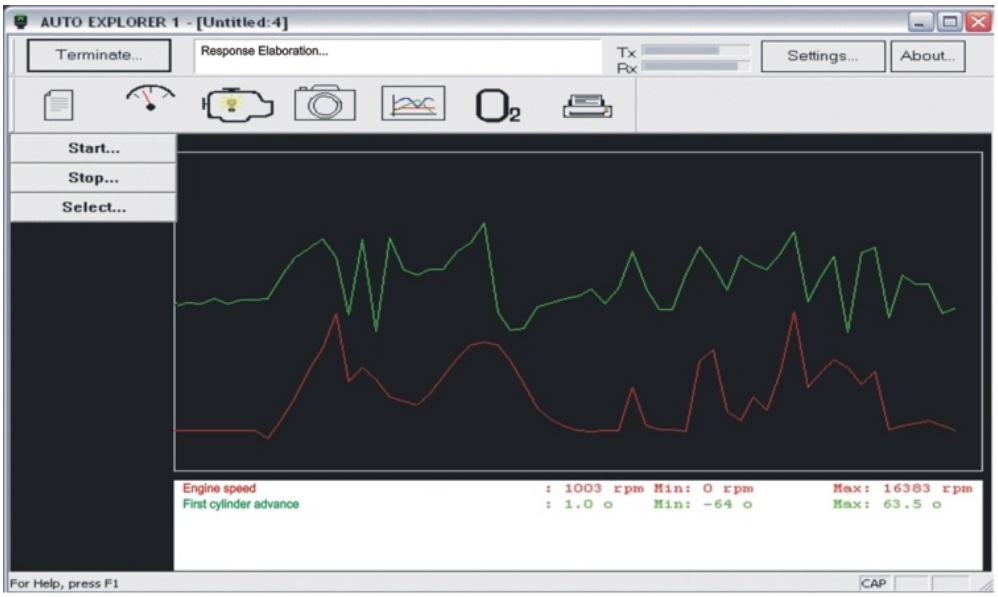

Figure 11 : Advance variation as a function of the engine speed at real driving conditions

Figure 12 shows the voltage variation of the two oxygen sensors in accordance to the engine speed. The voltage of the first oxygen sensor upstream of the catalyst (green color) goes continuously up and down for the permanent correction of the injected fuel. The voltage of the second oxygen sensor downstream of the catalyst (blue color) remains constant at the lower engine speed, because it corresponds to the constant oxygen

concentration of the exhaust gas (highest catalyst efficiency). However, as the engine speed increases (after the midle of the picture), the second oxygen sensor voltage follows in a parallel course the variation of the voltage of the first oxygen sensor. This fact can be explained as follows :

When the engine speed increases rapidly as the accelerator pedal is suddenly pressed, because of that transient driving phenomenon, the correction of the air–fuel ratio which could be achieved by the first oxygen sensor is not completed and thereafter the conversion factor of the catalyst is not sufficiently effective. At such cases even the second oxygen sensor itself produces a different voltage signal, just as it tries to correct the remained oxygen concentration in the exhaust gas into the control volume of the catalyst, due to the variation of the mixture stoichiometric caused by the transient motor load situation. This fluctuation of the voltage signal of the second oxygen sensor occurs even during the cold motor operation.

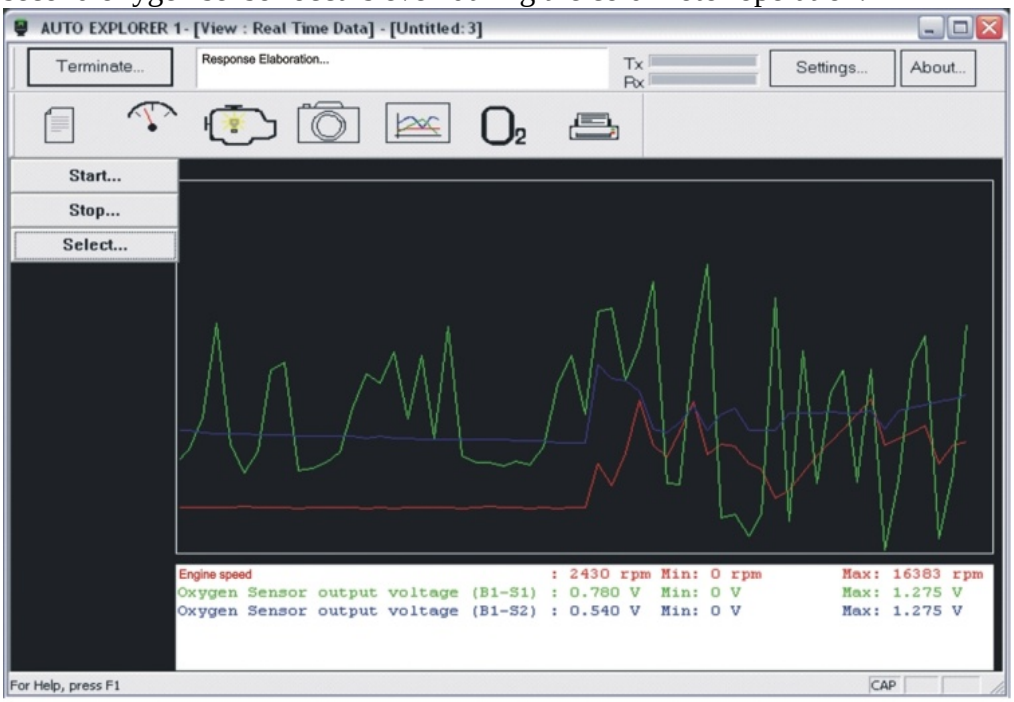

Figure 12 : Voltage variation of the two oxygen sensors at transient driving condition

CONCLUSION

1. OBD II is an absolute reliable car surveillance method to search possible malfunctions and/or damages of all modern engine systems.

2. Not only the operating condition of isolated sensors, but also many motor operation parameters can be checked.

3. The catalytic converter efficiency can be easily determined and the catalyst behavior at transient load condition can be studied and explained, as well.

4. By using the OBD III telemetry method, motor system malfunctions or high emission problems occurred in a car can be immediately transmitted to a supervising administration so that only these cars would be taken for inspection and repairing.

5. In the future, a so called «'fly by wire» acceleration pedal control system with electric wire can be applied to prevent abnormal ignitions in the next car generation with extreme low emissions.

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COMPARISON OF EXISTING TECHNOLOGY ACCEPTANCE THEORIES AND MODELS TO SUGGEST A WELL IMPROVED THEORY/MODEL

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Abstract

This paper presents a part of an on-going research study which aims to develop a model on technology acceptance appropriate to the Sri Lankan context. Current paper reviews the theoretical literature to propose an improved theory/model from a comparison of existing technology acceptance theories/models. In this technological era, awareness of technology is important in today's fast changing networked society. Since technology is of little value unless it is used, how people accept and use technology may have salient theoretical and practical implications. Therefore, researchers concurred on the fact that quality elucidations occur because of robust theories/models on technology acceptance. Despite of the negative aspects identified in the theoretical paradigms of these theories/models, one significant paradigm out of fourteen theories/models could be drawn from the conceptual review on theory/model comparison presented here. Among the fourteen theories reviewed, UTAUT seems to be an improved theory that could provide a useful tool to assess the likelihood of success for technology acceptance studies.

Keywords: Technology acceptance, Technology acceptance theories and models, Technology acceptance model comparison

Introduction:

This paper will discuss an improved technology acceptance theory/model which was selected for the main research study. The first part of the paper provides the background information on technology acceptance and the latter parts discuss fourteen technology acceptance theories and

models. Then the paper makes a comparison of technology acceptance theories and models to identify a model which is better explored the technology acceptance behaviour.

Technology:

Technology was defined as the spoken word of manual craft or cunning skill in the ancient time. The earliest use of the word technology in the United States was found in a Harvard University course on the "application of the Sciences to the useful Arts" in 1816. The 1832 Encyclopedia Americana defined technology as principles, processes, and nomenclatures.

The use of wireless electronic communication over 100 years ago was the starting point of the electronic era. The advancements in technology or modern technology have brought many changes to life styles of people. It has pervaded every aspect of human life whether it is health, education, economic, governance, entertainment etc. (Suvarna and Godavari 2012). Thus no matter what the field is, technology must have brought some positive change to work in away to increase productivity. Today, every nation strives to get the latest technology for the benefit of its citizens. Technological progress is vital in the fields of business, education as well as health care. Technology is also seen as an enabler or a vehicle to disseminate knowledge (Oye, Iahad and Ab.Rahim 2012).

Technology acceptance:

According to Louho, Kalliojaand Oittinen (2006), technology acceptance is about how people accept and adopt some technology for use. User acceptance of technology has further been explained as the demonstrable willingness within a user group to employ IT for the tasks it is designed to support (Dillon 2001). Therefore acceptance can be viewed as a function of user involvement in technology use. Acceptance can be further described as the critical factor in determining the success or failure of any technology and acceptance has been conceptualized as an outcome variable in a psychological process that users go through in making decisions about technology (Dillon and Morris 1996).

Technology is of little value, unless it is accepted and used (Oye, Iahad and Ab-Rahim 2012). Therefore the understanding of technology acceptance is vital because the most important benefit associated with access to the new technologies is the increase in the supply of information (Suvama and Godavari 2012). Researchers are interested strictly in identifying why people accept information technology so that superior processes for designing, evaluating, and predicting how users will react to new technology can be improved. Therefore, the researchers have studied a range of issues

related to technology acceptance from individual user characteristics such as cognitive style to internal beliefs and their impact on usage behavior (Dillon 2001). This individual user acceptance of technology for intended purposes have been modeled and predicted using theories. The main objective of many of those studies is to investigate how to promote usage and also explain what hinders acceptance and usage of technologies (Kripanont 2007). Many researchers have proposed theories and models of technology acceptance in order to explain and predict user acceptance with technology in order to account for rapid change in both technologies and their environment (Oye, Iahad and Ab-Rahim 2012). A review of the existing technology acceptance theories/ models is therefore important to suggest an improved model.

Technology acceptance theories and models:

Theories provide a set of explanatory variables which can be used to predict a particular phenomenon. A model, on the other hand, is defined as a systematic description of a system, a theory or a phenomenon that accounts for its known or inferred properties which may be used for further study of its characteristics. Also a model is any abstract representation of some portion of the real world, constructed for the purpose of understanding, explaining, predicting or controlling a phenomenon being investigated (Burch 2003: 266). A large number of theories/models have been designed to explore the acceptance and use of technologies environment. Therefore such theories/models that provide the basis for technology acceptance can be portrayed as follows:

Cognitive Dissonance Theory (CDT)

Cognitive Dissonance Theory was formulated by Festinger (1957) to explain how discrepancies (dissonance) between one's cognition and reality change the person's subsequent cognition and/or behaviour (Bhattacherjee 2001). This theory depicts a process model of individual behaviour whereby users from an initial pre-usage expectation (belief) about a technology, experience its usage overtime, and then from post-usage perceptions of the technology. The dissonance between users' original expectations and observed performance is captured in the disconfirmation construct (Bhattacherjee 2001).

Innovation Diffusion Theory (IDT)

Innovations Diffusion Theory (Rogers 1995; Rogers and Shoemaker 1971) uses to describe the innovation-decision process. It has gradually evolved until the best well-known innovation-decision process was introduced by Rogers (Rogers 1995; Rogers and Shoemaker 1971). Innovation diffusion theory is perhaps the principal theoretical perspective

on technology acceptance which has been applied at both individual and organizational levels of analysis while its primary intention is to provide an account of the manner in which any technological innovation moves from the stage of invention to widespread use (or not) (Dillon and Morris 1996).

Task Technology Fit Model (TTF)

Task-Technology Fit (Strong, Deshaw and Bandy1973) model holds that IT is more likely to have a positive impact on individual performance and can be used if the capabilities of IT match the tasks that the user must perform (Goodhue and Thompson 1995). TTF consists of eight factors: quality, locatability, authorization, compatibility, ease of use/training, production timeliness, systems reliability, and relationship with users. TTF has been applied in the context of a diverse range of information systems.

Expectation-Disconfirmation Theory (EDT)

Expectation Disconfirmation Theory or Expectation Confirmation Theory (Oliver 1980) which is built upon the basis of Cognitive Dissonance Theory definition and from Marketing has now come to be applied to the adoption of information technology (Bhattacherjee 2001). EDT focuses in particular on how and why user reactions change over time. It consists of four main constructs: expectations, performance, disconfirmation, and satisfaction.

Theory of Reasoned Action (TRA)

The first theoretical perspective to gain widespread acceptance in technology acceptance research is the Theory of Reasoned Action (Fishbein and Ajzen 1975). TRA is a versatile behavioral theory and models the attitude-behavior relationships. This theory maintains that individuals would use computers if they could see that there would be positive benefits (outcomes) associated with using them.

Theory of Planned Behaviour (TPB)

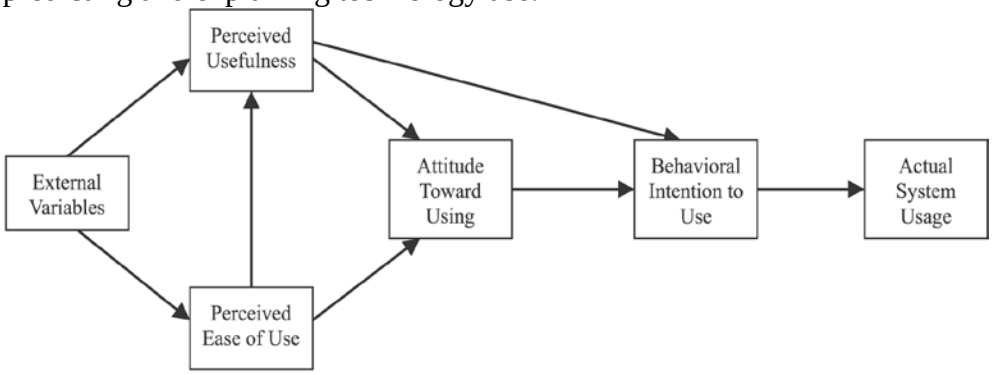
The Theory of Planned Behaviour (Ajzen 1985, 1991) is a successor of TRA and it introduced a third independent determinant of intention, perceived behavior control (PBC). It is determined by the availability of skills, resources, and opportunities, as well as the perceived importance of those skills, resources, and opportunities to achieve outcomes (Kriponant 2007). As Kriponant (2007) emphasised, by changing these three predictors (attitude, subject norm and perceived behavior control), the chance that the person will intend to do a desired action can be increased and thus increases the chance of the person actually doing it.

Social Cognitive Theory (SCT)

Social Cognitive Theory (Bandura 1986) is based on the basis that environmental influences such as social pressures or unique situational characteristics, cognitive and other personal factors including personality as well as demographic characteristics are equally significant in determining behaviour. Further, more variables: gender, age, and experience, from SCT were researched as to whether they play an important role in the explanation of technology acceptance (Losh 2004; Colley and Comber 2003; Venkatesh and Davis 2000).

Technology Acceptance Model (TAM)

Technology Acceptance Model (Davis 1989) was the first model to mention psychological factors affecting technology acceptance and it was developed from Theory of Reasoned Action (TRA) by Davis (Davis 1989). Davis (1989) developed and validated better measures through TAM for predicting and explaining technology use.



Source: Davis *et al.* (1989, p. 985)

Figure 1: TAM (Davis *et al.* 1989: 985)

As shown in Figure 1, TAM posits that perceived usefulness and perceived ease of use determine an individual's intention to use a system with the intention to use serving as a mediator of actual system use. Perceived usefulness is also seen as being directly impacted by perceived ease of use. The underlying links between two key constructs and users' attitudes, intentions and actual technology usage behaviour, were specified using the theoretical underpinning of the TRA. Attitude and perceived usefulness jointly determine the behavioural intention and attitude is determined by perceived usefulness and perceived ease of use.

Model of PC Utilization (MPCU)

Model of PC Utilization (Thompson *et al.* 1991) presents a competing perspective to the theories TRA and TPB and the underpinning conceptual

paradigm is theory of human behaviour of Triandis (1977). This model predicts the PC utilization behaviour. However, the nature of the model makes it particularly suited to predict individual acceptance and use of a range of information technologies (Venkatesh *et al.* 2003). Thompson *et al.* (1991) used this to predict usage behaviour rather than intention to use.

Motivational Model (MM)

Motivation theory (Davis, Bagozzi and Warshaw 1992) in psychology is the keystone concept behind this model. Several studies have examined motivational theory and adapted it for specific contexts and also applied it to understand new technology adaption and use (Venkatesh and Speier 1999). The core constructs of the theory are extrinsic motivation and intrinsic motivation.

Decomposed Theory of Planned Behaviour (DTPB)

The Decomposed TPB (DTPB) introduced by Taylor and Todd (1995) explores the dimensions of attitude belief, subjective norm (social influence) and perceived behavioral control by decomposing them into specific belief dimensions (Taylor and Todd 1995b). Taylor and Todd (1995b) suggest decomposing attitudinal belief into three factors: perceived usefulness (PU), perceived ease of use (PEOU), and compatibility. These three factors have been found to be consistently related specifically to IT usage (Kriponant 2007).

Combined TAM and TPB (C-TAM-TPB)

The key determinants of TPB, influence of social and control factors which are not used to measure the behaviour in TAM have been joined together to form the C-TAM-TPB. Taylor and Todd in 1995 added two factors: subjective norm and perceived behavioral control to TAM to provide a more complete test of the important determinants of IT usage, because of their predictive utility in IT usage research and their wide use in social psychology (Taylor and Todd 1995a). This is an adequate model of IT usage for users who are both experienced and inexperienced with a technology system.

Technology Acceptance Model (TAM2)

The goal of TAM2 (Venkatesh and Davis 2000) is a theoretical extension of the TAM to (1) include additional key determinants of TAM that explains perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes and (2) to understand how the effects of these determinants change with increasing user experience over time with the target technological system (Kriponanat 2007).

According to the study of Venkatesh and Davis (2000) both social influence processes (subjective norm, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) significantly influence user acceptance.

The Unified Theory of Acceptance and Use of Technology (UTAUT)

Another important theoretical model was proposed as the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Davis and Davis 2003) with four core determinants of intention and usage, and up to four moderators of key relationships. Four constructs, 1) performance expectancy 2) effort expectancy3) social influence and4) facilitating conditions, have been theorized in formulating UTAUT with the aim of determining user acceptance and usage behavior on technology as depicted in Figure 2.

Attitude toward using technology, self-efficacy, and anxiety are theorized not to be direct determinants of intention (Kriponant 2007). The key moderators in the model are gender, age, voluntariness, and experience. From a theoretical perspective, UTAUT (Venkatesh *et al.* 2003) provides a refined view of how the determinants of intention and behavior evolve over time, and it is important to emphasize that most of the key relationships in the model are moderated (Kriponant 2007).

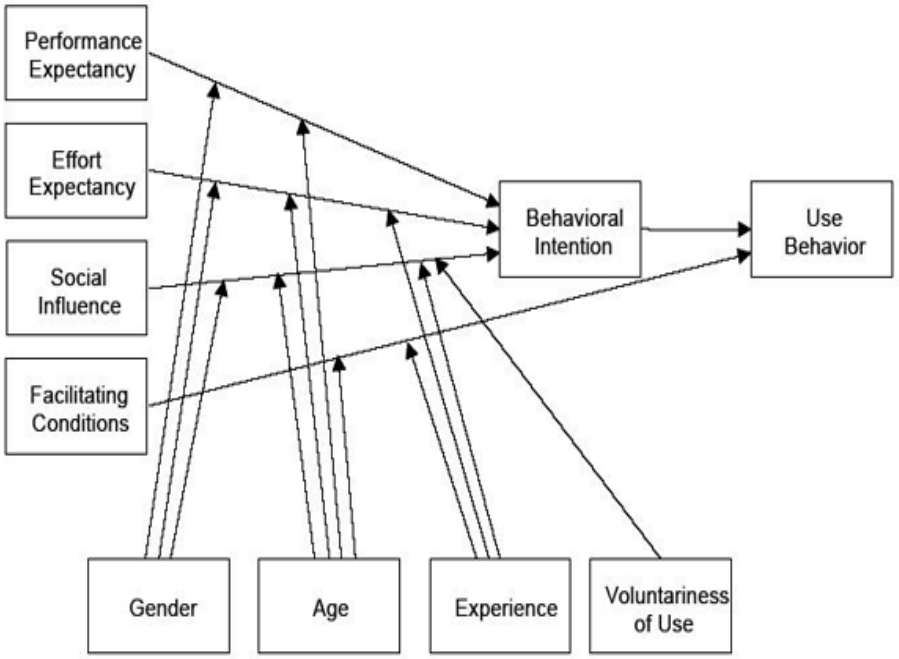


Figure 2: UTAUT model (Venkatesh *et al.* 2003)

Comparison of technology acceptance theories/models:

Comparison of technology acceptance theories/models in general is vital to position a well improved theoretical paradigm which provides an overall picture of underpinning concepts of theories/models which have been used on the technology acceptance environment.

The underpinning paradigms of CDT and EDT theories have been proved as more relevant to form technology acceptance through a few studies in the literature (Bhattacherjee and Premkumar 2004; Bhattacherjee 2001). However, those aspects do not appear to direct most of the technology acceptance studies sufficiently and they have not received the same level of attention in the available literature as the other theories/models in technology acceptance. CDT and EDT have not been researched in various contexts in technology acceptance.

TRA, TPB, TAM, TAM2 and UTAUT are more popular technology acceptance theories/ models that are being used worldwide in different settings more especially in IS literature.TRA has been adapted for use in many fields and is widely used in academia and business today (Magee 2002) and has demonstrated validity in the Information Systems literature (Han 2003). TRA model though has some limitations including a significant risk of confounding between attitudes and norms since attitudes can often be reframed as norms and vice versa. The second limitation is the assumption that when someone forms an intention to act, they will be free to act without limitation. In practice, constraints such as limited ability, time, environmental or organisational limits, and unconscious habits will limit the freedom to act. However, there is also a growing recognition that additional explanatory variables are needed for TRA (Thompson *et al.* 1991; Webster and Martocchio 1992).

The Theory of Planned Behaviour (TPB) attempts to resolve the limitations of TRA. TPB and has been the explicit theoretical basis for many studies over various contextual settings. Therefore, DTPB should provide a more complete understanding of technology usage (Taylor and Todd 1995b). But, Davis, Bagozzi and Warshaw (1989) explained that social norm scales have a very poor psychometric standpoint, and may not exert any influence on BI, especially when IS applications are fairly personal and individual usage is voluntary.

Generally, Technology Acceptance Model (TAM) specifies general determinants of individual technology acceptance and therefore can be and has been applied to explain or predict individual behaviours across a broad range of end user computing technologies and user groups (Davis, Bagozzi and Warshaw 1989). Simultaneously TAM compared favorably with TRA and TPB in parsimonious capability (Han 2003). However, TAM is easier to use than TPB, and provides a quick and inexpensive way of gathering

general information about an individual's perception of a technology. According to the critical review and meta-analysis of TAM Legris *et al.* (2003), claimed the TAM to be a useful model. However many researchers have attempted to expand TAM which has only created confusion (Baenbasat and Barki 2007). Therefore the comparisons confirm that TAM is parsimonious and easy to apply across different research settings; nevertheless, it has to pay the trade-off of losing information richness derived from the studies (Kriponant 2007).

In a meta-analysis study on TAM with 88 published studies, King and He (2006) concluded that the TAM is a valid and robust model. For the past two decades, substantial empirical evidence has supported TAM. Perceived usefulness, perceived ease of use, social influence, facilitating conditions, attitude, self-efficacy and anxiety together with UTAUT would thus be the basis of the explanation of the usage of new technology (van Raaij and Schepers 2008; Wills, El-Gayar and Bennett 2008; Wu, Tao and Yang 2007). Venkatesh *et al.* (2003) have also added situational variables, gender, age, experience and voluntariness of use to the UTAUT model even though core constructs play a very important role in the explanation of the acceptance and use of technology (De Wit, Heerwegh, and Verhoeven 2011; Verhoeven, Heerwegh and De Wit 2011; Verhoeven, Heerwegh and De Wit 2010). Therefore, the UTAUT has been playing a key role in technology acceptance research and provides a solid base to explain why users accept or reject technology in a specific perspective.

It is clear that these theories/models have been expansively applied in a vast array of research studies in technology contexts and other various areas of academic interest and they have further proven their enhanced applicability in modelling technology acceptance in different contextual settings. The reviewed literature on technology acceptance theories/models confirmed that they have different premises and benefits.

According to Singleton, Straits and Straits (1993), Taylor and Tod (1995) and Kriponant (2007), despite the specific advantages of each theory, the capability of a theory/model in predicting and explaining behavior is measured by the extent to which the predictors in the theory could account for a reasonable proportion of the variance in behavioral intention and usage behavior. Considerably better variances explain a broader range of phenomena. Therefore, it is necessary to compare them in order to identify the most appropriate ones in respect of their ability to predict and explain individual behavior towards acceptance and usage of technology. Literature reports superior comparisons of technology acceptance models by Venkatesh *et al.* (2003) and Kriponant (2007). Venkatesh *et al.* (2003) have compared eight models based on empirical data. Kriponant (2007) has also compared nine models based on literature. Therefore the model comparison of

Venkatesh *et al.* (2003) can be concluded as a more pragmatic approach and they have determined individual models' ability to explain behavioral intention (the explained variance R^2). Table 1 presents a summary of technology acceptance theories/models comparisons in terms of their key constructs, moderators and the explained variance.

Table 1: Technology acceptance theories/models comparison

Theory/Model	Constructs (Independent variables)	Moderators	Explained variance (R2)
1.Theory of Reasoned Action (TRA)	1. Attitude toward behavior 2. Subjective norm	1.Experience 2. Voluntariness	0.36
2.Technology Acceptance Model - a (TAM2)	1. Perceived usefulness 2. Perceived ease of use 3. Subjective norm	1.Experience 2. Voluntariness	0.53
- b (TAM- including gender)	1. Perceived usefulness 2. Perceived ease of use 3. Subjective norm	1. Gender 2. Experience	0.52
3.Motivation Model (MM)	1. Extrinsic motivation 2. Intrinsic motivation	None	0.38
4.Decomposed Theory of Planned Behavior (DTPB) - a TPB (including voluntariness)	1. Attitude toward behavior 2. Subjective norm 3. Perceived behavioral control	1.Experience 2. Voluntariness	0.36
- b TPB (including gender)	1. Attitude toward behavior 2. Subjective norm 3. Perceived behavioral control	1. Gender 2. Experience	0.46
- c TPB (including age)	1.Attitude toward behavior 2. Subjective norm 3. Perceived behavioral control	1. Age 2. Experience	0.47
5.Combined Technology Acceptance Model and Theory of Planned Behavior (C-TAM-TPB)	1. Attitude toward behavior 2. Subjective norm 3. Perceived behavioral control 4. perceived usefulness	1. Experience	0.39
6.Model of PC Utilization (MPCU)	1. Job fit 2. Complexity 3. Long term consequences 4. Affect towards use 5. Social factors 6. facilitating conditions	1. Experience	0.47
7.Innovation Diffusion Theory (IDT)	1. Relative advantage 2. Ease of use 3.Result demonstrability 4.Triability 5. Visibility 6. Image 7. Compatibility 8. Voluntariness of use	1. Experience	0.40
8.Social Cognitive Theory (SCT)	1.Outcome expectation 2. Self-efficacy 3. Affect 4. Anxiety	None	0.36
9.Unified Theory of Acceptance and Use of Technology (UTAUT)	1.Performance expectancy 2. Effort expectancy 3. Social influence 4.Facilitating conditions	1. Gender 2. Age 3. Experience 4.Voluntariness	**0.69**

Source: (Venkatesh*et al.* 2003; Kripanont 2007, Dulle, Minishi-Majanja and Coloete2010).

Following facts can be drawn from the model comparison in Table 1 by examining the constructs, moderators and the explanatory ability.

- Core constructs of the theories/models vary between 2 (TRA and MM) and 8 (IDT). Most of them consist of 3-4 constructs.
- Moderators show a discrepancy from 0-4. MM and SCT have no moderators and the highest number of moderators is included in the UTAUT. Most common moderator used in these theories/models is the 'experience'.
- The explanatory power of technology usage intention in terms of variance has ranged from 0.36 (TRA, SCT) lowest to 0.69 (UTAUT) highest.

It is evident that moderators can play a significant role on the explanatory ability of the theories/models even under situations of similar constructs. Explanatory power of the TAM2 and TPB varies with different moderator changes and same constructs from 0.52 to 0.53 and 0.36-0.47 respectively.

According to Taylor and Todd (1995b) models should be evaluated in terms of both parsimony (few predictors) and their contribution to understanding. This means that a model with a good explanatory power and a lesser number of variables is well suited. But the researchers have argued that parsimony is not desirable by itself but is desirable only to the extent that it facilitates understanding (Venkatesh *et al.* 2003). For predictive, practical applications of the model, parsimony may be more heavily weighted; on the other hand, if trying to obtain a complete understanding of a phenomenon, a degree of parsimony may be sacrificed (Kriponant 2007). As shown in the Table 5.1 the UTAUT is rich in the explanatory ability in explaining behavioral intention and usage of technology. Therefore, the theory in question contributes to a better understanding about the drivers of behavior of acceptance and the use of new technologies than other similar theories and models (Venkatesh *et al.* 2003; Kripanont 2007; Wu, Tao and Yang 2007; Dulle 2010).

Rationalization for a well improved theory/model:

This section will further provide a justification the suggestion of the UTAUT model as well improved theory/model for technology acceptance. This critique is principally based upon existing criticisms made by Information Science theorists, and the researcher's own arguments to provide a synthesis of various viewpoints on technology acceptance with logical reasoning. This is not a trial to find conformity with the opinions and arguments already made, but to make known the potential issues faced in formulating a rational conceptual basis for the selection of UTAUT as a better model to explore the technology acceptance behaviours.

According to the reviewed literature, Venkatesh *et al.* (2003) and Bagozzi (2007), the following important features could be drawn in flavor of UTAUT as a well improved model to explain the technology acceptance behavior.

- The explanatory power of the UTAUT is higher;
- Eight specific models (Theory of Reason Action, Theory of Planned Behavior, Technology Acceptance Model, Motivational Model, Combine Theory of Planned Behavior and Technology Acceptance Model, Model of PC Utilization, Innovation Diffusion Theory and Social Cognitive Theory) have been identified and discussed to form the determinants of behavioral intention and usage behavior of technology in constructing the UTAUT;
- Comparison of selected models was done using longitudinal data from four organizations (Entertainment, Telecom Services, Banking, and Public Administration) in constructing UTAUT;
- Use of conceptual and empirical similarities and disparities across eight models to formulate the conceptual framework of the UTAUT model;
- Empirically testing the conceptualized UTAUT model using the original data from the above four organizations and then cross-validated it using new data from additional two organizations (Financial services and Retail electronics);
- Growing number of empirical evidences in last 5-6 years in favor of UTAUT.

Considering above facts it is clear that UTAUT will provide a solid base to explain why users accept or reject a technology in a specific perspective and it has much potential in enhancing our understanding of technology acceptance.

Conclusion:

Many researchers in the IS field are interested in examining the role of human trust in technology acceptance. Trust in technology is an ever more imperative concept as anew mode of technologies is appearing and may become more complex and harder for some and not for others. Such substantial differences between groups in how they perceive items on technology acceptance may have salient theoretical and practical implications for usage predictions. In the course of conceptual improvement and empirical findings of past studies, most researchers have concurred on the fact that quality elucidations emerge through robust theories/models. Despite of the negative aspects identified in the theoretical paradigms of these theories/models, one significant paradigm out of the fourteen theories/models could be drawn from this conceptual review. This

recognized dominant theoretical perception, as UTAUT which could be duly used for modelling technology acceptance behaviour.

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TOWARD NEW SOCIAL NETWORK FOR SOLIDARITY

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Abstract

It is important to profit from the new era of web and mobile social networks for serving the fundamental physiological needs of human being. Therefore, we propose a new social network where we create a virtual community for charity by donating, borrowing, exchanging, and sharing things that are related to the physical requirements of the application users. Although the posted items can be of different types, the author has introduced original social network services which are food, scholar facilities (e.g., books, stationeries), clothes, and children games. Our system services involve that users support each other by these fundamental physical requirements in their raw form and not as cash payment. In this way, this social network provides its users opportunities to profit from items which are not useful momentarily or any longer by other users instead of purchasing them.

Keywords: Social networks, donate, borrow, exchange, share

1. Introduction

The evolution of social web on the Internet and the fast emergence of mobile application have made the circulation of information faster and the worldwide human connections on the social networks created in these platforms as easy as the social connections in a small village. It becomes possible that individuals expand their social networks in very simple ways by communicating online with each other despite their geographical proximity.

Basically, online social network form online communities among people with common interests, activities, backgrounds, and friendships. This allows users to upload profiles (text, images, and videos) and interact with others in numerous ways and for various purposes (Schneider, 2009). Then, it permits to collect information on users' social contacts, and traverse their list of connections to those made by others to construct a large interconnected social network (Adamic & Adar (2005), Boyd & Ellison (2007)).

Nowadays, social networks usage has reached an enormous scale. While in 2010 the fraction of Internet users visiting such services at least once a month has reached 57.5% (i.e., 127 million people), it is expected to be considerably increased in 2014 where more than 66% (i.e., 164.9 million people) will be regular users of social networks (Williamson, 2010). Reviews on social networks (Heidemann, Klier & Probst (2012), Leberknight, Inaltekin, Chiang & Poor (2012), Sherchan, Nepal & Paris (2013)) show that the ones having the scope of social connections (e.g., Facebook) are the top popular social networks although we do not believe that these are the most important ones for the life of human being. There are many other social networks for people to interact and collaborate with each other online while gaining more benefits from such human connections.

While existing literature intensively deals with people motives for using online social networks (Dwyer, Hiltz & Passerini (2007), Hu & Kettinger (2008)), we realize that there is lack of studies and proposals highlighting the major interests of human being in this field. The major contribution that we present in this paper is the idea of a new social network for serving the fundamental physiological needs of human being in a faster, easier, more flexible, and more efficient way. This can be achieved by implementing a web and mobile application where a virtual community is created for charity by donating, borrowing, exchanging, and sharing things that are related to the physical requirements of the application users. Such virtual community can facilitate the large scale interaction between the different social components to realize the defined purpose.

Application users are able to post the things that would like to donate, borrow, exchange, or share so that others can take benefit from them by applying directly to the user posting the requested item. Although the posted items can be of different types, the author has introduced original social network services which are food, scholar facilities (e.g., books, stationeries), clothes, and children games. Thus, such social network is different than the other existing ones in the fact that it proposes that users support each other by the physiological needs which have not been covered in any existing social network to the best of our knowledge. Moreover, the donations, exchange, borrow, and shares are done without any cash payment but by applying directly on the physical requirements of the people who are members of this network. This allows users to avoid purchasing new items of their needs while others dispose of as waste.

The paper is organized as follows. In the next section, we present an overview on the charitable social networks as these fit with the scope of our proposal. Then, we present the idea of the new social network in Section 3. Finally, the conclusion is presented in Section 4.

2. Related works

It is important to raise the awareness of the society about the existed types of social networks for trying to orient their activities and innovation on the social networks which could improve their lives and attain more benefits. We classify the vast spectrum of social networks, based on their key scopes, into ten major categories which are (i) Social connections (e.g., Facebook, Twitter, Google+, and MySpace), (ii) Multimedia sharing (e.g., YouTube, Instagram, Flickr, and Picasa), (iii) Professional (e.g., LinkedIn, Classroom, Nurse Connect, and SQL Monster), (iv) Educational (e.g., The Student Room, The Math Forum, ePALS School Blog, and eLearners), (v) Academic (e.g., Academia), (vi) Informational (e.g., HGTV Discussion Forums, and Do-It-yourself Community), (vii) Marriage/dating (e.g., Match, Zoosk, and Meetic), (viii) Hobbies (e.g., Sport Shouting), (ix) Environmental, and (x) Charitable.

We believe that environmental and charitable social networks are among the most important ones for improving the life of human being. Therefore, efforts should be done to inform people about the existing social networks in this scope and efficient ways should be practiced for motivating them to participate in such networks. Thus, we present in the following an overview on such social networks. Then, we present in the next section our new social network which enhances the solidarity among the application users.

A wide variety of social networks connect people interested in the environment. Such networks provide the users the opportunity to connect, share and/or collaborate with others online environmental issues. There are varieties of green social networks as online communities where individuals interested in adopting green living practices can interact (e.g., Super-Green-Me). Online users can also find out about green events or local reunions on social sites such as Do-Something, Meetup, Step-It-Up, TakingITGlobal, and WorldCoolers.

Activism sites enable collaboration to promote change through social activism. Example sites in this field include Care2, tree-nation, Wiser-Earth and many others. Besides, Oh-My-Bloom is specialized for gardening fan. Other green social networks sites enable users to share a personal pledge that contributes for being more eco-friendly. Such sites provide the users an opportunity to motivate each other for making such pledges and persist on their commitments. Examples include sites as Make-Me-Sustainable, PledgeBank, The-Carbon-Diet, and Yahoo Green.

On the other hand, many charitable social networks have been deployed on the web, in the last decade, for cash donation (e.g., MSF, 2014). Nowadays, such services converge toward the mobile technology since it offers more flexible and easier way for donation although its security issues are more challenging. One example of Mobile donation solution is Cellum's

mobile payment technology (Cellum Mobile donation, 2014) which provides the Smartphone users an easy and safe way to transfer money for donation. Besides, the Mobile Giving Foundation (Mobile Giving Foundation, 2014) allows the usage of text messages for donating money. By using the appropriate short-code and keyword wireless subscribers can donate small amounts of money to their favorite cause. Once a text message is sent the money is transferred and the subscriber is charged on his/her mobile bill by the donated amount. There are also social networks which allow helping hunger and sick people through money donation. Other charitable social networks are dedicated for orphanages as Orphanfaces which is like FaceBook for orphanages and sponsors. It allows the users who wish to donate money an easy access to the profiles of the orphans.

Cash donation for specific cause is not the only way used for charity in the existence social networks. Mobile applications have been also implemented and deployed to search for blood donation sessions. NHSBT provides such service in England and it also allows reserving an appointment for the donor and providing route guidance through Google maps when the donation time comes. Other social networks allow the users to donate, borrow, share, rent, loan, or reuse products on sites like freecycle, gigoit, loanables, rentoid, and Neighborgoods. Lastly, Carpooling networks allow members to arrange carpools on sites like GishiGo, GoLoco, pooln, and WorldCardShare.

Moreover, Share-Closet network help people show, swap and sell clothes, shoes and accessories. This social network has not been deployed neither used for charitable reasons. The users of this network can upload fashion images and determine how much someone can see of their clothes based on which group they allow that person to join. Lending clothes will be limited to the girls who are accepted as actual friends, whereas someone can sell items to any Share Closet member. Share-Closet will help facilitate shipping by providing a label and adding a flat rate onto the total transaction. Another feature is a series of reminders the application sends as it gets closer to the time for someone to return something she is borrowed.

3. Social Network for Solidarity

Our new social network can be implemented as a web and mobile phone application for donating, borrowing, exchanging, and sharing human's physiological needs. The users of such network can be individuals, groups (e.g., companies, scouts, hotels, and restaurants), municipalities, and various human organizations (e.g., health organizations, food organizations, social organizations, charities organization, and education organizations). Every application user creates its proper profile containing relevant personal information including its geographic location which is necessary to decide

whether the proximity permits to provide specific support. The geographic position of the user is determined on the web through its registered information and through GPS in case of the mobile phone application.

Application users are able to post the things that would like to donate, borrow, exchange, or share so that others can take benefit from them by applying directly to the user posting the requested item. Users can also conduct a search on the application specifying its need and geographic location. In this social network, individuals and groups can donate, borrow, exchange, and share things directly from each other and based on their proper selection and acceptance criteria or through trusted third party (e.g., human organization, municipality).

Our system services involve that users support each other by the physical requirements which are newly introduced in a mobile or web application as food, scholar facilities (e.g., books, stationeries), clothes, and children games. Such social network is different than the other existing ones in the fact that it covers the physiological needs which have not been covered in any existing social network to the best of our knowledge. Moreover, the donations, exchange, borrow, and shares are done without any cash payment but by applying directly on the physical requirements of the people who are members of this network. This allows users to avoid purchasing new items of their needs while others dispose of as waste.

However, the other requirements that have been already deployed in the literature (e.g., donating cash, blood, gadgets, stuff, goods, and Carpooling) could be also deployed in our application, if the bylaws allow, for providing a more complete solution that is able to fully support the physiological needs of human being. As we have already stated that the support could be achieved by donating, borrowing, exchanging, or sharing the posted item depending on its type.

In the following, we assign for each type of item the possibilities of support offered by the application and could be applied by any user:

- Food. For this type of item, user can post or apply for donate, exchange or share.
- Scholar facilities (e.g., books, stationeries). For this type of item, user can post or apply for donate, borrow or exchange.
- Clothes. For this type of item, user can post or apply for donate or exchange.
- Children games. For this type of item, user can post or apply for donate or exchange.

The delivery of items could be arranged directly between the users or through trusted third party (e.g., human organization, municipality). Particularly, it is preferable that the food are collected by such third party for

being examined and disposed in appropriate health conditions before being distributed to the users applying for it.

4. Conclusion

In this paper, we have introduced the idea of our new social network which is defined for serving the fundamental physiological requirements of human being. While some of these requirements have been already served by the existing social networks, many other requirements have not been considered yet. Therefore, the web and mobile social network that we define provides an opportunity for its users to support each other with new services as food, scholar facilities (e.g., books, stationeries), clothes, and children games. Any item of these types could be donated, exchanged, borrowed, or shared in their raw form and not as cash payment. In this way, this social network provides its users opportunities to profit from items which are not useful by other users momentarily or any longer instead of purchasing them.

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POWER GENERATION METHODS, TECHNIQUES AND ECONOMICAL STRATEGY

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Abstract

The world is facing problems of power Generation shortage, operational cost and high demand in these days. The main aim of this article is to know power generation methods, techniques and economical strategy which methods are suitable for indiviual country on the base its own natural resoucres, technical expertise and economy.This article is providing and guiding a best opportunity to select the right method and tecnique for right and economical power generation after study power generation, methods, Techniques and economical strategy.Many countries are producing the power against its opportunies and wrong methods. Every country can produce the power denpen upon its own local opportunits and resoucres under the guidlines of this article and its recoomendations.

Keywords: Guidelines & power generation

Introduction

The power generation and energy is back bone of every country to survice in this world. **Electricity generation** is the process of generating electrical power from other sources of primary energy. The fundamental principles of electricity generation were discovered during the 1820s and early 1830s by the British scientist Michael Faraday. His basic method is still used today: electricity is generated by the movement of a loop of wire, or disc of copper between the poles of a magnet. Mankind has been generating electricity on an industrial scale since 1881. The first power plants used hydroelectric power and coal power.

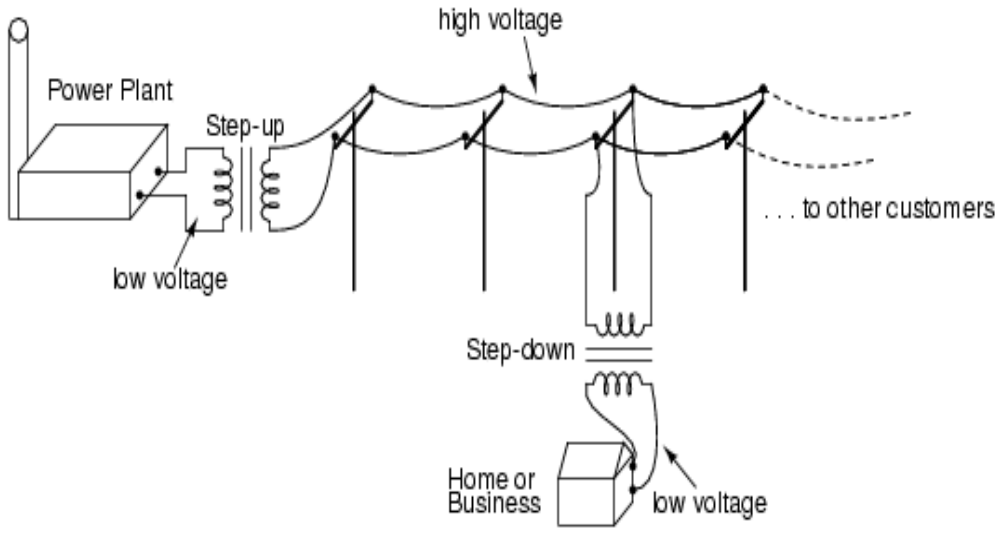
NOTE: <u>ALTERNATOR MEANS GENERATOR 'S ROTOR DRIVE & MOVE</u>: - BY (I.E. ENGINE, HYDRO, STEAM, WIND & GAS TURBINE, ETC)

An **alternator** is an electromechanical device that converts mechanical energy to electrical energy in the form of alternating current. Most alternators use a rotating magnetic field with a stationary armature but occasionally, a rotating armature is used with a stationary magnetic field; or

a linear alternator is used. The main aim is to move and drive the rotor by any method and techniques to produce power.

Alternators generate electricity using the same principle as DC generators, namely, when the magnetic field around a conductor changes, a current is induced in the conductor. Typically, a rotating magnet, called the rotor turns within a stationary set of conductors wound in coils on an iron core, called the stator. The field cuts across the conductors, generating an induced EMF (electromotive force), as the mechanical input causes the rotor to turn. The rotating magnetic field induces an AC voltage in the stator windings. Often there are three sets of stator windings, physically offset so that the rotating magnetic field produces a three phase current, displaced by one-third of a period with respect to each other.

Poles	RPM for 50 Hz	RPM for 60 Hz	RPM for 400 Hz
2	3,000	3,600	24,000
4	1,500	1,800	12,000
6	1,000	1,200	8,000
8	750	900	6,000
10	600	720	4,800
12	500	600	4,000
14	428.6	514.3	3,429
16	375	450	3,000
18	333.3	400	2,667
20	300	360	2,400
40	150	180	1,200



FUEL AND INPUT FOR POWER GENERATION

Petrol, Diesel, HFO, Uranium, Coal, Air, Earth Heat, Sea Water Waves, Water, Solar & Sunlight, Natural Gas, Biogas etc.

KEY POINT TO SELECT A RIGHT METHOD OF POWER GENERATION.

You have to select that method of power generation, when fuel and input will be local and not imported. That method will be cheap and excellence but based on your requirement of power and quality of power for industrial and domestic utilization. Solar power and wind power is not suitable for heavy load equipment and machinery. All methods have their own characteristics', quality, and quantity, merits & Demerits, fuel reliability & continuous availability, economical and utilization. The coal method is used maximum in the world for producing electricity in this time.

MOST IMPORT AND RELIABLY METHODS

These are very important, quality, high quantity, economical, industrial power insensitivity for heavy load and suitable methods of power generation i.e. Hydro-power, Coal Power, Nuclear, Thermal Power which are depend upon of the characteristic , economy and natural resources of every country. Hydro- and Coal power is very suitable, reliable and economical for Pakistan, China, India etc but worse for Saudi Arabia and Middle East etc. Whenever thermal power method is very economical, suitable and reliable for Saudi Arabia, Iran and Middle East etc but worse for Pakistan, India, and China etc.

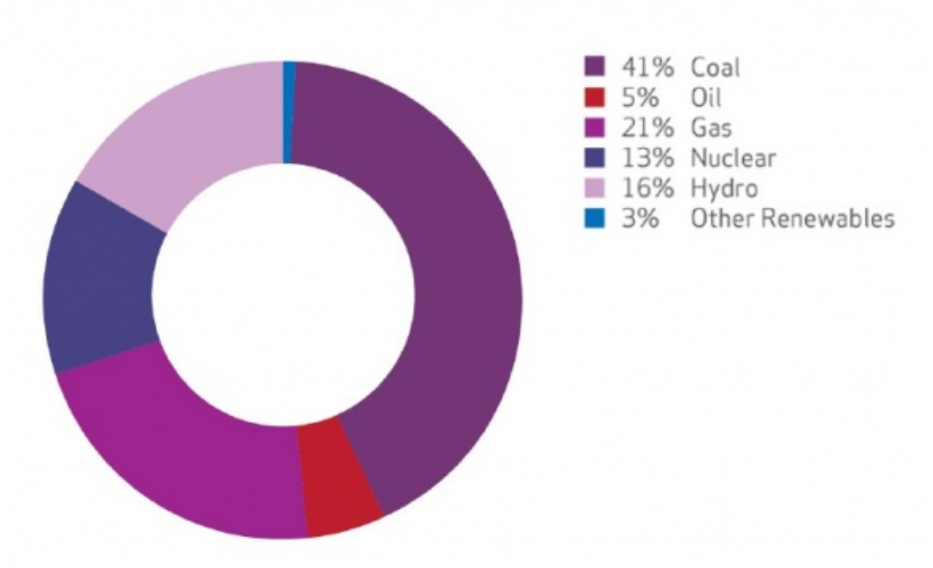
WORLD POWER GENERATION MACHINERY AND EQUIPMENT

BRAND: FG Wilson, AKSA- Turkey, Listterpetter-uk, Cummins-UK, VISA-Italy, Ottomotor- Mexico, GE-USA, GE-Jenbacher-Gas –Austria, Siemens- Germany, Caterpillar, Waukesha, Wartsila, Weichai & Sida, Dongfong-China. Mitsubishi-Japan, Jinko Solar, Hitachi, Toshiba, Man & Duetz-Germany, Toshiba-Japan etc.

I.C.Engine:- Weichai, Cummins, John Deere, Perkins, Volvo, Listerpitter, Chinese, Yuchai & Sida , MAN, Duetz etc,

Alternator :- Stamford, Leroy Somer, MECC, Sincro etc.

Factors Consider: - Economically, Quantity & quality, fuel-365, application, Capital investment etc.

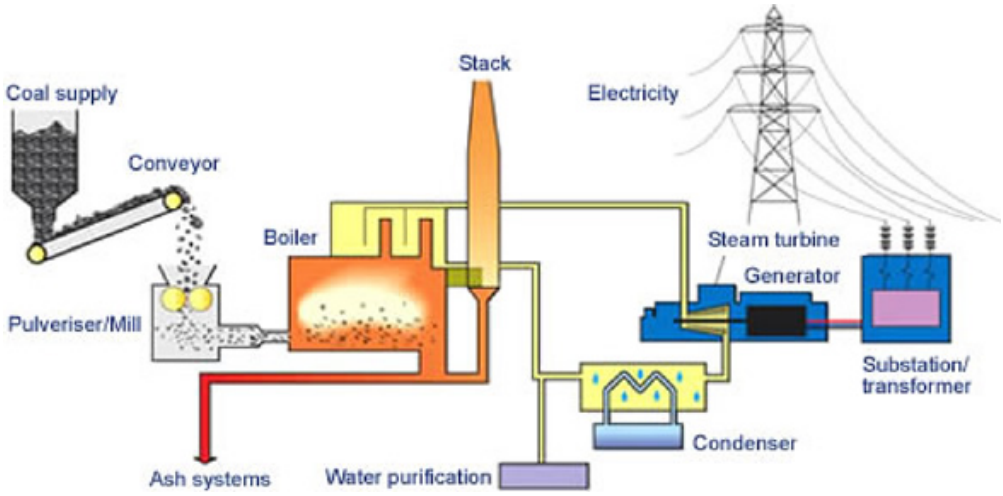


POPULAR WORLD POWER GENERATION FUEL & METHODS METHODS AND TECHNIQUES OF POWER GENERATION

There are different methods and techniques to generate the power and Electricity in the world with help of machinery and equipment as below.

1. COAL POWER GENERATION

Steam coal, also known as thermal coal, is used in power stations to generate electricity. Coal is first milled to a fine powder, which increases the surface area and allows it to burn more quickly. In these pulverized coal combustion (PCC) systems, the powdered coal is blown into the combustion chamber of a boiler where it is burnt at high temperature (see diagram below). The hot gases and heat energy produced converts water – in tubes lining the boiler – into steam.

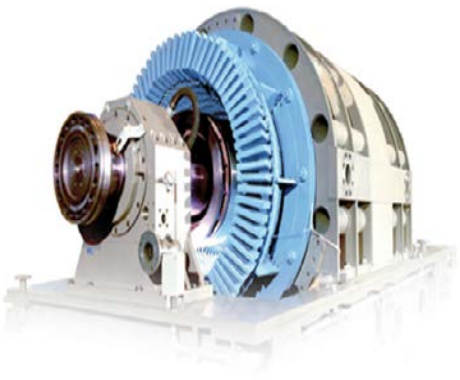


Coal plays a vital role in electricity generation worldwide. Coal-fired power plants currently fuel 41% of global electricity. In some countries, coal fuels a higher percentage of electricity.

Coal in Electricity Generation		
South Africa 93%	Poland 87%	PR China 79%
Australia 78%	Kazakhstan 75%	India 68%
Israel 58%	Czech Rep 51%	Morocco 51%
Greece 54%	USA 45%	Germany 41%

2. THERMAL POWER GENERATIONS

Small electricity generators are often powered by reciprocating engines burning diesel, biogas or natural gas. Diesel engines are often used for back up generation, usually at low voltages. However most large power grids also use diesel generators, originally provided as emergency back up for a specific facility such as a hospital, to feed power into the grid during certain circumstances. Biogas is often combusted where it is produced, such as a landfill or wastewater treatment plant, with a reciprocating engine or a micro turbine, which is a GE-Gas turbine and CAT –IE- Engine as below.



3. NUCLEAR POWER GENERATION

A nuclear reactor produces and controls the release of energy from splitting the atoms of uranium. Uranium-fuelled nuclear power is a clean and efficient way of boiling water to make steam which drives turbine generators. Except for the reactor itself, a nuclear power station works like most coal or gas-fired power stations.

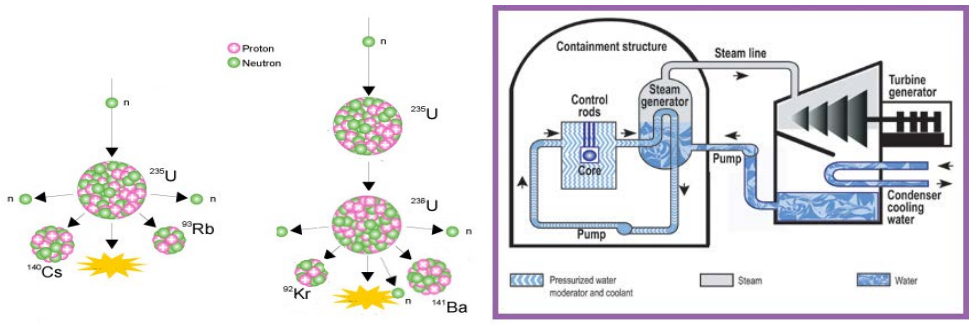


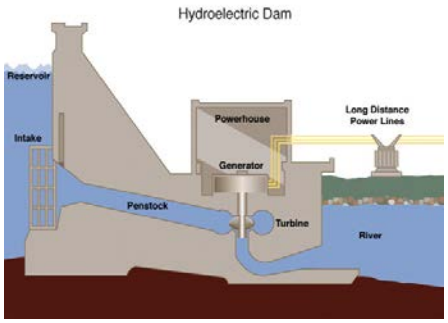
Diagram of Pressurized Water Reactor

PWRs and BWRs

The main design is the pressurized water reactor (PWR) which has water in its primary cooling/heat transfer circuit, and generates steam in a secondary circuit. The less popular boiling water reactor (BWR) makes steam in the primary circuit above the reactor core, though it is still under considerable pressure. Both types use water as both coolant and moderator, to slow neutrons.

4. ***HYDRO-POWER GENERATION***

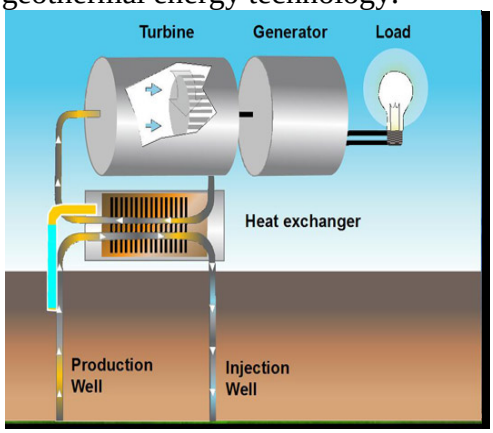
Hydro power is generated by using electricity generators to extract energy from moving water. Historically people used the power of rivers for agriculture and wheat grinding. Today, rivers and streams are re-directed through hydro generators to produce energy, although there are pros and cons as far as local ecosystems are concerned and diagram as below.

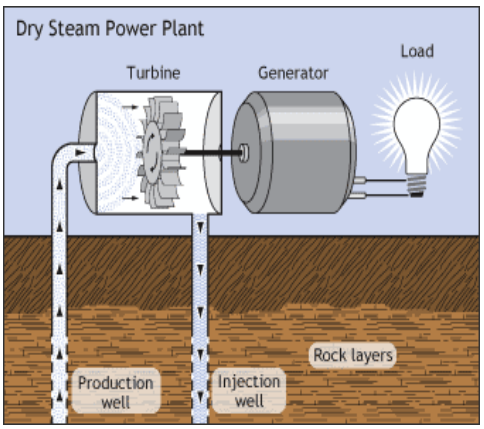


The Three Gorges Dam is a hydroelectric dam that spans the Yangtze River by the town of Sandouping, located in Yiling District, Yichang, Hubeiprovince, China. The Three Gorges Dam is the world's largest power station in terms of installed capacity (22,500 MW). In 2012, the amount of electricity the dam generated was similar to the amount generated by the Itaipu Dam.

5. ***GEOTHERMAL POWER GENERATION***

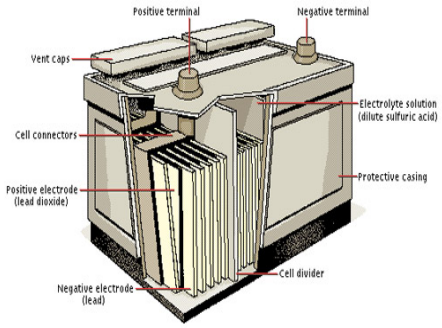
Geothermal energy is created by harnessing geothermal energy from the earth. Contrary to popular belief geothermal energy is not technically a renewable energy source. There is widespread debate as to its effectiveness for electricity generation or heating. The articles on this page explore geothermal energy technology.

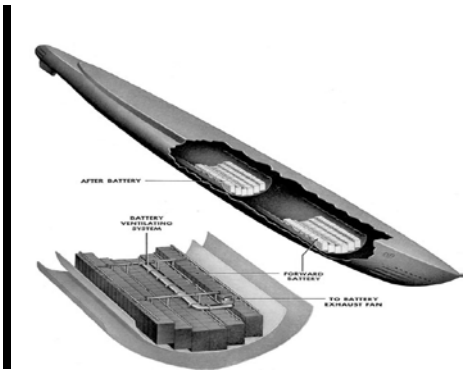




6. ***BATTERY POWER GENERATION***

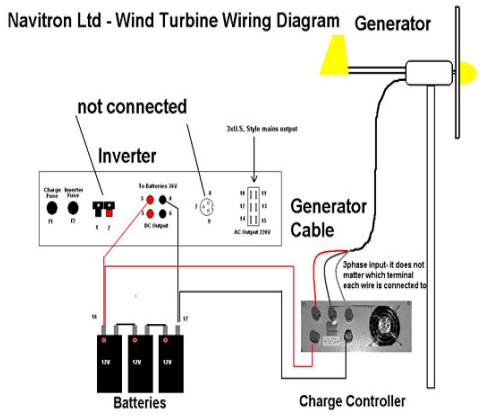
Batteries store electricity in a chemical form, inside a closed-energy system. They can be re-charged and re-used as a power source in small appliances, machinery and remote locations. Advances in battery technology may one day help to solve our energy crisis. The submarine and car are using battery power for operational this type. A submarine consists and use 24 cell for their operation in the sea and these cell are chargeable through diesel generator.

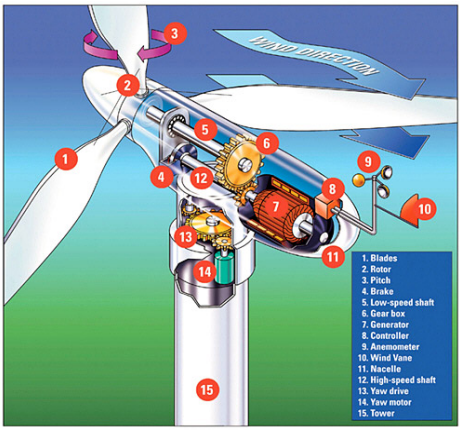




7. ***WIND POWER GENERATION***

Wind power is produced by using wind generators to harness the kinetic energy of wind. It is gaining worldwide popularity as a large scale energy source, although it still only provides less than one percent of global energy consumption.



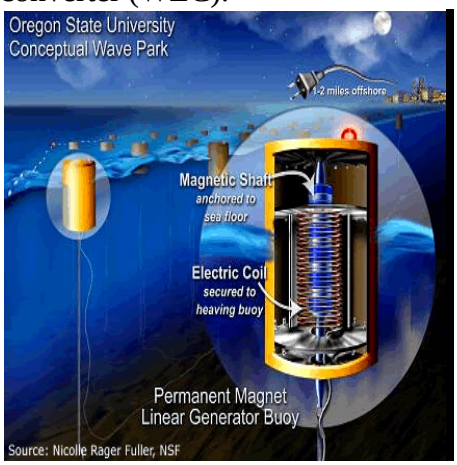


Wind turbines are used to generate electricity from the kinetic power of the wind. Historical they were more frequently used as a mechanical device to turn machinery. There are two main kinds of wind generators, those with a vertical axis, and those with a horizontal axis. Wind turbines can be used to generate large amounts of electricity in wind farms both onshore and offshore. The articles on this page are about wind turbines.

8. WAVES POWER GENERATION

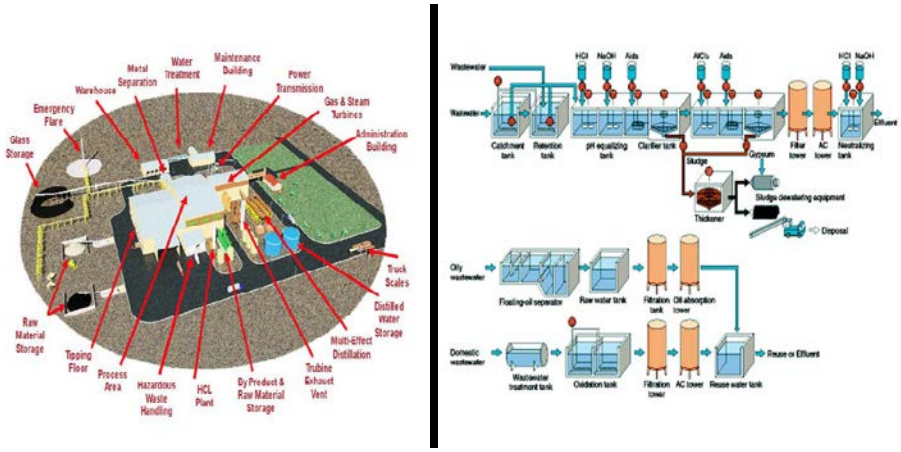
Wave energy is produced when electricity generators are placed on the surface of the ocean. The energy provided is most often used in desalination plants, power plants and water pumps. Energy output is determined by wave height, wave speed, wavelength, and water density. To date there are only a handful of experimental wave generator plants in operation around the world. The articles on this page explore the world of wave energy and its possible applications.

Wave power is the transport of energy by ocean surface waves, and the capture of that energy to do useful work – for example, electricity generation, water desalination, or the pumping of water (into reservoirs). Machinery able to exploit wave power is generally known as a wave energy converter (WEC).



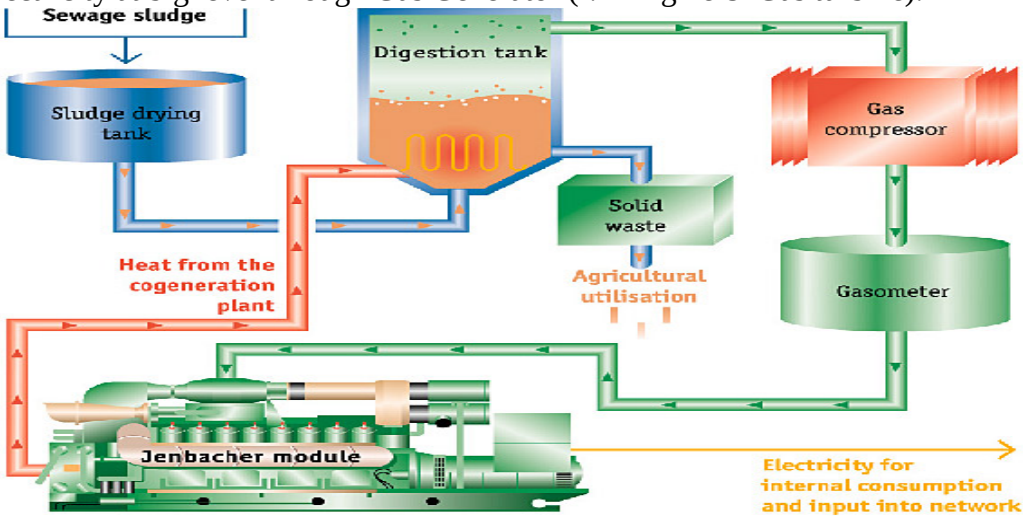
9. *WASTE WATER & BIO-GAS POWER*

The consumption habits of modern consumer lifestyles are causing a huge worldwide waste problem. Having overfilled local landfill capacities, many first world nations are now exporting their refuse to third world countries. This is having a devastating impact on ecosystems and cultures throughout the world. Some alternative energy companies are developing new ways to recycle waste by generating electricity from landfill waste and pollution.



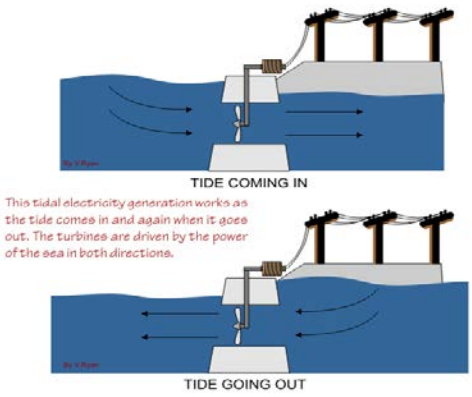
Note:- Wastage Water Hydro-Dam *can be make in the metropolitan and big city .We can study the total wastage water of big city per day and design the continuous wastage water available Hydro-Dam.*

The Bio Gas of city wastage can also be used to produce the electricity at big level through Gas Generator (I.E Engine & Gas turbine).



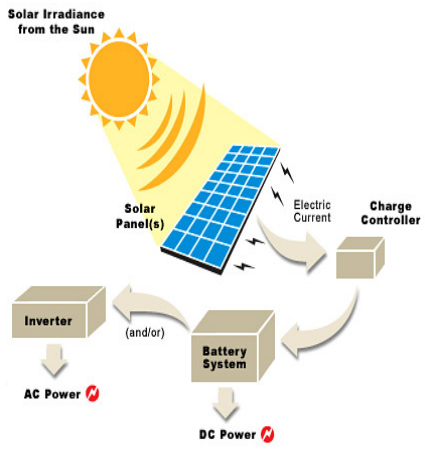
*10. **TIDAL POWER GENERATION***

Tidal energy is produced through the use of tidal energy generators. These large underwater turbines are placed in areas with high tidal movements, and are designed to capture the kinetic motion of the ebbing and surging of ocean tides in order to produce electricity. Tidal power has great potential for future power and electricity generation because of the massive size of the oceans.



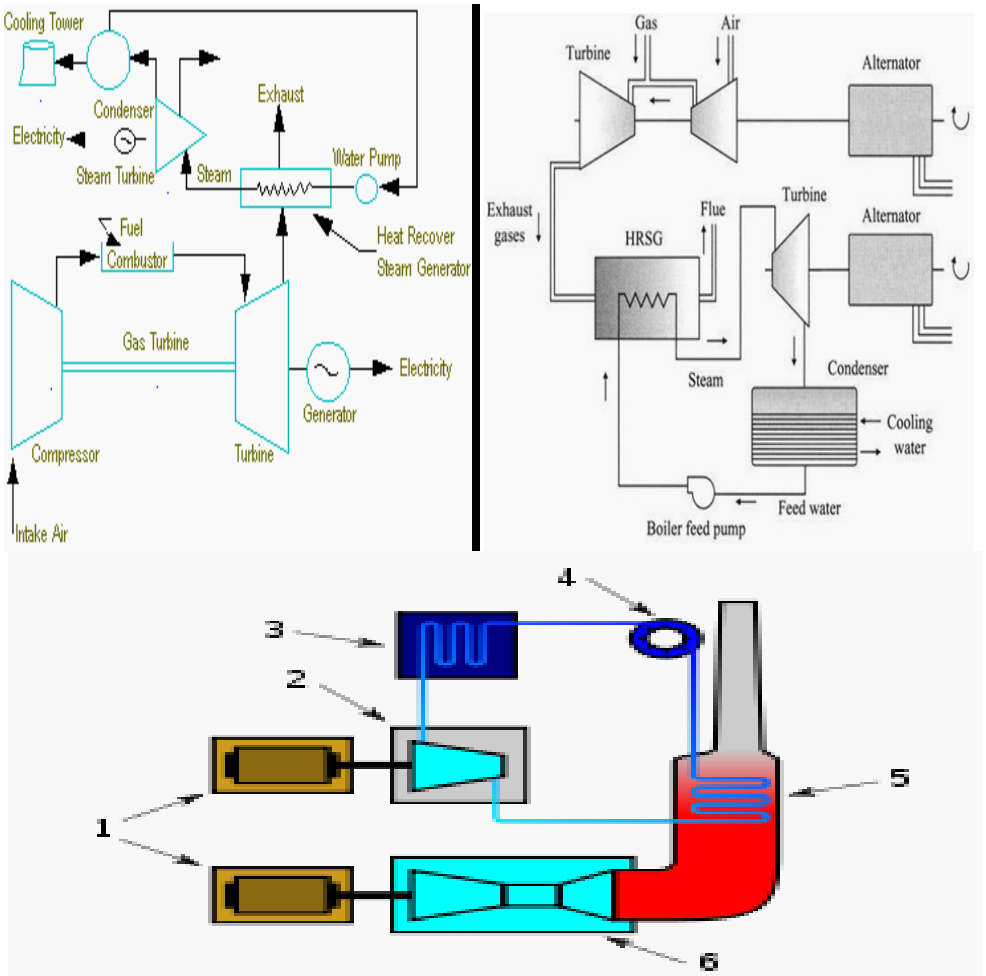
11. SOLAR POWER GENERATION

Solar power is produced by collecting sunlight and converting it into electricity. This is done by using solar panels, which are large flat panels made up of many individual solar cells. It is most often used in remote locations, although it is becoming more popular in urban areas as well.



12. COMBINE CYCLE POWER PLANT & GENERATION

In electric power generation a **combined cycle** is an assembly of heat engines that work in tandem from the same source of heat, converting it into mechanical energy, which in turn usually drives electrical generators. The principle is that the working fluid of the first heat engine is; after completing its cycle (in the first engine), still low enough in its Entropy, that a second; subsequent, heat engine may extract energy from the waste heat (energy) of the working fluid of the first engine.



Working principle of a combined cycle power plant (Legend: 1-Electric generators, 2-Steam turbine, 3-Condenser, 4-Pump, 5-Boiler/heat exchanger, 6-Gas turbine)

A gas turbine compresses air and mixes it with fuel. The fuel is burned and the resultant hot air-fuel mixture is expanded through turbine blades, making them spin about a shaft. The spinning turbine drives a generator that converts the spinning energy into electricity.

- Fuel is burned in a combustor
- The resulting energy in the gas turbine turns the generator drive shaft
- Exhaust heat from the gas turbine is sent to a heat recovery steam generator (HRSG)
- The HRSG creates steam using the gas turbine exhaust heat and delivers it to the steam turbine
- The steam turbine delivers additional energy to the generator drive shaft
- The generator converts the energy into electricity.

Economics of Power Generation and Production Of Electricity.

The world energy economy has the largest influence on the decisions that people and governments make. Current global consumption rates are depleting the planets ability to sustain our way of life. Increased demand means increased prices in every sector of the world economy. The selection of electricity production modes and their economic viability varies in accordance with demand and region. Hydroelectric plants, nuclear power plants, thermal power plants and renewable sources have their own pros and cons, and selection is based upon the local power requirement and the fluctuations in demand.

Nuclear, coal, oil and gas plants can supply base load, with the low-carbon option being nuclear. Thermal energy is economical in areas of high industrial density, as the high demand cannot be met by renewable sources. Nuclear power plants can produce a huge amount of power from a single unit. However, recent disasters in Japan have raised concerns over the safety of nuclear power, and the capital cost of nuclear plants is very high. Hydroelectric power plants are located in areas where the potential energy from flowing water can be harnessed for moving turbines and the generation of power.

It is not an economically viable source of production where the load varies too much during the annual production cycle and the ability to stop the flow of water is limited. Renewable sources other than hydroelectricity (solar power, wind energy, tidal power, etc.) due to advancements in technology, and with mass production, their cost of production has come down and the energy is now in many cases cost-comparative with fossil fuels. There are some very important example and point to study for producing the cheap and high torque bearable electricity for industrial and general consumption in a country.

The cost, quality and capacity of electricity depend upon the country and its nature resource along with economy. The power generation methods should be adopted and selected on the base of free nature fuel, 365 days per year's available, quality and quantity of requirement, characteristics, country economy, Environmental impact, reliability, capital and operational cost etc.

Conclusion & Recommendations:

The quality and usage of solar power, Waves power and battery power is not suitable for industrial and hard load as compare to Hydro, Nuclear, and Thermal electricity etc.

1. The thermal power is produced very expensive electricity in Pakistan but very cheap in Saudi Arabia and middle east.

2. The hydro-electricity will be very expensive in Saudi Arabia and Middle East but very cheap in Pakistan, India, China, Bangladesh etc. The water is not available whole years and face shortage in winter. China have world largest Hydro-Dam Three Gorges which can produce 22,500 MW power.
3. Pakistan has only one cheap and best method of electricity which is hydro-power. Pakistan can product thousand MW from the river and canal systems. The Hydro- power plant 22 MW is best example of HEAD RASOOL hydro-power in 1946.
4. The very method of electricity production has their own cost, quality; production capacity, equipment and machinery depend upon the every country economy and its natural resources which play a vital role for selection of feasible and suitable method in term of cost, capacity and quality of electricity.
5. The coal & HFO power generation is also very important and cheap method as compare to others method but if a country has good quantity and quality as input.
6. The machinery and equipment is also very important to produce cheap and electricity and its application.
7. All method should be adopt according to depend upon the application and area of country for taking best solution method.
8. Coal and thermal power generation method should be adopted and selected when country have it local available fuels. Otherwise it will be very expensive and failure of economy likes Pakistan energy crises. A doctor mistake kills a single person but an engineer mistake kill whole nation.
9. Pakistan should be adopted and selected only Hydro on river and canal, Gas-Turbine, Nuclear, Coal, solar and wind power on specific area for specific purpose. These are suitable and best economical method except thermal oil based. This is greatest blunder of Pakistan who gave the preference to thermal power as compare to others most economical methods. Saudi Arabia and Middle East made the Hydro Dam and take the water from others to fill the dam. What will be capital and operational cost? Who will be taken this decision but only a mad and mental leaders can do this?
10. The Hydro-Power method should be adopted those country which have river and canal systems. Pakistan should be designed the Hydro dam on river and canal which is best example of Head Rasool on Jehlum-link canal in 1946 and still working Two turbine 11MW each black smith –UK and prepared facility for third turbine but Pakistan became into. The Hindu narrow minded thinking did not send into

Pakistan from Delhi-India. Pakistan did not improve and enhance this project still. This is s level of Pakistan leaders planning and vision.

11. Nuclear method should have uranium as local material because it is very expensive material as compare to others. The water should be also required in good quality and quantity. They should have local capability to enrichment and prepare as raw material. Every country cannot afford and produce the nuclear power due to its Technical ability and resources.
12. Solar and Wind power method is applicable in the heavy sunlight and coastal sea area in small level production for light load. This is very expensive, complex and sensitive technology for small level. This should be adopted only for specific purpose and base feasibility in desert and sea. The huge area and continues sunlight required for solar power project for light load. These methods can produce few MW power with high capital cost as compare to others mechanical methods. The sunlight will be remained up to end of this world but free fuel for producing power through solar methods. Others all fuel can be disturb and shortage time to time but this will be available for every. This is very suitable for those countries which have maximum light per years and intensity of sunlight. Middle East Asia and Arab world are the best example and suitable for solar power production. The main factors and parameter is to select that area which feasibly for this purpose and requirement of solar power feasibility. The solar power is only one method which have fuel of sunlight forever as compare to all others methods and its fuel. It is also used in satellites where no others power available.
13. Waves and tidal power methods are also depend upon the main sources of life which is water. We can also produce the wave's power; if any country have the sea but rough sea is most suitable for this purpose. There is Death Sea which belongs to some country like Saudi Arabia, turkey; Russian etc. this method is depend upon underwater resource and good sea water waves.
14. Geothermal power generation method is used in very small level and available in very few countries. It is not use on commercial level properly and suitable for specific purpose.
15. The battery power method is used to produce DC and AC power for domestic and commercial application. This method is used for stand by and direct commercial application in Submarine, UPS, Telecommunication site and mobile. This power is used in small and specific purpose according to proper feasibility.
16. Waste water and Biogas is also very essential and excellent method to best utilization of your wastage and sewerage water. Sewage water

is used for filling the hydro-power generation dam in every metropolitan city. Hydro-Sewerage Water Dam is best concept and utilization for production of power in all big cities.

Biogas can be produced from wastage of all garbage of all cities and use to product the power through IC. Engine and Gas generators. It is also good process and procedure to adjust the wastage garbage of all cities. It is very simple and good method to produce power and easily available in world. Sugar industries already used this technology in Pakistan (Shakirghunj Sugar mill in Pakistan).

17. In physics, the **law of conservation of energy** states that the total energy of an isolated system cannot change—it is said to be *conserved* over time. Energy can be neither created nor destroyed, but can change form, for instance chemical energy can be converted to kinetic energy in the explosion of a stick of dynamite. The combine cycle power generation method is best technology and utilization of fuel in power sector. We are producing the power after utilization of fuel and the waste exhaust heat recycle into systems and turbine. The wastage of exhaust heat can be used for heating and cooling through chiller, boiler and many industrial process and operations. Still we are not using the exhaust heat of power plant for many fruitful purposes but through it into air. We can use all energy form and convert into another form for useful purpose.
18. All power generation fuel can be disturbed, finished and shortage except sunlight for solar power. The sunlight fuel is only available and reliable fuel forever in power generation till end of this world.
19. Coal power generation is mostly used to produce and popular power generation method in the world which is 41% out of 100%. It is most economical and available fuel 365 days.
20. The Coal, Hydro, Nuclear, Oil and Natural Gas power generations methods are producing 96% of world power and 4 % only through renewable energy methods. These five power Generation methods are using mechanical technique, equipment and machinery.
21. Only mechanical equipment and machinery can produce huge power as compare to others all methods. There is no replacement of internal Combustion engine (I.C Engine) and External combustion Engine (E.C Engine) in power generation sector and only can get maximum power from it.
22. Pakistan has no place in top twenty world largest power producing facilities whenever can do it every easily.
23. Flood water storage dam can also produce and store water in flood time and can also use whole years. Fire, Water and Air is huge a

power in this world and can be used it positive and negative according to Holy Quran 1400 years ago.

24. Pakistan, Bangladesh and India can produce million MW very cheap powers through river and best canal systems through running and storage water.
25. Every country should be adopted and selected a power generation method on base of only technical ground as compare to political decision making. An Engineers Team can make every impossible thing in this world after providing the right things on the base my article "Key of Success (15-Rights).

TOP 20 WORLD LARGEST POWER PRODUCING FACILITIES.

Rank	Station	Country	Location	Capacity (MW)	Annual generation (TWh)	Type
1	Three Gorges	China	30°49′15″N 111°00′08″E	22,500	98.1	Hydro
2	Itaipu	Brazil Paraguay	25°24′31″S 54°35′21″W	14,000	98.6 (2013)	Hydro
3	Guri	Venezuela	07°45′59″N 62°59′57″W	10,235		Hydro
4	Tucuruí	Brazil	03°49′53″S 49°38′36″W	8,370		Hydro
5	Kashiwazaki-Kariwa	Japan	37°25′45″N 138°35′43″E	8,212[note 1]	24.63	Nuclear
6	Xiluodu	China	28°15′52″N 103°38′47″E	7,700		Hydro
7	Grand Coulee	United States	47°57′23″N 118°58′56″W	6,809	24.5	Hydro
8	Longtan	China	25°01′38″N 107°0	6,426	18.7	Hydro

Rank	Station	Country	Location	Capacity (MW)	Annual generation (TWh)	Type
			2′51″E			
9	Sayano-Shushenskaya	Russia	54°49′33″N 91°22′13″E	6,400[note 2]	23.5	Hydro
10	Al-Qurayyah	Saudi Arabia	25°51′36″N 50°07′06″E	6,273		Oil
11	Bruce	Canada	44°19′31″N 81°35′58″W	6,272	36.25	Nuclear
12	Uljin	South Korea	37°05′34″N 129°23′01″E	6,157	44.81	Nuclear
13	Hanbit	South Korea	35°24′54″N 126°25′26″E	6,139	48.16	Nuclear
14	Krasnoyarsk	Russia	55°56′05″N 92°17′40″E	6,000	18.4	Hydro
15		South Korea	35°24′54″N 126°25′26″E	5,875		Nuclear
16	Hanul (Ulji n)	South Korea	37°5′34″N 129°23′1″E	5,873		Nuclear
17	Zaporizhzhia	Ukraine	47°30′44″N 34°35′09″E	5,700		Nuclear
18	Shoaiba	Saudi Arabia	20°40′48″N 139°31′24″E	5,600		Oil
19	Surgut-2	Russia	61°16′46″N 73°30′45″E	5,597.1		Natural Gas
20	Taichung	Taiwan	24°12′46″N 120°28′52″E	5,500		Coal

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first hydroelectric generating station was built on Niagara Falls.
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