


PAPER

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Ultrasensitive and bifunctional ZnO nanoplates for an oxidative electrochemical and chemical sensor of NO₂: implications towards environmental monitoring of the nitrite reaction†

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Herein, we focused on the one pot synthesis of ZnO nanoplates (NP edge thickness of ~100 nm) using a chemical emulsion approach for chemical (direct) and electrochemical (indirect) determination of NO₂. The structural and morphological elucidation of the as-synthesized ZnO NPs was carried out by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive analysis of X-ray (EDAX), thermogravimetric analysis (TGA) and BET-surface area measurements. The XRD studies of the as-synthesised NPs reveal that ZnO NPs have a Wurtzite type crystal structure with a crystallite size of ~100 nm. Such ZnO NPs were found to be highly sensitive to NO₂ gas at an operating temperature of 200 °C. Electrocatalytic abilities of these ZnO NPs towards NO₂/NO₂⁻ were verified through cyclic voltammetry (CV) and linear sweep voltammetry (LSV) using aqueous 1 mM NO₂⁻ (nitrite) in phosphate buffer (pH 7) solution. The results revealed enhanced activity at an onset potential of 0.60 V vs. RCE, achieved at a current density of 0.14 mA cm⁻². These ZnO NPs show selective NO₂ detection in the presence of other reactive species including CO, SO₂, CH₃OH and Cl₂. These obtained results show that this chemical route is a low cost and promising method for ZnO NPs synthesis and recommend further exploration into its applicability towards tunable electrochemical as well as solid state gas sensing of other toxic gases.

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1 Introduction

Nitrogen dioxide (NO₂) gas is well known to be one of the irritant gases, and is a prominent intermediate product of the industrial synthesis of nitric acid. Moreover, other common and considerable contributors to NO₂ gas production are combustion engines, the burning of fossil fuels, fertiliser industries, cigarette smoke, and butane and kerosene heaters and stoves.¹ Unfortunately, NO₂ can cause respiratory infections, photochemical smog and acid rain² and it is injurious to human health. Exposure to unsafe and elevated levels in the body can cause severe underlying diseases such as chronic obstructive pulmonary disease or asthma. For example, NO₂ reacts with water droplets in the trachea and lungs forming droplets of nitric acid and these tiny droplets penetrate deep into the lungs causing various respiratory diseases.³ Moreover, NO₂ exposure has also been associated with sudden infant death syndrome.⁴

Thus, it is imperative to develop a sensor for detecting NO₂ gas. Significantly, many solid state gas sensors have been recently explored for NO₂ gas sensing such as WO₃,⁵ VO₂,⁶ NiO,⁷ SnO₂ (ref. 8) and ZnO.⁹ Among these, ZnO is a cheap, stable and nontoxic material and it is possible to further improve its chemical and physical properties by controlling its dimensions in a micro/nano-regime. This motivated us to develop a new, cost effective, safer synthetic method for the synthesis of its nanostructures by a chemical approach, taking into consideration energy and environmental factors. The past literature reflects that the properties and performances of ZnO based devices are significantly influenced by its structural features.^{10,11} Recent studies in the literature have demonstrated that the crystal structure and its morphology have a significant influence on its surface sensitive reactions, especially gas-sensing, electronic, electrochemical and many more.^{12,13} For example, one-dimensional (1D) nanostructures of ZnO, such as nanowires,¹⁴ nanorods,¹⁵ and nanobelts¹⁶ and their hierarchical structures were widely used in gas sensor applications,¹⁵ also, recently, two-dimensional (2D) structures, such as NPs, have been another common structure of ZnO.^{17,18} Thus, the need for simple and cost effective ZnO based gas sensors further encourages us to design and develop a method for the synthesis

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Zinc oxide hierarchical nanostructures as potential NO₂ sensors



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ABSTRACT

A superficial thermal evaporation method has been employed for the fabrication of hierarchical zinc oxide (ZnO) nanostructured films, composed of nanorods (NR's) and bunch of nanowires (BNW's), on glass substrate and the diverse atmospheric annealing effect on their structural, morphological, compositional, and gas sensing properties has been systematically studied and reported. Structural investigation corroborates the formation of crystalline hexagonal wurtzite ZnO. The arrays of vertically aligned nanorods and bunch of nanowires of ZnO were observed on the substrate surface. As-prepared ZnO NR's and BNW's are utilized as a sensing material for detection of toxic nitrogen dioxide (NO₂). The ZnO sensors exhibit high response to NO₂ along with rapid response and recovery time values @200 °C. In addition, ZnO sensors respond to a very small exposure of NO₂ gas i.e. 1 ppm. Furthermore, the developed sensors attain excellent stability and reproducibility in response. Finally, the interaction of NO₂ gas molecules with hierarchical nanostructured ZnO sensors has successfully been studied and discussed by employing an electrochemical impedance spectroscopy measurement.

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1. Introduction

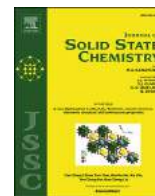
Metal oxide semiconductor-based gas sensors have been extensively investigated for the purpose of monitoring environmental biodiversity and detection of explosive and toxic gases at their lower concentrations [1–3]. Also, the detection of harmful gases is extremely essential for personal safety protection. In recent years, new morphologies like single-walled carbon nanotubes [4–6], nanoparticles [7–9], and semiconducting nanowires [10–13] etc., hold exhilarating prospects in sensors application, due to of their minuscule sizes; miniature molecules are enough active to vary the electrical properties of the sensor elements when used in electronic devices. One-dimensional (1D) nanostructured sensors have received considerable attraction as compared to thin film gas sensors due to their rapid response, superior spatial resolution, and higher sensitivity that arises from the elevated surface-to-volume ratio [14]. Recently, 1D semiconductor metal oxide nanostructures such as tin oxide (SnO₂), zinc oxide (ZnO), vanadium oxide (V₂O₅), and tungsten oxide (WO₃) have demonstrated excellent sensing properties with rapid response and recovery time values [15–22]. A

wurtzite crystal structure and wide band gap energy (3.37 eV) of ZnO made it a potential gas sensing material, which can be synthesized by chemical vapor deposition [23–26], thermal evaporation [25], plasma reaction [26], laser ablation [27], and arc/solution methods [28,29]. Among the abovementioned methods, growth of ZnO by thermal evaporation has several advantages as the growth is free from the catalyst. Due to intrinsic properties, ZnO (II–VI type semiconductor) has widely been used in several applications such as photocatalysts [30], solar cells [31], field effect transistors [32], luminescent materials [33], and gas sensor [34] etc. Moreover, it's less toxicity, low cost, availability of diverse morphologies, optimal conductivity, and amazing stability has additional benefits while scaling up the devices, used commercially.

Different types of ZnO nanostructures have been synthesized in literature and used in gas sensing application for the detection of methane, ethanol, nitric oxide, acetone, chlorobenzene, hydrogen, ammonia, nitrogen dioxide, and chlorine etc. [35–37]. A common air pollutant nitrogen dioxide (NO₂) gas is produced throughout combustion in industrial factories, automotive engines, and power plants. According to environmental protection agency (EPA), the toxicity limit of the NO₂ gas for the environmental issue is 53 ppb [38]. Therefore, there is a need to develop highly sensitive NO₂ gas sensors that can detect low concentrations of NO₂ with excellent

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Bismuth molybdate (α - $\text{Bi}_2\text{Mo}_3\text{O}_{12}$) nanoplates *via* facile hydrothermal and its gas sensing study

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ABSTRACT

Herein, we report a facile synthesis of bismuth molybdate (α - $\text{Bi}_2\text{Mo}_3\text{O}_{12}$) nanoplates (NPs) *via* hydrothermal route and studied its gas sensing performance. The developed α - $\text{Bi}_2\text{Mo}_3\text{O}_{12}$ was analyzed by various technique for structural and morphological studies. XRD analysis showed the monoclinic crystal structure of α phase of $\text{Bi}_2\text{Mo}_3\text{O}_{12}$ with crystalline size 40 nm. The morphological features were studied using FE-SEM and FE-TEM, showed $\text{Bi}_2\text{Mo}_3\text{O}_{12}$ nanoplates of thickness 20–25 nm and also showed the signs of variation with different hydrothermal reaction time. The chemical composition and their states were studied by XPS and EDAX analysis. The material was examined for gas sensing proficiency towards various reducing gases (acetone, ethanol, propanol, xylene, trimethylamine). $\text{Bi}_2\text{Mo}_3\text{O}_{12}$ NPs corroborate good selectivity (78%) towards ethanol at an optimum operating temperature 325 °C with the response and recovery time, 1'54s and 8'30s, respectively. Furthermore, the sensor showed better reproducibility and stability in response to consecutive exposure of ethanol. The α - $\text{Bi}_2\text{Mo}_3\text{O}_{12}$ has two acidic sites and one basic site, which excel the interactions and are responsible for better gas sensing performance.

1. 1. Introduction

Bismuth molybdates are an important class of semiconducting materials having the general chemical formula of $\text{Bi}_2\text{O}_3 \cdot n\text{MoO}_3$, where $n = 1-3$. Accordingly, they possess three phases (α , β , and γ) such as α - $\text{Bi}_2\text{Mo}_3\text{O}_{12}$, β - $\text{Bi}_2\text{Mo}_2\text{O}_9$ and γ - Bi_2MoO_6 [1,2]. Due to their interesting properties such as corrosion resistance, high dielectric strength, unique optical band gap, well-defined geometry, morphology, and cost effectiveness, they are receiving increasing attention in the research and development [3,4]. Amongst these three phases, n-type monoclinic bismuth molybdate (α - $\text{Bi}_2\text{Mo}_3\text{O}_{12}$) is more popular in applications such as catalyst in organic transformation, oxygen evolution, and pollutant degradation [5]. The specific reason is its highly oxygen-deficient fluorite structure (Mo atoms in $(\text{MoO}_4)^{2-}$ and vacancies with Bi sites) which facilitates possible chemical reactions. The vacancies are in an ordered

arrangement with Bi channels and three different Mo sites. Each of them coordinated with five O atoms favors the chemical reaction [6,7].

Historically, $\text{Bi}_2\text{Mo}_3\text{O}_{12}$ is considered as an industrial catalyst due to its various applications such as the conversion of propylene to acrylonitrile or selective oxidation of acrolein, the catalyst for oxidation of propene to acrolein, dehydrogenation of butane to butadiene [8] and literature therein. Owing to the high stability of bismuth molybdate, it is used as an active photocatalyst such as Hipólito et al., reported $\text{Bi}_2\text{Mo}_3\text{O}_{12}$ for photocatalytic nitrogen oxide (NO) removal [9] whereas, Cao, et al., and Liu et al., are prepared $\text{Bi}_2\text{Mo}_3\text{O}_{12}/\text{MoO}_3$ composites for efficient dye degradation [10], while, Mandlimath et al., explored $\text{Bi}_{2-x}\text{RE}_x\text{Mo}_3\text{O}_{12}$ nanorods for dye degradation. We have also reported pyridine intercalated $\text{Bi}_2\text{Mo}_3\text{O}_{12}$ nanorods [11].

In the state of art, various synthesis routes were adopted for developing $\text{Bi}_2\text{Mo}_3\text{O}_{12}$, namely, organic electrolyte-assisted UV-light exciting

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MWCNT incorporated silica aerogel prepared by ambient pressure drying: A recyclable catalyst for multicomponent synthesis of benzylpyrazolyl coumarin at room temperature

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Abstract

Multiwalled Carbon Nanotube (MWCNT) reinforced silica aerogel was synthesized in a very simple and cost effective sol - gel method. The process was followed by ambient pressure drying, and then the aerogel material was characterized by XRD, BET, SEM, EDX and FT-IR. 2.3×10^{-3} wt% MWCNTs were successfully incorporated in sodium silicate based silica aerogel. This metal-free nanocomposite catalyzed a four component organic reaction among 4-hydroxy coumarin, benzaldehyde, phenyl hydrazine, and ethyl acetoacetate for synthesizing medicinally important benzylpyrazolyl coumarin at room temperature. The MWCNT/silica aerogel composite material having easy accessible active sites and high catalytic activity was easily recovered and reused. The aerogel composite when impregnated with ceria offered very efficient and selective reaction methodology.

Keywords: MWCNT/silica aerogel synthesis; ambient pressure drying; heterogeneous catalysis; multicomponent reaction; benzylpyrazolyl coumarin.

Introduction

Multicomponent reactions (MCR) with atom economy, cost and energy savings, selectivity to desired product, easy work-up, catalyst recyclability and

the avoidance of metals and hazardous chemicals are of increasing importance among the wide range of methodologies explored in greening organic chemistry for the design and syntheses of biologically active molecules [1]. Partha P. Ghosh et

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MWCNT incorporated silica aerogel prepared by ambient pressure drying: A recyclable catalyst for multicomponent synthesis of benzylpyrazolyl coumarin at room temperature

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Introduction

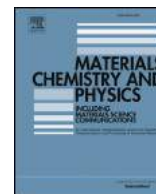
Multicomponent reactions (MCR) with atom economy, cost and energy savings, selectivity to desired product, easy work-up, catalyst recyclability and

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Enhanced energy density and stability of self-assembled cauliflower of Pd doped monoclinic WO₃ nanostructure supercapacitor



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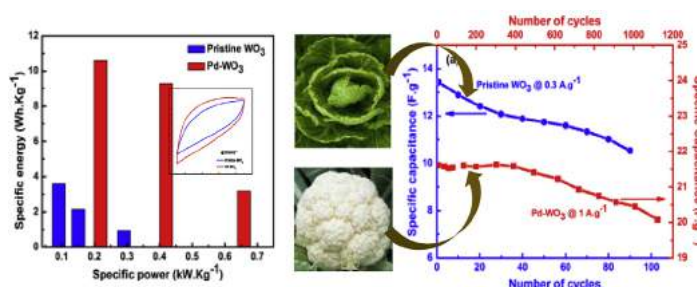
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HIGHLIGHTS

- Pristine WO₃ and Pd doped WO₃ is synthesized by simple hydrothermal method.
- The WO₃ cabbage morphology converted into WO₃ cauliflower by Pd doping.
- The greater surface area, crystallinity and conductivity are observed by doping.
- Almost four times higher specific capacitance is realized in WO₃ cauliflower.
- The excellent stability almost ten times higher is achieved in WO₃ cauliflower.

GRAPHICAL ABSTRACT



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Energy density

ABSTRACT

Enhanced electrochemical performance of WO₃ nanostructures by engineering their morphology, structural and surface defect at nanoscale is feasible. Herein we report the effect of Pd doping on the morphological and electrochemical properties of WO₃ at nanoscale prepared by a simple hydrothermal method. The synthesized pristine WO₃ (cabbage like morphology) and Pd doped WO₃ (cauliflower like morphology) are examined by using XRD, XPS, Raman spectra, BET, FE-SEM, TEM. The morphological investigation shows the effective re-building of nanosheets assembled cabbage shaped pristine WO₃ into nanobricks assembled cauliflower shaped Pd doped WO₃ with improvement in crystallinity, surface area and conductivity. As a result, the enhancement in the electrochemical performance of cauliflower shaped Pd-WO₃ is recorded four times higher specific capacitance than pristine WO₃. Additionally, the excellent cyclic stability (almost ten times higher than pristine WO₃) up to 1100 cycles with nearly 86.95% capacity retention is observed in Pd-WO₃ attributed to Pd content and highly modified structural arrangement.

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Synthesis of CuO thin film sensors by spray pyrolysis method for NO₂ gas detection

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ABSTRACT

The environmental pollution has become a major concern of today's era. Toxic gases such as CO, CO₂ and NO₂ are emitted from vehicles, industries, burning of crops etc. These gases are contributing a lot to the air pollution and also producing long term effect on lungs and respiratory system of human beings. Therefore gas sensing measurements for such toxic gases has received major attention. In this study, CuO is deposited by simple spray pyrolysis method and used for gas sensing measurements. The concentration of precursor solution is varied as 0.05 M, 0.1 M, 0.15 M and 0.2 M. The structural and morphological studies are done using XRD patterns and SEM images respectively. XRD patterns reveal the cubic structure of CuO. Gas sensing measurements have shown that the film deposited for 0.15 M concentration shows highest response of 56.23% for NO₂ gas. The lowest detection level has observed to be 5 ppm of NO₂. CuO has been found to be selective towards NO₂ gas.

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1. Introduction

Environment has its own composition of gases and other particulate matter. The increased composition of these constituents leads to the air pollution. There are number of factors those are responsible for the increased air pollution. Emissions from industries, vehicles' emissions and burning of crops contribute major to the air pollution. Therefore there is need of identifying the level of toxic gases in the environment. At the same time it is very important to install toxic gas detectors at many chemical industries in order to avoid accidents caused due to gas leakage.

So far various materials like polymers, metal oxides, mixed metal oxides etc. have been studied for the detection of various oxidizing and reducing gases like NO₂, CO, CO₂, H₂S etc. [1–6]. Amongst all materials, metal oxides are found to be more effective as gas detectors due to its low cost, high stability, high sensitivity, suitable morphology etc.

N-Type semiconducting metal oxides like ZnO, TiO₂, WO₃, In₂O₃ [7–9] etc. have been explored to large extent as a gas sensing material. However p-type materials are less used as gas detectors. Copper Oxide (III) or Cupric Oxide (CuO) is one of the p-type semiconducting metal oxides with energy band gap of 1.3 eV to 2.1 eV [10]. The surface area and defects introduced into the metal oxide during synthesis plays key role during gas sensing measurements. Therefore, proper selection of method for thin film deposition is very important. Deposition method should be simple, low cost and easy to handle. Spray pyrolysis is one of the advantageous techniques that provides stable thin film depositions [9].

In present investigation, we report study of NO₂ gas sensing properties of CuO thin films deposited by spray pyrolysis method for different solution concentration and effect of solution concentration on their structural, morphological and optical properties.

2. Experimental details

Copper chloride purchased from Sigma Aldrich (Purity: 99%) is used for preparing precursor solution. Copper chloride is dissolved

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Synthesis and structural, morphological, compositional, optical and electrical properties of DBSA-doped PPy–WO₃ nanocomposites



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ABSTRACT

Synthesis of DBSA-doped PPy–WO₃ (organic–inorganic) nanocomposites, using a novel approach, has been proposed, and further envisaged for their structural, compositional, morphological, optical and electrical properties. DBSA-doped PPy–WO₃ nanocomposites demonstrate superior above mentioned properties than their counterparts i.e. either PPy or WO₃. The XRD spectra of nanocomposites supported to conclude that both i.e. PPy and DBSA have no impact on the crystallinity of WO₃ nanoparticles. The chemical structure of DBSA-doped PPy–WO₃ nanocomposites have been elucidated using FTIR spectra. The morphologies and surface roughnesses of the DBSA-doped PPy–WO₃ nanocomposites were confirmed using scanning electron microscope and atomic force microscope images, respectively. Inter-connected type morphology and 13 nm average surface roughness were confirmed for DBSA doped PPy–WO₃ hybrid nanocomposites. The EDX and XPS analyses evidence that, the formation of DBSA doped PPy–WO₃ hybrid nanocomposites without any elemental impurities. The absorption peak of DBSA-doped PPy–WO₃ nanocomposites shift towards the lower wavelength side as compared to the PPy–WO₃ (50%) hybrid nanocomposites. Anionically charged sulfonate group which is supposed to stabilize doped state of the DBSA-PPy–WO₃ nanocomposites, may be responsible for this shift. The dc electrical conductivity of DBSA-doped PPy–WO₃ nanocomposites increases as the content of DBSA is increased from 10 to 50% this could be accounted for by the generation of conduction path through the PPy–WO₃ nanocomposites as DBSA has anionic surfactant nature by preventing an agglomeration of functional material.

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1. Introduction

Organic–inorganic nanocomposites (hybrid) are a fascinating class of materials, not only due to their fundamental properties but also for a number of practical applications [1–4]. Recently, nanocomposites have been studied extensively because of their potential applications in variety fields compared to corresponding pure organic and inorganic materials. Nanocomposites often exhibit unusual physical and chemical properties as compared to their bulk counterparts depending upon their sizes, shapes and stabilizing agents. The basic idea behind nanocomposites is to blend organic and inorganic materials into nanocomposites with molecular level control over interfaces, structures, and morphologies etc. [5,6]. These nanocomposites based on combination of organic and inorganic materials demonstrate several advantages over organic materials such as flexibility, light-weight, and good-moldability

and inorganic materials hold heat stability, high strength, and chemical resistance [7]. Depending upon the nature of association between the organic and inorganic components, nanocomposites are divided into two groups; one where the inorganic material is embedded into organic matrix, i.e. inorganic–in-organic composite [8] and the second, the organic polymer is confined into an inorganic material i.e. organic–in-inorganic composite [9]. These features of organic–inorganic nanocomposites help in designing various devices related to optics [10], electronics [11], gas sensors [12], mechanics [13] and photoconductors [14] etc.

In this context, we are successfully synthesized inorganic–in-organic composites where inorganic component is WO₃ nanoparticles which is well-embedded within the organic component i.e. polypyrrole (PPy). In juxtapose to this, we used DBSA as a dopant to modify the structural and the chemical properties of composites. Various sulfonic acids such as camphor sulfonic acid (CSA), dodecyl benzene sulfonic acid (DBSA), and β-naphthalene sulfonic acid (NSA) have been considered as dopants in literature [15]. Among available organic materials, PPy has attracted much interest because of its structural flexibility, excellent conductivity,

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Simple and low-temperature polyaniline-based flexible ammonia sensor: a step towards laboratory synthesis to economical device design†

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Flexible and highly sensitive polyaniline-based (PAni) ammonia (NH₃) gas sensors were developed through *in-situ* chemical oxidative polymerization of aniline on a polyethylene terephthalate substrate at three different temperatures, viz. 35 °C, 0 °C and −5 °C. In the initial stage, they were characterized with respect to their structural, morphological, and compositional analysis studies and in the second stage, the selectivity towards oxidizing (nitrogen dioxide, NO₂) and reducing (NH₃, ethanol, methanol and hydrogen sulphide, H₂S) gases was tested. The sensor fabricated at 0 °C showed an optimum response of 26% to 100 ppm NH₃ gas, which was superior to those obtained for the sensors developed at 35 °C (19%) and −5 °C (23%). The as-developed low-temperature flexible gas sensor demonstrated fast response (19 s) as well as recovery time (36 s) periods, 99% reproducibility and good stability, revealing commercial application potential for example in industry where high temperature operation is prohibited. Impedance spectroscopy was used to investigate the plausible interaction mechanism of the NH₃ gas molecules with the flexible PAni. The operation of the NH₃ gas sensor device, fabricated on a laboratory scale, was tested and explored as a demo-video clip.

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1. Introduction

Nowadays, a new trend towards the manufacturing of sensor films on a flexible substrate has become an interesting research topic, especially in modern electronics, where the fabrication of organic electronic devices on flexible substrates such as polyethylene terephthalate (PET) is essential for producing advanced portable consumer electronic items. Flexibility, shock resistance, low weight, and softness are merits on the record of the PET substrate.¹ Flexible and low-cost sensors have high potential for integration into smart electronic circuits used in fancy and lifestyle items.^{2,3} The main challenge in the field of gas sensors is not only the fabrication of flexibility, but also maintaining other properties like sensitivity, stability, reproducibility,

and mechanical and electrical strength at a desired level. The detection of toxic gases in the environment appears to dominate recent sensor research. The gases released from natural and industrial processes can cause both long term and immediate human health problems. Particularly, ammonia gas released from agricultural industries during the urea manufacturing process needs to be monitored. It has a sharp odor and if spills occur, problems like coughing and irritation follow quickly. Therefore, the development of simple and low-cost ammonia sensors for health and safety precautions is necessary.

Conducting polymers such as polyaniline (PAni), polypyrrole, and polythiophene are currently being heavily studied because of their remarkable electrical and mechanical properties, which are frequently utilised in sensors, actuators, and electronic devices.⁴⁻⁶ Among the family of conducting polymers, PAni has attracted much attention due to its easy synthesis and considerable environmental stability, and also its surface charge characteristics can be easily tailored by changing the dopant during the synthesis process. In recent reports, PAni has been envisaged for the detection of various oxidizing and reducing gases. Crowley *et al.*⁷ developed a PAni sensor using piezoelectric inkjet and screen printing methods which was further applied in the detection of hydrogen sulphide (H₂S), where a weak and slower response was observed. Sengupta *et al.*⁸ prepared PAni by a chemical oxidative polymerization method for NH₃ gas

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† Electronic supplementary information (ESI) available: Video-clip of operation of designed the flexible PAni sensor. See DOI: 10.1039/c5tc01483b



Rapid synthesis strategy of CuO nanocubes for sensitive and selective detection of NO₂



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ABSTRACT

In present work, copper oxide (CuO) films have been successfully synthesized onto a quartz substrate using a simple and catalyst-free thermal evaporation technique and their chemiresistive properties were carried out towards host of target gases. Structural analysis demonstrates the formation of polycrystalline single phase monoclinic CuO. Formation of nanocubes-type of surface morphology of CuO was observed from morphological investigation. Gas sensing results demonstrate that the CuO films, composed of nanocubes (NCs), are highly selective towards oxidizing nitrogen dioxide (NO₂) gas than other target gases along with rapid response and recovery times. CuO sensor films exhibit the maximum response value of 76%–100 ppm NO₂ @150 °C. In addition, CuO films are able to sense as low as 1 ppm concentration of NO₂ gas. The effect of operating temperature on the NO₂ sensing properties of CuO films was thoroughly investigated and reported. Impedance spectroscopy was used to study the interaction mechanism between CuO sensor film and NO₂ gas molecules.

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1. Introduction

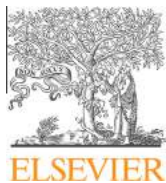
In recent years, the environmental air pollution has notably increased due to global industrialization, which is very harmful to the environment and human beings as well. The polluted air become hazardous due to growing in the concentration of poisonous gases like nitrogen dioxide (NO₂), carbon dioxide (CO₂), hydrogen sulfide (H₂S), carbon monoxide (CO), and sulphur dioxide (SO₂). Among these toxic gases, NO₂ is one of the most regular poisonous contaminants emitted from various fields such as combustion in automobile engines, home heaters, furnaces, and power plants [1,2]. NO₂ is also commonly generated from the many routine chemical production processes and photochemical smog, which is harmful to humans and animals. Even very low amounts of NO₂ gas are very toxic to humans and the environment as well [2]. As a result, the development of gas sensor systems, which can monitor NO₂ levels at low ppm concentrations is a challenge in the

gas sensing field. In the last few years, a variety of semiconducting metal oxides such as zinc oxide (ZnO), titanium dioxide (TiO₂), tin dioxide (SnO₂), and copper oxide (CuO) have been extensively investigated to detect NO₂ gas owing to their high response and excellent chemical stability [3–6]. The typical *p*-type semiconducting metal oxides such as cobalt oxide (Co₃O₄), nickel oxide (NiO), and CuO holds their individual characteristics [7–9]. Amongst them CuO has been extensively studied because of its variety of applications such as in high critical temperature superconductors, gas sensors, batteries, solar energy conversion systems, as a catalyst, and field emitters [8–10]. Till today, several physical and chemical routes such as polyol method, hydrothermal reaction, seed-mediated solution growth, anodization, thermal oxidation, and electro-spinning have been successfully utilized to prepare hierarchical CuO nanostructures [11–16]. All above-mentioned synthesis routes require higher processing temperatures and moderately sophisticated instruments.

In the present study, a simple and catalyst-free thermal evaporation (TE) method was successfully employed for the synthesis of CuO NCs onto quartz substrate. The TE method used for the

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Regular Article

Electrochemical synthesis and potential electrochemical energy storage performance of nodule-type polyaniline



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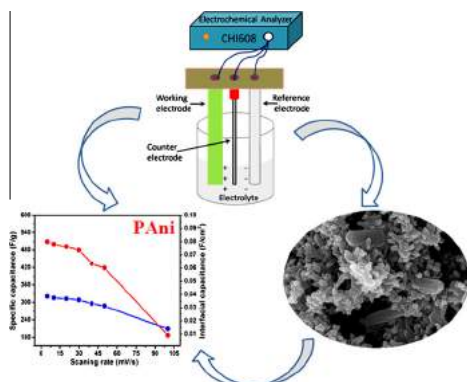
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ABSTRACT

Nodule-type polyaniline (PANi) has been successfully electrochemically synthesized onto conducting substrate and envisaged in electrochemical supercapacitor (ES) application as a potential energy storage electrode. Various bands are confirmed from the X-ray photoelectron and Fourier transform infrared spectra. Each nodule is of ~ 100 – 200 nm in length and 20 – 80 nm in diameter. The $\sim 45^\circ$ surface water contact angle with water of PANi surface can be beneficial for accessing an entire electrode area with minimum interfacial resistance loss when is in contact with the aqueous electrolyte for ES application. The PANi nodule-type electrode when electrochemically characterized using cyclic-voltammetry and galvanostatic charge–discharge measurements has demonstrated a specific capacitance of ~ 508 F g⁻¹, a specific energy of 32.12 W h kg⁻¹, a specific power of 13.39 kW kg⁻¹ and a Coulombic efficiency of 100% in 1 M H₂SO₄ electrolyte solution. An occurrence of 70% retention of initial capacity even after 5000 cycles is supporting for energy-storage application. Two separate redox reaction behaviors are confirmed in the discharge measurement.

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Short Communication

MWCNT/Silica aerogel: Preparation, characterization and applications in heterogeneous catalysis and decolorization of aqueous dye solutions

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Abstract

2.3 x 10⁻³ wt% multi-walled carbon nanotube incorporated silica aerogel (MWCNT/Silica aerogel) was synthesized by ambient pressure drying. The as-synthesized MWCNT reinforced silica aerogel was characterized by XRD, SEM, N₂-adsorption-desorption, etc. The MWCNT/Silica aerogel catalyzed a multicomponent reaction for synthesizing medicinally important benzylpyrazolyl coumarin derivative. And, in another application, the efficient decolorization of Eriochrome Black T and Methylene Blue from their respective aqueous solutions over MWCNT/Silica aerogel was also investigated using UV spectrophotometer. A comparison has also been made with decolorizing activities of silica gel and activated charcoal.

Keywords: MWCNT/Silica aerogel synthesis, ambient pressure drying, heterogeneous catalysis, dye decolorization

1. Introduction

Aerogel is an ultra-light synthetic porous material having unique microscopic (nanoscale skeleton) and macroscopic (condensed state matter) structural features. An aerogel is derived from gel made through sol-gel chemistry when the liquid component inside the wet gel is exchanged by air without damaging the solid microstructure (Kistler, 1931; Du, Zhou, Zhang, & Shen, 2013). Aerogels are attractive materials for their applications in thermal insulation, adsorption,

chemical sensors, catalysis, and space explorations. Usually silica aerogels have poor mechanical strength and are hygroscopic in nature. Off late, silica aerogels and metal-modified aerogels have been widely employed as catalyst support and catalysts (Müller, Schneider, Mallat, & Baiker, 2001). Carbon aerogels have interesting adsorption properties, structural stability, high thermal stability and most importantly the useful electronic conductivity for their applications in catalyst carriers, oil or organic solvents' adsorption and energy storage (Biener *et al.*, 2011; White, Brun, Budarin, Clark, & Titirici, 2014). Multi Walled Carbon Nanotubes (MWCNTs) were used as reinforcement to improve the mechanical properties of silica aerogels (Bangi, Kavale, Baek, & Park, 2012). MWCNT/Silica aerogel composites are useful hybrid aerogels (Bargozin, Amirkhani, Moghaddas, &

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Ahadian, 2012; Chernov *et al.*, 2016) and could be easily modified or fabricated than the pure carbon aerogels.

Herein, sol-gel method followed by ambient pressure drying was employed to prepare 2.3×10^{-3} wt% multi-walled carbon nanotube incorporated silica aerogel (MWCNT/Silica aerogel). This nanocomposite was characterized by XRD, BET, SEM, etc. and was evaluated as active catalyst for synthesis of benzylpyrazolyl coumarin in a multicomponent reaction (MCR). MWCNT/Silica aerogel was also employed as a functional material in decolorization of Eriochrome Black T (EBT) and Methylene Blue (MB) dyes from their respective aqueous solutions.

2. Experimental

2.1 Preparation of MWCNT incorporated silica aerogel

In a typical experiment, the dispersion of MWCNTs (2.3×10^{-3} wt%) was carried out by subjecting the mixture of MWCNTs, de-ionized water and Tween 80 to ultrasonication for 4 hrs. Thereafter, the gel was formed by mixing sodium silicate, MWCNTs and citric acid. The citric acid (3M) catalyzed the MWCNT/Silica gel formation. During the synthesis, the $\text{H}_2\text{O}:\text{Na}_2\text{SiO}_3$ molar ratio and the concentration of MWCNTs were kept constant at 146.67 and 2.3×10^{-3} wt% respectively and gel aging, solvent exchange, silylation and ambient pressure drying were subsequently performed. The surface of MWCNTs is functionalized with non-covalent surfactant Tween 80 so as to disperse the CNTs in water and the precursor solution. Tween 80 is an aromatic compound with the ethylene oxide as hydrophilic group. These hydrophilic groups play an important role in the generation of effective repulsive force by electrical double layer interactions. The adsorption of Tween 80 to the surface of MWCNTs helps to de-bundle CNTs by steric or electrostatic repulsions. The functionalization of MWCNTs using Tween 80 forms the hydroxyl groups on the surface of nanotubes helping CNTs get dispersed in the water. The silylated gels were dried at 50°C for one hour and then 200°C for one hour in PID controlled oven. A combination of sodium silicate and ambient pressure drying provides low cost alternative to the development of silica aerogels overcoming the difficulties encountered in expensive supercritical CO_2 drying. Photographs of the MWCNT/Silica aerogel material are shown in Figure 1.

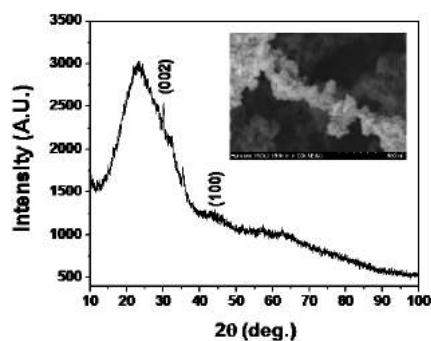


Figure 1. XRD pattern of MWCNT incorporated silica aerogel (Inset: FE-SEM image).

2.2 Characterization

Herein, low density (0.056 g/cc), highly porous (97%), semitransparent and super hydrophobic (148°) MWCNT incorporated silica aerogel was synthesized. The X-ray diffraction (XRD) pattern determined the crystallinity and composition whereas the Scanning Electron Microscopy (SEM) analyzed the morphology of the MWCNT/Silica aerogel (Figure 2). Figure 2 depicts the XRD diffractogram of MWCNTs/silica aerogel. It clearly shows a broad peak which is due to the amorphous and insulating nature of the nano-structured material. But there are two small peaks at 2θ of around 30.04° and 43.9° corresponding to the (002) and (100) planes of MWCNTs (Stamatin *et al.*, 2007). The Figure 2 inset depicting the SEM image of MWCNTs/Silica aerogel confirms the formation of mesoporous network structure and the capping of silica particles on the side walls of MWCNTs. This coupling is considerably strong and they cannot be detached from each other. This could be due to the hydrogen bonding interactions between silanol and surface OH groups on the modified MWCNTs surface as reported (Bangi, Kavale, Baek, & Park, 2012) in the reactions.

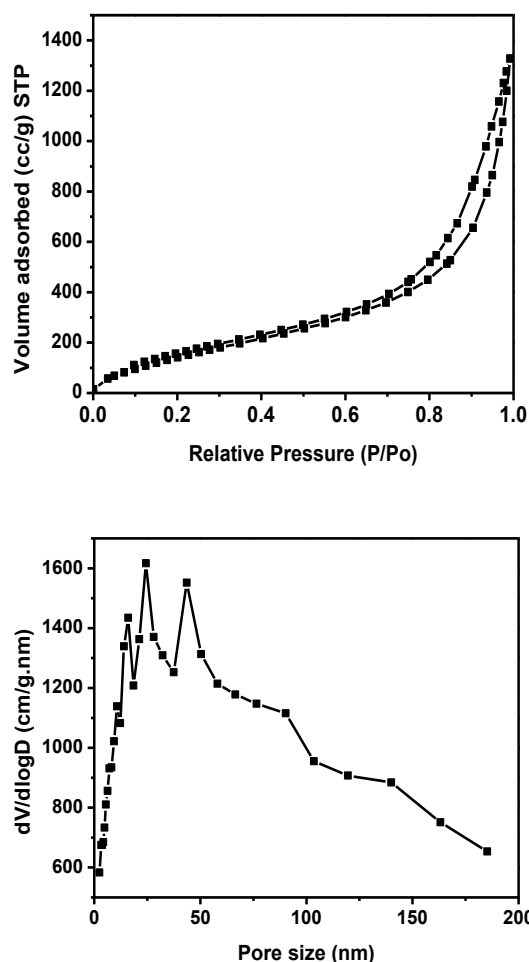


Figure 2. N_2 adsorption-desorption isotherm and pore size distribution.

The specific surface area, pore volume and pore size were derived from the N₂ adsorption–desorption isotherm at 77 K of the as-synthesized aerogel. As shown in Figure 3, the aerogel exhibited type IV isotherms with a type H1 hysteresis loop, typical for mesoporous materials. Further the material showed broad asymmetrical pore size distributions in the micro-mesopore range with more mesopores. The MWCNT/Silica aerogel exhibits high BET surface area of 645.65 m²/g, Langmuir surface area 1406.3 m²/g, BJH surface area 740.60 m²/g, pore volume 2.0113 cc/g and the average pore diameter of 12.46 nm.



Figure 3. Photographs of the MWCNT/Silica aerogel.

2.3 Applications

2.3.1 Catalyzed four-component organic reaction

The catalytic property of the MWCNT/Silica aerogel was studied by employing 15 mg of material in an MCR of phenyl hydrazine (1.0 mmol), ethyl acetoacetate (1.0 mmol), benzaldehyde (1.0 mmol) and 4-hydroxycoumarin (1.0 mmol) in the presence of acetonitrile as the solvent at room temperature and it afforded 60% yield of the desired benzyl-

pyrazolyl coumarin product within 40 minutes. The catalyst was easily recovered and reused without any loss in activity. Figure 4 shows the mass spectrum of the MCR product namely 4-((4-hydroxy-2-oxo-2H-chromen-3-yl)(phenyl)methyl)-5-methyl-2-phenyl-1H-pyrazol-3(2H)-one.

2.3.2 Decolorization of Eriochrome Black T and Methylene Blue from aqueous solutions

Organic dyes induce water pollution and the cleaning of this dye-medium i.e. the aqueous solution of dye is one of the most serious environmental problems today (Brillas & Martínez-Huitle, 2015). Methylene Blue (or Methylthionium chloride) is a potent cationic dye and is classified basic in nature by the Color Index International. MB (CAS Number 122965-43-9, Molecular Formula C₁₆H₁₈ClN₃S·xH₂O, MW 319.85, Absorption λ_{max} 660-665 nm) with thiazine group as the chromophore has been extensively used to dyeing paper, wool, silk and cotton. An excessive MB exposure may lead to side-effects (Janani, Rani, Ellappan, & Miranda, 2016) including health-issues such as dizziness, severe headache, hypertension, serotonin toxicity, etc. Eriochrome Black T / EBT (CAS Number 1787-61-7, Molecular Formula C₂₀H₁₂N₃NaO₇S, MW 461.38, Absorption λ_{max} 503 nm) is an azo dye with -N=N- (azo) structure as the chromophore. A literature survey showed that only few reports have raised the removal of EBT (Luna, Flores, Genuino, Futralan, & Wan, 2013).

3. Results and Discussion

The present manuscript reports preliminary results with respect to catalytic application of MWCNT/Silica aerogel and environmental application while touching upon the chemical as well as thermal and mechanical pathways behind the decolorization (of dyes).

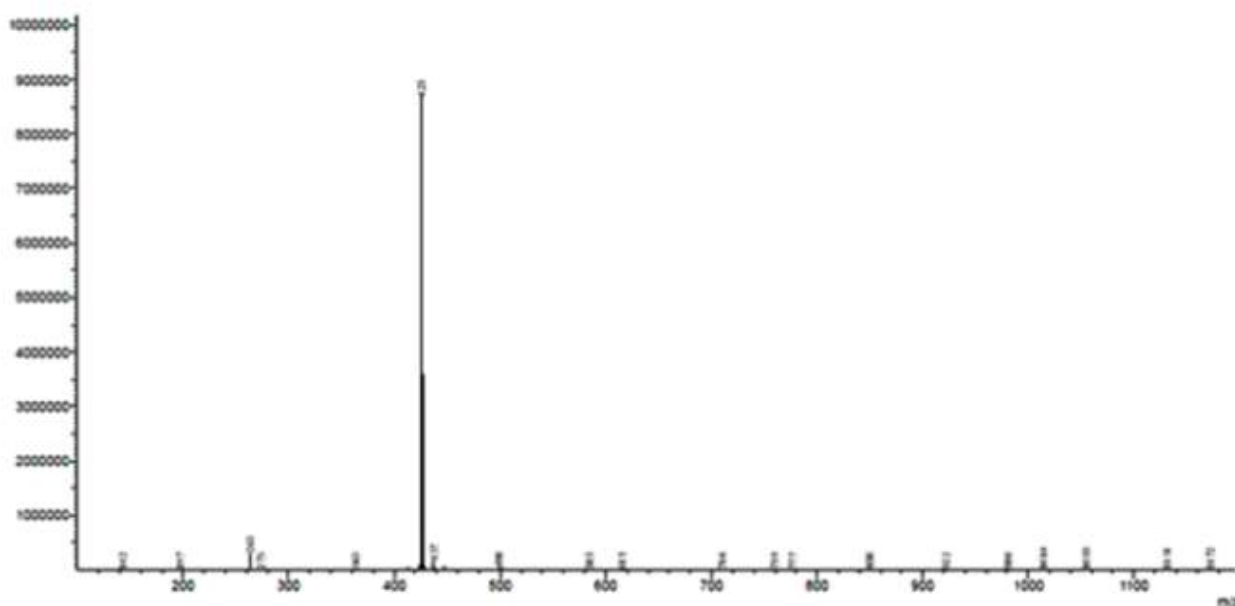


Figure 4. Mass spectrum of the MCR product.

3.1 MWCNT/Silica aerogel catalyzed synthesis of benzylpyrazolyl coumarin derivative

This MWCNT/Silica aerogel offered scope for its utility in organic reactions because of high silicon content and hydrophobic nature stemming from the surface $-\text{CH}_3$ groups. Active sites for the MCR on this catalytic material could have been generated by dehydroxylation of surface isolated hydroxyl groups or the strained siloxane bridge. Though we have no direct evidence of carbocatalysis or catalysis by MWCNTs as such, for sure, there is no metal impurity responsible for this catalytic application. In addition to this catalyzed MCR of phenyl hydrazine, ethyl acetoacetate, benzaldehyde and 4-hydroxycoumarin, the research results on the use of MWCNT/Silica aerogel and modified MWCNT/Silica aerogel as heterogeneous catalyst is underway and will be published in full elsewhere.

3.2 Decolorization of aqueous dye solutions by MWCNT/Silica aerogel

Dyes appear colored because these aromatic compounds absorb some particular wavelengths of light more than others. Most dyes are resistant to aerobic digestion (biological wastewater treatment) and are therefore very difficult to degrade and decolorise (owing to their structural features). The activated carbon has drawn widespread attention because it is able to adsorb various types of coloring contaminants with ease but high operation cost and regeneration complexity are the major limiting factors in setting-up an activated carbon unit in a wastewater treatment plant. It would be good if one could employ green chemistry approach or technique to remove water coloration by using functional materials other than the prevalent metal containing semiconductors (Sharma, 2015). In addition to adsorption, chemical treatment through destructing the chromophoric group of dye is yet another useful methodology. The authors expect that though the chemical destruction of chromophore does not offer the complete mineralization, this method can be applied to the treatment of colored water in combination with adsorption or absorbance techniques (Figure 5).

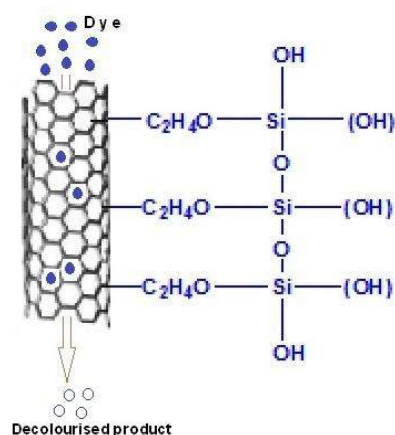


Figure 5. Schematic representation of the MWCNT/Silica aerogel. Silanol groups capped on a single layer of functionalized MWCNT are shown here.

The major advantages the authors have herein is of using ultra-light metal-free aerogel, which at its face value, allows us to apply different physical and chemical techniques at once with easy decolorization of the selected dye solutions. This is evident from the UV absorbance and % absorbance data noted down from the UV spectrophotometer at the respective lambda max of the chromophoric groups. A comparison has also been made with decolorizing activities of silica gel and activated charcoal. In case of the decolorization of aqueous MB dye solution, the activated charcoal showed the best performance followed by silica and then this MWCNT/Silica aerogel. In separate experiments with respect to the decolorization of EBT from its aqueous solution [Table 1 and the observations written and remarks given therein], the MWCNT/Silica aerogel showed the best efficiency followed by silica and then the activated charcoal. The best results were also confirmed after 2 hours' time-on-experiment using UV spectrophotometer.

4. Conclusions

Herein, sol-gel method followed by ambient pressure drying was employed to prepare 2.3×10^{-3} wt% multi-walled carbon nanotube incorporated silica aerogel. The as-synthesized material was appropriately characterized. This metal-free aerogel nanocomposite was found to be active towards the synthesis of benzylpyrazolyl coumarin via a four-component reaction of 4-hydroxy coumarin, benzaldehyde, phenyl hydrazine, and ethyl acetoacetate at room temperature. The MWCNT/Silica aerogel is also found efficient in decolorizing aqueous solutions of EBT and MB dyes.

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References

- Bangi, U. K. H., Kavale, M. S., Baek, S. S., & Park, H. H. (2012). Synthesis of MWCNTs doped sodium silicate based aerogels by ambient pressure drying. *Journal of Sol-Gel Science and Technology*, 62, 201-207. doi:10.1007/s10971-012-2710-1
- Bargozin, H., Amirkhani, L., Moghaddas, J. S., & Ahadian, M. M. (2012). Synthesis and application of silica aerogel-MWCNT nanocomposites for adsorption of organic pollutants. *Transaction F: Nanotechnology*, 17(2), 122-132. Retrieved from <http://archive.scientiairanica.com/PDF/Articles/00001538/moghadas.pdf>

- Biener, J., Stadermann, M., Suss, M., Worsley, M. A., Biener, M. M., Rose, K. A., & Baumann, T. F. (2011). Advanced carbon aerogels for energy applications. *Energy and Environmental Science*, 4, 656-667. doi:10.1039/C0EE00627K
- Brillas, E., & Martínez-Huitle, C. A. (2015). Decontamination of wastewaters containing synthetic organic dyes by electrochemical methods. An updated review. *Applied Catalysis B: Environmental*, 166-167, 603-643. doi:10.1016/j.apcatb.2014.11.016
- Chernov, A. I., Predein, A. Y., Danilyuk, A. F., Kuznetsov, V. L., Larina, T. V., & Obraztsova, E. D. (2016). Optical properties of silica aerogels with embedded multiwalled carbon nanotubes. *Physica Status Solidi B*, 253, 2440-2445. doi:10.1002/pssb.201600326
- de Luna, M. D. G., Flores, E. D., Genuino, D. A. D., Futralan, C. M., & Wan, M. W. (2013). Adsorption of eriochrome black T (EBT) dye using activated carbon prepared from waste rice hulls-optimization, isotherm and kinetic studies. *Journal of the Taiwan Institute of Chemical Engineers*, 44, 646-653. doi:10.1016/j.jtice.2013.01.010
- Du, A., Zhou, B., Zhang, Z. H., & Shen, J. (2013). A special material or a new state of matter: A Review and Reconsideration of the Aerogel. *Materials*, 6, 941-968. doi:10.3390/ma6030941
- Janani, S., Rani, K. S. S., Ellappan, P., & Miranda, L. R. (2016). Photodegradation of methyl blue using magnetically reduced graphene oxide bismuth oxybromide composite. *The Journal of Environmental Chemical Engineering*, 4, 534-541.
- Kistler, S. S. (1931). Coherent expanded aerogels and jellies. *Nature*, 127, 741. doi:10.1038/127741a0
- Müller, C. A., Schneider, M., Mallat, T., & Baiker, A. (2001). Amine-modified titania-silica hybrid gels as epoxidation catalysts. *Applied Catalysis A: General*, 201, 253-261. doi:10.1016/S0926-860X(00)00446-4
- Sharma, S. K. (2015). *Green chemistry for dyes removal from waste water: Research trends and applications*. Salem, MA: Wiley-Scrivener Publishing.
- Stamatin, I., Morozan, A., Dumitru, A. Ciupina, V., Prodan, G., Niewolski, J., & Figiel, H. (2007). The synthesis of multi-walled carbon nanotubes (MWNTs) by catalytic pyrolysis of the phenol-formaldehyde resins. *Physica E*, 37, 44-48. doi:10.1016/j.physe.2006.10.013
- White, R. J., Brun, N., Budarin, V. L., Clark, J. H., & Titirici, M. (2014). Always look on the "light" side of life: sustainable carbon aerogels. *ChemSusChem*, 7(3), 670-689. doi:10.1002/cssc.201300961

Journal Name

ARTICLE

Nanomorphology-dependent pseudocapacitive properties of NiO electrodes engineered through controlled potentiodynamic electrodeposition process[†]

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 DOI: 10.1039/x0xx00000x
www.rsc.org/

 Rohan M. Kore,^a Rajaram S. Mane,^{b,c} Mu. Naushad,^c Mohammad R. Khan,^c and Balkrishna J. Lokhande^{a,*}

Three nickel oxide (NiO) electrodes of different morphologies have been successfully engineered through a controlled potentiodynamic electrodeposition process in the presence of different nickel precursors. Effect of nickel precursors on structural, morphological and pseudocapacitive properties of NiO thin film electrodes have been systematically investigated. The structural information obtained from the X-ray diffraction patterns confirms the formation of cubic structured NiO. The field-emission scanning electron microscopic images endorse for the evolution of uniformly distributed up-grown nanoflakes, irregular nanoflake-like and a well-covered porous architecture comprised of interconnected uniform nanoflakes of NiO nanostructures with surface contact angle values 126°, 148° and 104°. The effect of the developed NiO nanostructures on pseudocapacitive behavior has been thoroughly investigated using cyclic voltammetry, chronopotentiometric charge-discharge and electrochemical impedance spectroscopy measurement techniques. The optimal specific capacitance of 893 F g⁻¹ has been achieved for NiO electrode having interconnected nanoflake-type morphology at the scan rate of 5 mVs⁻¹. Furthermore, these NiO electrodes have demonstrated long-term cycling stability in KOH electrolyte. The electrochemical impedance spectroscopy measurements carried out on developed NiO nanostructured electrodes corroborate that, NiO electrode composed of uniformly distributed interconnected nanoflakes is best and suitable electrode for good capacity electrochemical supercapacitor among others.

Introduction

The development of human civilization and advancement of modern technology have made energy at the centre of everlasting quest. An important intermediate step towards versatile and efficient energy applications includes energy storage and its transportation with minimum losses. Most effective and practical technologies, presently preferred, for electrochemical energy storage comprises batteries, fuel cells and electrochemical supercapacitors (ECs). ECs or ultracapacitors have attracted significant attention, mainly due to their high power density, long lifecycle and bridging function for the power/ energy gap between traditional capacitors (high power output) and batteries/fuel cells (high energy storage).¹⁻³ However, depending on the charge storage mechanism as well as active

materials used, ECs are classified into two categories. One, in electrochemical double layer capacitors (EDLCs), where carbon-based active materials, graphene etc., are in general considered, which stores charges at electrode/electrolyte interface. While in second type i.e. pseudocapacitors or redox supercapacitors, charge storage in electrode materials like transition metal oxides as well as electrically conducting polymers takes place through fast and reversible surface/near-surface reactions.⁴ Among various transition-metal oxides including RuO₂, IrO₂, MnO₂, NiO, Co₂O₃, SnO₂, Fe₂O₃, V₂O₅ etc.,⁵⁻¹³ nickel oxide (NiO) has found considerable attention and interest, due to its high theoretical capacity (2573 F g⁻¹), low-cost, low-toxicity, low environmental impact and sufficiently large pseudo-capacitive behaviour.^{14,15} There are several methods so far used to tune the size, shape and morphology of electrode used for EC. Commonly, layered nickel hydroxide (Ni(OH)₂) with various morphologies can be synthesized from solution methods like chemical precipitation,¹⁶ electrodeposition,¹⁷ followed by thermal decomposition using solutions of Ni(II). Lee *et al.* synthesized hierarchical microspheres of α -Ni(OH)₂ nanosheets, intercalated with desired anionic species (Cl⁻, NO₃⁻, OAc⁻, and SO₄²⁻), and showed change in specific capacitance as a function of size of the intercalated anion.¹⁸ Dubal *et al.* developed different nanostructures of β -Ni(OH)₂ using chemical bath deposition method from different nickel precursors.¹⁹ It is inferred that, the surface morphology and

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^b Centre for Nanomaterials & Energy Devices, School of Physical Sciences, SRTM, University, 431606, Nanded, India.

^c Department of Chemistry, College of Science, Bld#5, King Saud University, Riyadh, Saudi Arabia.

*Address to whom all correspondence can be addressed.

[†]Electronic Supplementary Information (ESI) available: Figure S1-S3 and Electronic circuitry parameters Table S1. DOI: 10.1039/x0xx00000x

Dielectric properties of poly(4-vinylphenol) with embedded PbO nanoparticles

WooJe Han^a, Hong-Sub Lee^a, Uzma K. H. Bangi^{a,b}, Byungwook Yoo^c and Hyung-Ho Park^{a*}

An organic/inorganic nanocomposite film was synthesized using poly(4-vinylphenol) (PVPh) as an organic insulating polymer and PbO nanoparticles as a high-k inorganic material to serve as an organic insulator with enhanced dielectric properties. PbO nanoparticles were dispersed into propylene glycol monomethyl ether acetate, and a solution of PbO/PVPh nanocomposite was prepared by adding a crosslinker. The PbO nanoparticle content within the PVPh polymer matrix was varied, and the effects of this variation upon the properties of the resulting nanocomposite films were studied, including the properties of surface morphology, surface bonding state and dielectric characteristic. The dielectric constant increased with increasing PbO content, reaching 9.2 at 1 MHz and with dielectric loss below 0.09 for the PbO content of 6 vol%. Furthermore, the leakage current increased to only $1.3 \times 10^{-8} \text{ A cm}^{-1}$ at the highest nanoparticle loadings, compared to the 7.2×10^{-9} of pristine PVPh. The addition of PbO nanoparticles was found to effectively suppress the absorption of moisture on the surface of PbO/PVPh nanocomposite, although it also increased surface roughness, owing to the agglomeration and particulation of PVPh arising from an anchoring effect of the PbO nanoparticles. Copyright © 2015 John Wiley & Sons, Ltd.

Keywords: PbO; PVPh; nanocomposite; dielectric property; surface roughness

INTRODUCTION

Recently organic materials have been attracted much attention in the development of thin film transistor (TFT) for many application fields.^[1,2] One of popular research area is flexible display because this application has adequate advantage of organic materials such as adhesion to flexible substrate, low manufacturing temperatures, low-cost deposition and low-power consumption.^[3–5] However, these transistors have been mainly fabricated from organic semiconductors and inorganic gate insulators.^[6] In gate dielectric, the inorganic and polymeric hybrid materials have been studied for an application to TFTs. The flexibility and lightness of polymers can offer them to have many advantages.^[7,8] Of the polymer dielectrics reported in the literature, poly(4-vinylphenol) (PVPh) has been considered as a dielectric with the highest mobility.^[9] Although the mobility is high, an organic TFT (OTFT) with PVPh as the dielectric exhibits a leakage current behavior that leads to up raising with the threshold voltage according to the gate-source voltage.^[10] A hydrophobic and less polar polymer is less affected with impurities such as moisture, oxygen, and mobile charges, which can cause hysteresis.^[11] Because cross-linker is helpful to overcome of these poor properties, PVPh have been reported to be used as organic material with low dielectric constant ($\epsilon = 2.5\text{--}2.6$) for a gate dielectric in TFTs by Knipp *et al.*^[12]

Recently, several research groups have investigated the leakage current or bias stress induced instability of OTFTs with SiO₂ and polymer gate dielectric films.^[13–15] However, the origins of the unreliable leakage current behavior found in these two types of OTFTs are still not clear, although the leakage current observed with the OTFTs with SiO₂ is probably associated with trapped electrons at the dielectric interface.^[14] To solve the matter of PVPh, PVPh nanocomposite with inorganic materials like as SiO₂, TiO₂ was investigated but these nanocomposites show low

dielectric constant under 3.5–5.^[4,13] Then a development of the insulation property of the gate dielectric layer of OTFT needs an adoption of high dielectric materials. Here PbO material can be a candidate inorganic material to solve these issues from its high dielectric constant. PbO has an α -phase and a β -phase, which form at low and high temperatures, respectively. α -PbO (litharge) and β -PbO (massicot) are photoactive semiconductors with gap energies of 1.92 and 2.7 eV, respectively. The narrow band gap of PbO increases the leakage current density when it is used in electronic devices, but offers a high dielectric constant: the dielectric constant of a PbO single crystal has been reported to exceed 200.^[16] Therefore, because of its optical and electrical characteristics, PbO has various applications. Nanoparticulation of PbO has been studied by Karami *et al.* and Gnanam *et al.* using a sonochemical method and hydrothermal process.^[17,18]

Nanocomplexing can be used to combine the desirable high dielectric constant of nanoparticles with the low leakage current density of polymers.^[19] Specifically, nanoparticulating PbO and

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E-mail: hhpark@yonsei.ac.kr

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Department of Materials Science and Engineering, Yonsei University, Seoul 120-749, Republic of Korea

b U. K. H. Bangi
Current address: School of Physical Sciences, Solapur University, Solapur-413255, Maharashtra, India

c B. Yoo
Flexible Display Research Center, Korea Electronics Technology Institute, Seongnam, Republic of Korea

**Trialect Global Medical Education Program – Training Program Contract with Host
Institute/Mentor/Program Director**

THIS AGREEMENT, dated as of _____ is entered into by and
between Trialect Inc. USA (existing under laws of California, USA). (hereinafter referred to as
"Trialect") and Ravindra S. Hegadi _____, (hereinafter referred to as
"Host" which is based in the India _____ with Solapur University, Solapur, India

Please note that while host institute may not sign and may not be a party to this contract, you, by signing this contract, are ensuring that your host institute has no objection to accepting health professionals to educate and train them through Trialect.

Key Terms: "Trialect" is a health information technology company that helps physicians and biomedical scientists with career-related opportunities, including, but not limited to, Traineeships, grants, and industry-academia partnerships in the best interest of a patient. Trialect provides and has been providing its services globally to around 200,000 members from more than 1000 organizations world-wide both online at www.Trialect.com and offline. **Trialect Global Medical Education Program helps facilitate short-term training and education to biomedical scientists and physicians to improve the quality of science and provide better patient care around the world.** A "Host" is an institute, or a mentor, or a program director, or independent physician, or independent investigator facilitating learning and career advancement of the Trainee. A "Trainee" is an individual who works closely with the Host to gain knowledge in the area of his/her interest pursuant to the Trialect Agreement. A "Traineeship Program/Training Traineeship Program" means a limited license or permission granted by the Host to the Trainee to learn and gain knowledge from the Host for the limited duration of the confirmed period of time. **HOST TAKES THE FINAL DECISION AND RESERVES THE RIGHT TO ACCEPT OR REJECT A TRAINEE** at any time before the Trainee reaches the host institution.

Term: This Agreement shall be in effect beginning 01/04/2018 _____ and shall continue until 31/03/2019 _____. The term of this Agreement may not exceed one (1) year unless renewed or extended in writing by Host and mutually agreed by Host and Trialect.

Renewal: Renewal or extension of this Agreement is dependent upon satisfactory progress of the relationship between Trialect and the Host as determined solely by the Host. In any event, nothing herein contained shall be construed to confer upon Host an automatic right to extension of this Agreement for a subsequent year.

Cancellation or change of terms: Host or Trialect can terminate the Agreement or change the terms at any time with 60-day prior notice. Host and Trialect may terminate this Agreement immediately and without notice in the event either of the parties is charged with or convicted of a serious misdemeanor or felony or enters a plea of no contest (nolo contendere) to same, or is charged with serious misbehavior in any forum and of any type where inimical to the teaching program or Host institutional standards before or during the term of this Agreement.

Traineeship Duration and Responsibilities: Host, in collaboration with Trialect, is responsible for determining the Trainee's training program. By this Agreement, the Host is appointed for a duration decided by both the parties to train the Trainees in exchange for fees or good will as agreed by both the parties. When a Host agrees to provide services or amenities to a Trainee as part of the Traineeship program, both parties acknowledge and agree that they, and not Trialect, will be responsible for

Sexual/Racial/Ethnic Harassment: The Host strives to provide training to Trainees in an environment that is free from sexual, racial, ethnic or other prohibited harassment. All allegations of sexual harassment will be thoroughly and appropriately investigated per the Host Harassment-Free Workplace Policy.

Trainee Grievance or Appeal: Should Trainee have a grievance against or appeal concerning the Host, the Host Grievance and Appeal policy governs the Trainee.

Illness or Injury Related to Traineeship Program Involvement: Any illness or injury related to Traineeship Program involvement must be reported immediately to Trialect as well as relevant local authorities by the Host. **THE TRAINEE IS RESPONSIBLE FOR HIS HEALTH AS WELL AS OVERSEAS TRAVEL INSURANCE.** Trialect does not act as an insurer.

Immigration Facilitation: Host, at its liberty, can consider issuing an invitation letter for the short-term Traineeship program to be used by the Trainees for the purpose of visa and travel to the Host institution.

Governance of Law: The laws of California, USA, hereunder shall in all respects govern this Agreement, the interpretation and enforcement thereof, and the rights of the parties.

YOU ARE SIGNING THIS CONTRACT ONLY AFTER DISCUSSING WITH YOUR HOST INSTITUTE. Please note that while host institute may not sign and may not be a party to this contract, you, by signing this contract, are ensuring that your host institutes has no objection to accepting Trainees and faculty from around the world through Trialect.

IN WITNESS WHEREOF, the parties hereto accept the terms and conditions herein and have caused this Agreement to be executed on the day and year herein above first written.

Date

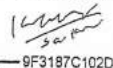
Ravindra S. Hegadi

Type name here and sign above
Host

Date 3/10/2018

Trialect Incorporation

Type name here and sign above
Trialect

DocuSigned by:

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सामाजिक शास्त्रे संकुल
दि. ०६/०९/२०१७

सादर -

सामाजिकशास्त्रे संकुलातील Centre for Foresight Studies व Finland Futures Research Centre, University of Turku, Finland यांच्या संयुक्त विद्यमाने दि.२९ व ३० सप्टेंबर, २०१७ दरम्यान "Clean Energy Futures : Quest for Low Carbon Civilization" या विषयावर आंतरराष्ट्रीय परिषदेचे (International Conference) आयोजन करण्यात येणार आहे.

सादर आंतरराष्ट्रीय परिषदेच्या आयोजनाच्या तयारीसाठी खालील कोष्टकात नमुदप्रमाणे अंदाजे खर्च करावयाचे आहे :

Sr.No.	Particulars	Tentative Exp. Rs.
०१	Hotel Advance	Rs.२५,०००/-
०२	Conference Kit and Banner	Rs.३०,०००/-
०३	Travel for the Key note and Pannel Speaker	Rs.३५,०००/-
०४	Miscellaneous	Rs.१०,०००/-
Total		Rs.१,००,०००/-


सबब,

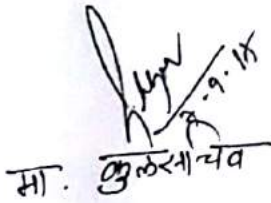
- उपरोक्तप्रमाणे खर्चास मान्यता असावी.
- उपरोक्त खर्चासाठी प्रा.डॉ.ई.एन. अशोककुमार, संचालक, सामाजिक शास्त्रे संकुल याच्या नावे अग्रिम घेण्यास मान्यता असावी.
- सादरचा खर्च International Conference in Collaboration with FFRC, Finland या अंदाजपत्रकीय शिर्षकातून खर्ची करण्यास मान्यता असावी.

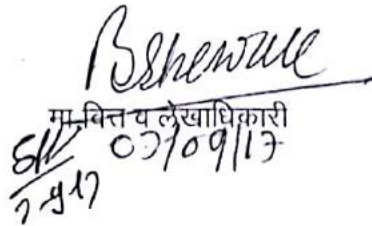
अंदाजपत्रकीय शिर्षक :- International Conference in Collaboration with FFRC, Finland
अंदाजपत्रकीय तरतूद :- रु.५,५०,०००/-
आज अखेर खर्च :- --
आज अखेर शिल्लक :- रु.५,५०,०००/-

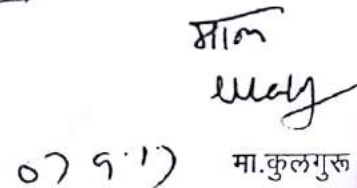
15

Abhalekya
06-09-17


संचालक 06/09/17


मा. कुलराजिव


मा. वित्त लेखाधिकारी
07/09/17


मा. कुलगुरु
07/9/17

Submitted:

Subject: Transfer of Rs.2,00,000/- from University Fund to the new budget head "International Conference" under the aegis of Centre for Foresight Studies, School of Social Sciences.

This is in continuation of my discussion with Hon'ble Vice Chancellor an amount of Rs.2,00,000/- (Two Lakhs only) may be transferred from the University Fund to the budget "International Conference" organized by the Centre for Foresight Studies, School of Social Sciences. This will help the School in organizing the event successfully.


Director
School of Social Sciences


Finance & Accounts Officer
09/05/17
W915

Approved the
following budget
Hon. Vice-Chancellor
Reappropriation.
Maldy

	Present budget provision.	Reappropriation
1. P. 6 - 5 f) Hon. V.C. Contingency fund:	20,00,000/-	18,00,000/-
2. P. 24. School of Social Sciences Univ. contribution for International conference in collaboration with the Finland	3,50,000/-	05,50,000/-
	<u>Total 23,50,000/-</u>	<u>23,50,000/-</u>
Further Approval is accorded to Add Rs. 2,00,000/- in the approved	06.5.17	Total Rs. 5,50,000/-
		Maldy 09.5.17

सादर,

विषय - अंदाजपत्रकीय तरतुदीचे पुनर्नियोजन करण्यास व नविन अंदाजपत्रकीय शिर्षक उघडण्यास मान्यतेबाबत. {सामाजिकशास्त्रे संकुल}

मा. कुलगुरु महोदय यांच्याशी झालेल्या चर्चेनुसार मा.संचालक, सामाजिक शास्त्रे संकुल यांनी सन २०१७-१८ या अंदाजपत्रकीय तरतुदीचे पुनर्नियोजन करण्यास व नविन अंदाजपत्रकीय शिर्षक उघडण्यास मान्यता मिळणेबाबतचा प्रस्ताव प्राप्त झाला असून तो सोबत आवलोकनार्थ सादर.

१. सामाजिक शास्त्रे संकुलास खालील अंदाजपत्रकीय शीर्षकाखाली तरतुद करण्यात आलेली असून त्यांचे पुनर्नियोजन करून नवीन अंदाजपत्रकीय शिर्षकाखाली वर्ग करण्यास मान्यता मिळणेबाबत विनंती केली आहे. त्यास अनुसरून सादर करण्यात येते की,

For the year 2017-18

Budget Head	Budget Estimate 2017-18	Revised Provision for 2017-18	Plus/ Minus
① Study Tour (for Four Department)	120000	80000	-40000
② Repairs & Servicing of Furniture & Equipments	40000	20000	-20000
③ Salary/ Honorarium	500000	450000	-50000
④ Departmental Research Fellow	520000	300000	-220000
⑤ Printing Expenses (Lab. Journal)	50000	40000	-10000
⑥ Alumni Expenses	20000	10000	-10000
⑦ International Conference in Collaboration with FFRC, Finland	0	350000	+350000
⑧ University Contribution for International Conference From Uni. Fund	0	200000	0

सबब वरील प्रमाणे अंदाजपत्रकीय तरतुदीचे पुनर्नियोजन करण्यास, नविन अंदाजपत्रकीय 'A' शिर्षक उघडण्यास व त्यास रक्कम वर्ग करण्यास मा.कुलगुरु यांची मान्यता असावी. मान्यतेसाठी सादर,

कनिष्ठ लिपिक

सहा. कक्ष अधिकारी

लेखापाल

सहा. कुलासचिव

B. Shewale
06/05
वित्त व लेखाधिकारी

मा. कुलगुरु

डा. संजय दुबे

निदेशक (प्रशासन एवम् नीति अनुसंधान)

Dr. Sanjay Dubey

Director (Administration & Policy Research)



राष्ट्रीय मानव अधिकार आयोग
National Human Rights Commission

Dated 05.12.2016

F.No. 23011/72/2016-17/Trg.

Dear Sir,

I am happy to inform that the Commission in its meeting has considered your Human Rights Training Proposal and approved the following programme and budget, which is to be conducted within three months of receipt of this approval letter, subject to the stipulation that the resource persons and course content would be decided in consultation with the Training Division of NHRC:

"One (One-Day) Basic Training Programme on Human Rights for at least 100 participants with total approved budget of Rs.50,000/- (Rupees Fifty Thousand only) as Grant In Aid from NHRC and minimum Rs.10,000/- (Rupees Ten Thousand only) as Institution contribution."

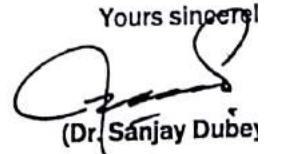
2. You may please go ahead and make all the necessary arrangements for conducting the said training programme as per schedule & budget annexed and adhered with the financial norms of the Commission, otherwise amount will be deducted from the sanctioned budget as per the norms of NHRC. Please also inform us the dates, venue and detailed programme schedule (Session-wise with names of the Resource Persons) alongwith formal invitation to NHRC, well in advance so as to reach this Commission at least 20 days before commencement of the programme, to enable NHRC officer to attend the programme, if possible. This may be ensured as non-adherence of this stipulation and holding the programme without sufficient timely intimation may result in non-payment of financial assistance. You may download reading material from our website www.nhrc.nic.in

3. Only on receipt of the detailed programme schedule (Session-wise with names of the Resource Persons) subject to approval of the same by the Commission, advance part payment of the sanctioned amount will be released. Please inform us in whose favour (Designation & Address only in whose name A/c of the Institution is maintained) the cheque has to be sent. Once again, I take this opportunity to thank you for the proposal and looking forward for more interaction in promotion of Human Rights.

4. It may be considered on the priority basis as the programme has to be completed well in time, as well as the Utilization Certificate (GFR 19-A format only) along with detailed Expenditure Statement duly audited and signed by the authorized signatory, Detailed Programme Report, Vouchers in original, List of Participants & Resource Persons, Photographs, Video Recording of the programme, Feedback Forms etc of the programme must be submitted within 20 days from the commencement of the same, so as to settle accounts of the Commission.

With regards

Yours sincerely


(Dr. Sanjay Dubey)

Encl.: Annexure- V & VI

Dr. D.N. Mishra
Registrar
Solapur University,
Solapur,
Maharashtra - 413 255

School of Social Sciences,

Inward No. 336

Date 14.12.2016

Clerk / Director Sign

School of Social Sci
Dr. D.N. Mishra
13.12.16

मानव अधिकार भवन, सी-ब्लॉक, जीपीओ कम्प्लेक्स आईएनए, नई दिल्ली-110 023
Manav Adhikar Bhawan, C-Block, GPO Complex, INA, New Delhi-110023
फोन (का) / Phone (O) : 011-24663466, फैक्स / Fax : +91-11-24651329
ई-मेल / E-mail : dir-nhrc@nic.in, www.nhrc.nic.in

23/7/2016

सामाजिकशास्त्रे संकुल
दि. २२/०७/२०१६

सादर,

सामाजिकशास्त्रे संकुलातर्फे सन २०१६ च्या सप्टेंबर महिन्याच्या चौथ्या आठवड्यात Human Rights and Deprived Section या विषयावर दोन दिवसीय राष्ट्रीय कार्यशाळा सोलापूर विद्यापीठात आयोजित करण्यात येत आहे. या परिषदेसाठी हैद्राबाद, बेंगलूरु, पुणे, मुंबई याठिकाणाहून आठ (०८) Resource Persons आमंत्रित करण्यात येणार आहे.

सदर कार्यशाळेसाठी येणारे पाहुणे आणि Resource Persons साठी प्रवासभत्ता, मानधन, राहण्याची व्यवस्था, निर्मात्रित आणि सदस्यांची जेवण, नाश्ता आणि चहापानाची व्यवस्था तसेच वर्कशॉप किट, प्रमाणपत्र, बुके, बॅनर आणि इतर संजावट यासाठी खालील खर्च अपेक्षित आहे. मान्यवरांना कार किंवा AC II क्लास रेल्वेने प्रवास करण्यास तसेच त्यांना प्रत्येकी रु. २,०००/- मानधन देण्यास तसेच त्यांची राहण्याची सोय विद्यापीठ अतिथीगृह व रंगभवन येथील विद्यापीठ अतिथी गृहामध्ये करण्यास मान्यता असावी.

सदर कार्यशाळेसाठी येणारा अंदाजे खर्च पुढीलप्रमाणे:

अनु.क्र.	तपशिल	रुपये
१.	आठ (०८) Resource Persons यांचे मानधन	रु. १६,०००/-
२.	मान्यवरांचा प्रवास भत्ता	रु. ३५,०००/-
३.	मान्यवर, सहभागी विद्यार्थ्यांचे अल्पोपहार (दोनवेळा), चहा तसेच आठ (०८) Resource Persons यांचे दोन दिवसांचे चहा, नाश्ता व जेवण	रु. २०,०००/-
४.	वर्कशॉप किट	रु. २०,०००/-
५.	बॅनर, बुके, प्रमाणपत्र इत्यादी	रु. ०९,०००/-
६.	किरकोळ खर्च	रु. ०५,०००/-
	एकूण खर्च	रु. १,०५,०००/-

तरी, सदर दोन दिवसीय राष्ट्रीय कार्यशाळा सोलापूर विद्यापीठाच्या सभागृहामध्ये आयोजित करण्यास व उपरोक्त तक्त्यानुसार होणारा रु. १,००,०००/- पर्यंतचा खर्च विद्यापीठाच्या H.R. & Duties Education या अंदाजपत्रकीय शिर्षकातून करण्यास व उर्वरित खर्च रु. ०५,०००/- सामाजिकशास्त्रे संकुलातील Miscellaneous/Contingency या अंदाजपत्रकीय शिर्षकातून करण्यास मान्यता मिळावी ही विनंती.

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२५-७-१६



Eranti, Ashok Kumar & Kaskinen, Juha (editors)

SUSTAINABLE ENERGY CHALLENGES OF INDIA

Essays of the study course "Future Sustainable Energy Challenges"

FINLAND FUTURES RESEARCH CENTRE
FFRC eBOOK 1/2018



Turun yliopisto
University of Turku



FINLAND FUTURES
RESEARCH CENTRE



Centre for Foresight Studies

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FOREWORD

Of recent, energy education is acquiring importance in Indian higher education system. As a signatory to many international protocols on reducing carbon emissions, India is obligated to pursue alternative sources of energy and awareness building among the masses to meet its global commitments. Once such initiative was undertaken in Solapur University, Maharashtra state, Western India, to introduce a course on “Future Sustainable Energy Challenges”, in collaboration with Finland Futures Research Centre (Turku School of Economics in University of Turku, Finland) under the financial assistance from the Finnish National Agency of Education.

The present book is a collection of essays developed by Master students as project work of their course in Energy Education. There are three essays presented in this book which provide glimpses on Renewable Energy Sources and their potential to meet energy needs of India in a sustainable manner. All the three essays are set in ‘Futures studies perspective’ and have discussed at length the challenges and limitations through specific case studies on wind, solar, biofuel energy, in the context of India’s energy sector.

Professor Eranti Ashok Kumar

Solapur University

On the behalf of FFRC I want to thanks Professor Kumar, his staff and of course the students for their effort for the course and this publication. Because of their enthusiasm and eagerness we were able to run through the course as planned. I also thank the Solapur University of its support. As an evidence of the learning curve of the students and the commitment of their teachers we wanted to publish the essays written by the students with help of their teachers.

I hope the publication will be an opening for continuous collaboration of our Universities for sustainable energy production and consumption in India

Director Juha Kaskinen

Finland Futures Research Centre

University of Turku

DETERMINANTS OF WIND ENERGY FUTURES FOR SOLAPUR DISTRICT: SOME PROBABLE SCENARIOS

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Under the Guidance of Dr. E. N. Ashok Kumar, Professor and Director, School of Social Sciences, Solapur University, Solapur

ABSTRACT

The present study is undertaken in the context of India and intends to answer the set of three questions: (i) What is the status of wind energy scenario in the region with respect to policy and technology variants? (ii) What is the interplay between system's components of PESTEC (Political, Economic, social, Technological, Environmental, and Cultural) and the policies & technologies? And (iii) What are the probable scenarios for wind energy futures? Compelled by the questions stated above, the study employed "Two-axis Morphological Matrix" method considering the need for (i) developing alternative strategies to promote wind energy in the region; (ii) analysing the future risks while implementing wind energy projects; (iii) comprehending the means and ends in the process of promoting wind energy; (iv) simplification of complex set of relationships in the course of transition towards wind energy production and distribution. The study infers by developing three sets of strategy scenarios such as idealistic scenarios, realistic scenarios and pessimistic scenarios. Further, the analysis reveals that the policy is more critical driver than the technology. The shortcomings of the existing technologies can be overcome through appropriate policy instruments. The strong policy driver can eliminate the weaknesses of the system components. Thus, the model throws open a number of viable alternatives for planners and developers.

Key words: Wind Energy, Policy, Technology, Drivers, System's Components.

INTRODUCTION

Wind power is a source of clean energy. It evolved over a period of time. At the end of 19th century, the first wind turbine was developed. During 1940s and 50s it underwent a formative stage with simpler technologies to capture wind power. By 1970s, there was a thrust for developing innovative and viable technologies in harnessing wind power due to the oil crises that pervaded the entire globe. At the end

of 1990s, wind turbine technologies were developed in different parts of the world. Denmark, Germany and Spain were the leading countries which contributed for the development of wind turbine technologies. In the recent years, wind energy has acquired greater importance and is the fastest growing renewable energy source. The global wind power capacity had increased from 76 GW in 1997 to 195.5 GW by 2009 (Zoba and Bansal, 2011). It was estimated that the wind power energy will develop to a scale of 12% of the global electricity supply by 2020 (as quoted in Yao, et al. Global Wind Scenario, Power Line 7 (2003) p. 49–53).

There are various factors affect the wind power as a technology. They are wind statistics for characterizing the variability of wind speed; load factor that is amount of output drawn; and seasonal variations of wind speed. The wind turbine sitting needs a careful considerations such as availability of land, power grid in certain cases, accessibility of site, terrain and soil and frequency of lightning strokes (Yao, et al., p. 8). There are reports available elsewhere that onshore wind energy is emerging as one of the most competitive source of electricity which is now almost within the same cost range that of a fossil fuel and sometimes, even less also. The reasons attributed are the higher hub heights and larger swept areas supported by policy instruments. This indicates that the technologies are improving towards reducing the cost and increasing the efficiency.

India has earned international status in wind energy promotion. Currently, wind power potential in the country is over 302 GW at 100 m height. India is one among the top 4 wind power generating countries in the world. And more interestingly, it is the only country in the world having a separate Ministry for Renewable Energy. India is poised for achieving NAPCC target of 15% from renewable by 2020 and 60 GW wind energy by 2022. However, wind farm establishment needs land acquisition and better Land Reforms and Evacuation Facility for expanding wind energy. As a satisfactory note, India has state-of-the-art technology available and there are 18 major companies already engaged in wind energy production with 44 models.

Wind turbines harvest kinetic energy and convert it into usable power which can provide electricity for home, farm, school, or business applications on small (residential), medium (community), or large (utility) scales (Zoba and Bansal, 2011).

Wind power is considered as the largest source of new renewable power capacity. Its role is growing in meeting electricity demand. China is one of the leading countries in wind power generation. The new markets emerged across the countries in Africa, Asia and Latin American continents. Corporations and private companies continued turning to wind energy for reliable and low cost power (REN 21, 2017, p. 11). The major challenge was the lack of transmission infrastructure. Despite the challenges, the annual additions to the wind power global capacity steadily increasing over the decade 2005–2015 (ibid: p. 24). Interestingly, the investment flow in wind power in 2015 increased more in developing countries than the developed countries (ibid: p. 28).

GLOBAL SCENARIO OF WIND ENERGY

There are highly encouraging trends at the global level with regard to renewable energy in general and wind energy in particular. Massive investments are made in solar (China and Japan) and offshore wind in Europe. The axiom “Sun in Asia, Wind in North Sea” is already in vogue in the renewable energy fraternity reflecting the popularity of these energy sources. In between 2014–15, there was nearly 50% plunge in the crude oil prices in the world market. Perhaps as a response to this trend, the year 2014 appears to be a major land mark in promoting renewables especially, wind energy by generating 49 GW which is a record figure (Bloomberg, 2016, p. 12–19). In the top ten countries investing on renewables BRICS countries have made substantial investments. Their investments have swollen substantially. For instance, India invested USD 7.4 billion preceded by Brazil USD 7.6 billion. Regarding costs and challenges, renewable have to face many challenges including unpredictable supportive policies which may hamper investors’ motivations (ibid: 2016).

The trends set during the 2014 continued through 2015. There were additional increments in wind and solar energy generation accounting for 118GW which is higher than the previous year (94 GW in 2014). The year 2015 witnessed a higher investment in renewables, double that of the investment made on fossil based sources. The UNCCC conference in Paris held on December, 2015 gave impetus to the policies of various countries to make commitment to invest on renewables and put in place appropriate policy instruments. There was an unprecedented consensus by 195 countries to strive for zero carbon emission in the second part of this century (Bloomberg, 2016, p. 11). The developing world continued to outweigh the investments on renewable than the developed world. China alone invested 102.9 billion dollars which is 36% of the world total (ibid: 2016). The cost of generating renewable energy continued to fall especially in the solar sector and this may have implication on other renewable like wind. However, despite all these encouraging developments, the policy support for renewables remained fickle in many countries including USA. There is high possibility that the prices of coal, oil and gas may fall in the international markets leading to fall back on fossil fuels by several developing countries. There is an emerging thrust on technologies developing storage batteries in the year supported by electric automobiles which is an encouraging trend. Unlike in the past, solar and wind energy sources are no more remained as luxuries and now affordable to the lower economic classes also.

There is a growing competition between fossil fuels and some sources of renewables. Oil competes with renewable power generation in oil producing countries. Gas competes with wind and solar in some European countries. Coal is still competing with renewable, in some parts of the developing world. However, renewables have merit in terms their installation time. For instance, wind farms take on an average 9 months, solar parks 3–6 months whereas coal, gas and nuclear energy sources take several years to install and start functioning (Ibid: 2016, p. 18).

Every year global wind day is observed on June 15 indicating the growing importance of wind energy all over the globe. In 2016 \$112.5 billion invested in wind power globally and wind power has crossed the 500 GW mile stone. According to the estimates available 1.2 million people are employed globally

in the wind industry. In 2016, un-subsidised new renewable power was cheaper than fossil fuels in over 30 countries which is noteworthy

INDIAN SCENARIO OF WIND ENERGY

Major Initiatives taken by the Ministry

During the year 2015–16, wind power capacity addition of 3.42 GW was made, which is highest ever wind power capacity addition in the country during a single year. The present wind power installed capacity in the country is around 28.28 GW. Now, in terms of wind power installed capacity India is globally placed at 4th position after China, USA and Germany.

India has a strong manufacturing base of wind power equipment in the country. Presently, there are 20 approved manufacturers with 53 models of wind turbines in the country up to a capacity of 3.00 MW single turbines. Wind turbines being manufactured in India are of international quality standards and cost-wise amongst the lowest in the world being exported to Europe, USA and other countries.

The wind power potential of the country has been reassessed by the National Institute for Wind Energy (NIWE), it has been estimated to be 302 GW at 100 meter hub-height. Online wind atlas is available on NIWE website. This will create new dimension to the wind power development in the country.

India has long coastline where there is a good possibility for developing offshore wind power projects. The cabinet has cleared the National Offshore Wind Energy Policy and the same has been notified on 6th October 2015. Certain blocks near Gujarat and Tamil Nadu coast line have been identified. NIWE is in process of doing the wind resource assessment in these coastal areas (MNRE, 2015).

Wind Energy Investment Destination: India

Draft National Offshore Wind Energy Policy, Ministry of New and Renewable Energy, Government of India, highlights the following points of policy support for Wind energy in India:

The entire wind energy industry is governed by solid foundations from the Electricity Act, viable regulatory procedures from CERC and other state regulatory policies.

The paradigm shift from retail market to the IPP market with major investors like Goldman Sachs, Black Stone, IDFC and others is proven demonstration of the interest of the private sector.

Capital cost in India is perhaps one of the lowest in the world and India is emerging as the fastest growing supply chain hub with many industries choosing for in-house manufacture of towers, blades, generators, convertors etc.

The commercial arm of MNRE, IREDA and other financial and banking institutions has backed the industry as a stable market where there is assured off take and no marketing challenges.

The Government of India has announced a laudable Renewable Energy target of 175GW by 2022 out of which 60GW will be coming from wind power.

This will require an addition of more than 5GW per annum. The country would require over 7000 MW per annum of RE to achieve 15% by all renewable by year 2020 under the National Action Plan for Climate Change.

The Government commitment to promotional tariff, incentivizing generation, plans to revitalize the REC market through RPO obligation will certainly make this market vibrant and self-sustaining.

India blessed with coastline of about 7600 KM. United Nations convention on law of the sea gives India an exclusive right over its exclusive economic zone (200 nautical miles from the baseline) to develop offshore wind energy (See: MNRE, 2015; Kiel, 2012; CEI, 2017; Raghab, 2017)

Against the above backdrop, the study intends to address the following set of three objectives:

Objectives and Methods

1. What is the status of wind energy scenario in the region with respect to policy and technology variants?
2. What is the interplay between system's components of PESTEC (Political, Economic, Social, Technological, Environmental, and Cultural) and the policies & technologies? and
3. What are the probable scenarios for wind energy future?

Compelled by the objectives stated above, the study employed "Two-axis Morphological Matrix" method considering the need for (i) developing alternative strategies to promote wind energy in the region; (ii) analysing the future risks while implementing wind energy projects; (iii) comprehending the means and ends in the process of promoting wind energy; (iv) simplification of complex set of relationships in the course of transition towards wind energy production and distribution; Investigating total set of relationships contained in PESTEC dimensions of wind energy; and creating qualitative (non-quantifiable) inference frameworks.

The methodology involved in identifying PESTEC dimensions in wind energy and assigning a range of relevant values or conditions in the form of standard phrases or abstract labels. For the purpose of operationalization two-axis method is employed where in "Policy" driver is taken on X-axis and "Technology" on the Y-axis. On the X-axis, there is continuum from the most favourable policy to the least favourable policy; and on the Y-axis, the most advanced technology to the status quo that is present technology. Thus, at the point of intersection of the two axes, there are four quadrants such as a) Upper Right (UR); b) Upper Left (UL); c) Lower Left (LL); and d) Lower Right (LR). When viewed through anti-clockwise direction, each quadrant provides a condition under which various interrelationships between parameter values take place.

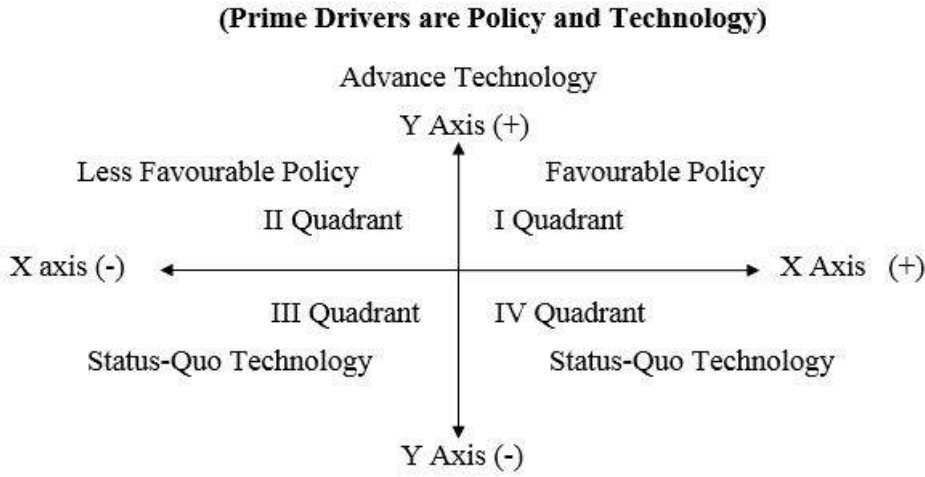
Thus, quadrant UR is a condition comprising of most viable and supportive policy and political system on one hand and most advanced viable technology on the other. The policy/political system and technology are chosen as "scenario placeholders" while the remaining dimensions such as economy, social, environmental and cultural are taken as interactive parameters assuming various values and conditionality. For further deepening our understanding, those parameters and associated values are

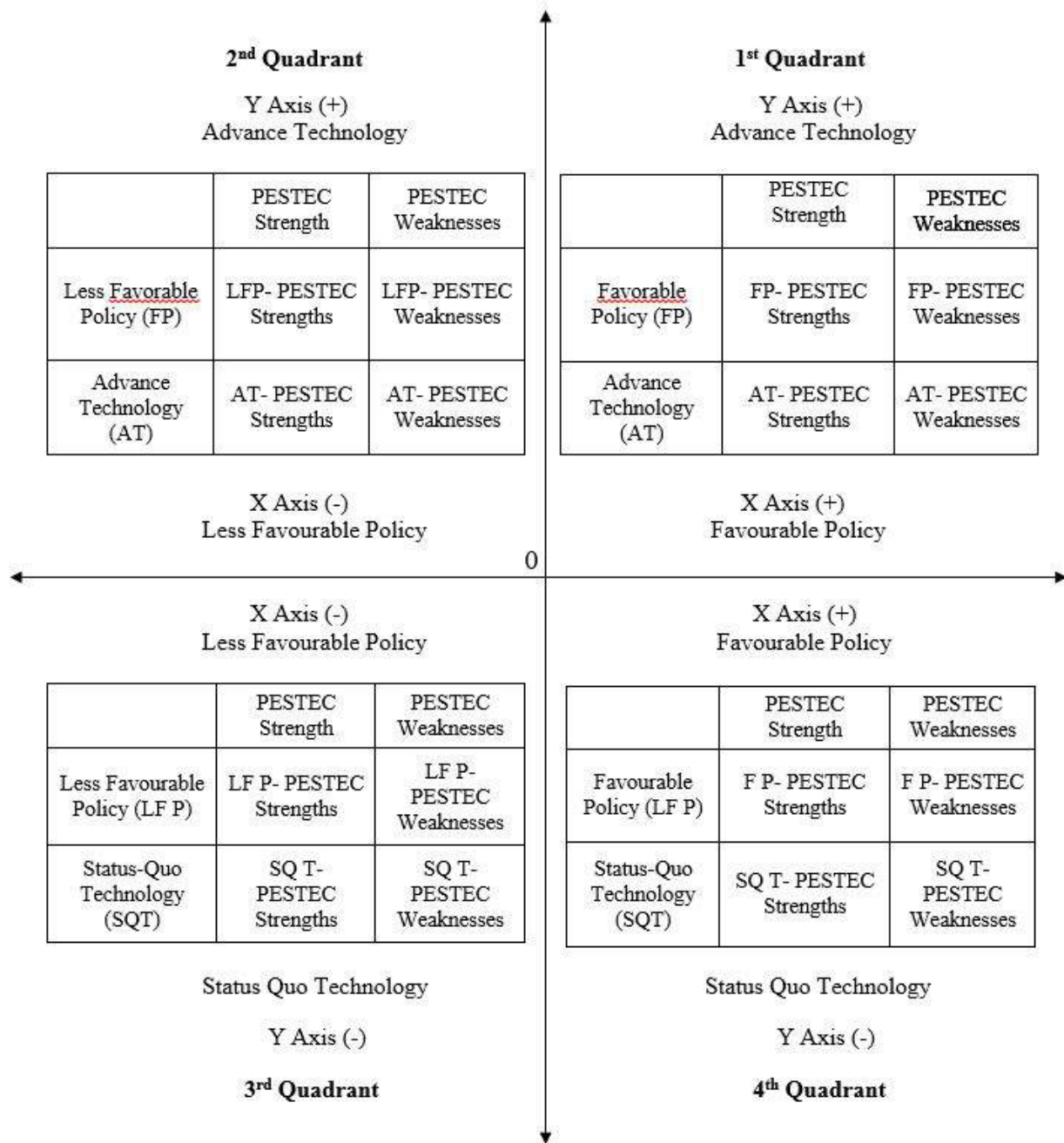
broken down into strong and weak conditionality. Now, under the quadrant UR the components of analysis are:

- Scenario Place holders: a) Policy/ Political system; b) Technology
- Analytical Parameters: Economic (E), Social (S), Environmental (K), and Cultural (C) under strong and weak conditions.
- Parameter conditions or values: (Explained in the next sections)

Each quadrant will have four scenario configurations since each scenario placeholder takes two sets of parameter matrix, one with strong values/conditions and the other with weak values/conditions. Thus, each quadrant will have four configuration sets. Theoretically, for four quadrants (4*4) 16 configuration sets are available for analysis. However, for the present study, two extreme quadrants, UR and LL are considered for analysis.

All the possible combinations of placeholders and analytical parameters are worked out for arriving at a number of strategies which sum up to 1554 (see the Annexure) from the two quadrants UR and LL. Eight strategy scenarios, 4 from each of the two quadrants (UR and LL) are considered for further interpretation. Since, the placeholders (Prime Drivers) Policy and Technology take 5 values each and assume their corresponding multiples when combined with the 4 analytical parameters, under two conditions, strong and the weak (see the Annexure). Those combinations which produce the highest number of strategies are chosen for strategy interpretation exercise.





WIND ENERGY PROMOTION: AN OVERVIEW

Wind power generation differs from conventional energy generation due to the changing nature of wind. Thus, wind power forecasting plays a key role in dealing with the challenges of supply and demand in electricity production system. Accurate wind power forecasting and calibrating production accordingly poses the need for additional balancing energy and reserve power to integrate wind power. There are many more issues associated with the promotion of wind energy in a country like India. Some such issues are generic in nature and applicable to elsewhere on the globe while some are specific to Indian state. For better comprehension and articulation, the literature scanned through, classifies the issues within the broader systemic components, PESTEC (Political, Economic, Social, Technological, Environmental and Cultural/Consumer related).

Political:

Putting appropriate policies in place plays a critical role in bringing any major change in the renewable energy sector. Since these are political decisions, there is a need for strong political will to frame policies that are conducive for renewables. One of the pitfalls in the policy formulation is about lack of integration of economic and technical concerns into policy making. For instance, the credit flow to Private Companies is on high interest rate in the range of 13-18% in the domestic market which is very high. Access to foreign loans though available, can only be used on a project basis according to regulations which curtails freedom (TERI, 2015, p. 14). Lack of coordination among key organizations like revenue department, state pollution control board, grid operators has led to time and cost overruns resulting in high logistical costs. Also, due to the lack of Government's accountability, developers must follow a large amount of paperwork and several levels of bureaucracy before subsidies are approved (Ibid p. 14). There are other inadequacies such as lack of information, publicity and other support programs; lack of financial support for R&D for carrying out studies & resource assessment; Environmental impact assessment; and Oceanographic studies (Ibid p. 1 to 4).

Policy challenges also include supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates (Kazmerski, 2006). Developing skilled manpower to handle the operations and maintenance of the wind energy systems is essential. Training the existing staff and recruiting trained staff may need allocation of budget. Another development difficulty is about the ability to maintain wind projects in rural India. Most of the rural community have modest local resources and require outside training and assistance to maintain their systems. However, such assistance is often expensive and not readily available (Maynard, et al., 2010, p. 33).

There are legislations already in place in India to promote renewable sources of energy. As per National Electricity Act-2003, state regulators are to specify a minimum percentage of power to be purchased from renewable sources. The National Tariff Policy -2005, state regulators provide preferential tariff for renewable power tariff rates offered in the range from Rs.3.40 to Rs.5.30/kwh (7-11 US

cents/kwh). This apart, the private companies producing renewable energy are given Income Tax Holiday for 10 year (Nigam, 2014). Other incentives include relaxation in VAT (value Added Tax). In some states there is practice of reduced or no VAT on Renewable Energy components. For instance, Tamil Nadu has reduced VAT From 14.5% to 5% while Karnataka offers 5.5% VAT for all the Renewable energy components. Again in Gujarat, Tamil Nadu and Maharashtra offer 5% VAT for all Renewable components. Capital subsidies are extended by the state governments to private companies. Maharashtra has the provision for capital subsidy to the extent of 11% for wind energy project set up by the cooperative sector. Rajasthan provides soft loan equal to 1/3 of capital cost at low interest rate (MNRE, 2014).

Renewable Purchase Obligation (RPO) is one of the important State Governments' policies and incentives for motivating private sector companies to enter into renewables like Wind.

As mentioned earlier, under the section 86,1 (a) the Electricity Act 2003, state is to purchase a fixed percentage of energy generated from R.E. resources. The RPO percentage varies from 0.5% to 10.25% depending on the local renewable resource and the electricity distribution in the states. RPO obligation can be fulfilled through direct purchase via bilateral contracts and tradable REC (Renewable Energy Certificate) mechanism which can further generate revenue for RE projects (MNRE, 2014).

Under the present circumstances, the status of RE development has many bottlenecks to overcome. The targets set forth by the state have multiple facets leaving stakeholders confused. There are no clearly demarcated performance benchmarks for RE projects posing difficulties for monitoring. Lack of cohesion in policy framework such as technology specific and State specific would create hurdles for smooth transition towards RE. Relaxed enforcement of regulations is not leading the stakeholders anywhere. India is a growing economy and demand for power is increasing. The conventional energy sources are either limited or due to obligations not ideal for use. There is huge untapped wind potential available in India which needs to be harnessed (MNRE, 2014).

Lack of provision of permitting stand-alone systems for rural and remote areas is a policy impediment for expansion of wind energy to the rural areas. In Indian context which is still more rural than urban and access to energy is inadequate. A large majority of the villages reel under energy poverty and the policy shifts in this sector would usher in green development in the country side (Aayog NITI, 2015, p. 7).

Supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates is a policy prerogative. Wind energy appears to be a viable alternative should proper interventions are made (TERI, 2015). Other Policy Initiatives for wind energy include sales tax and excise duty reliefs; concessional import duty on specified parts and components; IREDA and Nationalized Banks provide loan for commercial wind power projects at reasonable rates of interest; Preferential tariff by State Utilities supported by power Generation Based Incentives and many other packages to attract the private entrepreneurs in the renewable energy business. Central Electricity Regulatory Commission (CERC) has already brought out Tariff Regulations as early as in September, 2009 which reflects the commitment by the state. All these measures will have a bearing on tariff framework at state levels

in the coming period RPOs have been announced by major states (Nigam, 2014). Renewable Purchase Obligation (RPOs) announced in most states (up to 10%) and penalties were introduced for non-compliance announced by a few states of India. Renewable Energy Certificate (REC) mechanism is in place in many states. As a policy guideline, RECs are to be purchased through bidding process and can be used by companies and Distribution Licensees for meeting their RPOs (I bid).

The state has provided a vast range of incentives for the promotion of wind energy in India. The companies engaged in the production of wind power are exempted from paying Electricity Duty are also given CCD & SAD exemption on specified parts and components used in the installation of wind turbines. Feed-In-Tariff (FiT) and Accelerated Depreciation at 80% or Generation Based Incentive @Rs.0.50/unit are supportive services given by the State Regulators which is implemented with cap of Rs.10million per MW. The repowering policy of the state has paved the way for rejuvenating the non-functioning wind farms commissioned earlier. These facilities have potential to revive and sustain in the context of changing macro level scenario (Ibid).

Wind power generation is characterised by high level of intermittency that is fluctuations in the wind speed. The draft Wind-Solar Hybrid Policy mooted by the Government of India (GoI) in 2016 is a land mark in combining technologies and overcoming the problem of intermittency. The hybridization is a realistic policy initiative since these two sources of power are complementary to one another. The GoI has set an ambitious goal of achieving 10 GW of wind-solar hybrid energy by 2022 and this target seems to be achievable (Ibid).

Wind Policies in India vary across its states. Wind potential states are providing promotional tariff for wind power projects in varying degrees is a welcome move. This apart, states are also providing Concessional Wheeling, Banking, Electricity Duty and Cross Subsidy Surcharges to attract the energy entrepreneurs to engage in wind power production.

Environmental:

Wind farms, even though environmental friendly, are not free from hazards. Most commonly cited one is noise pollution. Wind turbines produce mechanical noise mainly from the gearbox and the generator. Noise occurred from wind turbines affect the residents nearby the wind farms. Due to high frequency sound human life and animal life get disturbed. Old age people and children are the main casualty due to sound occurring from the wind mills (Jaber, 2013). The modern turbines create very little noise (Macintosh & Downie, 2006). However, wind farms never affect the grazing of livestock. The land used for wind farms can still be used for farming and cattle grazing (Ibid: 2013).

Studies show that birds may become dis-oriented in poor weather or foggy night and subsequently, are attracted to light emitted from wind energy plants. Some birds tend to fly lower during heavy over-cast weather such as high winds, low clouds, and rain. This increases the bird's potential of flying through the wind turbines leading to fatalities (Ibid: 2013).

With regard to land acquisition and Land use, wind farms are often built on land that has already been impacted by land clearing (Ibid: 2013).

A wind turbine casts a shadow on their vicinity in direct sunlight and poses a problem in sunlight starved countries like those situated in Northern Europe. As the blades keep turning, they may cut through the light beams, causing a flickering effect. Nevertheless, the flickering is annoying when at home and awake and the stakeholder complain about this effect. In some cases like South Dakota, most residents respect their local resources, wildlife, and environment, and have concerns regarding the exploitation and/or degradation of those resources. They endorse the existential and aesthetic values of those natural resources (Jaber, 2013).

Wind energy can bring increased security for electricity supply to non-grid connected locations and it gives protection against electricity price rise. Renewable Obligations Certificates (ROCs) can be received by generating electricity. These can then be sold to electricity generators to allow them to meet their targets to derive a specified proportion of the electricity they supply to their customers from renewable energy sources. Wind power can provide energy while reducing the emission of CO₂. According to the World Energy Commission, use of one million kWh due to wind power can save 600 tonnes of CO₂ emission. Therefore, massive use of wind power will help mitigate climate change. The use of wind power can also avoid regional environmental problems brought about by burning coal (Jaber, 2013).

The conventional power plants use large amounts of water for the condensation process of the thermodynamic cycle. For coal power plants, water is used to clean and process coal and the amount of water used can be millions of litres per day. Wind energy can save that amount of water used by the coal plants (Saidur et al, 2011).

Environment value of wind energy

The primary environmental value of electricity generated from wind energy systems is that the wind offsets emissions that would have been caused by conventional fossil fuelled power plants. These emissions include sulphur dioxide (SO₂), nitrogen oxides (NO_x), carbon dioxide (CO₂), particulates, slag and ash. The amount of emission saved via the use of wind energy depends on the types of power plant that are replaced by the wind system, and the particular emissions control systems currently installed on the various fossil-fired plants (Saidur et al, 2011).

Vertical shaft turbines are safer and produce twice the energy of prop-style turbine. In addition, their slow turning blades gently generate clean, abundant energy for a revitalized, green Earth. Its design can decrease birds' mortality from collision of the wind turbine (See: Saidur et al, 2011; Kiel, 2012; Wind Energy Facts, 2017).

Social:

Constructing wind turbines and the associated grid creates a multitude of challenging social issues in communities. The primary ones are: adverse health impacts caused by noise; exclusion of women from the decision-making process; degradation of property values; community division and infringement on

the rights of citizens to enjoy the residential amenity of their own homes. Wind farms are also socially inequitable as they involve a wealth transfer by levies on energy bills from taxpayers to developers (Maynard, J. E., Lovecraft, A, 2010).

Wind turbines come with eye-catching designs, they impact the natural beauty of the landscape. When a lot more wind turbines are set up, the area becomes unsightly. In many locations, the local community starts resentment against installation of wind turbines, and this can escalate to a conflict (Ibid: 2010).

Another social impact is that citizens' health would increase over time. This means the opportunity cost on health expenditure would reduce due to the substitution of wind energy in place of energy from the fossil fuels. People would not be exposed to as many hazardous wastes and emissions because people would be moving away from burning fossil fuels and using cleaner, greener energy such as wind power (Ibid: 2010).

Wind farm development may be compatible with a variety of other land uses, including agriculture, grazing, open space, and habitat conservation, depending on the site, size, and design of the project. Other land uses, such as hunting/fishing, bird watching, and wildlife photography as well as resource values need to be considered when siting large wind projects in remote areas (Ibid p. 32).

Technology:

Mass scale transition towards renewables is of recent origin and therefore, there is technological mismatch to adopt and replace the conventional energy sources. The prominent ones are lack of high voltage direct current transmission lines, and inadequate grid system for distribution of power. Even though these problems are common to most of the renewables, it appears to be more conspicuous to wind energy. Improving the storage capacity for renewables is another challenging task before the technocrats. Varying sizes of wind turbines are not readily available in the market to suit off-grid requirements like dwelling homes and offices (Ibid p. 35).

In countries like India, the wind power potential has not been utilised to its optimum level. Improved siting of wind farms, may facilitate further expansion of wind energy production. The problem of intermittency is still persisting in wind energy systems (Ibid, 2010).

Incremental improvement in the various systems through the changes in turbine blades is quite possible. Even the advanced composition in the turbine construction, including carbon fibre, and new resins may be developed for better deployment in the field. Another challenge is on the technical front to create monumentally tall towers and light slender blades that can withstand the strong winds (Ibid, 2010).

Currently, there are two kinds of wind turbine technologies (i) vertical-axis wind turbine; and (ii) horizontal-axis wind turbine. The limitations with the vertical axis turbines are associated with, not being self-starting and thus, require generator to run in motor mode at start; lower efficiency (the blades lose energy as they turn out of the wind); and difficulty in controlling blade over-speed. With regard to horizontal axis turbines, generator and gearbox are to be mounted on a tower, which restricts

servicing; electricity production depends on- wind speed, location, and season and air temperature which add up to the (Ibid, 2010).

There is a consensus that the wind energy technology is still premature to reach a take-off point. Forward and backward linkages connected with wind energy production are missing in many locations of the world including India. Local technicians and operators who are responsible for technical support are yet to be developed. Due to lack of this grassroots cadre, wastage of productive time is substantial when the turbines were inoperable due to mechanical problems. Lack of adequate wind technology services at a state-wide levels, and more so in rural areas routinely results in inefficient generation or even complete shutdown (Ibid, 2010). Lack of high voltage direct current transmission lines, its impact on grid system for distribution, and costly storage facility further illustrate immaturity of technology and poor grid connection system in case of wind energy (Ibid p. 35–36).

Amongst several technical problems confronting wind energy systems, transmission and grid issues appear to be of importance. From economic point of view, the poor grid stability may cause 10–20% power loss. This pitfall may be the main reason for low actual energy output of wind power generation. The costs increase when the locations for generating wind energy are far distant from the locations of consumption (Zobb and Bansal, 2011).

The connectivity study needs to check if the proposed wind generator can be hosted by the existing power grid in view of stability as well as reliability aspects. Back in India, there is no such connectivity studies carried out systematically before commissioning wind energy projects (Ibid).

The cost of electricity can be reduced by integrating diesel systems with wind power generation, hybrid power system. This system has another advantage of reductions in size of diesel engine and battery storage system, which can save the fuel and reduce pollution. Autonomous hybrid power systems will have a parallel operation of diesel with one or more renewable energy based sources (wind, photovoltaic, micro hydro, biomass, etc.) to meet the electric demand (Ibid, 2010).

Economical:

Capital investment in wind energy is high as compared to other renewables. The policy of Government of India allows Foreign Direct Investment (FDI) in wind energy sector. As per the policy guidelines 100% FDI is allowed in wind power sector and this has helped a great deal in bringing private and foreign investment to India. After the introduction of GBI, FDI has increased in wind sector (MNRE, 2014). There are various economic parameters of wind energy which need to be understood. The prominent ones are (i) *Energy efficiency*: The efficiency of the wind energy conversion system affects the economics of the wind system. (ii) *Investment costs*: Civil work and construction cost include transportation, installation of wind turbine and tower including any cost from the start of the idea until the date of operation which includes land preparation, site, equipment, transport, design, consultancy, project management etc; (iii) *High Capital costs*: The determination of the capital or total investment cost generally involves the cost of wind turbines and its auxiliaries, i.e., tower, wiring, utility intercon-

nection or battery storage equipment, power conditioning unit, etc; Grid connection cost is high including the electric work, electricity line, and the connection point are typically 11% to 14% of the total capital cost; (iv) *Financing costs*: Wind energy projects have intensive amount of money to be invested in the beginning so that the purchase and installation costs are met. For this reason, the developer or purchaser will pay a limited down payment of 10–20% and borrow the rests from the public financial institutions; and (v) *Operation and Maintenance (O & M) costs*: According to the estimations available, O&M costs are very low when the turbines are brand new but increase as the turbine gets old. The O&M costs generally range from 1.5% to 3% of the original turbine cost. Annual operating costs also include battery replacement every 3 to 10 years, depending on the battery type and usage load. O&M costs is include components, insurance, regular maintenance, repair, spare parts, and administration. Except O & M, other costs involved are substantially high (Zobb and Bansal, 2011).

The cost of finance (currently ranging from 12–14%) forms a significant component of the power tariff from. Financing costs depends on the risk perceived by funding institutions and higher the perceived risks result in more stringent financial conditions. The relatively high cost and low availability of credit in India has significantly increased the cost of renewable energy projects which is a major barrier to the expansion of the renewable sector. Higher expenses are associated with equipment, operation, distribution & maintenance of system (Maynard et al, p. 36).

Sophisticated technology such as storage facility, grid system, wind mill components, etc). Grid connection cost is high including the electric work, electricity line, and the connection point are typically 11% to 14% of the total capital cost. Devaluation of rupee against the US dollar is the major barrier for importation of sophisticated technology. Price forecast of energy becomes more and more unpredictable (T E R I, 2015, p. 3–13).

Wind power generation costs have been falling over recent years. It is estimated that wind power in many countries is already competitive with fossil fuel and nuclear power if social/environmental costs are considered. One of the main advantages of generating electricity from the wind system is that the wind is free. The cost of the wind system just occurs once. More over there are efforts to reduce the cost of wind power. Those measures include design improvement, better manufacturing technology, finding new sites for wind systems, development of better control strategies (output and power quality control), development of policy and facilitating instruments, and human resource development (Ibid: 2015).

Cultural:

Unlike in many advanced countries, there are no noticeable conflicts between the communities and the wind farms in India, as of now. Therefore, the issues like lack of community support and acceptance is rare. Similar is the case with aesthetic concerns leading to opposition from the local communities. Not in My Backyard (NIMBY) syndrome, is also not so familiar problem with the Indian conditions. Perhaps, the expansion of wind farms and acquisition of common land for wind farms may lead to

dissent from the community. In the context of India, more relevant issues which are culture specific would be lack of public participation in the planning process and deficiency in public awareness. It requires sustained efforts and communication by planners and developers (Maynard et al, 2010 pp-32; MNRE, 2014).

1st Quadrant
Favourable Policy - ESKC Strength

Viabile Policy	Economic Condition	Social Condition	Environmental Condition	Cultural Condition
P1-Renewable Purchase Obligation (RPO)	E1- Wind power costs declining.	S1- Public health security and health benefits.	K1- Zero emissions.	C1- Wind energy has religious sanctity
P2-Tax Holiday (10 years) Relief in Tax & Excise Duty	E2- O & M costs are marginal (about 2%)	S2- No alienation of community lands.	K2- Boon for non greed locations	C2- Its usage has long tradition and acceptability
P3-Renewable Energy Certificate (REC)	E3- R & D Initiatives for better viability.	S3- Citizens' right of amenities	K3- Saves water	C3- Mind sets and receptive to clean energy
P4-Appropriate Legislations	E4- Wind power is competitive with other sources.	S4- access to clean energy.	K4- Helps to mitigate climate change	C4- Modern turbines make less noise and acceptable
P5-Institutional Credit	E5- Development of new economic instruments.		K5- Offsets CO2 (1mw=2600 Tones CO2)	
	E6- Foreign Direct Investment (FDI).		K6- Less harmful to flora and fauna compared to fossil fuel.	
	E7- Attracting private investments.			

Favourable Policy – ESKC Weaknesses

Viabile Policy	Economic Condition	Social Condition	Environmental Condition	Cultural Condition
P1-Renewable Purchase Obligation (RPO)	E1- Higher Investment capital costs	S1- Lack of communication amongst stakeholders	K1- Noise pollution is hazards	C1- Community support unpredictable
P2-Tax Holiday (10 years) Relief in Tax & Excise Duty	E2- Land transfers are tricky	S2- Lack of public awareness about the land issues	K2- Creates vibrational disturbances	C2- NMBY syndrome
P3-Renewable Energy Certificate (REC)	E3- Costs of finance is high (12% - 14%)	S3- lack of coordination between administration and the community	K3- Shadow flickers are irritating	C3- Lack of community participation in planning
P4-Appropriate Legislations	E4- Wind energy costs unpredictable	S4- Noise pollution and degradation of property value	K4- Affects avian population	C4- lack of right awareness among public
P5-Institutional Credit	E5- Fluctuating foreign exchange affects technology importation costs	S5- Natural and aesthetic beauty of the landscape hampers	K5- Wind farms near wild life sanctuaries/national park disturbs fauna	C5- Diverse perceptions about wind turbine installation
	E6- Greed connection costs is high (11%-14%)	S6- Concentration if wind turbines lead to conflict with administration	K6- Disrupts habitations in some circumstances	C6- Developers and planners have less knowledge about the community
	E7- Civil works are expensive	S7- unequal access to wind energy		
	E8- Wind energy pay back has technology linkages			
	E9- Transmission costs are more due to distance			
	E10- Intermittency implies costs			

Advanced Tech - ESKC Strength

Advanced Tech	Economic Condition	Social Condition	Environmental Condition	Cultural Condition
T1- Carbon Fiber Improved Turbines and Low Intermittency	E1- Reduced wind power generation costs	S1- Ecological security from fossil fuel emissions	K1- Less damage to environment	C1- Wind energy has religious connotation and acceptable
T2- Low Costs Towers	E2- Dismal O & M costs (2%)	S2- Wind farm lands are reusable	K2- Vertical shaft turbines are more eco-friendly and efficient	C2- Wind energy use has long tradition in India
T3- Autonomous Hybrid Power System	E3- Expand the scale of wind power production	S3- Community rights to have wind power amenity	K3- Wind farms abate climate change	C3- Favourable attitudes towards clean wind energy
T4- Expanded Siting of Wind Farms	E4- Competitive costs against fossil fuel	S4- Saves water compared to fossil fuel use	K4- Wind energy can offset Co2 Emission (1mw = 2600 tones Co2)	C4- Wind farm myths eliminated by new models
T5- Trained Man Power at the Grass Roots	E5- Compatible policy instruments E6- Tax and duty free incentives, REC & RPO privileges E7- Investments in grid connection having implications on costs		K5- Wind farms can accommodate other grid posturing activities	C5- Environmental education is changing perceptions

Advanced Tech - ESKC Weakness

Viabile Tech	Economic Condition	Social Condition	Environmental Condition	Cultural Condition
T1- Carbon Fiber Improved Turbines and Low Intermittency	E1- Prohibiting costs of equipment, storage and distribution	S1- Lack of communication and co-ordination among stakeholders	K1- Noise pollution is major pitfall	C1- lack of community acceptance and NIMBY syndrome
T2- Low Costs Towers	E2- unpredictable price for costs for wind energy	S2- lack of awareness about the processes of wind farm installation	K2- small turbines caused vibrational disturbances	C2- lack of public participation in planning
T3- Autonomous Hybrid Power System	E3- High costs of finance	S3- Lack of sensitivity of administration to address the community issues	K3- shadow flickering irritates eyes	C3- lack of public awareness
T4- Expanded Siting of Wind Farms	E4- Fluctuating costs of importing technology due to devaluation of currency	S4- Adverse health impacts and degradation of property value	K4- avian gets affected	C4- inadequate knowledge about rural issues
T5- Trained Man Power at the Grass Roots	E5- Higher costs of greed connection and electric line	S5- Affects natural beauty	K5- intermittent wind energy makes Co2 reduction ineffective	C5- use of common property resources is controversial
	E6- civil works, transportation and installation costs	S6- Overcrowding of wind turbines lead to conflicts with the community	K6- wind energy form dislocate habitat, human and non-human	C6- political interference in commissioning the wind farms
	E7- Uncertainty over energy payback period	S7- Uninterrupted access to wind energy and equity issues		
	E8- Initial investment costs is higher			
	E9- Transmission costs is high due to distance			

3rd Quadrant
Less Favourable Policy - ESKC Strength

Unviable Policy	Economic Condition	Social Condition	Environmental Condition	Cultural Condition
P1- Lack of integration of economic & technological Components	E1- Wind power costs declining.	S1- Public health security and health benefits.	K1- Zero emissions.	C1- Wind energy has religious sanctity
P2- Lack of coordination among the line department	E2- O & M costs are marginal (about 2%)	S2- No alienation of community lands.	K2- Boon for non greed locations	C2- Its usage has long tradition and acceptability
P3- Lack of Govt. accountability/ Fickle Nature of Policy	E3- R & D Initiatives for better viability.	S3- Citizens' right of amenities	K3- Saves water	C3- Mind sets and receptive to clean energy
P4- Lack of Support to R&D	E4- Wind power is competitive with other sources.	S4- access to clean energy.	K4- Helps to mitigate climate change	C4- Modern turbines make less noise and acceptable
P5- Difficulties in Getting Land Clearance	E5- Development of new economic instruments.		K5- Offsets CO2 (1mw=2600 Tones CO2)	
	E6- Foreign Direct Investment (FDI).		K6- Less harmful to flora and fauna compared to fossil fuel.	
	E7- Attracting private investments.			

Status Quo Tech - ESKC Weaknesses

Status Quo Tech	Economic Condition	Social Condition	Environmental Condition	Cultural Condition
P1- Lack of integration of economic & technological Components	E1- Higher Investment capital costs	S1- Lack of communication amongst stakeholders	K1- Noise pollution is hazards	C1- Community support unpredictable
P2- Lack of coordination among the line department	E2- Land transfers are tricky	S2- Lack of public awareness about the land issues	K2- Creates vibrational disturbances	C2- NMBY syndrome
P3- Lack of Govt. accountability/ Fickle Nature of Policy	E3- Costs of finance is high (12% - 14%)	S3- lack of coordination between administration and the community	K3- Shadow flickers are irritating	C3- Lack of community participation in planning
P4- Lack of Support to R&D	E4- Wind energy costs unpredictable	S4- Noise pollution and degradation of property value	K4- Affects avian population	C4- lack of right awareness among public
P5- Difficulties in Getting Land Clearance	E5- Fluctuating foreign exchange affects technology importation costs	S5- Natural and aesthetic beauty of the landscape hampers	K5- Wind farms near wild life sanctuaries/national park disturbs fauna	C5- Diverse perceptions about wind turbine installation
	E6- Greed connection costs is high (11%-14%)	S6- Concentration if wind turbines lead to conflict with administration	K6- Disrupts habitations in some circumstances	C6- Developers and planners have less knowledge about the community
	E7- Civil works are expensive	S7- unequal access to wind energy		
	E8- Wind energy pay back has technology linkages			
	E9- Transmission costs are more due to distance			
	E10- Intermittency implies costs.			

Status Quo Tech - ESKC Strength

Status Quo Tech	Economic Condition	Social Condition	Environmental Condition	Cultural Condition
T1- Immature Technology and intermittency	E1- Reduced wind power generation costs	S1- Ecological security from fossil fuel emissions	K1- Less damage to environment	C1- Wind energy has religious connotation and acceptable
T2- Inadequate wind energy technicians	E2- Dismal O & M costs (2%)	S2- Wind farm lands are reusable	K2- Vertical shaft turbines are more eco-friendly and efficient	C2- Wind energy use has long tradition in India
T3- Inefficiency of Greed and Storage Facility	E3- Expand the scale of wind power production	S3- Community rights to have wind power amenity	K3- Wind farms abate climate change	C3- Favourable attitudes towards clean wind energy
T4- Lack of improved wind siting	E4- Competitive costs against fossil fuel	S4- Saves water compared to fossil fuel use	K4- Wind energy can offset Co2 Emission (1mw = 2600 tones Co2)	C4- Wind farm myths eliminated by new models
T5- Non-availability of low cost turbines and towers	E5- Compatible policy instruments E6- Tax and duty free incentives, REC & RPO privileges E7- Investments in greed connection having implications on costs		K5- Wind farms can accommodate other greed posturing activities	C5- Environmental education is changing perceptions

Less Favourable Policy - ESKC Weaknesses

Less Favourable Policy	Economic Condition	Social Condition	Environmental Condition	Cultural Condition
T1- Immature Technology and intermittency	E1- Prohibiting costs of equipment, storage and distribution	S1- Lack of communication and co-ordination among stakeholders	K1- Noise pollution is major pitfall	C1- lack of community acceptance and NIMBY syndrome
T2- Inadequate wind energy technicians	E2- unpredictable price for costs for wind energy	S2- lack of awareness about the processes of wind farm installation	K2- small turbines caused vibrational disturbances	C2- lack of public participation in planning
T3- Inefficiency of Greed and Storage Facility	E3- High costs of finance	S3- Lack of sensitivity of administration to address the community issues	K3- shadow flickering irritates eyes	C3- lack of public awareness
T4- Lack of improved wind siting	E4- Fluctuating costs of importing technology due to devaluation of currency	S4- Adverse health impacts and degradation of property value	K4- avian gets affected	C4- inadequate knowledge about rural issues
T5- Non-availability of low cost turbines and towers	E5- Higher costs of greed connection and electric line	S5- Affects natural beauty	K5- intermittent wind energy makes Co2 reduction ineffective	C5- use of common property resources is controversial
	E6- civil works, transportation and installation costs	S6- Overcrowding of wind turbines lead to conflicts with the community	K6- wind energy form dislocate habitat, human and non-human	C6- political interference in commissioning the wind farms
	E7- Uncertainty over energy payback period	S7- Uninterrupted access to wind energy and equity issues		
	E8- Initial investment costs is higher			
	E9- Transmission costs is high due to distance			

Strategy 1: Strong Policy and Strong ESKC

P2 [E4,S4,K4,C3] = Tax Holidays/Reliefs[competition with fossils; access to clean energy; mitigate climate change; receptive to clean energy]

Tax holidays and related tax relief measures introduced by the state shall certainly attract the investors to enter into wind energy sector. This would attract not only service developers but also those who wish to seek tax reliefs for the income earned through other business ventures. As more number of private investors gets into wind energy business, supported by policy incentives and favourable markets, the present oligopolistic market would move towards perfect competition with the companies producing energy through fossils and also higher priced energy. This would lead to the present price advantage of the fossil fuel (which is low) getting neutralised with the wind energy. Under the present transparency norms of the state where the accountability of the business houses is greater, tax holidays and associated incentives would provide cushion effect to many business groups.

Access to clean energy is a social issue in India. Many parts of the country still reel under energy poverty and inadequate access to even for lighting homes and streets. Supply of electricity is still under the control of the state. Tax rebates would pave way for a large scale private investment into this sector leading to higher production with competitive prices affordable to the weaker sections in the villages. Equity of energy distribution is still a challenge to the state and the present pace of wind energy development would reduce the energy access gap in the society.

Promoting development and mitigating climate change, hand in hand, is a political issue. It needs appropriate linkages in the system. Increase in the renewable energy production, making it accessible to all sections would contribute for reduction in CO₂ and climate change. Such situation is only possible when the state introduces attractive policy instruments such as tax holidays and rebates attractive to the investors.

Simultaneously, on the receiving side, the general public need to have appropriate mind sets to use wind energy, a renewable, by paying the price less than or equal to the fossil fuel or even prepared to pay slightly higher price for wind energy. In metropolitan cities of India, the fossil fuel have created havoc and made the environment non-habitable. The health and other related social costs of fossil fuels are becoming enormous. The public are receptive to clean energy options and the conditions are ripe for promoting wind energy.

Strategy 2: Strong Policy and Weak ESKC

P3 [E10, S4, K6, C6]= REC[cost of intermittency; noise pollution and property degradation; disruption of natural habitation; lack of knowledge about the community by developers and planners]

Renewable Energy Certification (REC) is a complementary mechanism to Renewable Purchase Obligation (RPO). It is a market instrument to promote renewable energy which can be traded and exchanged for producing renewable energy. REC as an instrument can overcome some of the weaknesses of economic factors associated with wind energy production. Certain pitfalls of wind energy technology such as “intermittency” which constrain production to reach its economy to the scale would get incentives under REC. REC mechanism is like adding credits to the renewable energy producer for the quantity produced which can be traded or exchanged those incentives associated with the production. In case of wind energy, the producer can earn more REC credits during the favourable season and use it during the slack season.

The noise pollution and the consequent property degradation is another negativity of wind energy. The REC privileges given to the producer may empower for taking risks of investing in improving technologies available in the market that would reduce noise and consequently avoid degradation of the property value.

The disruption of avian and human life is a common drawback with wind turbine technologies. This would discourage many aspiring developers in India from investing in this sector despite being given REC facility. In the Indian context, given vast land space available, new siting for wind farms may be done far away from human habitat to reduce the social cost. Similar may be case with the avian life. The other option would be environmentalists and ornithologists can be invited for suggestions to divert the movement of avian life and their behaviour if possible. The other measures to reduce the disruption and associated social costs would be to keep the motivation levels of the developers intact to continue business and use REC privileges.

Very often, the developers and planners have little knowledge about the communities’ perceptions and attitudes towards wind farms which make them to oppose wind farm projects. Such conflicts and oppositions can be managed by educating them about the merits of wind energy and associated benefits. The alarming levels of air pollution in many metropolises of India may be used as an illustration to convince the community about hazards of pollution. This apart, the benefits offered through REC can motivate technology to innovate the system to reduce conflicts by way of understanding community’s sentiments, at times with the help of Anthropologists and Ethnographers.

Strategy 3: Strong Technology and Strong ESKC

T4[E4, S1, K3, C1] = Expanded Siting [competitive prices; eco-security from fossil fuels; abate climate change; mass appeal and religious acceptance]

Expanding wind farms sites is an important determinant of wind energy promotion in India. India is ahead of many countries in fine tuning wind energy technologies and expanding new sites to establish wind farms. The expanding siting will certainly pave way for production and storage of wind energy. This can be made available for distribution responding to the demands of the market. The expansion

would mean not only the production of energy in MW, also the manufacturing of wind mills and associated accessories. Therefore, the competitive prices refer to the units of energy produced and also the hardware of wind farms, which would become competitive.

Saving the masses of India from the hazards of exposure to the fossil fuels is one of the commitments of the state. Expanding the wind farms siting and making clean energy available for masses is a bold step in the direction of providing ecological security and freedom from air pollution. Providing ecological and environmental security is a human right issue and an indicator of sustainable development.

Obviously, the expansion of wind farm siting and increased production will contribute for climate change in the long term. The expansion of siting presupposes that other linkages will be in place such as storage, grid, transmission lines, market and demand. All these linkages ensure the potential consumers transit towards cleaner energy use. Under the conditions of strong system's components, there are better chances of increasing cleaner energy production and use.

In the Indian cultural context, wind is one amongst the five gods governing the universe (Pancha-Bhuta). Therefore, the energy produced through wind has religious sanctity and acceptable, especially, in rural areas. While promoting wind energy at the community level, this religious dimension of wind energy may be sited in the social marketing strategies. This would reduce the resistance from the community while installing wind farms and motivating them to use wind energy in rural areas.

Strategy 4: Strong Technology and Weak ESKC

T4 [E1, S1, K1, C1] = Expanded Siting [prohibiting costs; weak coordination among the stakeholders; noise pollution; lack of community acceptance (NIMBY)] Wind energy promotion may face challenges and setbacks under the conditions of strong technology and weak system's components. Expansion of wind farm siting adversely get affected if the wind power economics proves to be costly and expensive. This includes hardware of the wind farms and cost per unit of energy produced. Under strong technology, when the costs are prohibitive, expansion of siting may be allowed to proceed for some time until supply side reaches some saturation so that the costs are compelled to go down due to increase in supply. As a short time intervention, state may intervene in the market and incentivise or subsidise the power tariff, for some time to make the costs affordable. This strategy may set the demand and supply equilibrium to be stable in the medium term.

Weak coordination amongst the stakeholders may pose a serious problem for promoting wind energy despite strong technical options available for application. Under such circumstances, the better option would to create some institutional mechanisms to overcome the bottlenecks in coordination.

In a free market condition such institutional mechanisms keep evolving responding to the attractive incentive regimes in place. However, for the initial period, when the stakeholders' constituency is in disarray, the emerging markets may take time to create conditions conducive for the stakeholders to institutionalize themselves to ensure proper coordination. Until such time, state can come forward to

create institutions for better governance. In India, Indian Energy Development Agency (IEDA) and Maharashtra Energy Development Agency (MEDA) are good illustrations of state initiated institutions.

It is reported in the literature, that in many advanced countries, noise pollution is considered as hazardous due to wind farms and there are protests by the community. However, in the Indian context, noise, so far, is not taken seriously, even in the urban areas. If that would have been the case, honking vehicles in the middle of the night should have been protested in many Indian cities. Such protests are not in the news. In case of protests against the noise, the developers and the state would think of modern turbines which are available which make less noise.

Similar is the case with NIMBY (Not In My Back Yard) syndrome which is not familiar to Indian communities. Perhaps, it is a long way to go until wind turbines reach back yards of the individuals.

Strategy 5: Weak Policy and Strong ESKC

P3 [E6, S3, K4, C2] = Fickle nature of the policy [FDI; right to amenities; mitigate climate change; tradition of wind energy use]

Under a weak policy regime, which is a prime driver in the whole process would weaken strength points of the system's components such as economy, social, environmental and cultural conditions or may have to exert higher pressure to mend the ways of a weak policy. For instance, in investment starved India, FDI needs to be supported through appropriate policy instruments. If the policy remains weak, feeble and fickle, due to opposing political lobbies, investors from abroad may not show interest to invest in India. Policy needs to be strong and supportive to attract FDI.

Human Rights activists and citizens' fora would demand for clean energy and clean environment as their right. Weak policy regimes may not do much to fulfil the aspirations of these groups. Further, mending of policies would depend on how strong these lobbying groups are? What are their influences on the decision makers? And what is their control over the voters? These questions remain critical in policy advocacy issues. Under the conditions when other system components are congenial, due to weak policy drive, achieving clean energy targets is difficult.

The broader objective of the clean energy mission is to mitigate climate change, policy regime being the important driver in the system is expected to take a major role in moulding other components. In the present case, policy instruments are weak, and may lead to weakening of the other system's components. In the International fora, weak policies of India may become a subject of criticism and may have implications on international trade and commerce, and consequently hamper the economy of the country. India may lose its influence on international politics. This would cost dearly to the Indian nation state and its sphere of influence in domestic and international affairs.

The cultural capital, in the form of values and institutions, congenial for wind energy promotion may go waste under weak policy regime. The human rights lobbies, may make use of this cultural capital to organize and mobilize, public opinion in favour of clean energy and strengthen their lobby to bring

out necessary changes in the policy. Such efforts may take medium or long term time period with support of other stakeholders. The weak policies would ruin the spirit of clean energy mission in general and wind energy in particular.

Strategy 6: Weak Policy and Weak ESKC:

P1 [E2, S7, K4, C4] = Lack of Integration [tricky land transfers; unequal access; affect avian life; lack of right awareness]

Lack of integration and coordination among the different line departments is a reflection of weak policy instruments and weak governance. When the prime driver policy is weak and has to work with weak system's components, the results would be disastrous. In the Indian context, the departments of Energy, Forests and Revenue would constitute a good illustration to "lack of integration". For acquiring lands for wind farms all the three line departments have to work in an integrated way as they share a common objective, that is, reducing emissions. Some lands may come under the jurisdiction of Revenue Department while others under the Forests. If they work under isolation, it would be difficult to implement wind energy projects either under public or private sector. Currently, this issue of inter-departmental integration is an evolving mechanism of governance in India.

Indian society is highly stratified and segmented on the lines of caste, class, power and religion. Therefore, sharing of any resource is likely to percolate down unequally. Lack of integration as a policy instrument would accentuate unequal access to clean energy in already fragmented society and lead to conflicts. Egalitarian energy access could be the goal of this mission.

Wind farms affecting avian life may be a serious issue in India, in the medium term, when the scale of wind farms reaches its optimum level. Until such time the projects can be continued. Diverting the avian life to safer places is another alternative. With the support of ornithologists, appropriate plans may be worked out. Initiatives to protect avian life from wind farms are already in progress in many countries and lessons can be drawn from their experiences.

Lack of right awareness among the masses about the advantages of wind energy would be a major challenge in this mission. The lack of integrated policies may only facilitate spreading the wrong signals to the public when the new sites are commissioned. Under such circumstances, civil society organizations can assume the role of creating right awareness among the masses and the stakeholders. Lack of integration among the line departments is a weak policy driver and may further weaken the other system's components.

Strategy 7: Weak Technology and Strong ESKC

T1 [E1, S3, K2, C4] = Immature Technology/Intermittency [reduced cost; right to amenity; efficient vertical turbines; new turbine designs with less noise]

Immature wind farm technology, with problems of intermittency can move ahead with some progress under the strong and favourable conditions of system's components. The reduced costs of commissioning wind farms, that is, hardware, would still encourage the stakeholders to choose wind energy options. Because, the input cost is free, that is wind. Reduction in cost of the wind energy per unit produced will certainly make the consumers to use this energy irrespective of the fact whether the technology is advanced or not. As a policy issue, if the costs are kept competitive with the fossil fuels, consumers would accept it since they are concerned with energy per se and not the source from which energy is produced.

At the community level, citizens, as rational individuals, always strive for secured clean energy at a reasonable price as a human rights issue. Clean energy availability to the citizens is the obligation of the state. At the given point of time, whatever the technology available in the market, state is expected to make arrangements to ensure access to its citizens. The goal is to reduce emissions with the available technology mediated through the state. Pressure from the citizens' lobby is essential to evolve clean energy alternatives.

Technology option can never be an end in itself since it is an evolving process. The best available technology at the given point of time should be in place. In a global mission like "reduction of emissions" there is a need for transfer of technology without constraints from one corner of the world to another. Such initiatives would reduce emissions on global scale. Vertical turbine wind farms are considered to be more efficient within the available alternatives and may be advocated wherever viable in the Indian context.

Noise and ugly looks and flickers are some of the culture specific pitfalls with the existing wind turbine technology. A number of new designs are now, available in market. These new designs may have better appeal culturally, as compared to the old models. Even though there are technological shortcomings, in terms of intermittency and immaturity in storage, wind farms can be promoted under favourable system's components. Therefore, the shortcomings in present technology may not be a major constraint for promoting wind energy while other components are strong and favourable.

Strategy 8: Weak Technology and Weak ESKC

T4 [E7, S3, K4, C2] = No improved siting [uncertain pay-back period; insensitive administration; ill effects on avian life; no public participation]

Lack of technology initiatives for locating new sites for wind farms may lead to a major setback for expansion of wind energy. Expansion of wind farms is indispensable. In the absence of improved siting methods for augmenting wind energy production and the weak system's components would hinder the promotion of wind energy. The weak technology in the present together with weak system's components would conceptually, lead to downward spiral in the medium term and would lead to elimination of wind energy projects. The available limited siting of wind farms would not be adequate for the private developers to pay back the cost of investment they would make in different sites. For them, the investment would work out economy to the scale when the production levels reach optimum. The private investors should have scope to produce reasonable profit margin out of wind energy business. This would mean, expanding the number of sites where in the aggregate quantity of wind energy would help to reach reasonable profit margin. This would facilitate to overcome the uncertainties associated with the payback period. Unless such arrangements are in place, private sector cannot take-off wind energy production.

Insensitivity of the administration to respond to the needs and aspirations of the citizens for clean energy would further the down spiral trend in wind energy production. Administration is expected to be sensitive to the needs of the society. Under the conditions of administrative laxity state would not be successful in protecting the masses from the ill-effects of emission. State reaches out to the common public through its administrative machinery.

In the Indian context, ill-effects of wind farms on avian life are a minor issue until now. However, this may pose a problem when the wind farm expansion reaches its peak. Perhaps, that would be the time when environmentalists would protest the ill effects of wind farms on avian life and the aesthetics of nature. They may align with the locals to stall the wind farm projects or demand for the compensatory packages which would cost dearly to the state or the corporate.

Citizens' participation would necessary for the success of wind farm projects. Lack of participation may create setback to the wind energy projects. This will have ramifications on other weak components of the system and would adversely affect the program.

CONCLUSION

Out of the eight strategy alternatives discussed in the receding section, strategy-1 and strategy-3 are the critical determinants for the expansion of wind energy farms in the region. These would be idealistic scenarios. These two strategies are supported by strong policy instruments and advanced technology packages as the prime drivers supported by favourable system's components. The policy and

the technological conditions chosen for strategizing wind farm expansion appear to be appropriate and determining (eg: tax rebates/incentives and wind farm siting technology). These drivers are supported by strong other system's components. The strategy-5 and strategy-7, despite being weak in policy instruments and technology components, due to strong system's components, there are ways to mend drivers suitable for wind farm expansion. These would be realistic scenarios. The strategy-6 and strategy-8 depict both the drivers and the system's components are weak and the combined weaknesses lead to a downward spiral effect on the project. The drivers and the supportive components force the situations vulnerable for stagnation and regression in achieving the goal. These are pessimistic scenarios. Further, the analysis reveals that the policy is more critical driver than the technology. The shortcomings of the existing technologies can be overcome through appropriate policy instruments. The strong policy driver can eliminate the weaknesses of the system components. Thus, the model throws open a number of viable alternatives for planners and developers.

REFERENCES

- Aayog, N. I. T. I. (2015) Report on India's Renewable Electricity Roadmap 2030. Towards Accelerated Renewable Electricity Deployment. NITI Aayog, Government of India New Delhi. [http://shaktifoundation.in/wpcontent/uploads/2014/02/Report-on-Indias-RE-Road map-2030-full-report-web2.pdf](http://shaktifoundation.in/wpcontent/uploads/2014/02/Report-on-Indias-RE-Road-map-2030-full-report-web2.pdf), retrieved on 18 Nov, 2017.
- Al Hatmi, Y. & Tan, C. S. (2013) Issues and Challenges with Renewable Energy in Oman. *Gas (BCM)*, 4(9), 212–218.
- Bhutto, A. W., Bazmi, A. A. & Zahedi, G. (2013) Greener energy: Issues and challenges for Pakistan – wind power prospective. *Renewable and Sustainable Energy Reviews*, 20, 519–538.
- Bloomberg New Energy Finance/UNEP (2016) Executive Summary, *Global Trends in Renewable Energy Investment*. p. 12–19.
- Clean Energy Ideas, CEI (2007-17) www.clean-energy-ideas.com/about, retrieved on 9 Oct, 2017.
- Jaber, S. (2013) Environmental impacts of wind energy. *Journal of Clean Energy Technologies*, 1(3), 251–254.
- Kazmerski, L. L. (2006) Solar photovoltaics R&D at the tipping point: A 2005 technology overview. *Journal of Electron Spectroscopy and Related Phenomena*, 150(2), 105-135.
- Kiel (2012) The Telegraph.2012. "Subsidies for onshore wind farms to be axed by 2020", Retrieved from www.windawareireland.com/economic-issues/, retrieved on 11 Nov, 2017.
- Krithika, P. R. & Mahajan, S. (2014) Background paper Governance of renewable energy in India: Issues and challenges.
- Maynard, J. E., Lovcraft, A., Rose, C. & Chapin III, T. (2010) Factors influencing the development of wind power in rural Alaska communities (Doctoral dissertation, University of Alaska Fairbanks).
- Macintosh, A. & Downie, C. (2006) *Wind Farms: the facts and the fallacies*. Australia Institute.
- MNRE (2004) Annual report 2003-04, <http://centurionenergy.net/types-of-wind-turbines>, retrieved on 18 Dec, 2017.

- MNRE (2014) National wind mission: Objectives and scope, Ministry of new & Renewable Energy, 9 January 2014, Retrieved from <http://mnre.gov.in/file-manager/UserFiles/...09012014/Alok-Srivastava-JS-MNRE.pdf>, retrieved on 7 Sept, 2017.
- MNRE (2015) Draft national offshore wind energy policy, ministry of new and Renewable Energy, government of India, <http://mnre.gov.in/file-manager/UserFiles/presentations-offshore-wind.../JS-MNRE.pdf>, retrieved on 4 Oct, 2017.
- MNRE (2014) National wind mission: Objectives and scope, Ministry of new & Renewable Energy, 9 January 2014, <http://mnre.gov.in/file-manager/UserFiles/...09012014/Alok-Srivastava-JS-MNRE.pdf>, retrieved on 11 Nov, 2017.
- MNRE (2014) Existing Wind Power Policies and Incentives. Consultation on National Wind Energy Mission. January 9, 2014. New Delhi. <http://mnre.gov.in/file-manager/UserFiles/Presentations-NWM-09012014/Dilip-Nigam.pdf>, retrieved on 29 Nov, 2017.
- MNRE (2016) A new dawn in Renewable Energy- India attains 4th position – PIB, <http://pib.nic.in/newsite/PrintRelease.aspx?relid=155612>, Press Information Bureau Government of India Ministry of New and Renewable Energy, retrieved on 22 Nov, 2017,
- Mostafaeipour, A. (2010) Productivity and development issues of global wind turbine industry. *Renewable and Sustainable Energy Reviews*, 14(3), 1048–1058.
- Nigam, D (2014) Existing wind power policies and incentives, consultation on national wind energy mission, January 9, 2014, New Dehli, MNRE, <http://mnre.gov.in/file-manager/UserFiles/Presentations-NWM-09012014/Dilip-Nigam.pdf>, retrieved on 11 Dec, 2017.
- Ragheb (2017) Economics of wind energy, <http://mragheb.com/NPRE%20475%20Wind%20Power%20Systems/Economics%20of%20>, retrieved on 2 Jan, 2018.
- REN 21 (2017) Renewables 2017 Global Status Report (Paris: REN21 Secretariat). ISBN 978-3-9818107-6-9.
- Saidur, R., Rahim, N. A., Islam, M. R. & Solangi, K. H. (2011) Environmental impact of wind energy. *Renewable and sustainable energy reviews*, 15(5), 2423–2430.
- Singh, Madhu & Singh, Payal (2014) A Review of Wind Energy Scenario in India, *International Research Journal of Environment Sciences* Vol. 3(4), 87–92
- Solangi, K. H., Islam, M. R., Saidur, R., Rahim, N. A. & Fayaz, H. (2011) A review on global solar energy policy. *Renewable and sustainable energy reviews*, 15(4), 2149–2163.
- TERI (2015) Renewable energy and green growth in India, Draft final report renewable energy, www.teriin.org/projects/green/pdf/National-RE.pdf, retrieved on 11 Nov, 2017.
- The Economic Times(2016) , India’s renewable energy targets catch the attention of global investors, still need ground work, Urmi Goswami, ET Bureau | Updated: Jul 02, 2016, 04.03 AM IST. www.google.co.in/amp/m.economictimes.com/news, retrieved on 5 Nov, 2017.
- Windaware (2017) Economic Issues | Wind Aware Ireland, www.windawareireland.com/economic-issues/, retrieved on 11 Nov 2017.
- Wind Energy Facts (2017) <https://www.wind-energy-the-facts.org/index-43.html>, retrieved on 11 Dec, 2017.
- Wind Watch (2012) <http://www.wind-watch.org/news/wp-content/uploads/2012/06/Kingston-turbines.jpg>, retrieved on 11 Dec, 2017.
- Yao, F., Bansal, R. C., Dong, Z. Y., Saket, R. K. & Shakya, J. S. (2011) Wind energy resources: theory, design and applications. *Handbook of Renewable Energy Technology*, Section I: Wind Energy and Their Applications, 03–20.
- Zobaa, A. F. & Bansal, R. C. (2011) *Handbook of renewable energy technology*. World Scientific.

ANNEXURE

1. Strong Policy and Strong ESEC

a)	<i>P1</i>	$\begin{array}{cccc} E1 & S3 & K2 & C3 \\ E4 & S4 & K4 & - \\ E5 & - & K5 & - \\ E7 & - & - & - \end{array}$	b)	<i>P2</i>	$\begin{array}{cccc} E1 & S3 & K1 & C3 \\ E2 & S4 & K2 & - \\ E4 & - & K4 & - \\ E6 & - & K5 & - \\ E7 & - & - & - \end{array}$
c)	<i>P3</i>	$\begin{array}{cccc} E3 & S4 & K2 & C3 \\ E4 & - & K4 & - \\ E6 & - & - & - \\ E7 & - & - & - \end{array}$	d)	<i>P4</i>	$\begin{array}{cccc} E3 & S2 & K2 & C3 \\ E6 & S3 & K4 & - \\ E7 & S4 & K5 & - \end{array}$
e)	<i>P5</i>	$\begin{array}{cccc} E1 & S3 & K2 & C4 \\ E3 & S4 & K4 & - \\ E4 & - & - & - \\ E7 & - & - & - \end{array}$			

2. Strong Policy Weak ESEC

a)	<i>P1</i>	$\begin{array}{cccc} E1 & S1 & K1 & C1 \\ E3 & S3 & K4 & C3 \\ E4 & - & K5 & C6 \\ E8 & - & - & - \\ E10 & - & - & - \end{array}$	b)	<i>P2</i>	$\begin{array}{cccc} E1 & S1 & K4 & C1 \\ E3 & S3 & K5 & C3 \\ E4 & - & - & C4 \\ E8 & - & - & C5 \\ E9 & - & - & - \end{array}$
c)	<i>P3</i>	$\begin{array}{cccc} E3 & S1 & K4 & C1 \\ E4 & S3 & K5 & C3 \\ E6 & S4 & K6 & C5 \\ E8 & - & - & C6 \\ E10 & - & - & - \end{array}$	d)	<i>P4</i>	$\begin{array}{cccc} E1 & S1 & K4 & C1 \\ E2 & S2 & K5 & C3 \\ E4 & S3 & - & - \\ E8 & S7 & - & - \\ E10 & - & - & - \end{array}$
e)	<i>P5</i>	$\begin{array}{cccc} E1 & S3 & - & C1 \\ E3 & S7 & - & C6 \\ E6 & - & - & - \\ E7 & - & - & - \end{array}$			

3. Strong Technology and Strong ESEC

$$\text{a) } T1 \begin{vmatrix} E1 & S1 & K1 & C3 \\ E3 & S3 & K2 & C4 \\ E4 & - & K3 & - \\ E6 & - & K4 & - \\ E7 & - & - & - \end{vmatrix}$$

$$\text{b) } T2 \begin{vmatrix} E1 & S2 & K1 & C2 \\ E2 & S3 & K2 & C3 \\ E4 & - & K3 & - \\ E7 & - & K4 & - \end{vmatrix}$$

$$\text{c) } T3 \begin{vmatrix} E3 & S1 & K1 & C3 \\ E5 & S3 & K2 & C4 \\ E7 & - & K3 & C5 \end{vmatrix}$$

$$\text{d) } T4 \begin{vmatrix} E1 & S1 & K1 & C1 \\ E3 & S3 & K2 & C3 \\ E4 & S4 & K3 & C3 \\ E5 & - & K4 & - \\ E6 & - & - & - \end{vmatrix}$$

$$\text{e) } T5 \begin{vmatrix} E1 & - & K3 & C3 \\ E2 & - & K4 & C5 \\ E3 & - & - & - \end{vmatrix}$$

4) Strong Technology and Weak ESEC

$$\text{a) } T1 \begin{vmatrix} E1 & S1 & K1 & C1 \\ E2 & S2 & K5 & C2 \\ E3 & S3 & - & C5 \\ - & S7 & - & - \end{vmatrix}$$

$$\text{b) } T2 \begin{vmatrix} E1 & S2 & K1 & C2 \\ E3 & S6 & K2 & C3 \\ E5 & - & - & - \end{vmatrix}$$

$$\text{c) } T3 \begin{vmatrix} E2 & S2 & K1 & C2 \\ E4 & S3 & K5 & C3 \\ E7 & S7 & - & C4 \\ E9 & - & - & - \end{vmatrix}$$

$$\text{d) } T4 \begin{vmatrix} E1 & S1 & K1 & C2 \\ E5 & S2 & K2 & C3 \\ E6 & S3 & K4 & C4 \\ E7 & S6 & K6 & C5 \\ E9 & S7 & - & C6 \end{vmatrix}$$

$$\text{e) } T5 \begin{vmatrix} E3 & S3 & - & C2 \\ E7 & S7 & - & - \\ - & - & - & - \\ - & - & - & - \end{vmatrix}$$

5) Weak Policy and Strong ESEC

$$\text{a) } P1 \begin{vmatrix} E1 & S2 & K2 & C2 \\ E3 & S3 & K4 & C3 \\ E4 & S4 & K5 & - \\ E6 & - & - & - \\ E7 & - & - & - \end{vmatrix}$$

$$\text{b) } P2 \begin{vmatrix} E1 & S2 & K1 & C1 \\ E3 & S3 & K2 & C2 \\ E4 & S4 & K4 & C3 \\ E6 & - & K5 & - \\ E7 & - & - & - \end{vmatrix}$$

$$\text{c) } P3 \begin{vmatrix} E1 & S2 & K1 & C1 \\ E3 & S3 & K2 & C2 \\ E4 & S4 & K4 & C2 \\ E5 & - & K5 & - \\ E6 & - & - & - \\ E7 & - & - & - \end{vmatrix}$$

$$\text{d) } P4 \begin{vmatrix} E1 & S3 & K1 & C1 \\ E4 & S4 & K2 & C2 \\ E5 & - & K4 & C3 \\ E6 & - & K5 & - \\ E7 & - & - & - \end{vmatrix}$$

$$\text{e) } P5 \begin{vmatrix} E4 & S2 & K1 & C1 \\ E5 & S3 & K4 & C3 \\ E6 & S4 & E5 & - \\ E7 & - & - & - \end{vmatrix}$$

6) Weak Policy and Weak ESEC

$$\text{a) } P1 \begin{vmatrix} E2 & S1 & K4 & C1 \\ E4 & S3 & K5 & C3 \\ E5 & S7 & K6 & C4 \\ E8 & - & - & C5 \\ E10 & - & - & - \end{vmatrix}$$

$$\text{b) } P2 \begin{vmatrix} E1 & S3 & K4 & C1 \\ E2 & S6 & K5 & C3 \\ E4 & S7 & - & C5 \\ E5 & - & - & - \\ E8 & - & - & - \\ E10 & - & - & - \end{vmatrix}$$

$$\text{c) } P3 \begin{vmatrix} E1 & S1 & K4 & C1 \\ E2 & S2 & K5 & C2 \\ E5 & S3 & K6 & C4 \\ E8 & S7 & - & - \end{vmatrix}$$

$$\text{d) } P4 \begin{vmatrix} E1 & S3 & K1 & - \\ E4 & S4 & K2 & - \\ E6 & - & K3 & - \\ E10 & - & - & - \end{vmatrix}$$

$$\text{e) } P5 \begin{vmatrix} E1 & S1 & K4 & C3 \\ E2 & S3 & K5 & C4 \\ - & S5 & K6 & C5 \\ - & S6 & - & - \end{vmatrix}$$

7) *Weak Technology and Strong ESEC*

$$\text{a) } T1 \begin{vmatrix} E1 & S1 & K2 & C2 \\ E3 & S3 & K3 & C4 \\ E4 & S4 & K4 & C5 \\ E6 & - & - & - \end{vmatrix}$$

$$\text{b) } T2 \begin{vmatrix} E2 & S1 & K2 & C3 \\ E3 & S3 & K3 & C4 \\ E4 & - & K4 & - \\ - & - & - & - \end{vmatrix}$$

$$\text{c) } T3 \begin{vmatrix} E1 & S1 & K1 & C1 \\ E3 & S3 & K3 & C3 \\ E4 & - & K4 & - \\ E7 & - & - & - \end{vmatrix}$$

$$\text{d) } T4 \begin{vmatrix} E1 & S1 & K3 & C3 \\ E3 & S3 & K3 & C5 \\ E4 & - & - & - \\ E5 & - & - & - \end{vmatrix}$$

$$\text{e) } T5 \begin{vmatrix} E3 & S1 & K1 & C2 \\ E4 & S3 & K2 & C3 \\ E5 & - & K3 & - \\ E6 & - & K4 & - \end{vmatrix}$$

8) *Weak Technology and Weak ESEC*

$$\text{a) } T1 \begin{vmatrix} E1 & S2 & K1 & C2 \\ E5 & S3 & K2 & C3 \\ E9 & S7 & K3 & - \\ - & - & K5 & - \end{vmatrix}$$

$$\text{b) } T2 \begin{vmatrix} - & S3 & - & C2 \\ - & S7 & - & C4 \\ - & - & - & - \\ - & - & - & - \end{vmatrix}$$

$$\text{c) } T3 \begin{vmatrix} E1 & S2 & K5 & C2 \\ E2 & S3 & - & C4 \\ E5 & S7 & - & - \\ E9 & - & - & - \end{vmatrix}$$

$$\text{d) } T4 \begin{vmatrix} E1 & S1 & K1 & C2 \\ E2 & S2 & K4 & C3 \\ E5 & S3 & K5 & C6 \\ E7 & S7 & - & - \end{vmatrix}$$

$$\text{e) } T5 \begin{vmatrix} E1 & S7 & K1 & C6 \\ E3 & - & K4 & - \\ E5 & - & K5 & - \\ E8 & - & - & - \end{vmatrix}$$

SOLAR ENERGY FUTURES FOR SOLAPUR SMART CITY: A PESTEC APPROACH

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ABSTRACT

This study presents a comprehensive analysis of renewable and especially solar energy through a political, economic, social, technology, environmental, and citizen/consumer (PESTEC) analysis approach and by reviewing the most up to date relevant literature and the field rights available. The study focuses on the Solapur Smart City given the favourable environmental resources for such technologies; the number of solar projects proposed by the local Municipal Government as well as attracting huge amount of the private and public investment in upcoming years. Findings of the analysis identify the challenges and opportunity, and multiple stakeholders involved at all stages of the solar energy projects development from the conceptualization of the design, right through to decommissioning. Many of the stakeholders present benefits through funding, incentives and knowledge sharing to the potential risks in the future of the projects. From this study it can be concluded that several of these challenges can be mitigated early and the opportunity for the future by providing incentives to the stakeholders involved to making Solapur most liveable city with new eco-friendly amenities to the citizens.

Keywords: Solar, Challenges, Smart City, Energy, Future.

INTRODUCTION

Urban areas will occupied around 66% of the world's population by 2050. In India about 32% of population lives in urban areas as of 2014. The rising migration to these developed cities necessitates that our cities be 'smarter'. Realizing this need, the Government has started the 'Smart Cities Mission'. The Smart Cities Mission is an ambitious initiative taken by the Government of India. It seeks to redefine not just urban life but also the Indian economy and our social structure as a whole. It has transformational potential; however, this undertaking necessitates change in the paradigm in the way of managing our cities. The Smart Cities is a thoughtful ideal which brings multiple ideas under it and that involves whole economic sectors in themselves. The Energy is one such idea reflected in the Smart-Cities' archi-

texture and design. The Energy is the primary requirement among the long list of public goods and services that a city provides its inhabitants. The Energy has direct and indirect impacts on the almost every other sector, including critical ones such as water, transport, and industry etc. This makes Energy one of the topmost priorities when addressing the Smart Cities Mission. Before implementation begins, the mission has to develop the definitional framework with well-defined standards and design that are suitably modified only to meet regional and local objectives or constraints. The stakeholders' involvement and participation would act as the preliminary step towards achieving this objective.

Solar energy is a major renewable energy source with the potential to meet huge energy demand. The use of Solar Energy is increasing in popularity because it is versatile use with many benefits to people and the environment. Solar energy is a safe alternative which can replace current fossil fuels like coal and gas for generation of electricity that produce air and water pollution and land degradation. Therefore, solar energy is a clean renewable resource with zero emission, and it has tremendous potential for energy production which can be harnessed using a variety of devices. With recent developments, solar energy systems are easily available for industrial and domestic use with the added advantage of minimum maintenance. Solar energy could be made financially viable with government tax incentives and rebates. Most of the developed countries are switching over to solar energy as one of the prime renewable energy source.

Against this background, the study seeks to be a 'conversation starter' around the idea of Solar Energy integration in to Smart Cities and would kick-start wide consultations with stakeholders that would ultimately inform government policy towards a cogent and cohesive implementation framework for executing the Smart Cities Mission in India.

BACKGROUND

Solapur city has been selected by the Ministry of Urban Development, Government of India (GoI) as one of the top 10 cities for developing as a "Smart City". Accordingly, the Local Government Body (LGB) has been prepared the Smart City Proposal (SCP) a master plan for making Solapur as a Smart city. As per the Smart Cities Mission Guidelines by GoI, It has been mandated that 10% of the smart cities' energy requirement will come from solar energy and at least 80% buildings should be energy efficient and green buildings. In this context, LGB has estimated a number of plans such as installation of solar panels on the area of municipal buildings, stadium, and bus shelters. Furthermore, LGB is projecting energy efficient solar street lighting and installation of solar panels in public space. Solar PV panels on all these facilities will be generating 2.4 MW (i.e. 12% of energy demand in selected area).

The scenarios compiled all expected to help the SMC to find a direction for their experimentation and piloting. In doing so, the study will help to identify challenges and future opportunities before the SMC. The study also brings out the highly unpredictable events which can carry a massive impact on

the smart city project. On the other side, the study aims to demonstrate the increasing importance of sharing economy solutions in the quest for sustainability through the solar energy.

POTENTIAL IN THE SOLAPUR CITY FOR SOLAR ENERGY

Solapur city is located in the south-western region of the Indian state of Maharashtra. Solapur is located on major road and rail routes between metro cities like Mumbai and Hyderabad, with a branch line to the cities such as Bijapur and Gadag in the neighbouring state of Karnataka. However, Solapur is classified as a 2 Tier and B-2 class city in India, although it is the 49th most populous city in India and the 43rd largest urban agglomeration (SMC 2017).

As per 2011, census of India, the population of Solapur city in 2011 was 9,51,118. The average literacy rate of Solapur city is 83.88%.Hinduism is the major religion in Solapur city with 75.73% followers (Census of India, 2011). The civic administration of the city is managed by the Solapur Municipal Corporation, which was established on the 1 May 1964. The corporation oversees the engineering works, health, sanitation, water supply, administration and taxation in the Solapur city. The corporation is headed by a mayor who is assisted by municipal commissioner and elected representatives. The Solapur city is divided into 135 wards and 6 zones. The corporation members also known as corporators are elected by the citizens of Solapur after every five years (SMC, 2017).

Solapur City's energy demand of 135 megawatt is completely met by the non-renewable energy sources. However, the Solapur is located in solar intensity zone 1, and there is enough potential for solar energy utilization. In Solapur city has around 250–300 sunny days per year. An annual average solar irradiation value of 5.34 kWh/m²/day makes Solapur a suitable city to tap solar energy and solar power generation (Solar Energy Centre, 2015).

OBJECTIVE

Following are the objectives of the study;

- to comprehend analysis of solar energy issues for Solapur city through a PESTEC analysis approach.
- to study the challenges and opportunities of the solar energy within the Solapur city.
- to identify the high risk the Solapur smart city may vulnerable; and
- to develop the various solar energy scenarios for the Solapur city.

METHODOLOGY

The study employs horizon scanning method using PESTEC analysis. The black swan scenarios are constructed to carry out the unpredictable events which may impact on the solar energy project. Various e-resources used to understand the challenges and debates for the promotion of solar energy in the Solapur smart city. To carry-out this exercise, PESTEC analysis and horizon scanning are together used to identify and each one is considered for developing future opportunities considering the present situation and the bottlenecks. The analysis is presented in the comparative table manner. This exercise is limited to the Solapur smart city context of solar energy.

PESTEC ANALYSIS

This section provides the core part of the study. However, the study considering PESTEC as critical drivers and the analysis has been made to explore the challenges and future opportunities for solar energy sector in Solapur smart city.

Table 1: PESTEC Analysis.

Challenges	PESTEC	Opportunities
<ul style="list-style-type: none"> • Three-tier Governance • changes in legal and regulatory systems • heterogeneous and complex formalities • Transparency in authorization, certification and licensing. • Absences of solar manufacturing industry. 	Political	<ul style="list-style-type: none"> • Conducive policy & regulatory framework • Promote the investment on solar manufacturing industry • Lobby activity and educate the politicians. • Incentive for citizen and private institutions
<ul style="list-style-type: none"> • Inadequate financial capability • Low cost substitute conventional energy dominance 	Economical	<ul style="list-style-type: none"> • Public Private Partnership (PPP) model has potential. • Progressive cost reductions • Financial incentives on the solar rooftop installations • saving and earning money by solar
<ul style="list-style-type: none"> • Misinformation and poor dissemination • Non-involvement of private individuals and institutions • Unavailability of skilled employee 	Social	<ul style="list-style-type: none"> • Paradoxical messages • Public campaign • Collaborative work • incentive schemes • Employment generation • Improves local micro economics • Poverty alleviation • Solapur University as knowledge transfer source
<ul style="list-style-type: none"> • cost reduction in installed capacity • complexity of manufacturing process • underperformance of cells • dependency on scarce materials • Advanced storage technologies • Integration into the network 	Technological	<ul style="list-style-type: none"> • R & D to develop sustainable technologies using abundant materials. • Adopting advanced storage devices like tesla batteries. • Smart grid connection.

<ul style="list-style-type: none"> • grid connectivity • Dust accumulation 		<ul style="list-style-type: none"> • Adopt advanced technologies to counter the dust problem
<ul style="list-style-type: none"> • Solar life-cycle emission • Use of hazardous materials • Workers harmed by exposure to hazardous chemicals. • Recycling of solar panels • adversely affect native vegetation and wildlife 	Environmental	<ul style="list-style-type: none"> • Rare materials like are recycled rather than thrown away.
<ul style="list-style-type: none"> • Risk of accidental fire • Visual impact 	Citizen	<ul style="list-style-type: none"> • Contribute to sustaining the status in the society. • Economic and social integration benefit to the citizen.

Political

Politics has the potential to have a dramatic effect on the future of solar energy offering many opportunities alongside many risks to existing and future solar developments in Solapur city. The SMC alone does not have complete control as its policies are dictated to an extent by Central and State level politics. Stability of the elected Government varies at Central, State and Local levels. The political framework and the regulatory constraints affect investments in the solar energy sector decisively. Frequent changes in legal, regulatory or tax systems introduced by a government may lead to the absence of a clear coherent solar energy policy and a concise planning. These unstable and unpredictable conditions create uncertainty. Therefore, the state is required to prepare conducive policy & regulatory framework to strengthen the progress.

Another important factor for smart city in solar energy project is the administrative procedural management and the forecast for the result of the policies implemented, which usually turn out to be inefficient. The formalities are often cumbersome and complex as different political parties leads Governments at various levels. The transparency and corresponding rules regarding authorization, certification and licensing are still needed.

Solapur region does not have a solar panel manufacturing industry. Solapur city also has to depend on other regions for the maintenance of the solar panels as well. SMC will need to take political decision to promote the investment on solar manufacturing industry in the Solapur region. They can also prepare some schemes for attracting the investor to manufacturing solar panels locally.

The political issues of solar energy are of great importance in the smart city development project, since the solar industry still is at an early stage and to some extent dependent on subsidies from the government. For SMC, it is important, as a way of achieving their goals, to have political linkages so that the corporation can execute lobby activity and influence the politicians, on the corporations' opinions regarding political issues related to the renewable energy (Paul Breeze 2008).

Economical

The overall economic framework meets more relevant factors as regards strategic concerns: availability of funds, technological competitiveness compared to other forms of energy generation, exchanges rate, inflation in the costs, risks affecting cash flow of investment and investment and absolute or relative energy price changes that undermine the profit margin of the investment.

The Solapur city falls under the second tier city as compared with the income generation. Therefore, SMC has inadequate financial capability for funding the big solar projects in Solapur. However, this problem can be tackled with the public-private-partnership (P-P-P) establishing solar energy projects.

Solar energy efficiency has synergy with economic competitiveness. There are growing number of policies to address them in related to economy targets and regulations. The competitiveness of the solar energy sector compared to other energy generation technologies, depends on the reduction of costs and selling prices of solar energy. In the last

Decade, they had seen a reduction in the range of 50% to 70% of solar panel costs, a major contribution to the exponential growth experienced by the renewable energy sector. Progressive cost reductions will allow achieving the medium-term grid parity so that solar technology would be in a position to compete with both other renewable and conventional energies.

Similarly, low cost substitute conventional sources of energy are already present in the Solapur market in a dominant form. Therefore, the awareness among the society is required to promote the solar energy. Solapur is the city of middle and low income group citizens, in this sense the solar rooftop installations seem to be beneficial for individual households to save money as well as earn money by selling additional energy produced by the solar.

Social

The commitments expressed in the Conference of Parties COP21, Paris encourages the participation of citizen in the renewable energy markets, generating and consuming their own energy source, with consequent saving in electricity bills. Indeed society is increasingly aware of environmental changes and shows greater concern about environment conservation. But they do not receive clear information within the general context of energy. In some countries, misinformation and poor dissemination of the socio-economic benefits of renewable energy sector have caused confusion and rejection by public opinion. Therefore, paradoxical messages must issue stronger measure to curb the effects of climate change and rejection signs against renewable energy. Public campaign helps to increasing awareness to use solar energy as it is a clean and pollution free energy source and can motivate peoples to change traditional mind set. The collaborative work with community can be beneficial to expand the use of solar energy in the city; while it also contributes to reduce world carbon gas emissions and carbon footprints.

Solapur smart city development plan does not include private individuals and institutions to contribute solar energy maturation. Social engagement is essential to share the benefits. For encouraging

community, the SMC should chalk-out incentive schemes specifically for citizen and private institutions using solar energy.

Solar energy can create full- and part-time jobs during installation and maintenance process that will help to improve local household economics and drives to poverty alleviation. Along with this, the skilled manpower is required for cleaning and maintenance of solar panels, which is not available in the Solapur city at the moment. SMC have to bring skilled human resources from other areas. All this will result higher operational costs. This problem can be reduced by collaborating with Solapur University encouraging colleges as a knowledge partners. Solapur University's initiative in research and development might help to address the solar energy issues. Along with this, the University can also run the education and training course on the solar energy. This will fulfil the requirement of skilled man power for cleaning and maintenance of solar panels in the Solapur city.

Technological

The energy model systems should tend towards a more decentralized and diversified. This would be more rational and efficient model perfectly fits in the solar energy resources, given its abundance and the benefits of their technology on the issues of modularity and versatility.

There are three relevant issues concerning Solapur smart city context. They are cost, storage and distribution network. The first one is cost reduction in installed capacity including both solar panels and balance of system costs. Regard with to the solar panels, the most advanced and mature technology that led the market is composed of silicon cells (c-Si), but it still has some limitations (MIT2015). Two such limitations are the complexity of manufacturing process and the underperformance of cells. In this respect, this is an opportunity for industry players to further the improvement in efficiency and reduce costs. Another vital limitation is the dependence on scarce materials such as silver, one of the major impediments to large-scale development of the solar panel manufacturing industry. It is an opportunity for research and development sector to develop sustainable technologies using abundant and cheaper materials on the planet (MIT 2015).

The second most important factor is the need to develop new competitive storage technologies, as mass implementation depends on them. The development of these storage mechanisms is bound to the manageability of the facilities connected to the network and will encourage consumption of solar energy.

The third issue related to photovoltaic development is its integration into the network. Transport infrastructure, distribution and management mechanisms are insufficient and in many cases suffer major capacity constraints. So, there is need to improve the quality of the network, to adapt the administration management and coordination between the different agents will allow achieving the objective of stabilization and security of supply, meeting the demand while providing value-added services.

There is a great potential for solar power utilization in the Solapur city by employing solar photovoltaic (PV) modules. But, the dust accumulation on the surface of solar PV modules, mirrors, reflectors

and other solar collectors is of great concern due to dust in the Solapur city. Solapur city is one of the most dust prone city in the country. So, the dust issue is major obstruction to the solar projects in the city. The performances of such solar devices are significantly affected by dust accumulation. According to a study indicates that power decrease by as much as 50% can be experienced for solar PV modules that are left unclean for a period of over six months. Solar tracker improves power output and helps reduce dust accumulation effect by 50% at off-peak time (Muhammed et al.2013).

Environmental

Global warming and emissions can be reduced from solar energy, but emissions associated with other stages of the solar life-cycle, including manufacturing, materials, transportation, installation, maintenance, and decommissioning and dismantlement. (IPCC 2011)

Hazard classification of chemicals typically used in solar panel (PV) manufacturing includes a variety of acids or corrosive liquids. These acids or corrosive liquid contains hydrochloric acid, sulphuric acid, nitric acid, and hydrogen fluoride. These chemicals are mainly used for the cleaning of wafers or to remove impurities from raw semiconductor materials. Solvents comprise 1,1,1-trichloroethane and acetone are also used in large quantities in the various cleaning stages conducted during the production processes. Etching compounds such as sodium hydroxide can also be used in large quantities. Therefore, manufacturing of solar cells involves the use of multiple chemicals classified as hazardous, including highly explosive and toxic gases (Roni George et al.2016).

Workers are also facing risks associated with inhaling silicon dust. Thus, solar panel (PV) manufacturers must follow U.S. laws to ensure that workers are not harmed by exposure to these chemicals and that manufacturing waste products are disposed of properly. If these hazardous materials are not handled and disposed of properly, they could pose serious environmental or public health threats (Hand M.M. et al. 2012).

The recycling of solar panels is the big issue, specifically, there aren't enough locations to recycle old solar panels, and there aren't enough non-operational solar panels to make recycling them economically attractive. Recycling of solar panels is vitally necessary due to the materials used to make the panels are rare or precious metals, all of them being composed of silver, tellurium, or indium. Because of the limitability of recycling the panels, those recoverable metals may be going to waste which may result in resource scarcity issues in the future. Moreover, manufacturers have a strong financial incentive to ensure that these highly valuable and often rare materials are recycled rather than thrown away. (IPCC 2011)

The use of large scale rooftop areas for solar panel facilities can adversely affect native vegetation and wildlife in many ways, including loss of habitat; interference with rainfall and drainage; or direct contact causing injury or death. The impacts are exacerbated when the species are classified as sensitive, rare, or threatened and endangered (Handbook of Renewable Energy Technology2011).

Citizen/Customer

Solar panels (PV) may release the hazardous materials which are likely to occur as a result of abnormal plant operations, damaged modules or fire and therefore pose risk to public and occupational health. The increased potential danger of electrocution from the direct current produced by systems and this needs to be taken into account especially by untrained users. (Roni George et al. 2016).

Solapur City's energy demand of 135 megawatt is completely met by the non-renewable energy sources as of date. These resulted in increased pollution in the Solapur city which again had effect on the health of the citizen. However, the Solapur city has an annual average solar irradiation value of 5.34 kWh/m²/day and this makes a suitable city to tap solar energy and solar power generation. This will also help to reduce pollution and improve the health of the citizens. Thus, SMC can contribute to sustaining the standard of living status in the society through economic and social integration.

With regards to visual impact, one person's beauty is another person's eyesore. For some people, solar panels evoke positive feelings, even when set in a rooftop. For others, the sight of a solar panel invading a pristine desert rooftop beauty. It's largely a matter of opinion.

BLACK SWANS ANALYSIS

The concept of black swan refers to an event that is highly improbable and difficult to anticipate, and which has dramatic impacts if realised. According to Nassim Nicolas Taleb's (2007) definition, black swans are events that cannot be foreseen. Taleb claims, that black swans are an interpretation to almost every significant event in our world. Black swans, wild cards and X events (Casti 2017) are used almost synonymously to refer to sudden, surprising, unanticipated events with broad and radical effects (Heinonen 2013). Black swans are the most debated developmental paths along with weak signals paths within futures studies. However, there may be a lot of information available about the common trends; it is more difficult to foresee the unexpected developments (Steinmüller 2007, 22–23). The study is tries to critically analyse the highly improbable and unpredictable events that would carry massive impacts on the solar energy development in the Solapur city.

Table 2: Black Swan

Political	<ul style="list-style-type: none"> • China will stop supplying cheaper solar panels and related material. • Government would lose their control and coordination.
Economics	<ul style="list-style-type: none"> • Cheap non-renewable energy supply by NTPC / import from neighbouring states.
Social	<ul style="list-style-type: none"> • Boycott solar due misconceptions.
Technological	<ul style="list-style-type: none"> • Collapse storage system due to dependency on scarce material.
Environmental	<ul style="list-style-type: none"> • Accidental releases of hazardous gases or vapours
Citizen	<ul style="list-style-type: none"> • Consumer due to lower cost switching towards the Substitute non-renewable sources

The SMC has been importing solar panels (PV) from China. Most of the Indian companies are only assembling the solar panels components which one manufactured in the China. Therefore, majority of Indian solar panel (PV) industries are depends on the China. There is plausibility or the relations huge scope for the black swan, if the war situation arises between the Indian and Chinese military, or the relation soar. That will also affect the business sector. The supply of new solar panels and related material can completely stop due to conflict. This will create worst situation for Indian solar industry due to its dependency on China.

In case of the governance system in India, it has three tiers Government i.e. Central, State, and Local. Currently, all at the three tiers are headed by one single political party. However, in the future elections the situation may or may not be the same at different levels of governance. There would create black swan. If three tier governance is ruled by different political parties, this situation, would affect smart city project and lose their control over the effective coordination between central, state and local government agencies on various issues related to financing and sharing of best practices and service delivery processes.

National Thermal Power Corporation (NTPC) is setting up coal based power plant with capacity 1320 MW near the Solapur city. The first phase with 660 MW capacities is already constructed and expected to complete the second phase soon. The black swan would fall on the solar energy sector of Solapur city when NTCP starts working with full capacity. Perhaps, there would be drop-in the price of non-renewable energy due to increase in large scale production. Under such situation the solar power price per unit can't complete with the NTPC rate. The average Indian consumers are more price conscious than anywhere else in the world (C. Lakshman 2015). Therefore, there will be the danger of switching of the customer to cheap non-renewable energy source (coal based).

There has been a growing awareness among citizens, of the benefits of sustainable energy products such as solar rooftop. According to a report by Amazon India, demand for solar rooftop and green products online is the highest in urban and semi-urban cities. Perhaps, the society is not getting the complete information about the solar energy or they receive misinformation and poor dissemination

that will create confusion and rejection by the public. Condition of this type may destruct whole solar energy development due wide misconceptions.

Solar energy can be powerful instrument to mitigate fossil fuel depletion, but on the other hand scarcity of raw material may pose constraints to enhance deployment of solar power. Securing access to required scarce inorganic mineral raw materials (IRM) at reasonable prices is an upcoming challenge for solar manufacturing industry. Future IRM (e.g. silver) constraints will cause imbalanced demand and supply. In such a case, it may be economically viable to increase production in response to rising demand for certain components or elements. This will cause the complex price patterns and supply risks emerge; while the market tension also occurs in response to unexpected changes in demand. As a result, there will be a risk of collapse of the energy storage system due to dependency on the scarce IRM (IPCC 2011).

Hazardous materials used in the solar panel manufacturing could pose serious environmental or public health threats. Especially, the use of arsine and phosphine in high volumes in current manufacturing technology of PV panels (III-V modules), where relatively high quantities of arsine are used. A facility with a 10 MW/yr production of flat-panel will consume about 23 tons of arsine a year. The quantities required in flat-panel designs could present terrible risks in the future. It is essential to consider that arsine is almost as toxic as methyl isocyanate (MIC) and its release of 40 tons of the latter in Bhopal killed 3,000 people and injured 200,000 more. Perhaps, accidental releases of hazardous gases or vapours can have adverse consequences for environment (Vasilis M. F. and Biays Bowerman 2013). The consumer behaviour itself is unpredictable, dynamic and constantly changing (Chandrasekar 2010). The black swan in the form of consumer behaviour may influence the consumer of solar power to switch towards the substitute non-renewable sources available in the market. This will be displacing the solar power from market.

FUTURE SCENARIOS

Moving from SMC proposed planning of solar implementation to actual use of solar energy requires a long-term perspective. The expected solar energy infrastructure takes time to build up. Government policy shifts often also need many years to take actual effect. On the International scene the transition from fossil fuel to renewable energy will require additional investment and higher supply costs over about twenty years. However, the use of solar energy will have tremendous economic benefits in the long term. Any analysis that seeks to tackle energy and environmental issues that will need to look ahead at least until the mid-century. Scenarios are absolutely necessary to describe possible development paths, to give decision-makers a broad overview and indicate that how they can shape the future energy system (Greenpeace 2015).

There are three scenarios used to show future energy supply in Solapur smart city.

1. Constructive Energy Scenario
2. Discouraging Energy Scenario
3. Revolutionary Energy Scenario

1. Constructive Energy Scenario

The Constructive Energy Scenario is an update of the Energy scenario, which followed the key target set by the Government to reduce carbon dioxide emissions. In this scenario, it is assumed that the Government takes initiatives to implement energy policy.

Politics play an important role to make a constructive energy system in the Solapur city. The ruling party is stable at Central, State and Local level lead by the single political party. Therefore, the energy policy and the regulatory tools affect positively on the investments in the solar energy sector. The Government has engaged a nodal agency to regulate energy policy and planning for the future. Therefore, the transparency in authorization, certification and licensing are encouraging the development of solar energy in the Solapur city.

It is assumed that, Solapur region succeeds to attract solar panel manufacturing industry. SMC's political decision to promote the investment and provide schemes is a call for the solar manufacturing industry to the Solapur region. As a result, the initial cost of solar panel gets reduced. It also fulfils the need for skilled manpower for maintenance of solar panel. Overall effect shows there would be increase the use of solar energy in the Solapur city.

Currently, the solar industry depends on Governments' subsidies. It is assumed that, the Government would continue the subsidy in the future as well as it can provide additional benefits to the household rooftop solar users. This will encourage the people to adopt solar energy.

The installation of roof top Solar PV on all Government buildings as part of Smart City Mission would reduce the electricity cost for SMC by 10% accounting for Rs. 3.6 Crore per annum. This model would receive acceptance by the citizen for using roof top solar PV in the city. As a result, the solar rooftop installations would seem beneficial for individual households to reduce expenditure on the energy bill in every month as well as earn money by selling additional energy produced at the household level.

The financial capability can be expanded by establishing the public-private-partnership (P-P-P) project. The large solar power generation plant can be constructed in Solapur through public-private-partnership (P-P-P). That will supply clean energy to the city and make the Solapur as a Green city.

The community is utmost aware about environmental changes and would show greater concern about environment issues. They receive clear information with the socio-economic benefits of renewable energy sector. Public awareness campaigns assist to spread message of solar energy as it is a clean and pollution free energy source. This would change the traditional mind set of the consumers. The collaboration with community would promote the solar energy in the city and would reduce carbon emissions in Solapur city.

It is expected that, Solapur smart city development plan would include private-public partnership in expansion of solar energy. SMC would introduce new incentive schemes for private partner in solar energy generation. This would positively affect on the energy sector of the Solapur city leading to sustainable development.

Solapur University would work as a knowledge partner for Solapur city. Solapur University could carry out research and development based on the solar energy issues on the one hand and on the other hand, could provide the solar energy capacity building training courses. This will help to generate skilled human resource for maintenance of solar panels in the city. Furthermore, the expansion of solar energy would generate thousands of new employment opportunities in the city while micro economy would grow subsequently.

It is anticipated that the innovative research and development occur in the solar PV technology. It would bring forthcoming improvement in work efficiency and reduce cost of solar PV in the future. Forthcoming sustainable technology would use abundant sunlight and would reduce dependency on the scarce material such as silver for the manufacturing of solar panel.

Furthermore, the new technology is expected to upgrade the storage mechanisms which are capable to store huge energy for longer period. It would increase the durability of the solar PV and would make renewables more reliable and feasible in the future. However, this would easily integrate in to the grid network and enrich the quality of network and prepare towards the fulfilment of consumer demand. The advanced technological improvements in the solar PV would attract the mass of consumers in future and reduce the carbon emission.

Perhaps, the recycling of solar PV panels would not be a major issue in the future. Based on the demand, the state would provide separate parks for recycling purpose. These recycling parks would come up build in remote areas and separate the precious metals used in the solar PV. In addition, manufacturers receive financial incentive from the state to recycle these valuable and rare materials. All these initiatives would go a long way to assist reducing the scarcity for renewable energy in the long run.

As a probability, the accidental risk due solar PV hazardous material can be managed with the safety measures. The trained staff would contribute towards spreading awareness among the citizen. If citizens receive clear information they would more likely to use rooftop solar energy at every household. The final outcome presents Solapur as a pollution free city, more eco-friendly and most liveable city in the country.

2. Discouraging Energy Scenario

This scenario is discouraging pathway which is totally opposite of the previous scenario approach of the constructive Energy. The efforts taken by the Government are adversely implemented; there would a discouraging energy future. Therefore, solar electricity generation decreases significantly in this scenario, assuming solar power sources to be reflected in the future.

Politics has the potential of posing risk on the future solar energy growth in Solapur city. Currently, existing institutions of governance are led by one political party at Central, State and Local level. However, in the upcoming elections by the year 2019, the situation may not be same as today. If the Governments are headed by the different political parties' coordination among these institutions would pose a major critical problem. Political parties in power may mislead to the policy, planning and coordination. Such development would affect the solar energy progress in the Solapur city.

The absence of manufacturing industry in Solapur region may pose a serious problem in the future. Solapur city is import based and if any disputes arise with the suppliers in the future, would stall the progress of solar energy in Solapur city. The cheaper product may be made available at their door step of the citizens. Apart from this, if the Solapur region would start-up the manufacturing industry in the vicinity would also put the city at risk. There would be always a risk of accident and chances of release of hazardous gases in the environment, which may create seriously health issues in the future. Therefore, there is risk at both side, and the administrators have to take correct decision in the future.

The SMC is presenting the deficit financial budget. It indicates that, SMC is struggling to provide the basic amenities to the citizens. In this situation, the SMC can invest more in the solar power generation. SMC is aware of carbon emissions and their effects on the environment, but the financial limitations restrict them to make high investment in the solar power. Therefore, immediate transition from conventional energy to solar energy is quite difficult for the SMC. Under such circumstance, the carbon emissions are likely to continue in the Solapur city leading to environmental and health of the citizens.

National Thermal Power Corporation (NTPC), Solapur is setting up coal based power plant with capacity 1320 MW near Solapur city. The first phase with 660 MW capacities is already constructed and is expected to complete second phase soon. The black swan would encounter the energy sector of Solapur city when NTPC starts working with full capacity. Perhaps, there will be a fall in the price of non-renewable energy due to increase in the scale of production. This situation would make solar power price less competitive with the NTPC rate. The common Indian consumers are more price conscious than others. (C. Lakshman. 2015). There will be a risk that customers switching over to cheaper non-renewable energy source.

Coal based power generation plant (NTPC) is expected to produce energy very soon in Solapur city. If the production starts with full capacity, then the cost of solar power is likely to fall than the current prices of solar power produced at roof tops. Low price power availability may be the biggest challenge for the solar energy in Solapur city. Consumer switches towards the cheaper energy source that would adversely affect the solar development in Solapur.

The citizens' awareness is essential for the sustenance of solar energy use. Citizens should in a position to accept and reject coal energy even when there is a price advantage. Without such preparedness marketing solar energy is difficult.

Solar energy development program in Solapur city does not include private stakeholders. Possibly, this would bring out negative impacts on the private stakeholders. They may voluntarily exclude from

this mission. There is possibility of losing a game changer from the ground. Finally, the progress of solar energy may be hampered in the city.

Till date, the solar energy has not acquired a professional image to offer career for the youth. Therefore, students are not seriously aware about the solar energy as a career prospect. Solapur University can start education and training course related to the solar energy. This lacuna may pose a serious problem related to the skilled manpower development. Inadequate availability of skilled manpower at the local level would increase the operational costs. There are problems for cleaning and maintenance of solar panels in the city. Without skilled manpower, it would be difficult to sustain and maintain the solar power for long run in Solapur city.

There are many unsolved technical issues in the solar energy. The first one is related to the silicon cells (c-Si) used in the solar PV. It is most advanced and mature technology, but still it has some limitations (MIT, 2015). It involves the complexity of manufacturing process and the underperformance of cells on one hand and on the other hand, solar dependencies on scarce materials like silver will be the major problem in the future. The solar energy is not having an advanced storage technologies, as mass production depends on that. This storage technology would be more critical for the implementation of solar energy.

Furthermore, the solar PV has barriers in the energy distribution and management mechanisms. Solar energy is insufficient due to capacity constraints. Apart from this, consumer wants stabilized and security of supply with value-added services. If solar sector cannot fulfil the customers demand, that will impact on the customer loyalty towards the solar energy (World Energy Outlook 2014)

The dust pollution in the city is major obstacle for the solar energy implementation. The solar devices are significantly affected by dust and reduce the performance. Sometimes, the dust accumulation on the surface of solar PV panel, mirrors, reflectors and other solar collectors need to be cleaned with pure drinking water. However, Solapur city is already struggling to supply drinking water to citizens and this situation, will create a big problem for local Government and individual users to arrange water for cleaning. If solar PVs are not cleaned properly then it reduces its output up to 50%. This may lead to resistance from the solar energy users due to the low output.

The increase in the use of solar PVs might lead to the problems regarding recycling. Solapur city doesn't have locations to store and recycle old solar panels. Also; there is no availability of recycling mechanism for non-operational solar PV panels. Due to the absence of recycling mechanism, the recoverability of precious metal like silver, tellurium, or indium used in solar PV is not possible. This valuable metal will go waste and that may result in resource scarcity in the future.

Solar PVs are made up of with hazardous materials and chemicals. If there is any accident occurs or wrong disposed solar panels get damaged or may prove to fire that will create public health issues. Any such incidence is sufficient for creating scarce among the citizens. They may reject the use of solar PV.

3. Revolutionary Energy Scenario

The Revolutionary Energy Scenario is based on the Government's future policies. Its assumption is based on the drastic implementation of large solar power generation plant in Solapur. There are main three major proposals considered under this scenario. This includes, floating solar panels at Ujjani¹ dam generate power, Ministry of New and Renewable Energy (MNRE) support for solar city development and NTCP is contemplating to shift from non-renewable to renewable. These three projects need heavy investment and long time for implementation. However, any one project out of these three succeeds in the future, that will be a revolutionary change and will have massive impact on the Solapur power generation capacity.

The State Government of Maharashtra is working on the mega solar projects in Solapur. The Ujjani Dam is the terminal dam on the river and it is the largest in the valley that intercepts a catchment area of 14,858 km². Every year, the dam loses over 1.5 TMC water due to evaporation. Therefore, the State Water Resources Department of Maharashtra and the Department of Energy, New and Renewable Energy have tied up with a private company to set up a solar energy plant. Under this plant, the solar panels will be set up on a water surface of 4,640 acres. The State Government aims to generate 1,000 megawatt (MW) electricity with this project. The Ujjani dam is located in an area where the temperature is high. Thus, the solar panels will generate a lot of power (Vilas Rajput 2017).

If this project is finalized by the State Government, this will be the milestone for the Solapur city. Furthermore, the power generated through the floating solar panels linked with the state power grid owned by the Maharashtra State Electricity Distribution Limited (MSEDCL) will be the great achievement of the project. This project will also generate employment for over 5,000 people. Thus, this floating solar project will fulfill the need for electricity of Solapur city as well as other part of the state. This project will be first-of-its-kind plant in India and one of the largest in the world, if materialized.

Government of India's MNRE has created a Solar City Program. This program supports cities in the development of solar energy. The financial assistance from MNRE is also potentially available for installation of solar energy devices as well as support for other technical activities. Support also is provided to municipal corporations for the preparation and implementation of a master plan, or road map, to develop their cities as Solar Cities. SMC can approach to MNRE to make Solapur as a solar city, because it has potential to become solar city. If MNRE accepts this proposal, then it will be the revolutionary initiative in the resources use for energy generation. In real terms, Solapur city will be the smart city with sustainability.

¹ Ujjani is a dam located 100 km from Solapur. A pipeline is laid to supply drinking water facility to Solapur city.

National Thermal Power Corporation (NTPC) is setting up coal based power plant close to the Solapur city. Its total power generation capacity is 1320 MW out of which, first phase with 660 MW capacities already completed and second phase will be finished soon. This energy is purely based on the non-renewable source. According to the current scenario, NTPC is shifting its focus from non-renewable energy to renewable energy. NTPC will go slow on coal-fired generation capacity addition to bring its business plan in line with the Government's priority to fight climate change. On this line, NTPC Solapur also shifts its focus plant from non-renewable to renewable, that will be a great transition for Solapur city as well. The Solapur city gets clean energy without any financial burdens on the SMC, which again may possibly reduce carbon emission from the energy use.

CONCLUSIONS

The Solapur has an abundance of solar energy sources, which have the potential to play a major role in the future of the Solapur power generation. However, the SMC's solar project is still being in its early stages of development. So, there are numerous areas of uncertainty which need to be explored to secure the future of the solar energy. The study carried out a comprehensive PESTEC analysis of solar energy projects within Solapur city. The PESTEC further analysed on the basis of challenges and opportunities for Solapur city. Black Swans analysis is also being carried in the study. This analysis provides improbable and unpredictable future events that would carry drastic changes. However, the black swan events are classified with PESTEC approach. Finally, the study brings the three types of different scenarios. It involves constructive, discouraging and revolutionary energy scenarios. All three scenarios are discussed in detail about their probable impacts on the Solapur city. The study provides few recommendations for the policy makers to avoid the risk associated with solar energy development in Solapur city. Thus, Solapur city prepare for transition towards clean energy. The solar energy will have major role to play in changing the face of modern Solapur city in the coming years.

REFERENCES

- Casti, J. L. (2017) Complexity, Extreme Events and Human Social Progress. Keynote at "Futures of a Complex World" Conference, 12 June 2017, Turku, Finland.
- Census of Indian (2011) District Census Handbook Solapur. Directorate of Census Operations Maharashtra, Census Government of India. <http://censusindia.gov.in/>
- Chandrasekar (2010) Marketing Management: Text & Cases. Tata McGraw-Hill Education, p. 146.
- Greenpeace International, (2015) World energy Revolution a sustainable world energy outlook report 5th edition 2015 world energy scenario, International Energy Agency, World Energy Outlook 2014.
- Hand M. M., Baldwin, S. et al. (2012) Renewable Electricity Futures Study. National Renewable Energy Laboratory, 4 vols.

- Handbook of Renewable Energy Technology (2011) World Scientific Publishing Singapore. p. 243. ISBN-13 978-981-4289-06-1.
- Heinonen, S. (2013) Dance of the Black Swans In: Black Swans – What Will Change the World Next? Entries from the writing contest of the Committee for the Future of the Parliament of Finland. The Publishing series of the Committee for the Future 5/2013, p. 20–40.
- IPCC (2011) Special Report on Renewable Energy Sources and Climate Change Mitigation. Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, USA, p. 1075.
- Lakshman, C. (2015) Doing Business in India: A Framework for Strategic Understanding. Elsevier Ltd., USA, p. 64.
- MIT (2015) The future of solar energy. Energy Initiative Massachusetts Institute of Technology, Cambridge. Retrieve 18 Oct. 2017 from <http://mitei.mit.edu>.
- Muhammed J. Adinoyi & Syed A.M. Said (2013) Effect of dust accumulation on the power outputs of solar photovoltaic modules. Renewable Energy Elsevier Ltd. Volume 60, p. 633–636.
- Paul Breeze (2008) The Future of Solar Power: Key Technologies and Drivers for a Solar Future. Business Insights Limited.
- Roni George And Arun Babu (2016) Environmental Impacts of Solar Energy Technologies. Imperial International Journal of Eco-friendly Technologies, Delhi, Vol. 1, Issue 1, p. 75–79.
- SMC (2017) Solapur Municipal Corporation. Retrieved 12 Aug. 2017 from www.solapurcorporation.gov.in.
- Solar Energy Centre (2015) Solar Radiant Energy over India. Solar Energy Centre. Ministry of New and Renewable Energy, Delhi. <http://mnre.gov.in/centers/about-sec-2/hand-book-on-energy-conscious-buildings/>
- Steinmüller, K. (2007) 'Thinking Out of the Box'. Weak Signals and Wild Cards for European Regions. Futura, 2, 22–29.
- Taleb, N. (2007) The Black Swan. The Impact of the Highly Improbable. Random House, New York.
- Vasilis, M. Fthenakis & Biays Bowerman (2013) Environmental Health and Safety (EHS) issues in III-V Solar Cell Manufacturing. National PV EHS Assistance Center Brookhaven National Laboratory. USA.
- Vilas, Rajput (2017) Floating solar panels at Ujjani dam to save water, generate power. Pune Mirror, Pune. Retrieved 08 Dec. 2017 from <http://punemirror.indiatimes.com/pune/ci vic/floating-solar-panels-at-ujjani-dam-to-savewater-generatepower/articleshow/61715744.cms>

FUTURE OF BIOENERGY: A CASE OF BAGASSE COGENERATION SECTOR (BCS)

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ABSTRACT

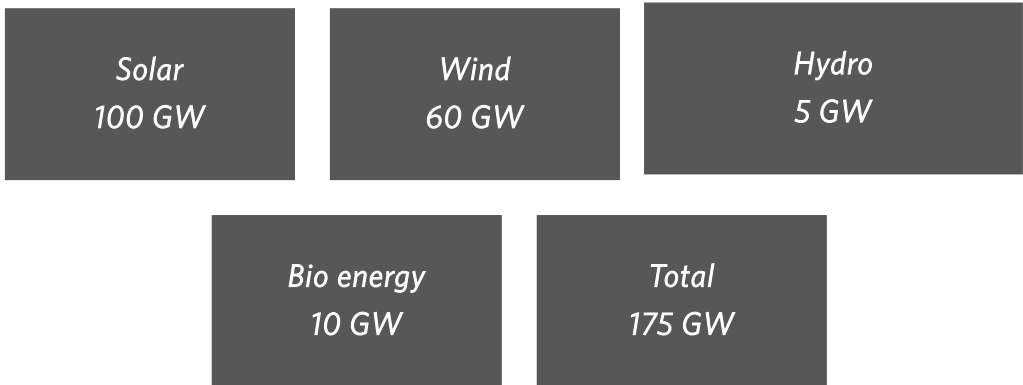
The Government of India has taken up one of the progressive steps towards clean and carbon free society in the next twenty years in the context of several crucial international commitments and national responsibility towards sustainable development. The national and state governments have decided their clean energy targets the NITI Aayog (National Institute for Transforming India) a national policy institute of Government of India constituted an Expert Group in June 2015 to assess the requirements and utilization of public finance for achieving 175 GW RE by 2022 through harnessing Solar (100 GW), Wind (60 GW), Hydro (5 GW) and Bio-energy (10 GW). This study executes a case study analysis of one of the Bio renewable sources (BRE's) in India – which is relatively understudied and underutilized – that is bagasse cogeneration sector (BCS). The BCS is an upcoming RE sector and an important organ of India's second biggest trade, Sugar Industry. Based on the futures methodology this study specifically explores the specific hurdles and their key drivers and also offers policy options for future sustainability of BCS. The study locates that if the BCS in India has to come forward as a sound and self-sufficient RE producer, there is a pressing need to make not only structural but several unconventional changes in the entire system as a whole.

Keywords: Bioenergy, Bagasse, Cogeneration, Sugar Factory, PESTEL.

INTRODUCTION AND RATIONALE

The dynamics of electricity supply process in a country like India has always been a challenge in front of various governments since independence. The pace of supplying energy to all has not kept equally along with the growing population, industrialization and urbanization. At present India is dominantly depend upon the energy produced by coal which contributes more than 50% that causes highest amount of pollution and threatens the sustainability of our environment (Tiwari, 2013). Therefore, in the context of 'Paris agreement' and our environmental social responsibility (ESR) perspective one of the growing and upcoming challenges in the near future is providing clean energy to all. However,

despite with all complexities the present Modi government has been emerging as a responsible actor towards 'low carbon civilization' through 'clean energy movement'. One of India's key advantages at present and going forward is its renewable energy (RE) prospective which is enormous and mostly unused. Current estimation demonstrate that India's solar potential is greater than 750 GW and its announced wind potential is 302 GW (actual could be higher than 1000 GW (NITI Aayog, 2015)). India Energy Security Scenarios 2047 show a possibility of achieving a high of 410 GW of wind and 479 GW of solar PV by 2047. The potential of biomass and small hydro is also significant (ESI, 2017). Thus, renewable energy has the potential to anchor the development of India's electricity sector. With this challenge in mind, the NITI Aayog² constituted an Expert Group in June 2015 to assess the requirements and utilization of public finance for achieving 175 GW RE by 2022.



India's clean energy policy environment harnessing Renewable Energy (RE) from all available sources including, Bio-fuels (Bagasse cogeneration). Unlike the other popular RE sector such as solar and wind the energy produced by bagasse cogeneration through sugar factories in India has not much explored and even under researched at policy and academia (Halder, 2014; Kumar et al, 2010). However, there is a huge potential to tap clean energy from bagasse cogeneration through sugar factories in India. India's sugar sector is the second largest in the world- could provide approximately 7 GW of power through India's 704 sugar mills (Vivek Patel, 2017: 335).

Thus, taking into consideration of the future potential of bagasse cogeneration sector (henceforth BCS) an inquiry based on futures methodology has been initiated. The report is mainly categorised into five broad sections including the first part introduction and rationale. The second section of the report offers the origin and development of BCS at global and Indian context. Section third discusses a detailed methodology adopted for the present investigation including research questions and there corresponding key futures methods. It also offers important stages of the application of futures meth-

² NITI Aayog (National Institute for Transforming India) is a national policy institute of Government of India.

ods. The section fourth of the report which is the core body of the report relied on results and discussion where an attempt has been made to analyse the process according to the four select research questions. The final section fifth of the report is based on overall conclusion of the analysis. The conclusion part is also divided into two distinctive sections, at first instance conclusion is drawn according to four research questions and at the end general conclusion has been made on the entire analysis.

THE ORIGIN AND DEVELOPMENT OF BCS AT INDIAN CONTEXT

Before going to deal with the origin and development of BCS in India it is inevitable to have a brief note on the historical developments in the RE movement in India. The dawn of RE movement in India had been started successfully with the establishment of a Commission for Additional Sources of Energy in the Department of Science and Technology (DST) during 1970s. Later on, a separate department called as (Department of Non-Conventional Energy Sources-MNES) in 1982 which was eventually upgraded as into the Ministry of Non-conventional Energy Sources (MNES) in 1992. To finance RE projects Indian Renewable Energy Development Agency (IREDA) was established in 1987. Meanwhile, to conquer the upcoming challenges in the area of RE the government of India have come up with an exclusive ministry called as Ministry of New and Renewable Energy (MNRE) in October 2006. This is the only such separate ministry in the world at present solely devoted to the promotion of RE sources to make India a carbon free society. MNRE is accountable for the encouragement, management and global collaborations and Research and development for the RE sources such as wind, small hydro, bio-energy and solar energy. RE scenario in India has been growing sustainably at both private and public level as a consequence of sustained initiatives of MNRE. After having a brief genealogy of RE sector in India the coming section discusses the energy produced by bagasse cogeneration in India's sugar industry (See: Bhattacharya and Jana, 2009).

Global sugar dynamics and the dawn of Bagasse Cogeneration at Indian Context

The global sugar industry, similar to the other sectors of commodities, facing critical conditions because of the uncertain and continues decline/ fluctuations in sugar prices and productions. The report published by Food and Agricultural Organization (FAO) 2004, focused on the condition of global agricultural goods market observes that since the mid-1990's the minimum support prices for sugar at global sugar market have been pave way for its decline mainly due to surplus supply and policies adopted on the grounds of Liberalization, Privatization and Globalization(LPG) (FAO,2004). This kind of miserable market condition has deeply affected together to worlds developed sugar-exporting nations for instance: (Australia and the European Union) and developing sugar-exporting nations for instance: (Mauritius and Brazil) therefore realizing the future challenges they have come up with an alternative to diversify sugarcane into allied by-products (Milford, 2003; Filho and Badr, 2004). The policy shift has opened way for few pertinent popular bio-products such as: alcohol, molasses, and

black liquor. The energy production through bagasse is also one of the important alternatives that have been widely accepted at worldwide including, India. Diversification of sugar sector has been resulted into several allied socio-economic benefits especially in a highly populous country like India (Ranganathan, 2005). Scholars like Pellegrini and de Oliveira (2011) are of the opinion that it has become inevitable to the Indian sugar industry to diversify, because dependency for revenue generation merely on sugar alone was highly unsustainable. Thus, the global conditions created by the process of LPG and its impact at national level sugar market towards economic sustainability including the rise of global consensus to harness clean energy compelled government of India and the Indian sugar industry to explore alternative strategies like BCS.

BCS in Indian Sugar factories

In the post-Independence era a plan for production of energy through high efficiency cogeneration plants in the sugar factories was mooted during 1980s mainly to cope up with the growing energy demand. In view of the fact that high efficiency bagasse cogeneration plants have become as one of the smart technology options in the context of its dual benefits to make carbon neutral electricity and financial profits for the sugar industry. Considering future policy potential of BCS, several national and international schemes were introduced to expand RE mainly through BCS. Few vital initiatives in this regard are depicted in Table 1.

Table 1: Synopsis of major programmes supported for BCS in India (Source: Haya et al, 2009: 70; Patil, 2017).

Funding agency	Type of support provided
Ministry of Non-Conventional Energy Sources (MNES)	Interest subsidy, capital subsidy, tax benefits, workshops, pilot projects in the cooperative sector and lower customs duty for importing technologies
US Agency for International Development (USAID)	Up to 10% equity contribution for nine demonstration projects, trainings, workshops, newsletter and outreach activities
Indian Renewable Energy Development Agency (IREDA)	Multilateral lines of credit for renewable energy development provided through IREDA from international and bilateral finance institutions. The Asian Development Bank (ADB) provided funds dedicated for bagasse cogeneration
Clean Development Mechanism (CDM)	A project-based carbon off setting programme established under the Kyoto Protocol
Global Environmental Facility (GEF)	Project under preparation to provide creative financing to cooperative mills

The sugar industry has future potential to harness energy from bagasse cogeneration mainly for the following factors: 1) manufacturing sugar through the uninterrupted process which is helpful for continuous power generation; 2) sugar production need only low-pressure steam, creating higher pressure steam accessible for electricity generation; 3) it reduces competence losses due to its favourable nature of decentralized sources of electricity supply; and 4) the cogeneration of bagasse generates zero net energy emission of carbon dioxide, as the carbon freed as CO₂ while bagasse is combusted, was taken out of the atmosphere through photosynthesis(Haya et al,2009).

What is Bagasse Cogeneration?

- Bagasse is the fibrous matter that remains after sugarcane stalks are crushed to extract their juice and is a by product generated in the process of manufacture of sugar³.
- The concept of cogeneration produces two types of energy from one fuel simultaneously in the forms of heat and the other may be electrical energy. The bagasse produced in a sugar factory is however used for generation of steam which in turn is used as a fuel source and the surplus generation is exported to the power grids of state governments(see: Rosen, Le, and Dincer, 2005).
- The distinctive process of the functioning of bagasse cogeneration in sugar factory is described in the following figure no 1.

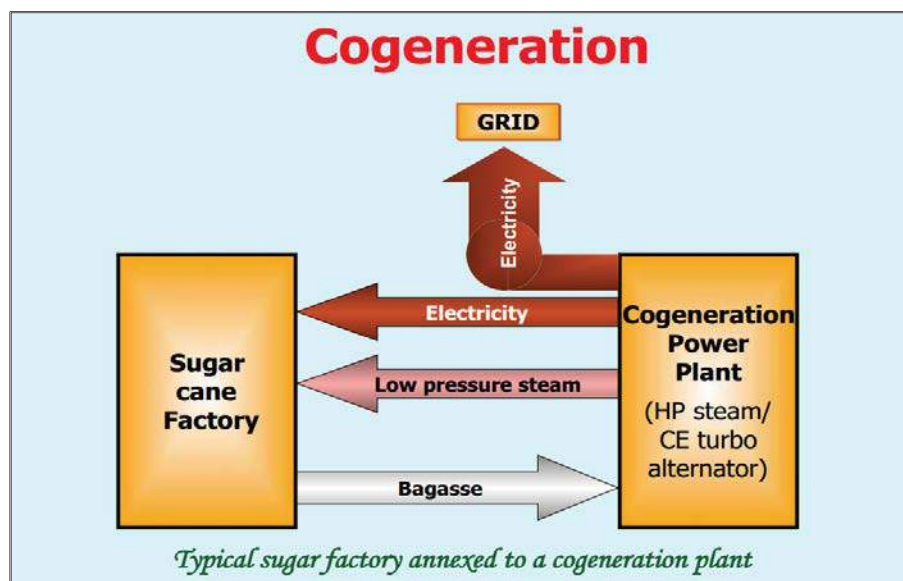


Figure 1: The model of bagasse cogeneration plant at Sugar Factory (Source: <http://www.zionenggworks.com/images/zion-cogen-process.jpg>)

³ <http://www.birla-sugar.com/Our-Products/Bagasse-Cogeneration-Renewable-Energy>

Generally the electricity produced by the bagasse cogeneration plant (henceforth BCP) mainly during sugar production period is used by the concerned Sugar factory and the surplus energy is being transferred to the grid. This concept provides few vital advantages: no fuel cost, employment to the local population, strengthening sugar factories socio-economic potency, energy security and reduction in transmission and distribution fatalities. The following figure no 2 shows schematic diagram of power generation in a typical sugar factory.

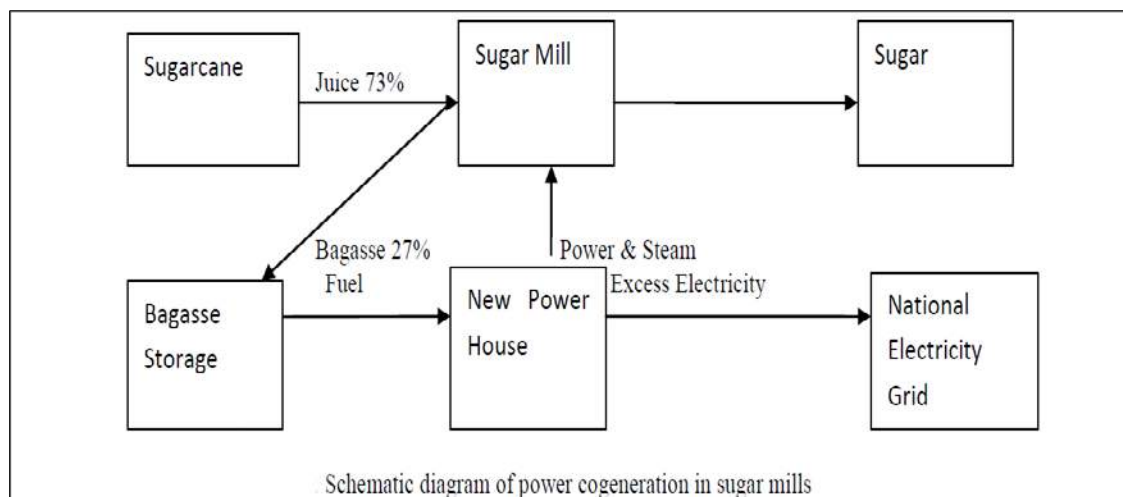


Figure 2: Schematic diagram of power generation in a typical sugar factory. (Source: Kalpana Bisht and Renu, 2016)

Present status of BCS in India

At present nearly 4 million hectares of agricultural land is under sugarcane cultivation including with roughly an average yield of 70 tons per hectare. As of 2016 around 550 sugar factories are operating in India. Sugar industry in India is mainly divided into three sections i) Cooperative ii) public and iii) private in which the highest number of factories are of cooperative in nature. To overcome with growing challenges of the sustainability of industry apart from sugar production industries have started several allied activities. Generating energy through cogeneration is one such futuristic option. During last three-four decades now the concept of bagasse cogeneration has been a well matured sector in India. The following table no 2 shows state wise status of bagasse cogeneration and its potential, installed capacity and utilization in India as on 31-03-2013 (Bishit et al, 2016:561).

Table 2: State-wide scenario of BCS in India, 2013 (Source: Kalpana Bisht and Renu, 2016).

Sr. No	State	Potential (MW)	No of Projects	Installed capacity	% Utilization
1	Andhra	300	22	163.05	54.35
2	Bihar	300	4	43.30	14.43
3	Gujarat	350	0	00.00	00.00
4	Haryana	350	4	31.80	9.09
5	Karnataka	450	32	403.88	89.75
6	Maharashtra	1250	65	580.90	46.47
7	Punjab	300	6	62.00	20.67
8	Tamilnadu	450	26	327.00	72.67
9	Uttarpradesh	1250	53	710.50	56.8
10	Uttarakhand	--	1	10.00	--
	Total	5000	213	2332.43	46.64

It is estimated that bagasse-cogeneration has potential to generate 5000 MW (31.12.2016). Apart from this additional 7000 MW of power could be generated through bagasse based cogeneration if 550 sugar mills will adopt technical and economical optimal levels in process (MNRE, 2016)⁴.

Setting of the Study

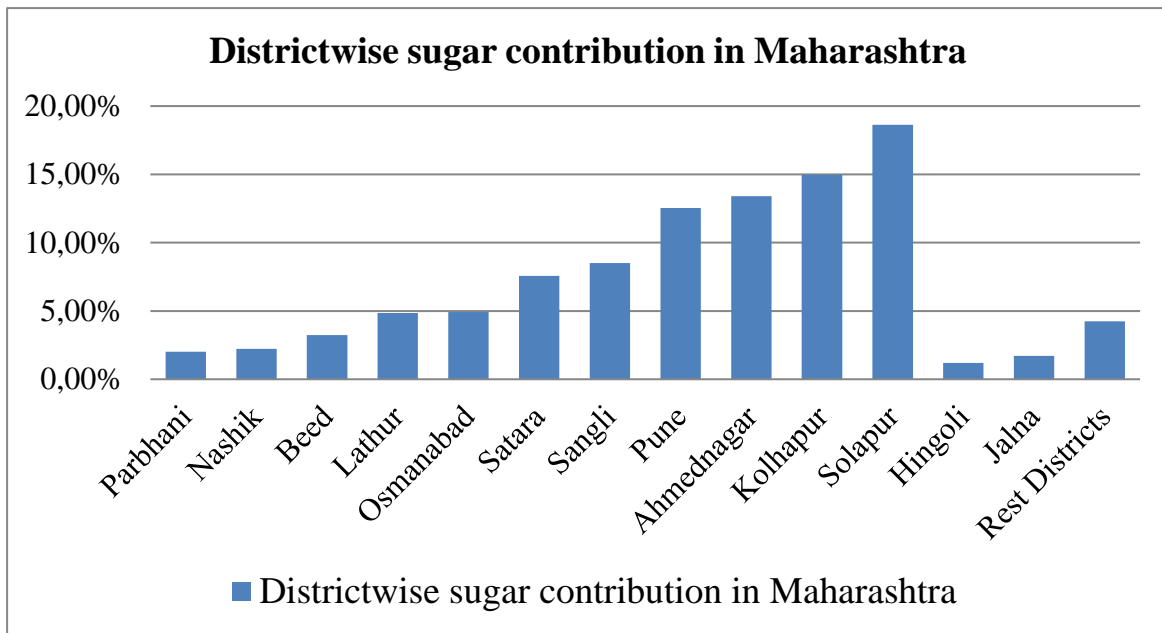
Maharashtra is one of the leading and industrialized states in India. At present, a highest number that is 196 sugar mills are functioning in Maharashtra – 173 co-operative and 23 Private Mills. As per MNRE Maharashtra has potential to generate 1250 MW of energy from cogeneration process as bagasse is abundantly available after sugar crushing process⁵. For the present study Maharashtra state has been considered as a universe of study and district Solapur is selected purposively as a unit of study. This study presents both macro (National) and micro (Solapur) level insights as a representative case for sugar factories to analyze the intricacies involved in the BCS from futuristic perspective. The rationale behind the selection is multi-fold:

- i) Solapur district has highest number of sugar mills not only in Maharashtra State but also at national context.
- ii) It has a unique blend of cooperative and private models of sugar factories that gives special advantage to study under systems approach.
- iii) It has 47 sugar mills up to 2017 with a capacity of more than 1250 TCD. The capacity of private sugar mills is constantly increasing as to cooperative sugar mills.

⁴ <http://mnre.gov.in/schemes/grid-connected/biomass-powercogen/>

⁵ https://www.mahaurja.com/meda/grid_connected_power/bagasse

- iv) The capacity of sugar mills is 2500-5000 TCD which is now expanding and going even beyond 1000 TCD.
- v) The 8% of the total sugar production in India and 17% in state are from Solapur district. The present energy generation capacity is 500 MW and will expand up to 750 MW in next three years⁶.
- vi) Most of the cogeneration plant in Sholapur District is developed in sugar mills as they have the enough quantity of bagasse.
- vii) Solapur is one of the highest contributors of sugar in Maharashtra (see following figure no 3) hence bagasse is also easily available which is used as fuel in order to meet power and steam requirements of production process (See: Solapur District Census, 2011).



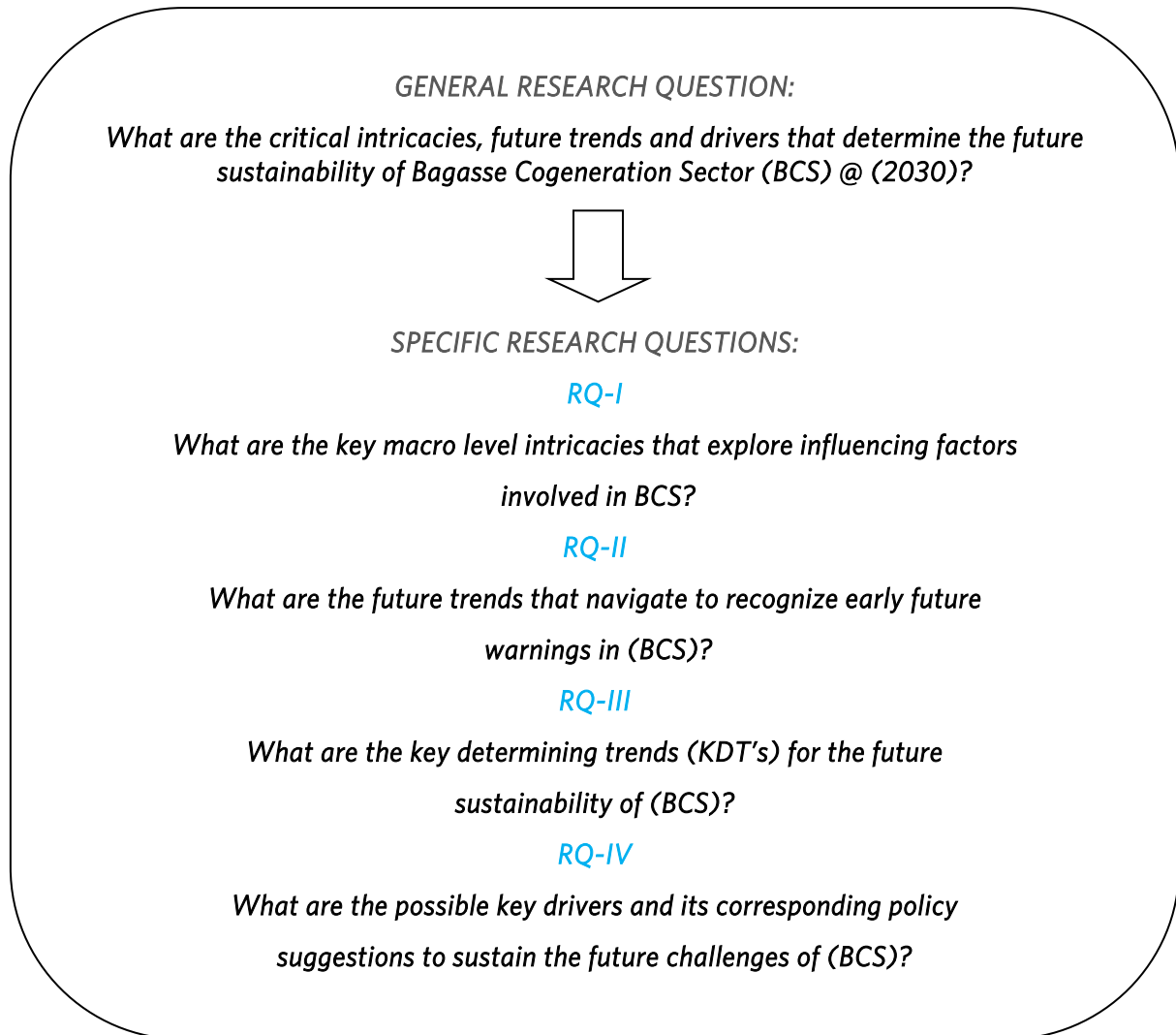
Source: <https://www.google.co.in/imgreswww.vsisugar.com%2Fimages%2Fjpg%2Fstatistics%2Fdistrict>

As per above data we can see that more than 18% of sugar contribution in Maharashtra State comes from Solapur District alone.

⁶ https://en.wikipedia.org/wiki/Solapur_district

Research questions

Thus, taking into consideration of the future potential of this sector an inquiry based on futures perspective has been initiated with following research questions:



METHODS AND ITS OPERATION

In order to operationalize the aforementioned research questions the following corresponding appropriate futures method have been applied:

RQ-I

i) Method: PESTEC: Any structural intricacies of the system consist with multiple dimensions. Therefore, the method of PESTEL analysis was used here to identify the various internal/external (political, economic, social, technological, environmental and cultural) factors that might affect a system as a whole. This exercise helped a lot to assess the contemporary risks and future possible coping strategies for the sustainability of (BCS).

ii) Process: To execute the (PESTEC) method in operation two specific tools have been used i) literature review and ii) brainstorming.

RQ-II

i) Method: Mini-Delphi: Considering the futuristic nature of the second RQ it was decided to have a Delphi method to assess the future trends implicated in (BCS) that could widen at 2030. For the present research we adopted face-to-face meetings with panellists that are called as mini-Delphi. It has benefited to outline three different possible trends (the *uncertain trend; certain trend and static trend*).

ii) Process:

- According to Wendell Bel (1997) Delphi researchers aim to predict and explore alternative future possibilities, their probabilities of occurrence, and their desirability by tapping into the expertise of respondents.
- For this study group of experts from the following three areas were identified:
- Researchers (social sciences, engineering and technology) ii. Managers (from Sugar industry) iii. Policy/Administrators (MEDA, MNRE).
- Altogether 11 experts were selected purposively to discuss on the intended RQ's and to bring their own argued future views into the discussion during June-August, 2017.
- The insights from the above data were used to develop mapping future trends (MFT's). The future trends were grouped in to three spheres (Uncertain trends, UT; Certain trends, CT and Static trends, ST); likewise, to quantify and measure the future trends we applied probability score ranking exercise {1-4(UT); 4-7 (ST); 7-10 (CT)} furthermore, to provide strategic impetus possible future policy impact (FPI) of these trends were also captured on the basis of probability score and future trends. The (FPI) has been measured with the help of the above three fold stratification: {++ and + are positive, = is neutral or unknown, - and - - are negative effects} respectively.
- To analyze the (MFT) exercise four key variables were selected viz: (Technological, Political, Environmental and Economical). See Table no 3.

RQ-III

i) Method: mixed methods: In order to operationalize RQ III we have adopted mixed methods such as (informal interviews, mini Delphi and personal observations). Data was collected from the officials of two sugar factories (Shri Siddeshwar Sugar Factory- Category: Cooperative and Lokmangal Factory- Category: Private).

ii) Process: On the basis of RQ II a clear scenario was emerged towards the possible future trends (PFT's). Later on, based on the MFT exercise four vital key determining trends (KDT's) for the future sustainability of (BCS) in India were identified. See Figure no 4.

RQ-IV

i) Method: mixed methods: To execute the final RQ we have relied exclusively on mixed methods (brainstorming, informal interviews and qualitative observations and diary notes).

ii) Process: The process of exploring answers of RQ-IV was based on futures framework: two steps were developed i) based on the qualitative insights from the preliminary RQ's (I-II and III) specific key drivers (SKD's) for each four key determining trends (KDT's) were selected; ii) finally, policy suggestions to the corresponding four KDT's were proposed with a primary intention to offer remedies or coping strategies to overcome the future challenges possibly affecting the very sustainability of (BCS) in India. See Table no 4.

RESULTS AND DISCUSSION

This section provides analysis based on the four research questions presented in the earlier section. The upcoming segment attempts to explore the answers of the first research question briefly, followed by the remaining questions suitably.

RQ-I

This section has two specific aims with regard to the first RQ. It begins to explore the macro level intricacies involved in the BCS and subsequently also offer key influencing factors responsible for the future sustainability of BCS in India with the help of PESTEL analysis. PESTEL is an acronym that stands for six main categories: political, economic, social and technology, environment and legal (see Table no 3).

Political:

The BC sector in India has been evolved along with multiple rationales. Therefore, it has become more complex to analyse the intricacies implicated in this sector. One of the important common threads that influence the sustainability of BCS is the political factor. BCS is an important subsection of Sugar factory. Hence, any positive/negative changes occur in sugar factory also has similar magnitude towards BCS. The Indian sugar industry is under high political influence similarly, political economy. However, there are contradictions at the national and local level political leadership with regard to RE in general and BCS in particular. At national level presently the Modi government has created a positive environment through enacting favorable policies, plans and programs (e.g Energy for all) and engaged in agreements related to sustainable development at international level to make India a clean and zero carbon country. However, India is a nation with full of paradoxes. One of the vital intricacies at political level is a severe lacking of political leadership at local level who can execute the policies, programs with the same zeal. Historically, majority of sugar factories are headed by political leaders

and their families with political interest (See: Baviskar, 1980). Likewise, the Indian political environment especially the opposition show wasted interest that might affect the future growth of this sector. One of the most crucial policy aspects that hinder the present and future augmentation of BCS is the constitutional existence of "Energy" sector as a common subject between federal state and central governments. This kind of dual freedom creates challenges for proper execution of programs. There are incidences where state governments have made special provisions which are contrary to the central governments guidelines for instance under Energy Act 2003 there is a freedom for renewable energy producers to sell the energy to any state across India. However, few federal states law restricts to enjoy the freedom provided by the central government act. In future there will be grave conflicts between the energy producers and federal state agencies that might create unfavourable conditions for the cooperative in general and private sector in particular.

Economic:

The economic sustainability of India's second most popular industry that is sugar sector had been facing both internal-external challenges. Some of the internal challenges are: i) Low level of financial returns ii) Majority of SF's are extremely bankrupt iii) Due to poor financial condition majority of SF's not able to upgrade latest technology for BC in order to produce surplus power for grid iv) Disputes with state/ power agencies with regard to PPA v) Growing future risk towards financial sustainability vi) lack of goodwill not able to take loan from domestic/international banks.

Thus, considering the financial intricacies at present in the BCS it seems that the sector is going to be affected by serious challenges in the near future. Some of the key future challenges that might affect the economic sustainability of BCS are: i) the impact of climate change and the excessive use of water and pesticide has already disturbing sugar production/ revenue generation at large scale ii) there will be crises to function BC plants due to lack of sufficient bagasse iii) due to surplus production and next generation advancement in other RE like solar and wind it will be difficult for the agencies to purchase energy produced from BC with relatively high purchase rate iv) the high level of professionalism and technological up-gradation by the cogeneration units run by private sector may create monopoly in market becomes threat to the cooperative cogeneration units v) the uncertain global market trends may also affect severely to the SF and similarly to the BCS vi) this kind of trend will not only affects cooperative sector but also creates challenges to government to achieve its required goal.

Table 3: PESTEL analysis: Present status and future challenges

Variables	Present status	Future Challenges @2030
Political	<ul style="list-style-type: none"> i.Strong leadership to promote RE at central level (MNRE;EA;NEP;IEP;REP) ii.International partnership and agreements(KP, PA etc) iii. Protective acts (Electricity Act-2003) 	<ul style="list-style-type: none"> i.Severe leadership gap to execute RE policies/ programs at federal state level ii.Growing pressure and vested interest by opponent parties and lobbying groups iii.Limitations in EA-2003 for expansion of RE sector and contradictory state laws
Economic	<ul style="list-style-type: none"> i.Huge amount of readily available bagasse and infrastructure ii. Striking Tariff rates by MNRE iii.Attractive subsidies and startup grants iv.Growing privatization in BCS v. Good credibility for loan/funding 	<ul style="list-style-type: none"> i.Increasing environmental risk and lack of managerial/technical base to utilize total bagasse; age-old and poor infrastructure ii.Lack of uniformity in tariff rates among the different federal states iii. Bureaucratic delays/corruption and lack of competition in domestic market iv.Privatization may create monopoly and threat to cooperative sugar sector v.The BCS may lose trustworthiness to take loan/fund for further developments
Social	<ul style="list-style-type: none"> i.Growing awareness among the young entrepreneurs to start new BC plants ii.Provides employment to rural youth iii.Indian sugar industry is under high political pressure iv.Due to LPG Indian sugar sector is reliant on global market forces 	<ul style="list-style-type: none"> i.fragile international exposure and managerial/professional skills ii.Scarcity of trained and skilled human resource iii. Increasing dominance of few dominant political groups may creates serious hurdles, political economy will become serious future threat iv.Unfavourable global market trends may affects the social sustainability
Technical	<ul style="list-style-type: none"> i.Favourable state funding for technology and R and D innovation ii.Sugar industries adopting next generation technology to harness optimum energy iii. Off grid technology is improving iv.Policy push for technology funding 	<ul style="list-style-type: none"> i.Growing dependency on imported technology and lacks indigenous R&D ii.Old sugar factories face economic and technological challenges to revamp old technology may shut down BC plants iii.Threat of surplus energy production iv.Cost for technology implementation/management will become more than the returns from (BCS)energy
Environmental	<ul style="list-style-type: none"> i.Favourable climate for sugar cultivation ii. Burning bagasse produces no sulphur dioxide iii.Eco-friendly policies by state 	<ul style="list-style-type: none"> i.Water scarcity, land salinity and climate change impacts may create serious challenges to shut down SF's or changes in its geography ii.Desposal of ash may create future problems iii.Growing insensitivity towards environmental policies and lack of effective monitoring by state agencies
Legal	<ul style="list-style-type: none"> i.Conducive acts and legal provisions by central government ii.Electricity Act-2003 offers guidelines to all states for functioning of RE projects iii.To protect of the interest of energy producer /end users effective laws have been formed 	<ul style="list-style-type: none"> i. Subjective interpretation of central laws and distractive substitute sub laws by state ii. Coordination and monitoring of laws for RE projects creates a challenge iii. Increasing political interference and misuse of laws by sugar lobbies

Social:

The social sphere of BCS also provides wide-ranging intricacies. At present BCS has opened up few positive avenues such as i) providing employment opportunities to the rural unemployed masses; ii) creating awareness about issues related to clean energy and its direct application/production at village level; iii) it has also been found that there is a growing consciousness among the youths to become green entrepreneurs through establishing private BC projects; iv) it opens up the process of empowering group of people with own green energy production units. Likewise, apart from positive aspects there are few challenges in the social sphere that might affect the social sustainability of BCS such as: i) although there is a cheap labor available for BCS however, the existing labour force lacks professionalism and minimum skills to be applied for the development of the sector at large like Europe and Australia ii) the managerial and leadership level issues at SF's (mainly at cooperative SF's) are indeed worst for instance: delaying in making policy decisions by Board of Management might be due to wasted interest and political economy; lack of international exposure and professional/managerial weakness also hinders the future development of BCS; corruption and tendency of extreme dependency on government relief packages; and poor level of awareness among the primary sugar producers towards the management of sugar leaf during harvesting season; lack of courage for new alternative experiments in BCS. Thus, the social sphere of BCS has shown multiple limitations and linkages with the allied indicators of PESTEL therefore, suitable policy suggestions with the help of specific drivers can be developed to overcome with the existing problems.

Technological:

The BCS has primarily been relied on imported technology since its beginning. Technology has played a crucial role in the establishment and development of cogeneration sector in India. While analyzing the present status and future prospects of the technological sphere of BCS the following intricacies have been emerged. i) It has been observed that government of India through MNRE has providing sustainable financial packages/subsidies for BC plants (see figure no 4) ii) new sugar factories are adopting advanced technology like (CTIG and GTCC) iii) the energy produced by cogeneration does not require storage as is the case with solar iv) adequate technological expertise for maintenance and deployment. In such an optimistic scenario there are some policy and practical gaps that can become future challenges for the BCS. The first and foremost challenge is i)to use 100% energy through BC plants from sugar factories however as of 2013 only 213 sugar mills out of around (35%) have been installed BC plants which comes around merely 35–40% of the total sugar factories ii) due to technological limitations and lack of standardization of cogeneration technologies for high pressure configuration mainly at small sugar mills majority of the small mills are unable to install cogeneration plant iii) majority of SF are established during cooperative revolution having old conventional technology using traditional equipments such as low-pressure boilers and counter-pressure turbo alternators, the level and reliability of electricity production is not sufficient to change the energy balance and attract

interest for export to the electric power grid (see: <https://www.bioenergyconsult.com/cogeneration-of-bagasse/>) iv) there is also discrimination in terms of capital subsidy among private and cooperative and sugar factories according to their presser boiler(See figure no 4) v) Indian BCS sector has poor indigenous R&D mechanism vi)dependency on imported technology creates huge establishment cost. As a result, the expected growth of BCS is being stagnant and its linkages are multifold. Therefore, considering the intricacies involved in the technological sphere there is an urgent need to reframe suitable policies both at local (SF) and at national (MNRE) level.

CAPITAL SUBSIDY		
For setting up bagasse plants		
Projects by cooperative/ public/joint sector		Private projects
Pressure	Subsidy (per mw)	
40-59 bar	Rs 40 lakh*	Rs 15 lakh**
60-79 bar	Rs 50 lakh	x (capacity
80 bar	Rs 60 lakh	in mw) ^{0.646}
& above	(Maximum support can go up to Rs 80 crore per project)	For eg, a 10 mw plant will get Rs 66.38 lakh

**In case of back pressure system subsidy will be 50%*
***Rs 18 in Northeast, J&K, Sikkim, Uttarakhand and Himachal Pradesh*
 Source: Ministry of New and Renewable Energy

Figure 4: Capital subsidy by MNRE to setup BC plants (Source: <http://mnre.gov.in/schemes/grid-connected/biomass-powercogen/>)

Environmental:

Similar to various industries, the sugarcane and sugar-bio-product factories are also struggling with issues related to environmental sustainability. Bagasse cogeneration industry also involves intricate concerns with regard to environment. However, as compare to other conventional energy sources the energy produced through BCS has few positive insights with regards to environment: i) BCS produces carbon neutral electricity, the power produced through co-generation substitutes the conventional thermal alternative and reduces greenhouse gas emissions. High-efficiency bagasse cogeneration was perceived as an attractive technology both in terms of its potential to produce carbon neutral electricity⁷. ii) Bagasse-based cogeneration earns carbon credits; burning bagasse produces no sulphur dioxide and very little ash as compared to lignite, the lowest rank of coal. Most coal available in India is of low grade. Bagasse-based cogeneration earns carbon credits since CO₂ absorbed by sugarcane plants while growing is more than the CO₂ produced in burning bagasse⁸. iii) The Indian climatic condition is

⁷ <https://www.indiamart.com/proddetail/bagasse-co-generation-of-renewable-energy-9365954855.html>

⁸ <http://www.downtoearth.org.in/coverage/crank-it-up-3445>

very much suitable for sugarcane cultivation with large area of cultivable land. On the other hand, signs are emerging at BCS towards its future environmental sustainability some of the future challenges are: i) the study conducted by Sahu et al (2015) article provides the first ever estimation, current status and overview of magnitude of air pollutant emissions from rapidly growing bagasse based cogeneration technology in Indian sugar mills,⁹ ii) dawn of multiple impacts of climate change i) due to uneven rainfall and growing temperature severely affecting sugar productivity and recovery; ii) land salinity is increasing due to unscientific surplus use of water for sugarcane farming; iii) lack of sufficient quantity of sugarcane factories are in deep crises towards its functioning (Shrivastava, 2014); iv) sugar production in India set to drop 9% in 2017 as drought hits Maharashtra, Karnataka a forecast made by Indian Sugar Mills Association (ISMA,2017);¹⁰ v) Solapur district, with 32 sugar mills, is the most hit, where the area under sugarcane cultivation has come down by 22,367 hectares. The total reduction of such crop areas in the Mharashtra state alone is 63,457 hectares in 2014-15 (See: ISMA, 2017); vi) ground water depletion, in water-stressed regions like Solapur and Marathwada regions, the increase in area for sugarcane cultivation has resulted in ruthless depletion of the groundwater level, causing acute water crises during summer that creates serious threat for the sustainability of sugar crop. The aforesaid brief analysis of environmental sphere of BCS provides the fact that although the present ecological condition is relatively conducive for its development however, the pace of the development of BCS may offer critical future challenges that needs both micro-macro level policy interventions in near future.

Legal:

India has one of the progressive set of renewable energy laws in the world. At present the electricity sector which includes power generated from RE is covered under Electricity Act (EC)-2003. After almost more than thirteen years of the implementation of EC Act-2003 a few critical issues have been emerging which are threatening the very existence of RE environment in India. Therefore, it needs suitable modifications for its future development. Some of the present intricacies involved in this Act are as follows: i) it lacks push for open access and alternative for supplier for enlarging RE sector ii) as per present law the review process for tariff fixation takes generally after every three year, which is not much conducive from the producers point of view iii) the escalation phase for Tariff for energy produced through bagasse based cogeneration usually not competitive considering the growing maintenances and production cost iv) the laws enacted by several federal states such as Maharashtra Electricity Regulatory Commission (MERC) RE regulations, 2010 adversely affecting BC projects in

⁹ The estimated emission from the world's second largest sugar industry in India for particulate matter, NO_x, SO₂, CO and CO₂ is estimated to be 444 ± 225 Gg yr⁻¹, 188 ± 95 Gg yr⁻¹, 43 ± 22 Gg yr⁻¹, 463 ± 240 Gg yr⁻¹ and 47.4 ± 9 Tg yr⁻¹, respectively in 2014(Sahu, 2015).

¹⁰ <http://www.financialexpress.com>

terms or problems related to PPA, legal ambiguities and general business environment; ¹¹ v) increasing political interference/wasted political interest from both ruling and opposition parties and misuse of laws by sugar lobbies vi) growing disputes and non-cooperation by line departments during enforcement of legal matters. These are the few representative intricacies' that have emerged out of the primary data collected from the stakeholders. The EA-2003 enacted during the earlier UPA government when the pace and zeal towards the development of RE sources was somewhat sluggish as compared to the present NDA government. However, the present NDA government took an exceptionally significant strike towards the making India a zero carbon nation. During the process of operationalizing the set targets RE producers, suppliers and even national/state government agencies have been realizing the legal lacunas in the present EA-2003. In view of the growing contradictions within the EA-2003 the central government/ MNRE has come up with the draft National Renewable Energy Act (NREA), 2015 (See Annexure-I)¹². The aforesaid (NREA) is yet to be cleared by the Indian parliament. Since Gol has shown an optimistic stands at an international level during Paris agreement and allied associations towards clean energy movement it has become an inevitable for the government to show its practical implications. Legal hurdles within the present EA-2003 is restricting MNRE to get clearances from different departments and ministries. Therefore, it is important to know about the enforcement of the proposed law. However, politicization and non-cooperation by the opposition may create future challenges in the clearance of (NREA) in general and the development of RE in particular.

Thus, the above PESTEL analysis reflects the answers of the first RQ which basically provides the intricacies affianced within the BCS and helps to recognize the influencing factors that are interlinked within the PESTEL and also have possible future consequences with regard to the sustainability of BCS as a whole. As a result, the first RQ has set the environment to move forward to capture the potential future trends that navigate to recognize early future warnings that are associated with the sustainability of (BCS) as put-forth in the RQ II.

RQ-II

Usually, tools and methods in the direction of analyzing the future do not able to predict the future, even though appraising the probabilities of alternative futures is one of the vital aspects of the methods of future studies. To be more precise, methods of futures studies are normally intended to facilitate public better aware future possibilities in order to formulate better decisions today¹³. In this context in tune with the general RQ of the present study the specific RQ no II attempts to explore future potential trends and their associated early warnings with special reference to the sustainability of BCS @

¹¹ http://www.mercindia.org.in/pdf/Order%2058%2042/Order_46_49_66_of_2012_13_May_2013.pdf

¹² For more details see: <http://mnre.gov.in/file-manager/UserFiles/draft-rea-2015.pdf>

¹³ For more details see: <http://www.crab.rutgers.edu/~goertzel/futuristmethods.htm>

2030. In order to employ the futures analysis based on RQ II, the mapping future trends (MFT's) exercise was prepared through applying one of the prominent futures method that is mini-Delphi. For this study an operational definition of future trends has been described as "a common path on the way to future through which something is commencing or changing with special reference to the problem identified for investigation", furthermore, it is an assessment, calculation or forecast of a future state of affairs based on a specific futures method of data of present context that we have".¹⁴ One of the important objectives of (MFT) exercise is to offer future possibilities of trends and warnings towards the sustainability of BCS that will help the stakeholders to make suitable coping strategies in the present context. In order to capture future trends in BCS four variables (Technological, Political, Economical and Environmental) have been identified. Under each four variables three possible future trends (PFT's) have been recognized on the basis of Delphi exercise and afterward it has also been quantified to measure its possibility through probability score rated by the Delphi participants and on the basis of the results of probability score the future policy impact (FPI) of each three possible future trends have been drawn.

Future Trends in Technology

The results of the future trends of the first variable that is technological offer three important future trends for the BCS @ 2030. The most probable certain trend (CT) for the technological variable shows that there will be breakthrough technological innovations at BCS in terms of (Small scale turbine, nano and cost effective hybrid technology) convenient even for small scale sugar factories which also has + + positive Future Policy Impact as a whole. This trend will create two major changes at BCS i) at present only high pressure big sugar factories are able to have BC plants, however due to technological innovations mainly nano and cost effective technology small sugar factories with limited TCD can also become able to start BC unit with increasing amount of power for instance: the advanced technology can generate 6-10% more energy than the old¹⁵; ii) through this change the industry could be able to use 100% bagasse for energy generation at present only 30–40% sugar factories are only having BC plants iii) likewise, due to unavailability of bagasse during off season majority of SF are not able to start their BC plants however, because of advanced hybrid cogeneration plants in future the BC plants can be able to start their plants even during off season with the help of alternative biomass available at rural areas such as huge amount of sugar leaf is available after sugar cane cutting that can readily be used as an alternative to bagasse along with other available rural bio mass. As far as the static trend is concerned it projects that although there will an advanced technological revolution in BCS due to the increasing cost small sugar factories and overdependence on government funding majority of SF will be out of the

¹⁴ For more details see: <https://dictionary.cambridge.org/dictionary/english>

¹⁵ MNRE Annual Report 2012–2013, New Delhi, India retrieved from <http://mnre.gov.in/file-manager/annual-report/2012-2013/EN/chapter3.html> on 03-12-2017

BCS. Hence, the same trend will remain without much positive change in the BCS. Therefore, appropriate policy changes have to be initiated according to the future trends captured as above.

Future Trends in Political Sphere

The future trends in political sphere reflect three different trends for BCS. The most uncertain trend shows the drastic political shift at both (Central and State) level which further creates dismal policy environment for RE sector as a whole. However, considering the back casting and present political mapping in India there are very less probabilities to occur this trend in true, however, this can be treated as a black-swan @ 2030. Even though, despite of the drastic shift at the national and state level political affairs it is quite not oblivious that the new government will not continue the RE movement further. Because the recognition which the government of India gained at international level about the environmental stewardship in particularly after the Paris agreement bind the upcoming government to continue the earlier engagements even further. However, the question only remains about its pace of change to implement the RE policies with the same zeal like the NDA government. The remaining trends offer relatively possible computation, the most certain trend proposes + + positive future policy impact which emphasizes further conducive policy and programs for the expansion of RE sector due to the political consistency in leadership, conducive policy environment, operational practical evidences in terms of RE policies and up gradation in present laws and policies according to the conditions¹⁶. Meanwhile, the static trend suggests that the policy makers should not be over utopian towards RE policies which might create utopian policy environment at RE sector and due to over utopianism the Government may make policy shrink without any drastic changes in coming 10 years.

Future trends in environmental sphere

The existence of sugar cane crop is largely based on water, land and sunlight and therefore has a significant dependency on environmental aspects. The impact of climate change has created serious threats to the sugar industry all over the world. Therefore, to know future trends for the management of environmental risks has become an important chore for the stakeholders associated with sugar industry. The primary insights based on the Delphi propose three alternative future trends with reference to environmental sphere that creates future possible impacts on BCS. The most certain trend which has further positive policy impact + shows a sharp behavioral change among the sugarcane cultivators which includes following few most crucial aspects: changes in the sustainable cropping practices such as use of micro irrigation tools, use of organic seed and fertilizers, advanced farming tools and including forced change in topography of sugar cane crop may appears in the coming years

¹⁶ The present NDA government has proposed a Draft Renewable Energy Act, 2015 for further policy improvement

@ 2030. The key drivers behind such behavioral changes are manifolds for instance: policy enactment by state governments towards sustainable agriculture (see Box no-I); insecurity and unfavorable conditions to divert to other cash crop; growing awareness about sustainable farming; feminization of agriculture and political economy associated with sugar cane farming.

Maharashtra Government Makes Drip Irrigation Must for Sugarcane Cultivation

Maharashtra is one of the highest sugar cane production states in India. Being a progressive and most industrialized state in India, Maharashtra state has always been ahead in taking contextual future oriented sustainable decisions. In the month of June 2017 the government has taken a significant decision to make drip irrigation compulsory for sugarcane cultivation. There were criticisms by development community towards the huge exploitation of water for sugar cane farming there are critical incidences at rural areas of Maharashtra. As per the cabinet approved scheme the government will provide loan to sugar cane cultivator of up to Rs.85,400 per hectare with financial support at an affordable 2% interest rate. The state government desire to cover nearly 3.05 lakh hectares of land of the total 9.42 lakh hectare under sugarcane cultivation under this scheme in coming two years (2017–2019). The positive sign is already there are 2.25 lakh hectares of land covered under drip irrigation¹⁷.

On the other hand, the remaining future trends tend to depict that due to most hostile climate conditions mainly scarcity of water the cultivation of sugar cane crop will fall drastically in near future¹⁸. If government and the farming community at large do not make self-assessment towards sustainable farming practices the future of sugar cane farming will be in exiled. Therefore, there is a need to create sufficient and necessary conditions by all stakeholders to cope with future environmental challenges that is going to be affected the sugar cane and ultimately BCS in India.

¹⁷ The state government has asked NABARD to have a dedicated micro irrigation fund and long term loans will be given to farmers from that fund. The original interest rate for these loans will be at 7.25 % of which 4% will be borne by the state government, 1.25% will have to be borne by the sugar cooperative which buys the sugarcane from the farmer and the remaining 2% will be borne by the farmers himself. Sugarcane is 18-month cash crop, it required nearly 25,000 tmc water for one hectare of the crop and if drip irrigation is introduced the state government aims at saving nearly 7500-12500 tmc of water per hectare, said officials from the state agriculture department. "There was a huge hue and cry over the water requirement of sugarcane during the drought years. Large parts of the drought prone Marathwada grows sugarcane and this scheme will benefit such areas largely," said an official from the agriculture department. Data retrieved from: <https://timesofindia.indiatimes.com/city/mumbai/drip-irrigation-a-must-for-maharashtra-sugarcane-cultivation/articleshow/59651898.cms> on 03-12-2017.

¹⁸ The satellite images of later part of June 2016 showing the sugarcane acreage across the country was procured by the Indian Sugar Mills Association (ISMA) and after detailed analysis, it was estimated the total sugarcane acreage of the country in the 2016-17 sugar season, which begins from October 2016, would be around 49.91 lakh hectare (hectares), which is about 5.5 percent less than last year. For more details see: <http://commoditiescontrol.com/eagrtrader/common/newsdetail.php?type=SPR&itemid=8384&comid=,6,&cid1=cid1&varietyid=,25,&varid=>

Future trends in economic sphere

The BCS is one of the sub-sectors and solely based on the future of sugar industry for its survival. However, this productive industry is in the midst of turmoil now. The future economic trends illustrate three most crucial trends with varying degree of impact on BCS. If we see the pace of RE sector at large at Indian context it has been growing very much fast than the expectation. Mainly the wind and solar sectors are growing at high rate this trend might create future conflicts within the RE sectors and the relatively under-researched and growing sector like BCS might face problems mainly with regard to its day by day falling tariff charges and policy/legal challenges involved in selling energy to the state and private agencies. The growing maintenance and initial establishment cost of BC plant has become a major challenge in contrast problems are emerging with regard to its grid connectivity, disputes in tariff rates fixed by state agencies and RPO. Thus, considering the issues related to the profit-loss appraisal the sector may face severe risks in near future. The only option remains is to utilize the energy generated by BC plant for the sugar factory itself. This trend creates negative future policy effects. Likewise, the second future trend that show static trend and having = neutral or unknown future policy impact also explores ground level realities. Sugarcane and the sugar industry both are known as a multi-producers, therefore occupies a prominent position on the agro-industrial map of India. However, considering the matters related to the rising financial un-sustainability of BCS in future the sugar industries may think to divert the bagasse to allied sectors like pulp, paper industries and bio-plastic. The most certain trend proposed by the Delphi experts put forward the fact that the future of BCS will be based on small scale, cluster based and private sector. The possible linkages associated with this trend are: i) there will be a paucity of availability of bagasse that might affect big sugar factories ii) the cooperative BCS have multiple economic challenges due to; under heavy debt burden, dominant political economy, corruption, historical mistakes made in setting up sugar factories in close proximity to one another; lack of professional/financial forecasting; lacking of fiscal equity for improvements in competence and towards updating advanced cogeneration equipment. In contrary, private bagasse cogeneration sector will have positive future trend due to their professional and financial strengths in coming future. Likewise, to overcome with the paucity of bagasse during main/off season small/cluster based models can become viable options. Thus, the aforesaid section (RQ-II) based on the analysis of extensive Delphi exercise provides the larger canvas of the possible future trends that might help to recognize possible alternative futures and their corresponding linkages from a systems perspective. This MFT exercise can be employed as a future tool kit for planning strategies and capturing possible key determining trends for the sustainability of BCS in India @ 2030.

Table 4: Mapping future trends for BCS based on Delphi exercise @2030

Variable	Future trend(s)	P S	ToT	F P I
Technological	i) There will be breakthrough technological innovations in terms of (Small scale turbine, nano and cost effective hybrid technology) convenient for small scale sugar factories.	7-10	CT	++
	ii) The increasing cost of advanced technology will remain the main technological hurdle for the large number of small scale sugar factories. Hence, the situation will remain constant until next 10 years.	4-7	ST	=
	iii) There will be no breakthrough innovation and cost effective technology in the next ten years.	1-4	UT	-
Political	i) There will be a drastic political shift at both (Central & State) level. Coalition government may take charge. Hence, RE Policy may face negative effect in coming 10 years.	1-4	UT	-
	ii) Further conducive policy environment at RE sector may exist in coming 10 years with an extension of another term for the NDA	7-10	CT	++
	iii) There will be a utopian policy environment at RE sector and due to over utopianism the Government may make policy shrink without any drastic changes in coming 10 years.	4-7	ST	=
Environmental	i) Considering the droughts and erratic rain fall, effects of climate change and growing pressure on water (ground and dam) there will be a serious future problem of sugar cane cultivation in next 10 years.	1-4	UT	=
	ii) Due to climate change farmers may change the cropping practices or change topography and also adopts micro irrigation tools/ organic farming to sustain sugar cane farming	7-10	CT	+
	iii) Farmers will not change their traditional attitude to exploit natural resources for sugar cane cultivation and do not stop sugar can cultivation at large scale.	4-7	ST	--
Economical	i) The bagasse cogeneration industry will not be a much profitable sector due to slowdown in Terrif rates because of surplus energy production in next 10 years.	1-4	UT	-
	ii) Due to increasing demand for bagasse from other growing sectors like pulp and paper industries there will be an enormous increase to purchase bagasse. That might affect the future of cogeneration plants in next 10 years.	4-7	ST	=
	iii) In future only small scale, cluster based and private cogeneration plants can be a viable future option.	7-10	CT	+

Probability Score (PS): 1-4(UT); 4-7 (ST); 7-10 (CT)

Type of Trend(s) (ToT): Uncertain Trend (UT); Static Tend (ST); Certain Trend (CT)

Future Policy Impact (FPI): ++ and + are positive, = is neutral or unknown, - and -- are negative effects

RQ-III

The analysis based on the earlier RQ-II sets the ground for further refinement of the futures process that tend to reflect possible key determining trends (KDT's) for the future of BCS @ 2030. In futures methodology, drawing (KDT's) can be seen as a potential tool for developing vigorous, concise futures viewpoint or an outline, which can remove prejudices and unlock minds through exploring and mingling across-the-board developments that may affect the very ecology and surroundings in which the future processes takes place(See: Troutman and Palombo,1983). It is in the context of above futures underpinnings the present sub-section (RQ-III) offers four precise possible (KDT's) with special reference to BCS @ 2030. After MFT's analysis it becomes more imperative to establish what are the most crucial trends which determine the very development and sustainability of BCS? The KDT's depicted in figure no 5 provides a specific trustworthy foundation for assumption/prediction than trust on sheer perception.

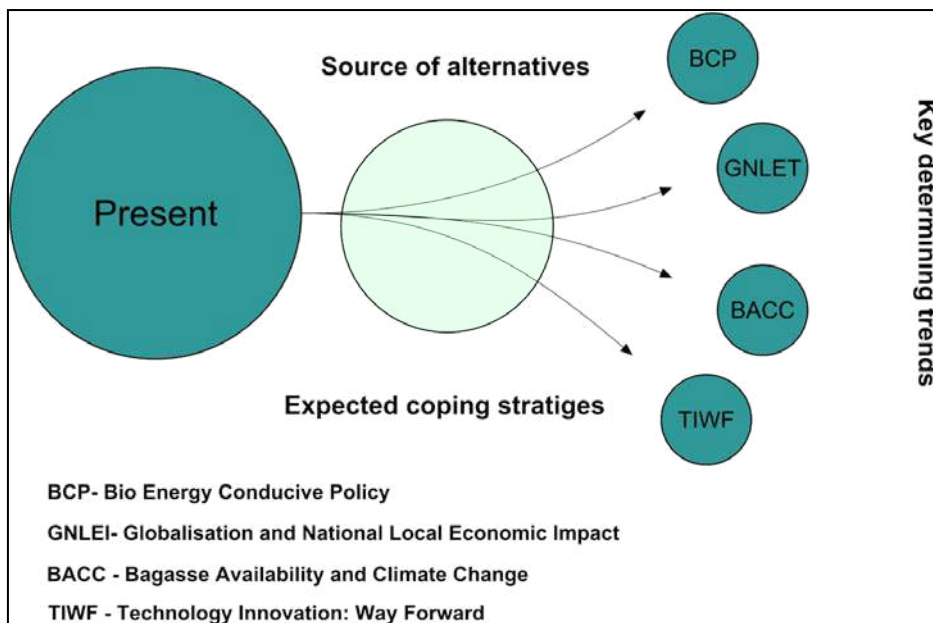


Figure no 5: Key determining trends for BCS @ 2030

KDT-I:

The above KD trend has a significant denotation for the future development and sustainability of BCS in India. The policies/laws related to BCS come broadly under bio- energy which also includes other bio-energy energy sources such as: bio fuel, ethanol, bio gas and bio mass. As a result, it has been observed that the BCS is being neglected at policy level. Considering the holistic and interdependent nature of BCS which is on the one side covered under EA-2003 and on the other hand also depends on the laws applied to the sugar factory. This kind of dual policy playback is being affecting the overall growth and sustainability of BCS. Therefore, there is an urgent need to have BCS specific responsive conducive policies and strategies.

KDT-II:

The second KDT although offer a macro framework of globalization however formulate a variety of consequences at national and local level in relation to sugar industry and their co-industry that is BCS. Considering the world-systems perspective the above KDT's inspect the trajectories of globalization and their corresponding future effects on sugar industry and BCS. In an era of globalization the markets/industries are interconnected hence do have the impact on production, consumption and trade at global/national/local level. India with a large consumption base for sugar has a greater impact at global level, if their sugar supply fluctuates even by a small percentage (Hira, 2011). It has been observed that the Indian SF/BCS have the aforesaid weaknesses: lacks in global sector specific linkages; lacks in global collaborations in R&D, HR up-gradation and intersectional market, financial/funding linkages. These barriers make the industry stagnant and create challenges for the sustainability. In spite being the biggest customer of sugar and the second highest producer of sugar at the global level, sugar industry including bagasse cogeneration sector, more so in the globalization era, has not curved out to be a source of attraction for their stakeholders (Sharma A. K. et al, 2015).

KDT-III:

At worldwide, sugarcane is flattering as one of the sole crops for bio-energy production in general and BCS in particular. The growing problem of greenhouse gas effect and global climatic change results in the rising rate and amount of tremendous weather affairs. Global and National agencies such as (IPCC 2015, FAO 2012, UNDP, 2009) noted that the ill effects of climate change has already been taking place and creating serious consequences for sugarcane production at world, especially in the developing countries like India due to comparatively small adaptive capability, extreme susceptibility to environmental hazards, including fragile weather forecasting and technological/human extenuating policies. Likewise, population growth, changing food consumption pattern both at national/global level and speedily degrading natural resources are also becoming major problems. Consequently, under such hostile geo-ecological conditions at Indian agriculture climate change is an upcoming threat to the very future of sugar cane crop that further have possible pessimistic linkages to its associated sub-sectors like BCS. One of the crucial future impacts is the scarcity of bagasse which is the primary raw material used to generate cogeneration plants. Thus, trustworthy forecasts of sugarcane response to climate change with specific drivers and concurrent policy suggestions are inevitable for the policy makers to plan coping strategies at the earliest.

KDT-IV:

The optimum production of energy through bagasse cogeneration primarily depends upon two factors: i) the variety of sugarcane crop having added fiber/moisture content/percentage and ii) most significantly, the technology adopted by the sugar industry it includes: the boiler configuration and level of steam pressure (lower/higher) turbines. The technological assessment of the present status of BCS in India shows mixed realities the relatively newly opened sugar factories (mainly after 2000) and

preferably private sugar factories having only advanced technology the percentage roughly goes to 30-35 % however, old sugar factories dominantly cooperative/public sector and small sugar factories using traditional technology with low pressure. Studies (Luo et al, 2009; Purohit and Michaelowa, 2007) found that using advanced technology creates 6-10% more energy from BC plants. Therefore, an urgent need is to modernize sugar mills and the existing BC plants for optimum and superfluous energy generation. Furthermore, there are yet 269 sugar mills roughly (60%) of total that are yet to be connected with BC plants and the small mills having (1000 TCD) can also become part of the future energy production through bagasse.

Thus, the above analysis tries to capture four most vital KDT's for enhanced and precise understanding of the composition and extent of intricate backward and forward linkages involved in various connected sectors of the BCS which are not allowing the BCS to tap its full energy potential. Therefore, for the future prospects of BCS suitable policy suggestions based on select drivers has to be developed.

RQ-IV

The preceding section proposed four (KDT's) that impels a range of outlines of the current futures investigation. Therefore, it needs specific drivers to analyze its enormity that unites various trends and concerns raised in the each KDT's. Drivers are the factors resulting in to change and further influencing or shaping the future (FAO, 2014)¹⁹. In futures studies drivers also assists the futurists to formulate specific policy suggestions to make desirable choices and forecast to avoid future problems to face.

¹⁹ "Thus, drivers of change are those factors, forces or events [...] which may be amenable to changes according to one's strategic choices, investments, R&D activities or foresight knowledge and strategies. They are both presently accessible and future relevant". (Saritas O., Smith J, 2011:295). For more details see: Saritas O., Smith J. (2011) The Big Picture: Trends, drivers, wild cards, discontinuities and weak signals, *Futures* 43(3): 292–312.

Table 5: Key Determining Trends their Drivers of Change and Policy Concern(s)/Suggestion(s)

KDT-I: Bio-energy Conducive Policy		
Sr.no	Drivers	Policy concern(s) and suggestion(s)
1	Structural reforms in the BCS	2.1. Reforms like Sugar Sector Action Map (SSAM) and Bagasse Industry Efficiency Mission (BIEM) it includes: modernization of cane fields/ production, energy efficiency certificates, incentive/ fund for bagasse storage; creating independent power companies; public-private-co-operative linkages. 2.3. Bagasse Energy Situational Audits(BESA) mandatory for establishing new SF and BC plants 2.4. National level RE segmented data management agency (REDMA) with special reference to all available RE sources and regional specifications.
2	The higher establishment cost and stagnant tariff/ escalation rate	5.1. Bagasse tariff rate/fuel price indexation mechanism formula will be developed every year by the competent agency to overcome with the low tariff rate under (RPO) and including its escalation percentage. 5.2. There must be a state-wise minimum benchmark for fixing tariff rate, centralized or state-level parameters to fix tariffs shall be prepared under a National Electricity Plan and National Tariff Policy by Central Electricity Regulatory Commission (CERC)
3	Sustainable relationships with primary sugarcane growers	3.1. To compensate and encourage growers a good viable plan for sugarcane price could be evolved which is not merely based on sugar content but equally relied on sugar quantity and fiber content. Such future practices will be a panacea for the sustainability of the BCS and SF. 3.2. This kind of crop-incentive would enable them to adopt modern farm practices such as: higher recovery sugar seeds and innovative sugar crop like 'fuel cane' and micro irrigation practices.
KDT-II: Globalization and national/local economic impact		
Sr.no	Drivers	Policy concern(s) and suggestion(s)
1	International funding linkages	1.1. Open up new avenue/ framework for international funding through MNRE and Cogeneration Association of India (CAI) such as independent power producers; small/cluster based BC plants; special bagasse energy economic zones (BEZ).
2	Global reforms in FDI/ industry and future of BCS	2.1. To make the BCS vibrant there must be fair competitive business environment and scope for private international/national actors for investment and expansion 2.2. Since India has secured first time the top 100 rank in the World Bank's 'Ease of Doing Business' ranking there is a huge scope for business reforms in Sugar sector including BCS to attract international investors, partnership and R&D like Brazil, Mauritius and EU countries. 2.3. To sustain Indian sugar industry Indian government endorsed 100 % FDI and creating enabling environment through qualitative reforms and tax exemptions. 2.4. Need to create to favorable environment by MNRE, Sugar federations to get advanced technology, capital investment that brings competition within the local markets, improve managerial skills, innovative ways for energy storage, transfer and additional energy production.
3	Building lobbying and leadership at international level for clean movement	3.1. Already, India has initiated 'International Solar Alliance-ISA", being world's largest sugar producer India has an opportunity to form "International Sugar Energy Industry Alliance-ISEIA" even, initially alliance at BRICS/ASEAN countries can also be a viable option which will help to open new spaces and resources for BCS. 3.2. The alliance of this kind will create future opportunity to: lead global movement in clean energy; fund created through the alliance cane be useful for R&D, training, employment generation and infrastructure; get fund from World Bank and IMF; achieve goal of 175 GW clean energy at 2022; capacity building of Indian research institutes working on clean energy and trap full energy potential through BCS.

KDT-III: Bagasse availability and climate change		
Sr.no	Drivers	Policy concern(s) and suggestion(s)
1	Climate Change and Sustainability of land and water for cane production	<p>1.1. Climate change is emerging as key driver threatening future sugar cane production. An action plan towards sustainable coping strategies on climate change has to be implemented in collaboration with IPCC/ICAR/ISRI.</p> <p>1.2. Due to one of the vital commercial cash crops land under sugar cane is growing steadily which may create problem of future food security and due to lack of awareness and traditional farming mindset to get more production farmers are using huge water and pesticides for sugar cane farming which results in land salinity and water depletion at higher rate.</p> <p>1.3. To sustain sugarcane land it is essential to encourage sugarcane grower clubs(SGC) on participatory basis towards agronomic modern ecological land/water management practices such as: incentives for organic sugar farmers associations(OSFA) and special policy/packages for Cooperative/Company based Sugar Farming(CBSF); region wise mapping exercise of future potential zones for sugar cane(FPZS) with the help of Indian Space Research Organization(ISRO) and special sugarcane farming drip irrigation act(SFDIA) for water sustainability.</p>
2	Seasonal availability/ scarcity of bagasse	<p>2.1. Seasonal availability and scarcity of bagasse has been one of the ever greatest barriers affecting energy potential and commercial viability of cogeneration plant which restricts the BC plant only during the crushing term (100 - 180 days).</p> <p>2.2. The Delphi interviews suggested that to overcome with the seasonality problem an alternative is possible through implementing preservation of bagasse and mixing with off related agro waste such as rice shell, crop scums, region wise seasonal residues/waste materials can be used as fuel for BC plants. This needs a careful seasonal biomass mapping plan (SBMP).</p> <p>2.3. There are model cases like in Maharashtra state '<i>Shri Pandurang Sugar Factory</i>' and in Karnataka state '<i>Ugar Sugar Factory</i>' both have successfully established the alternative fuel linkages during off-season by exclusively utilizing sugar cane leaf/garbage available from in and around the command area of sugar factory.</p> <p>2.4. Although, there is an alternative for bagasse during off-season however, there are critical issues related to the practical application of an alternative biomass such as: the collection of such a huge amount of biomass, packaging, distribution, storage, marketing, pricing, trained human resource and transport/selling.</p>
3	Climate change road map	<p>3.1. It is suggested that considering the future sustainability of BCS the MNRE in collaboration with Ministry of Agriculture(MoA) and Environment(MoE) and National Skill Development Corporation (NCDC) prepare a roadmap for institutionalizing the biomass banks(BMB) through a decentralized approach to financially/technically encouraging private/ rural SHG's/ cooperative institutions/<i>grampanchayats</i> to establish strong value chain and linkages for such new avenues which will sustain BCS and also creates enormous employment opportunities in clean energy sector.</p> <p>3.2. Likewise, MNRE in collaboration with ICAR and Sugarcane Breeding Institute (SBI) instigate special program for developing new varieties of "energy/fuel cane" to overcome with the problem of scarcity and seasonal availability of bagasse.</p>
KDT-IV: Technological Innovation: way forward		
Sr.no	Drivers	Policy concern(s) and suggestion(s)
01	Advancements in plant technologies	<p>1.1. There are two important technological related lacunas that are persistently hampering the development of BCS in India i) Out of total (576) SF's around 156 (27%) small sugar factories with capacity of lower than 2,500 TCD are not eligible to get fund for BC plant and therefore, lacking with standard/advanced technology ii) the rest of SF's around 420 (73 %) are above 2,500 that are eligible for</p>

		<p>funding for BC plant but, out of that only 213(37%) sugar factories installed BC plants, yet 207(36%) SF's are not connected under BC plants as on 2013(PIB, 2013). Yet, in all 363 (63%) SF's can become a part of India's clean energy movement.</p> <p>1.2. There is an urgent need of technological policy reforms in two ways: i) MNRE could relax the funding norms for small SF's below 2,500 TCD and suggest suitable well tested technology for small SF's; generate policy guidelines for new BC plants(GNBCP) for small SF's ii) there is a discrimination for funding for new BC plants among the cooperative and private SF's it is suggested that MNRE shall give equal funding for even private SF's because they are in more numbers with advanced techno-managerial facilities.</p>
02	Manufacturing capabilities	<p>2.1. To harness maximum amount of energy from BC plants advanced state of art technology with relatively low cost is a need of hour. MNRE shall initiate indigenous manufacturing units under 'Make in India' initiatives to develop generation next cost-effective bagasse technology such as: development of hybrid small scale efficient high pressure technology; bagasse and blended biomass cogeneration technology; special funding for technology updating on the basis of merit and outcome; increase approved manufacturers and suppliers region wise.</p>
03	Non-feasibility of Technology push policy	<p>3.1. It is observed that the so-called technology push policy is not adequate to develop the BCS in India. Instead, 'demand pull policy' on the basis of through market mapping exercise in collaboration with stakeholders demand for technology assessment and economic requirement is in fact needed(See Scherer, 1982).</p>

CONCLUSION

The upcoming developments and rising accountability in the area of RE sources have spurred the prospects of Indian policy makers and allied stakeholders to make future expansion by creating conducive environment for the future RE area like bagasse cogeneration sector (BCS) managed by sugar factories. However, for any growing sector there are always gaps and anxieties about its future role and sustainability. The present study is probably the first attempt to empirically try to fill the aforesaid gap by using futures methodology. In particular, the study on India's BCS analyses three vital aspects: i) the future prospects for (BCS) by using PESTEL method ii) mapping future trends and their key determining trends(KDT's) and finally offers iii) key drivers and their explicit policy suggestions for future sustainability. The study provides answers to the four specific research questions (RQ's) as above: RQ-I and II: both the RQ's offers two distinctive trends at first instance it concludes with proposing twelve future trends that help to be acquainted with early future warnings and later on finalizes four KDT's. These four dominant KDT's are highly likely to influence the very sustainability of bagasse cogeneration wherein funding, regulatory policies and institutional/ecological features have become more crucial. RQ- III and IV: The final RQ's concludes with drivers of change based on the four KDT's that are causing change and affecting/shaping the future sustainability of bagasse cogeneration and also offers concrete practical policy suggestions. Thus, considering the immediate and foreseeable future that is (2030) for (BCS) it is concluded that, based on the policy suggestions systemic changes in the sector as a whole have to be made.

REFERENCES

- Alexandratos, N. & Bruinsma, J. (2012) World agriculture towards 2030/2050: the 2012 revision (No. 12-03, p. 4). Rome, FAO: ESA Working paper. www.fao.org/docrep/016/ap106e/ap106e.pdf retrieved on 27 Oct, 2017.
- Anselmo Filho, P. & Badr, O. (2004) Biomass resources for energy in North-Eastern Brazil. *Applied Energy*, 77(1), 51–67.
- Baviskar, B. S. & Attwood, D. W (1984) Rural co-operatives in India: A comparative analysis of their economic survival and social impact. *Contributions to Indian Sociology*, 18(1), 85–107.
- Bell, W. (1997) The purposes of futures studies. *The Futurist*, 31(6), 42.
- Bhattacharya, S. C. & Jana, C. (2009) Renewable energy in India: historical developments and prospects. *Energy*, 34(8), 981–991.
- District Census, Solapur (2011) Census 2011 <http://solapur.gov.in/htmldocs/demog.pdf>, retrieved on 18 Nov, 2017.
- Energy Situation in India 2017 file:///C:/Users/admin/Desktop/New%20pub%20task/Project%20FFRc/Energy%20Situation%20in%20India%20and%20Renewables.pdf, retrieved on 11 Nov, 2017.
- FAO (2004) State of Agricultural Commodity Markets. Rome: Food and Agricultural Organization.
- Food and Agriculture Organization Fourth World Food Survey (UN, Rome, 1984); Fifth World Food Survey (UN, Rome, 1987)
- Halder, P., Arevalo, J., Tahvanainen, L. & Pelkonen, P. (2014) Benefits and challenges associated with the development of forest-based bioenergy projects in India: Results from an expert survey. *Challenges*, 5(1), 100–111.
- Haya, B., Ranganathan, M. & Kirpekar, S. (2009) Barriers to sugar mill cogeneration in India: Insights into the structure of post-2012 climate financing instruments. *Climate and Development*, 1(1), 66–81.
- Hira, A (2011) Sugar rush: Prospects for a global ethanol market. *Energy Policy*, 39(11), 6925–6935.
- IPCC (2015) Working Group II: Crop production: Impacts, Adaptation and Vulnerability <http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=390>, retrieved on 9 Oct, 2017.
- Kalpna Bisht & Renu (2016) Bagasse Power, an Untapped Potential in India – A Review *International Journal of Engineering Sciences & Research Technology*, Vol. 5(12).
- Kumar, A., Kumar, K., Kaushik, N., Sharma, S., & Mishra, S (2010) Renewable energy in India: current status and future potentials. *Renewable and Sustainable Energy Reviews*, 14(8), 2434–2442.
- Luo, L., Van Der Voet, E., & Huppes, G (2009) Life cycle assessment and life cycle costing of bioethanol from sugarcane in Brazil. *Renewable and Sustainable Energy Reviews*, 13(6), 1613–1619.
- Milford, B (2003) Improving the economic competitiveness of the Australian sugar industry. *International sugar journal*, 105(1253), 216–222.
- MNRE(2013)Energy from sugar mills, Press Information Bureau, Government of India Ministry of New and Renewable Energy, <http://pib.nic.in/newsite/PrintRelease.aspx?relid=98949>, retrieved on 27 Oct, 2017.
- Purohit, P. & Michaelowa, A (2007) CDM potential of bagasse cogeneration in India. *Energy policy*, 35(10), 4779–4798.
- Patel, V. (2017) Potential and Installed Capacity of Major Renewable Energy Sources in India. *International Journal of Engineering Technology Science and Research*, Volume 4, Issue 5.

- Pellegrini, L. F. & de Oliveira Junior, S (2011) Combined production of sugar, ethanol and electricity: thermo economic and environmental analysis and optimization. *Energy*, 36(6), 3704–3715.
- Patil, D. A. (2017) *Exploring Future Prospects and Alternative Scenarios for Bagasse based bio-energy in Solapur District*, paper presented at the International conference on “Clean Energy Futures: Quest for Low Carbon Civilization”, organised by Centre for Futures Studies, Solapur University, Solapur in collaboration with Finland Futures Research Centre, University of Turku, Finland, 29–30 Sept, 2017.
- Ranganathan, M. (2005) Can co-ops become energy producers too. Master of Science Thesis, Energy and Resources Group of the University of California, Berkeley.
- Rosen, M. A., Le, M. N. & Dincer, I. (2005) Efficiency analysis of a cogeneration and district energy system. *Applied thermal engineering*, 25(1), 147–159.
- Saritas O. & Smith J. (2011) The Big Picture: Trends, drivers, wild cards, discontinuities and weak signals, *Futures* 43(3): 292–312.
- Sahu, S. K., Ohara, T., Beig, G., Kurokawa, J. & Nagashima, T. (2015) Rising critical emission of air pollutants from renewable biomass based cogeneration from the sugar industry in India. *Environmental Research Letters*, 10(9), 095002.
- Scherer, F. M. (1982) Demand-pull and technological invention: Schmookler revisited. *The Journal of Industrial Economics*, 225–237.
- Sharma, A. K., Prakash, B., Sachan, A. & Ashfaq, M. (2015) Inter-and Intra-sectoral Linkages and Priorities for Transforming Sugar Sector of India. *Agricultural Economics Research Review*, 28(Conference), 55–67.
- Tiwari, A. K., Shahbaz, M. & Hye, Q. M. A. (2013) The environmental Kuznets curve and the role of coal consumption in India: cointegration and causality analysis in an open economy. *Renewable and Sustainable Energy Reviews*, 18(5), 519–527.
- Troutman, B. I. & Palombo, R. D. (1983) Identifying Futures Trends in Curriculum Planning. *Educational Leadership*, 41(1), 49.
- UNPD (2009) Climate Change PERSPECTIVES FROM INDIA, http://www.undp.org/content/dam/india/docs/undp_climate_change.pdf, retrieved on 22 Oct, 2017.

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कार्यक्रम वृत्तांत

'10 जनवरी' विश्व हिंदी दिवस के उपलक्ष्य में 21 जनवरी, 2020 को पुण्यश्लोक अहिल्यादेवी होलकर सोलापुर विश्वविद्यालय, सोलापुर भाषा एवं वाङ्मय संकुल, हिंदी विभाग और बैंक ऑफ इंडिया के सयुक्त तत्वावधान में आयोजित 'छात्र संगोष्ठी' विषय- 'भारतीय नागरिकों के मौलिक कर्तव्यों की प्रासंगिकता एवं प्रभाव'। इस संगोष्ठी में विश्वविद्यालय के विभिन्न संकुल तथा महाविद्यालय के छात्र-छात्रों ने हिस्सा लिया और 'भारतीय नागरिकों के मौलिक कर्तव्यों की प्रासंगिकता एवं प्रभाव' इस संगोष्ठी में उपस्थित छात्रों के प्रतिभागियों को कविताओं का भी पठन किया गया। तो कुछ छात्र-छात्राओं ने स्वयं लिखी हुई कविताएँ भी सुनाई। इस कार्यक्रम के लिए अध्यक्ष के रूप में पालि विभाग के प्रा.विजयकुमार झुबरे यह उपस्थित रहे। तो कार्यक्रम की भूमिका डॉ.अनंत वडघणे ने रखी। सूत्रसंचालन प्रा.ममता बोल्ली ने किया।

17 सितम्बर 2019 को 'हिंदी भाषा एवं संस्कृति' इस विषय पर विशेष व्याख्यान का आयोजन किया गया। जिसमें प्रमुख अतिथि के रूप में प्रा.डॉ.भगवान आदटराव, विभागाध्यक्ष, हिंदी विभाग, संतोष भिमराव पाटील महाविद्यालय, मुद्रप उपस्थित रहे हैं। कार्यक्रम की अध्यक्षता प्रा.डॉ. प्रभाकर कोळेकर, संचालक, भाषा एवं वाङ्मय संकुल ने की। कार्यक्रम की भूमिका डॉ. अनंत वडघणे ने रखी तो सूत्रसंचालन प्रा.ममता बोल्ली ने किया। इस कार्यक्रम में भाषा एवं वाङ्मय संकुल छात्र-छात्राओं और अध्यापकों ने हिस्सा लिया।

हिंदी विभाग



वक्तृत्व स्पर्धेत श्वेता झंवर प्रथम

लोकमत न्यूज नेटवर्क

सोलापूर : पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठात हिंदी विभागातर्फे वक्तृत्व स्पर्धा घेण्यात आली. वक्तृत्व स्पर्धेचा विषय 'भारतीय नागरीकां के कर्तव्यों की प्रासंगिकता एवम प्रभावह्व असा होता. या स्पर्धेत हिराचंद नेमचंद वाणिज्य महाविद्यालयाची श्वेता झंवर हिने प्रथम क्रमांक मिळवला.

विद्यापीठाचे वित्त व लेखाधिकारी श्रेणीक शहा यांनी या कार्यक्रमाचे उद्घाटन केले. ते म्हणाले आजच्या काळात संवादाची अतिशय गरज आहे. एकमेकांशी संवाद साधण्यासाठी वक्तृत्व तसेच विविध कार्यक्रमांची, स्पर्धांची गरज असते.

अध्यक्षीय मनोगत व्यक्त करताना डॉ. कोळेकर म्हणाले, कोणताही उपक्रम करण्यासाठी राजाश्रय, लोकाश्रय आणि धनाश्रय मिळतो. तेव्हा या उपक्रमाला एक वेगळी उंची देता येते. प्रमुख पाहुणे म्हणून बँक ऑफ इंडियाचे क्षेत्रीय

प्रबंधक अजय कडू हे उपस्थित होते. कार्यक्रमाला बँक ऑफ इंडियाचे राजभाषा अधिकारी रमेश गच्छी, भाषा संकुलातील प्राध्यापक उपस्थित होते.

उद्घाटनानंतर वक्तृत्व स्पर्धा घेण्यात आली. या स्पर्धेत विविध महाविद्यालयातील विद्यार्थी मोठ्या संख्येने सहभागी झाले होते. स्पर्धेनंतर पारितोषिके वितरित करण्यात आली. पारितोषिक वितरण समारंभाला क्रीडा संचालक डॉ. एस. के. पवार उपस्थित होते. स्पर्धेचा निकाल : या स्पर्धेत श्वेता झंवर प्रथम तर द्वितीय क्रमांक पूजा खपाले (हिराचंद नेमचंद वाणिज्य महाविद्यालय), तृतीय क्रमांक मयुरी वाघमारे (सोलापूर विद्यापीठ अधिविभाग) हिने पटकावला. उत्तेजनार्थ पारितोषिके स्मिता गदगे (सोलापूर विद्यापीठ), उजमा फारुक (सोशल कॉलेज, सोलापूर), शिवराज मिटकरी यांनी मिळवला. कार्यक्रमाचे सूत्रसंचालन डॉ. अनंत वडघणे यांनी केले तर आभार प्रा. गणेश संकपाळ यांनी मानले.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ, सोलापूर

भाषा व वाडमय संकुल, उर्दू विभाग

व

खादीमाने उर्दू फोरम सोलापूर

एक दिवसीय राज्यस्तरीय कार्यशाळा: तर्जुमा निगारी

08.01.2020

बुधवार

अहिल्यादेवी होळकर या उत्तम प्रशासक होत्या त्यांच्या प्रशासनाचा अजेंडा सर्व भारतभर होता भारतात भाषिक विविधता आहे. त्यामुळे त्यांच्यावरील साहित्य हे प्रत्येक भाषेत अनुवादित होणे गरजेचे असल्याचे मत पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठाच्या कुलगुरू डॉक्टर मृणालिनी फडणवीस यांनी व्यक्त केले.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ भाषा व वाडमय संकुल उर्दू विभाग व खादीमाने उर्दू फोरम सोलापूर यांच्या संयुक्त विद्यमाने हा अनुवाद शास्त्र या राष्ट्रीय कार्यशाळे प्रसंगी कुलगुरू डॉक्टर मृणालिनी फडणवीस बोलत होत्या. यावेळी व्यासपीठावर खादीमाने उर्दू फोरम चे सचिव डॉक्टर शफी चोपदार, फोरमचे अध्यक्ष वकार अहमद शेख, वकार कादरी, निजामुद्दीन शेख, भाषा संकुलाचे संचालक डॉक्टर प्रभाकर कोळेकर उपस्थित होते.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ, सोलापूर व खादीमाने उर्दू फोरम यांच्या संयुक्त विद्यमाने तर्जुमा निगारी हे एक दिवशीय राज्यस्तरीय कार्यशाळा घेण्यात आली. या कार्यशाळासाठी सोलापूर विद्यापीठाच्या माननीय कुलगुरू प्राध्यापक डॉक्टर मृणालिनी फडणवीस तसेच प्रमुख उपस्थिती म्हणून खादीमाने उर्दू फोरमचे अध्यक्ष विकार अहमद शेख व उर्दू भाषेचे प्रसिद्ध

अनुवादक उर्दू साहित्य अकादमी महाराष्ट्र चे माजी सदस्य वकार कादरी आ ण भाषा व वाडमय संकुल चे संचालक प्राध्यापक डॉक्टर प्रभाकर कोळेकर, खादीमाने उर्दू फोरमचे सेक्रेटरी व अभ्यास मंडळाचे अध्यक्ष डॉक्टर मोहम्मद शफी चोपदार व भाषा संकुलाचे सर्व प्राध्यापक गण आ ण सर्व वद्यार्थी या कार्यशाळेत उपस्थित होते.

यावेळी प्रमुख पाहुण्यांचा परिचय व खादीमाने उर्दू फोरम ची ओळख करून देताना डॉक्टर मोहम्मद शफी चोपदार म्हणाले की उर्दू भाषेच्या वकासासाठी अनेक उपक्रम व कार्यक्रम आ ण कार्यशाळा घेतल्या जातात. खादीमाने उर्दू फोरमच्या कार्याचे उल्लेख करताना डॉक्टर शफी चोपदार म्हणाले गेल्या चार वर्षांपासून शहरात व वध सामाजिक, साहित्यिक व शक्षण संस्था सोबत आश्रा उर्दू दहा दिवसीय उर्दू भाषा संवर्धन कार्यक्रम आयोजित करण्यात आलेला आहे. याचा प्रमुख हेतू उर्दू भाषा साहित्य आ ण उर्दू माध्यम शी निगडीत व वध अडचणी शोधने व त्याचे निराकरण करणे असा आहे. उर्दू साहित्याचे प्रचार व प्रसार करत आहे. तसेच वद्यार्थ्यांमधील लुप्त गुणांना उजागर करून त्यांना स्कॉलर शप देणे शक्षकांना नवीन टेक्नॉलॉजीची जोडणे. उर्दूला वज्ञान, टेक्नॉलॉजी, इतिहास, भूगोल, अर्थशास्त्रशी जोडणे आ ण वद्यार्थ्यांच्या व्यक्तिमत्व वकासासाठी प्रयत्न करणे. अन्य भाषक लोकांना उर्दू शकवणे व उर्दू साहित्य आ ण शक्षा क्षेत्रांमध्ये विशेष प्रा वण्य प्राप्त साहित्यकार यांना आ ण वद्यार्थ्यांना प्रेरणादायी बक्षसे देऊन सन्मान करणे. हा खादीमाने उर्दू फोरमचा उद्देश आहे.

खादीमाने उर्दू फोरमचे अध्यक्ष वकार अहमद शेख यांनी या एक दिवसीय राज्यस्तरीय कार्यशाळा बद्दल माहिती देताना म्हणाले की अनुवादानाची कला वद्यार्थ्यांमध्ये अवगत करण्यासाठी आ ण अनुवाद हे करियर म्हणून निवडण्य हेतू या कार्यशाळे चे आयोजन करण्यात आले आहे. या चर्चासत्रात आपले बित भाषक म्हणून मनोगत व्यक्त करताना वकार कादरी म्हणाले तर्जुमा हे चालू पढीला अत्यंत उपयुक्त आहे. कारण यामुळे नव्या पढीतील लोकांना व वध साहित्य काय आहेत हे माहिती होईल आ ण इतर भाषांचा प्रसारही तर्जुमा करून आपण करू शकतो. वकार कादरी याबद्दल सखोल माहिती देत होते. वकार अहमद शेख हे आपल्या मनोगतात म्हणाले की कोणत्याही भाषेने इतर भाषेतील शब्द सामावून घेतले तर ती भाषा समृद्ध होते अनुवादातून भाषा जवळ येतात. या साहित्य व्यवहारातून वेगवेगळे भाषक लोक जवळ येतात व त्यातून राष्ट्रीय एकात्मता टिकवली जाते असे त्यांनी नमूद केले त्यानंतर प्र सद्ध अनुवादक वकार कादरी यांनी अनुवादाचे महत्त्व अधोरे खत केले.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर वद्यपीठाच्या माननीय कुलगुरु डॉक्टर मृणा लनी फडणवीस यांनी खादीमाने उर्दू फोरम यांच्याशी चर्चा करताना अशी इच्छा व्यक्त केली की

त्यांनी अहिल्यादेवी होळकर यांच्या जीवन चरित्राचा उर्दू मधून अनुवाद करावा. ज्यामुळे उर्दू व इतर भाषेतील वदयार्थ्यांना अहिल्यादेवी होळकर यांच्या आयुष्याची माहिती वदयार्थ्यांपर्यंत पोहोचवता येईल. तसेच उर्दू व इतर भाषांचे प्रसार होणे गरजेचे आहे. वदयापीठाचे प्राध्यापक डॉक्टर प्रभाकर कोळेकर म्हणाले उर्दू व मराठी भाषेच्या अनुवादाची ही एक मोठी कार्यशाळा संपन्न झाली आहे.

कार्यक्रमाच्या अध्यक्ष प्राध्यापक डॉक्टर मृणा लनी फडणवीस कुलगुरू सोलापूर वदयापीठ सोलापूर यांनी खादीमाने उर्दू फोरम सोलापूर यांच्यासोबत सामंजस्य करार करण्याचेही घोषित केले. त्यांनी खादीमाने उर्दू फोरम कडून अनुवादासाठी जास्तीत जास्त प्रयत्न व्हावे अशी आशा व्यक्त केली.

प्रमुख पाहुणे वकार कादरी माजी सदस्य उर्दू साहित्य अकादमी महाराष्ट्र यांनी तर्जुमा कसे करावे त्याचे महत्त्व व तर्जुमा शकण्यासाठी व वध सूत्रे सांगतली. तसेच वेगवेगळे शब्द प्रयोग करून दाखवले. त्यांनी स्वतः खूप पुस्तकांचे अनुवाद केलेले असून त्यांचे अनेक पुस्तके व साहित्य वाचकांसाठी उपलब्ध करून दिली आहेत. या तर्जुमा मधून कंवा अनुवादातून समाजात जागृती निर्माण करण्याचे मोठे कार्य केलेले असून अजूनही अनुवादाचे खूप सारे मार्ग मोकळे आहेत असे ते म्हणाले.

कार्यक्रमाच्या अध्यक्ष प्राध्यापक डॉक्टर मृणा लनी फडणवीस कुलगुरू सोलापूर वदयापीठ सोलापूर यांनी खादीमाने उर्दू फोरम सोलापूर यांच्यासोबत सामंजस्य करार करण्याचेही घोषित केले. त्यांनी खादीमाने उर्दू फोरम कडून अनुवादासाठी जास्तीत जास्त प्रयत्न व्हावे अशी आशा व्यक्त केली.

कार्यक्रमाचे सूत्रसंचालन सोलापूर वदयापीठाच्या भाषा व वाङ्मय संकुलाच्या प्राध्यापक आयेशा पठाण ने केले तर आभार डॉक्टर सुमय्या बागबान यांनी मानले. यावेळी डॉक्टर शफी चोपदार, नजीर मुनशी, श्रीरामपूर हुन आलेले प्रमुख पाहुणे मोहम्मद उमर बागबान सर व त्यांच्या समवेत उर्दू वभागाचे वदयार्थी आण भाषा व वाङ्मय संकुलाचे सर्व वर्षांचे प्राध्यापक गण इत्यादींनी ही कार्यशाळा यशस्वी करण्यासाठी प्रयत्न केले.





आरोग्य केंद्र

दि.५/६/२०१८

विषय: एक्युप्रेसर प्रशिक्षण शिबीर आयोजित करण्यास प्रशासकीय मान्यता मिळणेबाबत

सादर,

उपरोक्त विषयास अनुसरून मा.कुलगुरू महोदय यांच्या दालनात झालेल्या चर्चेनुसार मा.कुलगुरू महोदयांनी विद्यापीठातील तसेच विद्यापीठाशी संलग्नित सर्व महाविद्यालये यांच्यातील सर्व विद्यार्थी, शिक्षक व शिक्षकेतर कर्मचारी तसेच सोलापुरातील नागरिक यांच्या करता विद्यापीठामार्फत एक्युप्रेसर प्रशिक्षण शिबीर आयोजित करण्याचे निर्देश दिलेले होते. यासाठी त्यांनी श्री.पराग कुलकर्णी (एक्युप्रेसर तज्ञ, नागपूर) यांचे नाव सुचविलेले असून त्यांचाशी संपर्क केला असता त्यांनी २ आठवड्यांच्या प्रशिक्षण शिबीर कार्यक्रमाचा आराखडा पाठविलेला आहे. सदर आराखडा अवलोकनी घ्यावा. या आराखड्यानुसार श्री.पराग कुलकर्णी व त्यांचे एक सहकारी अशी दोन जण या.दि.२ जुलै ते दि. १५ जुलै असे २ आठवड्यांच्या कालावधीत शिबिरात प्रशिक्षण देणार आहेत. सदर प्रशिक्षण शिबिराची सुरुवात दि. २ जुलै रोजी श्री.पराग कुलकर्णी यांच्या व्याख्यानाने होईल. हे व्याख्यान हे विद्यापीठाच्या सभागृहात आयोजित करावायचे आहे. या व्याख्यानासाठी व्याख्यात्यांचे मानधन व सत्कार या पोटी अंदाजे रु.१५००० (व्याख्यात्यांचे मानधन, प्रवास खर्च, २ आठवड्यांचा जेवण खर्च इत्यादी) इतका खर्च अपेक्षित आहे. सदर व्याख्यान हे सर्व विद्यार्थी, शिक्षक व शिक्षकेतर कर्मचारी तसेच सोलापूर शहरातील सर्व नागरिक यांच्यासाठी खुले असेल. तसेच सदर व्याख्यान झाल्यानंतर २ आठवड्यांच्या प्रशिक्षण शिबिराची सुरुवात होणार असून सदर शिबीर विद्यापीठ आरोग्य केंद्रात आयोजित करण्यात येणार आहे. सदर प्रशिक्षण शिबीर हे सशुल्क ठेवून विद्यार्थ्यांसाठी रु.५०० तर इतर इच्छुकांसाठी रु.१००० इतके शुल्क आकारणे योग्य राहिल असे वाटते.

सबब,

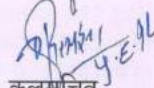
१. दि.२-१५ जुलै या कालावधीत विद्यापीठात सशुल्क एक्युप्रेसर प्रशिक्षण शिबीर आयोजित करण्यास प्रशासकीय मान्यता मिळावी.
२. दि.२ जुलै रोजी विद्यापीठ सभागृहात श्री.पराग जोशी यांचे उद्घाटनपर व्याख्यान आयोजित करण्यास मान्यता मिळावी.
३. सदर व्याख्यान आयोजित करण्यासाठी येणारा अंदाजे रु.१५००० इतका खर्च आरोग्य केंद्राच्या Health Camp/Lecture Expenses या बजेट हेड मधून करण्यास प्रशासकीय मान्यता मिळावी.
४. सदर प्रशिक्षण शिबिराची माहिती सर्व महाविद्यालयांना पत्र पाठवून कळविण्यास मान्यता असावी.

बजेट हेड- Health Camp/Lecture Expenses

तरतूद- रु.५००००

पुढील आदेशार्थ सादर,

१२/६
२६/६/२०१६
वैद्यकीय अधिकारी


कुलसचिव

५००००
५००००
५-६-२०१६
मा.कुलगुरु



सोलापूर विद्यापीठ, सोलापूर परिपत्रक

प्रस्तुत विद्यापीठातील सर्व शिक्षक, प्रशासकीय अधिकारी, कर्मचारी, विद्यार्थी व विद्यार्थिनी यांना आदेशान्वये कळविण्यात येते की, विद्यापीठ कौशल्य विकास केंद्र व विद्यापीठ आरोग्य केंद्र यांच्या संयुक्त विद्यमाने दि.०२/०७/२०१८ ते १५/०७/२०१८ या कालावधीमध्ये एक्यूप्रेशर चिकित्सा पध्दती या विषयावर प्रशिक्षण शिबीर विद्यापीठातील आरोग्य केंद्र येथे आयोजित केले आहे. सदर प्रशिक्षण देण्यासाठी नागपूर येथील प्रसिध्द एक्यूप्रेशर तज्ञ श्री. पराग कुलकर्णी व त्यांचे सहकारी हे उपस्थित राहणार आहेत.

सदर शिबीराची सुरुवात दि.०२/०७/२०१८ रोजी श्री. पराग कुलकर्णी यांच्या व्याख्यानाने होणार असून सदर व्याख्यान विद्यापीठ सभागृहात सकाळी ११:०० वा. आयोजित करण्यात आलेले असून व्याख्यान सर्वांसाठी खुले आहे. दिनांक ०३/०७/२०१८ पासून प्रत्यक्ष प्रशिक्षण शिबिरास सुरुवात होणार आहे. प्रशिक्षण शिबिर हे सशुल्क आहे त्याची माहिती खालील प्रमाणे आहे.

- १) विद्यार्थ्यांकरिता शिबिरासाठी नोंदणी शुल्क रु.५००/-
- २) शिक्षक व प्रशासकीय अधिकारी / कर्मचारी यांच्यासाठी नोंदणी शुल्क रु.१०००/-
- ३) प्रशिक्षण शिबिर पूर्ण करणाऱ्यांना सोलापूर विद्यापीठ कौशल्य विकास केंद्रमार्फत प्रमाणपत्र देण्यात येईल.
- ४) विद्यापीठातील शिक्षक व प्रशासकीय अधिकारी/कर्मचारी यांना सदर प्रशिक्षण शिबिरासाठी नाव नोंदणी करावयाचे आहे त्यांनी दि.२५/०६/२०१८ पर्यंत वैद्यकीय अधिकारी डॉ. अभिजित जगताप (संपर्क क्र.९७३०९०५९६९) अथवा सहायक कुलसचिव डॉ. शिवाजी शिंदे (संपर्क क्र.९३७०६२९४७५) यांच्याकडे स.१०:२० ते संध्या. ६:०० या वेळेत नोंदणी करावी.
- ५) प्रशिक्षण शिबिराचे वेळापत्रक व माहिती सोबत जोडले आहे.

जा.क्र. सोविसो/आस्था/२०१८/ 5195

दिनांक : 21 JUN 2018

प्रति,

- १ सर्व प्रशासकीय विभाग प्रमुख, प्रस्तुत विद्यापीठ
- २ सर्व शैक्षणिक विभाग प्रमुख, प्रस्तुत विद्यापीठ
- ३ नोटीस बोर्ड

सदर परिपत्रक आपल्या विभाग/संकुलातील सर्व शिक्षक, प्रशासकीय अधिकारी, कर्मचारी व विद्यार्थ्यांच्या निदर्शनास आणून द्यावे.


कुलसचिव

कृपया सर्वोच्च नोटीस बोर्ड शिवाजी शिंदे

Inward No :- 2996
+ Jr. Clerk
21 JUN 2018
DIRECTOR
Asst. Registrar Dy. Registrar

सोलापूर विद्यापीठ कौशल्य विकास केंद्र व आरोग्य केंद्र यांच्या संयुक्त विद्यमाने आयोजित

एक्यूप्रेसर प्रशिक्षण शिबीर

कालावधी - दि.२ ते १५ जुलै २०१८

प्रशिक्षक : श्री.पराग कुलकर्णी (नागपूर)

Time Table of Acupressure Training Program				
Date	Program	Timing	Venue	Participant
2 nd July 2018	Introductory Lecture on Acupressure	11.00 am	University Auditorium	Open to all
3 rd July 2018	History & Introduction to Acupressure	Morning Afternoon	University Health Centre	Registered Candidates
4 th to 6 th July 2018	Reflexology	Morning Afternoon	University Health Centre	Registered Candidates
7 th July 2018	Basics of Acupressure	Morning Afternoon	University Health Centre	Registered Candidates
8 th to 14 th July 2018	Meridianology	Morning Afternoon	University Health Centre	Registered Candidates
15 th July 2018	Epilogue Session & Certificate Distribution	11.00 am	University Auditorium	

Registration Details:

Fees: Rs.500 for all students (Identity Card or Bonafied Certificate is necessary)

Rs.1000 for teaching, non teaching staff and outside common people

Contact Details for Registration:

Name	Designation	Mobile Number	Email
Dr. Abhijeet Jagtap	Medical Officer	9730105961	ahjagtap@sus.ac.in
Dr. Shivaji Shinde	Asst. Registrar	9370621475	snshinde@sus.ac.in



कौशल्य विकास केंद्र व आरोग्य केंद्र
सोलापूर विद्यापीठ, सोलापूर
आयोजित



एक्यूप्रेशर चिकित्सा पद्धती प्रशिक्षण शिबीर

दि. २ जुलै ते १५ जुलै २०१८

स्थळ : आरोग्य केंद्र सोलापूर विद्यापीठ

सदर शिबीरामध्ये तज्ञ मार्गदर्शकांद्वारे एक्यूप्रेशर चिकित्सा पद्धतीचे शास्त्रशुद्ध प्रशिक्षण देण्यात येणार असून प्रशिक्षण पूर्ण करणाऱ्या व्यक्तींना सोलापूर विद्यापीठ कौशल्य विकास केंद्राकडून प्रमाणपत्र देण्यात येणार आहे. सदर शिबीराबाबतची विस्तृत माहिती सोलापूर विद्यापीठाच्या <http://su.digitaluniversity.ac/> या संकेतस्थळावर "कौशल्य विकास केंद्र" या शीर्षकांतर्गत उपलब्ध आहे. सदर प्रशिक्षणासाठी विद्यार्थ्यांना रु. ५०० तर इतर व्यक्तींसाठी रु. १००० इतके शुल्क असून ज्या इच्छुकांना सदर शिबीरात नाव नोंदवायचे आहे त्यांनी विद्यापीठ वैद्यकीय अधिकारी डॉ. अभिजीत जगताप यांच्याशी ९७३०१०५९६१ अथवा (०२१७-२७४४७७४ - Ext.१२६) या क्रमांकावर संपर्क साधावा.

Acupressure Training Workshop Registration List - 2 to 15 July 2018.

Sr.no.	Name	Age	Sex	Category	Form no.	Receipt no	Amount
1	Gajendragadkar v.j.	58	M	general	1	2790	1000
2	Dhokte M.S.	51	M	nonteaching	2	2877	1000
3	Rokade A.M.	40	F	general	3	4016	1000
4	Chormale P.R.	42	M	nonteaching	4	2853	1000
5	Dr.Mente R.S.	49	M	teaching	5	3117	1000
6	Mehenkar V.N	25	M	student	6	4204	500
7	Shaikh M.M	34	M	naonteaching	7	3263	1000
8	Kolekar A.N.	39	M	nonteaching	8	3262	1000
9	Pawar S.K.	55	M	nonteaching	9	3499	1000
10	Dr.Shah R.M	57	M	general	10	3915	1000
11	Boddu S.J.	49	M	general	11	3916	1000
12	Dr.Patil A.B.	53	M	general	12	3682	1000
13	Dr.Chokakkar K.T.	43	M	nonteaching	13	3681	1000
14	Sartape V.S.	39	F	nonteaching	14	3970	1000
15	Kamble P.A.	21	F	student	15	3796	1000
16	Dr.Shetasandhi M.U.	60	M	general	16	3798	1000
17	Pawar A.B.	39	M	nonteaching	17	3859	1000
18	Dr.Kurde S.V.	32	M	nonteaching	18	4206	1000
19	Aghar G.R.	28	F.	general	19	3929	1000
20	Deshmane S.V.	59	F	general	20	3927	1000
21	Katakdhond R.N.	53	M	teaching	21	4207	1000
22	Upadhye A.D.	58	M	general	22	3926	1000
23	Aher J.D.	37	M	general	23	3933	1000
24	Jawale P.M.	56	M	nonteaching	24	3919	1000
25	Sabale K.K.	55	F	general	25	4423	1000
26	Parekar M.S.	38	F	nonteaching	26	3344	1000
27	Dr.Shinde S.N.	27	M	nonteaching	27	3425	1000
28	Jadhav S.S.	27	F	nonteaching	28	3343	1000
29	Gadmire V.R.	45	F	nonteaching	29	4186	1000
30	Naikwadi F.M.	48	F	nonteaching	30	3408	1000
31	Sawant P.L.	38	F	nonteaching	31	3688	1000
32	Kaladgi A.M.	35	F	nonteaching	32	4049	1000
33	Dr.Vhankade P.G.	35	M	teaching	33	3923	1000
34	Dr.Kolekar P.N.	37	M	teaching	34	3922	1000
35	Dr.Gadhve R.A.	35	M	teaching	35	3974	1000
36	Bombdya D.Y.	33	M	nonteaching	36	3981	1000
37	Tate N.N.	37	M	nonteaching	37	3979	1000
38	Sonkamble N.Y.	43	M	nonteaching	38	3980	1000
39	Patthan J.R.	39	M	nonteaching	39	3982	1000
40	Paskanti G.S.	48	M	general	40	4067	1000
41	Harwalkar K.A.	39	F	general	41	4065	1000
42	Meharkar S.N..	48	F	general	42	4063	1000
43	DR.Malji U.P.	37	M	general	43	4061	1000
44	Bugde U.S.	58	M	general	44	4072	1000
45	Rathod K.V.	31	M	general	45	4070	1000
46	Gade A.S.	43	M	general	46	4181	1000
47	Kavhekar V.R.	62	M	general	47	4060	1000
48	Vadavrao S.S.	40	F	nonteaching	48	4112	1000
49	Dr.Kulkarni R.P.	41	M	general	49	4187	1000

51	Pawar M.V.	46	F	general	51	4069	1000
52	Joshi A.M.	44	M	general	52	4073	1000
53	Deshpande S.S.	65	F	general	53	3930	1000
54	Neel A.B.	33	F	nonteaching	54	4048	1000
55	Dalvi B.P.	70	M	general	55	3924	1000
56	Tabbasum L.A.	32	F	general	56	3951	1000
57	Bharate J.V.	34	M	general	57	3940	1000
58	Gadad S.S.	41	F	general	58	4183	1000
59	Adakul R.S.	50	F	general	59	4066	1000
60	Rajaram S.K.	36	F	general	60	4131	1000
61	Belure S.Y.	19	F	general	61	4205	1000
62	Khapale R.U.	40	M	nonteaching	62	4229	1000
63	Joshi J.D.	62	M	general	63	4326	1000
64	Adakul P.S.	23	M	student	64	4059	500
65	Hulle A.M.	19	F	student	65	4121	500
66	Sakhare S.V.	59	M	general	66	3928	1000
67	Kadam L.S.	54	M	nonteaching	67	4003	1000
68	Swami R.U.	28	M	general	68	4039	1000
69	Gujjeti B.T.	32	M	general	69	4068	1000
70	Ankad S.S.	26	M	general	70	4037	1000
71	Koravi C.M.	29	M	nonteaching	71	4038	1000
72	Adakul S.S.	52	M	general	72	4071	1000
73	Boddu U.B.	41	M	general	73	4062	1000
74	Tallare V.M.	33	M	general	74	4064	1000
75	Kodam R.B.	37	M	general	75	4178	1000
76	Dontul B.L.	41	M	general	76	4074	1000
77	Dontul S.B.	19	F	student	77	4058	500
78	Talwar S.T.	21	M	general	78	4424	1000
79	Gade A.A.	27	F	general	79	3934	1000
80	Kalaskar N.S.	19	F	student	80	4120	500
81	Patil V.S.	49	M	nonteaching	81	4011	1000
82	Rathod M.J.	47	M	student	82	3931	500
83	Tarapure S.P.	36	F	nonteaching	83	4300	1000
84	Ankad S.s.	23	M	student	84	4036	500
85	Jadhav A.B.	49	M	nonteaching	85	4209	1000
86	Dr.Gajdhane A.S.	33	M	teaching	86	3975	1000
87	Chippa P.A.	27	F	teaching	87	3976	1000
88	Joshi M.M.	40	F	nonteaching	88	3971	1000
89	Bhaske A.L.	38	M	teaching	89	3973	1000
90	Sonkawade M.M.	38	F	nonteaching	90	3969	1000
91	Dr. Patil M.J.	52	F	teaching	91	3972	1000
92	Bhosle R.R.	50	F	general	94	4014	1000
93	Pandhre D.N.	34	F	nonteaching	95	4015	1000
94	Dr.Mane M.V.	61	F	nonteaching	96	4042 & 4043	1000
95	Nimbalkar D.A.	34	M	nonteaching	97	4013	1000
96	Salunke A.S.	39	F	nonteaching	98	4772	1000
97	DR.Bhosle R.B.	56	M	teaching	99	4034	1000
98	Dr.Lawand A.S.	48	F	teaching	100	4106	1000
99	Bhadule S.D.	42	M	nonteaching	101	4199	1000

91.000
3.500
97.500



Acupressure Training Workshop Report

Organized by: Skill Development Centre and Health Centre of Solapur University

Duration: Two weeks, starting from 2nd July upto 15th July 2018

Trainer: Mr. Parag Kulkarni Acupressure Expert (PKAT Nagpur)

Mr. Bhawtik Joshi Acupressure Trainer Nagpur

Coordinator: Dr. Abhijeet Jagtap – Medical Officer Solapur University

Aims & Objectives:

1. To introduce the acupressure related diagnostic and therapeutic skills to the students.
2. To develop a pool of young aspirant students to pursue advanced training in acupressure in future.
3. To enable students to start earning while learning with help of basic acupressure therapeutic skill.

Registration Charges: Rs.500 for all UG/PG students

Rs.1000 for teaching, non teaching staff and common citizens

Summary of the Workshop:

Acupressure training workshop received tremendous response from all the strata of society. Total 100 individuals registered themselves for the workshop. As many as 7 doctors, 3 yoga teachers, 15 teachers, 12 house wives, 40 non teaching government employees, 8 college students and 5 retired employees were registered for the workshop. Workshop was conducted in 2 batches. One batch was trained in Post Graduate Centre of Solapur University located in the heart of city and another batch was trained in the Health Centre of Solapur University. To enable these registered candidates to gain practical hand on training University started acupressure treatment consultancy in the health centre. Patients were examined and treated on OPD basis in the consulting room.

Outcome:

- Solapur University generated amount of Rs.96000 as registration fees from the registered candidates.
- University earned Rs.32050 as consultancy fees from the OPD patients.
- University created a pool of 100 well trained acupressure experts who can start their own acupressure treatment centre and start their own earning.
- All students gave a positive feedback and made a demand that University should start a proper training course in acupressure of 6month- 1 year duration.

SOLAPUR UNIVERSITY, SOLAPUR



Skill Development Centre

Acupressure Training Workshop

2nd - 15th July 2018

CERTIFICATE

Sr. No. SDW/7/2018 -

This is to certify that Mr./Ms. _____ has
attended and successfully completed **Acupressure Training Workshop** organized by Skill Development Centre,
Solapur University from 2nd - 15th July 2018.

Shri. Parag Kulkarni
Acupressure Trainer

Dr. Abhijeet Jagtap
Workshop Co-ordinator

Prof. Dr. Vikas Patil
O.S.D.
Academic Research & Development

Dr. Mrunalini Fadnavis
Hon. Vice-Chancellor











विद्यापीठ अॅक्युप्रेशर कोर्स सुरू करणार : डॉ. फडणवीस

अॅक्युप्रेशर कार्यशाळेचे समारोप उत्साहात

प्रतिनिधी,
सोलापूर, दि. १६ जुलै -
सोलापूर विद्यापीठ अॅक्युप्रेशरच्या संदर्भात सहा महिन्यांच्या प्रमाणपत्र अभ्यासक्रमासह विविध अभ्यासक्रम सुरू करणार असून सोलापूर हे पुढील काळात अॅक्युप्रेशरच्या संदर्भात ओळखले जावे अशी अपेक्षा कुलगुरु डॉ. मृणालिनी फडणवीस यांनी व्यक्त केली आहे.

विद्यापीठांमध्ये मागील पंधरा दिवसांपासून सुरू असलेल्या अॅक्युप्रेशर कार्यशाळेचा समारोप विद्यापीठाच्या मुख्य सभागृहात संपन्न झाला. याप्रसंगी कुलगुरु डॉ. फडणवीस बोलत होत्या. मंचावर नागपूर येथील प्रसिद्ध अॅक्युप्रेशर तज्ञ पराग कुलकर्णी, विद्यापीठाचे कुलसचिव डॉ. गणेश मंड्रा, विशेष कार्यासन अधिकारी डॉ. व्ही. बी. पाटील, परीक्षा व मूल्यमापन संस्थेचे संचालक बी. पी. पाटील

शेवाळे, वैद्यकीय अधिकारी डॉ. अभिजीत जगताप आदी उपस्थित होते.

पुढे बोलताना कुलगुरु डॉ. फडणवीस म्हणाल्या की, विद्यापीठाने ऑगस्ट २०१८ पासून सहा महिन्यांचा अॅक्युप्रेशर प्रमाणपत्र अभ्यासक्रम सुरू करण्याचा निर्णय घेतला आहे. एक व दोन वर्षांचे अभ्यासक्रम सुरू करण्याबाबत विचार सुरू आहे. मात्र त्यासाठी काही संस्थांसमवेत सामंजस्य करार करून, अभ्यासक्रमांची आखणी करण्यात येईल असे मत व्यक्त केले आहे.

याप्रसंगी प्रातिनिधिक स्वरूपात प्रमाणपत्रांचे वितरणही करण्यात आले. कार्यक्रमाचे सूत्रसंचालन कक्षाधिकारी आनंद पवार यांनी केले. यंत्रणा विश्लेषक प्रशांत चोरमले यांनी आभार मानले. कार्यक्रमास नागरिक, कर्मचारी, व्यावसायिक विद्यार्थी प्रोत्साहन देणारे



यावेळी चंद्र देडिया, श्रीनिवास बोडु, जयंत जोशी, जगन्नाथ भगटे, आरती हुळे, देशमाने, परीक्षा व मूल्यमापन विभागाचे संचालक बी. पी. पाटील आदींनी आपले अनुभव सांगून अॅक्युप्रेशर कार्यशाळेचा केवळ स्वतःलाच नव्हे तर कुटुंबीय आणि इतरांना उपयोग झाला आहे. त्यामुळे आरोग्यावर आणि मनावर सकारात्मक बदल झाल्याचे मनोगत व्यक्त केले.

पुन्हा अॅक्युप्रेशर कार्यशाळा घेतली जाईल

कार्यशाळेस १०० पेक्षा अधिक जणांनी नोंदणी केली. मिळालेल्या उत्सुकते व प्रचंड प्रतिसादांमुळे २ ते १५ जुलै दरम्यान विद्यापीठ परिसरात व शहरातील विद्यापीठ अभ्यासकेंद्रात अशा दोन ठिकाणी वेगवेगळ्या वेळेत कार्यशाळा घेण्यात आली. पराग कुलकर्णी आणि त्यांचे सहकारी भवतिक जोशी यांच्याकडून अॅक्युप्रेशर उपचार घेण्यासाठीही रुग्णांची रोजगारी होत होती. यापुढच्या काळातही अॅक्युप्रेशर कार्यशाळा आयोजित केली जाईल.

— डॉ. अभिजीत जगताप, आरोग्य केंद्र पाठ्य

लोकमत

अॅक्युप्रेशर निरोगी जीवनास उपयुक्त चिकित्सा

पराग कुलकर्णी : सोलापूर विद्यापीठातील १५ दिवसीय कार्यशाळेचे उद्घाटन

लोकमत न्यूज नेटवर्क

सोलापूर : अॅक्युप्रेशर ही संपूर्ण भारतीय व स्वयंचिकित्सा पद्धती असून यामुळे निरोगी जीवन जगणे शक्य होते. या ज्ञानाचा अवलंब प्रत्येक व्यक्ती सहजपणे करू शकते, असे मत नागपूर येथील प्रसिद्ध अॅक्युप्रेशरतज्ञ पराग कुलकर्णी यांनी व्यक्त केले.

सोलापूर विद्यापीठात कौशल्य विकास केंद्राच्यावतीने आयोजित केलेल्या १५ दिवसीय अॅक्युप्रेशर कार्यशाळेच्या उद्घाटनप्रसंगी ते बोलत होते. अध्यक्षस्थानी कुलगुरु डॉ. मृणालिनी फडणवीस होत्या. मंचावर शैक्षणिक संशोधन व विकास विभागाचे विशेष कार्यासन अधिकारी डॉ. व्ही. बी. पाटील, वित्त व लेखा

अधिकारी डॉ. बी. सी. शेवाळे, वैद्यकीय अधिकारी डॉ. अभिजीत जगताप होते. हा उद्घाटन समारंभ सोमवारी सकाळी ११ वाजता विद्यापीठाच्या मुख्य सभागृहात संपन्न झाला.

याप्रसंगी पुढे बोलताना पराग कुलकर्णी म्हणाले, अॅक्युप्रेशर ही भारतात प्राचीन काळात विकसित झालेली चिकित्सा पद्धती आहे. त्याला मर्मविद्या असे नाव आहे. निसर्गापचार पद्धतीचाच हा उपभाग आहे.

कुलगुरु डॉ. फडणवीस आपल्या भाषणात म्हणाल्या की, आजच्या काळात प्रत्येकाच्या जीवनात ताणतणाव खूप आहेत, तसेच विविध व्याधी जडण्याचे प्रमाणही मोठे आहे. अशा काळात औषधांवर अवलंबून

१५ दिवस कार्यशाळा

◆ ही अॅक्युप्रेशर कार्यशाळा ३ ते १५ जुलैदरम्यान चालणार आहे. सोलापूर शहरातील नागरिकांनाही याचा लाभ घेता यावा, यासाठी रंगभवन परिसरातील विद्यापीठ अभ्यास केंद्रात दररोज सकाळी ८ ते १० या वेळेत तर विद्यापीठात दुपारी २.३० ते ४.३० या वेळेत कार्यशाळा होईल.

जगण्यापेक्षा औषधाविना निरोगी जगण्याचा चांगला मार्ग अॅक्युप्रेशर आहे. जवळपास ४० व्याधींसाठी ही चिकित्सा पद्धती उपयोगी सिद्ध झालेली आहे. या चिकित्सा पद्धतीचा अवलंब करून विविध व्याधींपासून मुक्त झालेली अनेक उदाहरणे मी पाहिली आहेत. या चिकित्सा पद्धतीबाबत सोलापूर विद्यापीठातर्फे प्रमाणपत्र अभ्यासक्रमासह एखादा पदवी अभ्यासक्रमही सुरू करता येईल

काय? याचा विचार विद्यापीठ करणार आहे.

प्रारंभी विद्यापीठाचे वैद्यकीय अधिकारी डॉ. अभिजीत जगताप यांनी पाहुण्यांचा परिचय करून दिला. सहायक कुलसचिव डॉ. शिवाजी शिंदे यांनी सूत्रसंचालन केले. कार्यक्रमास व्यवस्थापन परिषद सदस्य, विविध संकुलांचे संचालक, शिक्षक व शिक्षकेतर कर्मचारी, विद्यार्थी, नागरिक मोठ्या प्रमाणात उपस्थित होते.

अॅक्युप्रेसर पद्धतीमुळे निरोगी जीवन शक्य

पराग कुलकर्णी; सोलापूर विद्यापीठात अॅक्युप्रेसर कार्यशाळेचे उद्घाटन

सोलापूर : प्रतिनिधी

अॅक्युप्रेसर ही संपूर्ण भारतीय व स्वयंचिकित्सा पद्धती असून यामुळे निरोगी जीवन जगणे शक्य आहे. याचा अवलंब प्रत्येक व्यक्तीने करावा, असे मत नागपूर येथील प्रसिध्द अॅक्युप्रेसर तज्ज्ञ पराग कुलकर्णी यांनी व्यक्त केले.

सोलापूर विद्यापीठात कौशल्य विकास केंद्रातर्फे अॅक्युप्रेसर कार्यशाळेचे उद्घाटन २ जुलै रोजी सकाळी ११ वाजता विद्यापीठाच्या मुख्य सभागृहात झाले. त्याप्रसंगी ते बोलत होते. कार्यक्रमाच्या अध्यक्षस्थानी कुलगुरु डॉ. मृणालिनी फडणवीस होत्या. व्यासपीठावर शैक्षणिक संशोधन व विकास विभागाचे विशेष कार्यासन अधिकारी डॉ. व्ही. बी. पाटील, वित्त व लेखा अधिकारी डॉ. बी. सी. शेवाळे,

पंधरा दिवसांची कार्यशाळा

सदरची अॅक्युप्रेसर कार्यशाळा ३ ते १५ जुलै २०१८ दरम्यान होईल. शहरातील नागरिकांनाही याचा लाभ घेता यावा, यासाठी रंगभवन परिसरातील विद्यापीठ अभ्यासकेंद्रात दररोज सकाळी ८ ते १० यावेळेत, तर विद्यापीठात दुपारी २.३० ते ४.३० यावेळेत कार्यशाळा होईल. ज्यांना यामध्ये सहभाग घ्यावयाचा आहे, त्यांनी विद्यापीठाचे वैद्यकीय अधिकारी डॉ. जगताप यांच्याशी संपर्क साधावा.

वैद्यकीय अधिकारी डॉ. अभिजित जगताप होते.

पुढे अॅक्युप्रेसर तज्ज्ञ कुलकर्णी म्हणाले, अॅक्युप्रेसर ही भारतात प्राचीन काळात विकसित झालेली चिकित्सा पद्धती आहे. त्याला मर्मविद्या असे नाव आहे. निसर्गोपचार पद्धतीचाच हा एक भाग आहे. अॅक्युप्रेसर चिकित्सा पद्धतीत नेमके काय केले जाते ते स्पष्ट करताना ते म्हणाले, आपले हात आणि

पाय यात काही ठराविक केंद्र असतात. या केंद्रांवर ठराविक पद्धतीने दाब दिला की, अनेक दुखणी कायमची संपुष्टात येतात. यात कुठलाही खर्च नाही. आपण स्वतःच आपला उपचार करू शकतो. विद्यार्थ्यांपासून वृद्धांपर्यंत कोणीही कोणत्याही वयात ही उपचार पद्धती शिकून निरोगी जगण्यासाठी उपयोगात आणता येते. पराग कुलकर्णी यांनी यासंदर्भात प्रात्यक्षिकेही

दाखविली.

कुलगुरु डॉ. फडणवीस म्हणाल्या, आजच्या काळात प्रत्येकाच्या जीवनात ताण-तणाव खूप आहेत. त्यामुळे विविध व्याधी जडण्याचे प्रमाणही अधिक आहे. अशा काळात औषधांवर अवलंबून जगण्यापेक्षा औषधाविना निरोगी जगण्याचा चांगला मार्ग अॅक्युप्रेसर आहे.

विद्यापीठाचे वैद्यकीय अधिकारी डॉ. अभिजित जगताप यांनी पाहुण्यांचा परिचय करून दिला. सहाय्यक कुलसचिव डॉ. शिवाजी शिंदे यांनी सूत्रसंचालन केले. कार्यक्रमास व्यवस्थापन परिषद सदस्य, विविध संकुलांचे संचालक, शिक्षक व शिक्षकेतर कर्मचारी, विद्यार्थी व नागरिक उपस्थित होते.

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विद्यापीठ अॅक्युप्रेसर कोर्स सुरू करणार : डॉ. फडणवीस

अॅक्युप्रेसर कार्यशाळेचे समारोप उत्साहात

प्रतिनिधी,

सोलापूर, दि. १६ जुलै-

सोलापूर विद्यापीठात अॅक्युप्रेसरच्या संदर्भात सहा महिन्यांच्या प्रमाणपर अभ्यासक्रमासह विविध अभ्यासक्रम सुरू करणार असून सोलापूर हे पुढील काळात अॅक्युप्रेसरच्या संदर्भात ओळखले जावे अशी अपेक्षा कुलगुरु डॉ. मृणालिनी फडणवीस यांनी व्यक्त केली आहे.

विद्यापीठामध्ये मागील पंधरा दिवसांपासून सुरू असलेल्या अॅक्युप्रेसर कार्यशाळेचा समारोप विद्यापीठाच्या मुख्य सभागृहात संपन्न झाला. याप्रसंगी कुलगुरु डॉ. फडणवीस बोलत होत्या. मंचावर नागपूर येथील प्रसिध्द अॅक्युप्रेसर तज्ज्ञ पराग कुलकर्णी, विद्यापीठाचे कुलसचिव डॉ. गणेश मंडा, विशेष कार्यासन अधिकारी डॉ. व्ही. बी. पाटील, परीक्षा व मूल्यमापन मंडळाचे संचालक बी. पी. पाटील, वित्त व लेखाधिकारी डॉ. बी. सी.

शेवाळे, वैद्यकीय अधिकारी डॉ. अभिजित जगताप आदी उपस्थित होते.

पुढे बोलताना कुलगुरु डॉ. फडणवीस म्हणाल्या की, विद्यापीठाने ऑगस्ट २०१८ पासून सहा महिन्यांच्या अॅक्युप्रेसर प्रमाणपर अभ्यासक्रम सुरू करण्याचा निर्णय घेतला आहे. एक व दोन वर्षांचे अभ्यासक्रम सुरू करण्याबाबत विचार सुरू आहे. मात्र त्यासाठी काही संस्थांसमवेत सामंजस्य करार करून, अभ्यासक्रमांची आखणी करण्यात येईल असे मत व्यक्त केले आहे.

याप्रसंगी प्रातिनिधिक स्वरूपात प्रमाणपत्रांचे वितरणही करण्यात आले. कार्यक्रमाचे सूत्रसंचालन कक्षाधिकारी आनंद पवार यांनी केले. यंत्रणा विश्लेषक प्रशांत चोरमले यांनी आभार मानले. कार्यक्रमास नागरिक, कर्मचारी, अध्यापक, विद्यार्थी मोठ्या संख्येने उपस्थित होते.



यावेळी चंद्र देहिया, श्रीनिवास बोहु, जयंत जोशी, जगन्नाथ बराटे, आरती व्हडले, देशमाने, परीक्षा व मूल्यमापन विभागाचे संचालक बी. पी. पाटील आदींनी आपले अनुभव सांगून अॅक्युप्रेसर कार्यशाळेचा केवळ स्वतःलाच नव्हे तर कुटुंबीय आणि इतरांना उपयोग झाला आहे. त्यामुळे आरोग्यावर आणि मनावर सकारात्मक बदल झाल्याचे मनोगत व्यक्त केले.

पुन्हा अॅक्युप्रेसर कार्यशाळा घेतली जाईल

कार्यशाळेस १०० पेक्षा अधिक जणांनी नोंदणी केली. मिळालेल्या उत्स्फूर्त व प्रचंड प्रतिसादांमुळे २ ते १५ जुलै दरम्यान विद्यापीठ परिसरात व शहरातील विद्यापीठ अभ्यासकेंद्रात अशा दोन ठिकाणी वेगवेगळ्या वेळात कार्यशाळा घेण्यात आली. पराग कुलकर्णी आणि त्यांचे सहकारी भवनिक जोशी यांच्याकडून अॅक्युप्रेसर उपचार पध्दतीसाठीही रुग्णांची रोज गर्दी होत होती. यापुढच्या काळातही अॅक्युप्रेसर कार्यशाळा आयोजित केली जाईल.

-डॉ. अभिजित जगताप, आरोग्य केंद्र प्रमुख



YASHODHARA
SUPER SPECIALITY HOSPITAL PVT. LTD.



Date: 11/03/2020

To,
The Director,
School of Allied Health Science,
PAH Solapur University
Solapur.

Respected Sir/Madam,

This is to certify that, following student have satisfactorily completed one month internship program in department of Dietetics at, Yashodhara Superspecility Hospital Solapur from 01/01/2020 to 31/01/2020

Thanking You,

Dr. Vijay Desai
Administrator

Dr. B. S. Kolar
Chairman

School of Allied Health Science

Inward No. 86

Date 16/03/2020

Pooja Chik
Clerk

Director

16.3.2020

Director

Clerk

Date

Inward No.

School of Allied Health Science

Student List

Sr. No.	Name of the Students
1	DONGARKAR DEVIKA AJIT
2	GHATE PRATIMA DILIP
3	GADADE VAISHALI BHARATRAO
4	HIRANANDANI KIRAN LAXMANDAS
5	HIREMATH VEENA MALLINATH
6	INGOLE ROHINI SHESHRAO
7	JADHAV MEGHNA GUNVANT
8	JAGTAP HARSHALI MADHUKAR
9	KAKADE MEGHA BHAUSAHEB
10	KALE RUPALI AMBADAS
11	MORE RAJASHRI RAMRAO
12	MALAGE TEJAWINI CHANDRASHEKAR
13	NANAWARE MANJUSHA PRAVIN
14	NANAWARE PRAVIN GANPAT
15	NAVLE DEEPA RAHUL
16	NALLAMANDU NIKHAT RUHI
17	PAWAR SUPRIYA SURESH
18	SHETI SHUBHANGI AJIT
19	SHINDE MOHINI ASHOK
20	SURYAVANSHI ASMITA VIDYADHAR
21	WAWARE ANJALI VASANT

For: Yashodhara Super-Speciality Hospital (P) Ltd.

Dr. Basavaraj S. Kolar



कौशल्य विकास केंद्र
सोलापूर विद्यापीठ, सोलापूर
आयोजित

Therapeutic Nutrition & Dietetics Training Workshop
(पोषण व आहारशास्त्र प्रशिक्षण शिबीर)

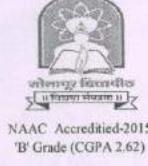


दि.३ ते ९ ऑक्टोबर २०१८

स्थळ: ऑडीटोरीयम, यशोधरा हॉस्पिटल, जिल्हा परिषद जवळ, सोलापूर

सदर शिबिरामध्ये तज्ञ मार्गदर्शकांद्वारे Therapeutic Nutrition and Dietetics (पोषण व आहारशास्त्र)या विषयावर शास्त्रशुद्ध प्रशिक्षण देण्यात येणार असून प्रशिक्षण पूर्ण करणाऱ्या व्यक्तींना सोलापूर विद्यापीठ कौशल्य विकास केंद्राकडून प्रमाणपत्र देण्यात येणार आहे. सदर शिबिराबाबतची विस्तृत माहिती सोलापूर विद्यापीठाच्या <http://su.digitaluniversity.ac/> या संकेतस्थळावर "कौशल्य विकास केंद्र" या शीर्षकांतर्गत उपलब्ध आहे. सदर प्रशिक्षणासाठी विद्यार्थ्यांना रु.२५० तर इतर व्यक्तींसाठी रु.७५० इतके शुल्क असून ज्या इच्छुकांना सदर शिबिरात नाव नोंदवायचे आहे त्यांनी विद्यापीठ वैद्यकीय अधिकारी डॉ.अभिजित जगताप यांच्याशी ९७३०१०५९६१ अथवा (०२१७-२७४४७७४ -Ext.२२८) या क्रमांकावर संपर्क साधावा.





सोलापूर विद्यापीठ, कौशल्य विकास केंद्रामार्फत आयोजित
थेरपेटिक न्यूट्रीशन व आहारशास्त्र प्रशिक्षण शिबीर

दि. ३ ते ९ ऑक्टोबर, २०१८

स्थळ:- ऑडीटोरीयम, यशोधरा हॉस्पिटल, जिल्हा परिषद जवळ, सोलापूर

वेळ: सकाळी ८:०० ते १०:३०

थेरपेटिक न्यूट्रीशन हे अन्नाशी संबंधित शास्त्र आहे. पोषक द्रव्ये, अन्नघटक व पोषकता आणि त्यांचा शरीरावर होणारा परिणाम याचाच अभ्यास या शास्त्रात होतो. अन्नाबाबतीतील प्रत्येक गोष्ट, खाण्यापासून ते त्याचा निचरा होईपर्यंतच प्रत्येक गोष्ट न्यूट्रीशन मध्ये अंतर्भूत आहे. अन्नघटकांचे आरोग्यातील महत्त्व तसेच विविध आजारांमधील पोषण कसे असावे याचा अभ्यास थेरपेटिक न्यूट्रीशन या शास्त्राद्वारे केला जातो.

“आहार शास्त्र” हे योग्य आहार घेण्याची कला शिकवणारे शास्त्र असून विविध वयोगटातील, वेगवेगळ्या परिस्थितीतील लोकांच्या आरोग्य परिस्थितीनुसार व त्यांच्या आहाराच्या व पोषकतेच्या तत्वांचा यामध्ये अभ्यास केला जातो. समतोल आहार हे निरोगी जीवनाचे मूळ आहे. त्यामुळे शरीरप्रकृती चांगली रहाते, व रोगांपासूनही संरक्षण होते.

सोलापूर शहर झपाटयाने वाढत आहे. फास्ट फूड संस्कृती हळूहळू सोलापूर शहरात रूजत आहे आणि अशावेळी चुकीच्या आहारामुळे सामान्य जनतेस मधुमेह, उच्च रक्तदाब अशा लाईफस्टाईल आजारास सामोरे जावे लागत आहे. अशावेळी प्रत्येक व्यक्तीस आहार व पोषण यासंबंधी माहिती असणे गरजेचे आहे. नेमकी हीच गरज ओळखून सोलापूर विद्यापीठ कौशल्य विकास केंद्राने दि. ३ ते ९ ऑक्टोबर, २०१८ या कालावधीत पोषण व आहारशास्त्र या विषयावर प्रशिक्षण शिबीराचे आयोजन केलेले आहे.

सदर प्रशिक्षण सर्वांसाठी खुले असून विशेषतः वैद्यकीय, नर्सिंग विद्यार्थी तसेच शारीरिक शिक्षण प्रशिक्षक यांच्यासाठी उपयुक्त असून सदर प्रशिक्षण शिबिरासाठी विद्यार्थ्यांना रु. २५०/- तर इतर व्यक्तींसाठी रु. ७५०/- इतके नोंदणी शुल्क आकारण्यात येणार आहे. प्रशिक्षण शिबीर पूर्ण करणाऱ्या विद्यार्थ्यांना/व्यक्तींना विद्यापीठ कौशल्य विकास केंद्रामार्फत प्रमाणपत्र दिले जाणार आहे. सदर शिबिरासाठी नाव नोंदणी चालू झालेली असून ज्यांना नाव नोंदणी करावयाची आहे, त्यांनी शिबीर समन्वयक डॉ. अभिजीत जगताप यांच्याशी ९७३०१०५९६१ अथवा (०२१७-२७४४७७४-Ext No-२२८) या क्रमांकावर संपर्क साधावा.





सोलापूर विद्यापीठ ,सोलापूर
शैक्षणिक, संशोधन व विकास
कौशल्य विकासकेंद्र

परिपत्रक

परिपत्रकाअन्वये आपणास कळविण्यात येते की, विद्यापीठ, कौशल्य विकासकेंद्रमार्फत दि.३ ते ९ ऑक्टोबर,२०१८ या कालावधीत थेरेपेटिक न्युट्रीशन व आहारशास्त्र या विषयावर प्रशिक्षण शिबीर आयोजित करण्यात आले आहे. या प्रशिक्षण शिबीरामध्ये सर्व इच्छुक शिक्षक/शिक्षकेत्तर कर्मचारी तसेच विद्यार्थी/विद्यार्थिनी यांना सहभागी होता येईल. सदर प्रशिक्षण सशुल्क असून सहभागी होवू इच्छिणाऱ्या विद्यार्थी/विद्यार्थिनी यांना रू.२५०/- तर इतरांसाठी रू.७५०/- इतके नोंदणी शुल्क आकारण्यात येईल. याबाबत अधिकची माहिती डॉ.अभिजित जगताप,शिबीर समन्वयक यांच्याशी संपर्क साधावा. ज्या शिक्षक व शिक्षकेत्तर कर्मचारी यांना सदर शिबीरास सहभागी व्हायचे आहे त्यांनी आपल्या विभाग प्रमुख/संचालक यांची पुर्व परवानगी घ्यावी जेणे करून विभागातील दैनंदिन कामकाजावर परिणाम होणार नाही.

डॉ.प्रभाकर कोळेकर

समन्वयक
कौशल्य विकासकेंद्र

सोविसो/कौशल्य विकासकेंद्र/२०१८/ ८३५९

दिनांक:- 25 SEP 2018

स्थळ:-ऑडीटोरीयम,यशोधरा हॉस्पिटल,जिल्हा परिषद जवळ,सोलापूर.

वेळ:- सकाळी ८:०० ते १०:००

कौशल्य विकास केंद्र

दि.१९/०९/२०१८

विषय: Therapeutic Nutrition and Dietetics प्रशिक्षण शिबिराच्या आयोजनाबाबत

सादर,

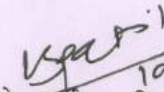
उपरोक्त संदर्भित विषयास अनुसरून विद्यापीठ कौशल्य विकास केंद्रामार्फत दि.३ ते ९ ऑक्टोबर २०१८ या कालावधीत Therapeutic Nutrition and Dietetics या विषयावर प्रशिक्षण शिबीर आयोजित केले आहे. सदर शिबीर हे विद्यापीठाशी संलग्नित विविध संस्थामधील पॅरामेडिकल अभ्यासक्रमांच्या विद्यार्थ्यांसाठी उपयुक्त असल्याने सर्व संस्थाना त्यांच्या विद्यार्थ्यांना सदर शिबिरासाठी नावनोंदणी करण्याच्या सूचना दिलेल्या आहेत. सदर प्रशिक्षण शिबीर शहरातील मध्यवर्ती ठिकाणी ठेवल्यास सदर शिबिरासाठी नाव नोंदणी करण्यास चांगला प्रतिसाद मिळेल असे वाटते. या संदर्भात मा.कुलगुरू महोदय यांच्या परवानगीने सोलापूर शहरातील यशोधरा सुपर स्पेशालिटी हॉस्पिटल यांच्याशी संपर्क केला असता त्यांनी त्यांच्या सभागृहात सदर शिबीर आयोजित करता येऊ शकेल असे सांगितले आहे. सदर प्रशिक्षण शिबिर यशोधरा हॉस्पिटल येथे आयोजित करून शिबिराच्या समारोपाचा कार्यक्रम विद्यापीठाच्या मुख्य सभागृहात कारणे उचित राहिल असे वाटते.

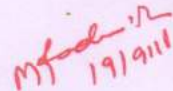
सबब दि.३ ते ९ ऑक्टोबर २०१८ या कालावधीत Therapeutic Nutrition and Dietetics या विषयावरील प्रशिक्षण शिबीर यशोधरा सुपरस्पेशालिटी हॉस्पिटल सोलापूर यांच्या सभागृहात आयोजित करण्यास प्रशासकीय मान्यता असावी.

शिबीर समन्वयक


समन्वयक

कौशल्य विकास केंद्र


19-9-2018
विशेष कार्यासन अधिकारी
शैक्षणिक संशोधन व विकास


19/9/18
मा.कुलगुरू

199/285

कौशल्य विकासकेंद्र

दि. २७/०९/२०१८

विषय:- Therapeutic Nutrition and Dietetics प्रशिक्षण शिबीराची द्वितीय बॅच सुरू करण्यास प्रशासकीय मान्यता मिळणेबाबत.

सादर,

उपरोक्त विषयास अनुसरून कौशल्य विकासकेंद्रमार्फत दि.३ ते ९ ऑक्टोबर, २०१८ या कालावधीत Therapeutic Nutrition and Dietetics या विषयावरील प्रशिक्षण शिबीराचे आयोजन यशोधरा सुपरस्पेशलिटी हॉस्पिटल, सोलापूर येथे करण्यास मा.कुलगुरू महोदय यांनी दि.१९/०९/२०१८ रोजीच्या टिपणी अन्वये मान्यता दिलेली आहे.

मा.प्राचार्य, आर.वाय.पाटील, कॉलेज ऑफ फार्मसी, जुळे सोलापूर येथील विद्यार्थ्यांचा प्रतिसाद पाहता त्यांच्या विद्यार्थ्यांसाठी सदर प्रशिक्षण शिबीर दि.३ ते ९ ऑक्टोबर, २०१८ या कालावधीत संबंधित कॉलेज मध्ये दुपारी ४ ते ६ या वेळेत आयोजित करण्यात यावे अशी विनंती केली आहे.

कॉलेज ऑफ फार्मसी येथे प्रशिक्षण शिबीर दि.३ ते ९ ऑक्टोबर, २०१८ या कालावधीत संबंधित कॉलेज मध्ये दुपारी ४ ते ६ या वेळेत द्वितीय बॅच सुरू केली तर प्रशिक्षकांचे वाढीव मानधन करण्यासाठी खालीलप्रमाणे खर्च अपेक्षित आहे.

अ.क्र.	बाब	तपशील	अपेक्षित अंदाजे खर्च
१	प्रशिक्षकाचे वाढीव मानधन	रु.१००० प्रति सेशन X ७ दिवस	रु.७०००/-
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सबब,

१.सदर प्रशिक्षण शिबीरसाठी द्वितीय बॅच कॉलेज ऑफ फार्मसी येथे दि.३ ते ९ ऑक्टोबर, २०१८ या कालावधीत दुपारी ४:०० ते ६:०० या वेळेत घेण्यास मान्यता असावी.

२.सदर प्रशिक्षण शिबीरसाठी वाढीव मानधन व इतर खर्च मिळून रु.१००००/- खर्चास मान्यता असावी.

लिपिक

डॉ.ए.एच.जगताप
शिबीर समन्वयक

डॉ.प्रभाकर कोळेकर
समन्वयक
कौशल्य विकासकेंद्र

199/285
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मा.कुलगुरूसाठे.

SOLAPUR UNIVERSITY, SOLAPUR



Skill Development Centre

Therapeutic Nutrition & Dietetics Training Workshop

3rd - 9th October 2018



Sr. No. SDW/10/2018 - 294

This is to certify that Mr./Ms. Shaikh Simran A. Jabbar has attended and successfully completed **Therapeutic Nutrition & Dietetics Training Workshop** organized by Skill Development Centre, Solapur University from 3rd - 9th October 2018.

 Dr. Manali Kane Nutrition & Dietetics Trainer	 Dr. Abhijeet Jagtap Workshop Co-ordinator	 Dr. P. N. Kolekar Co-ordinator SDC	 Prof. Dr. Vikas Patil O.S.D. (A R & D)	 Dr. Mrunalini Fadnavis Hon. Vice-Chancellor
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Therapeutic Nutrition and Dietetic Workshop - 3rd - 9th Oct
List of Students. 2018.

Sr. No.	Student Name	Signature
1	Aamtekar Priya Babu	<i>[Signature]</i>
2	Aher Jaysing Dadarao	<i>[Signature]</i>
3	Ajnalkar Pallavi Sanjay	<i>[Signature]</i> N.S.
4	Aken Gopal Sudarshan	<i>[Signature]</i>
5	Anande Babu Shivaji	<i>[Signature]</i>
6	Arkhed Rehanu Riyaz	<i>[Signature]</i> N.S.
7	Atanur Preeti Shridhar <i>gp</i>	<i>[Signature]</i>
8	Atanur Priya Shridhar	<i>[Signature]</i>
9	Atanur Shridhar Sidramappa	<i>[Signature]</i>
10	Atkare Anjali Gautam <i>gp</i>	
11	Awatade Trupti Ramesh	<i>[Signature]</i> ...
12	Bagalkote Zainab Altaf Husain	<i>[Signature]</i>
13	Bagwan Munzareen M. Hanif	<i>[Signature]</i>
14	Bali Pragati Sandeep	<i>[Signature]</i>
15	Bandgar Aditi Ramchandra	<i>[Signature]</i>
16	Bandi Ambadas Krishnashri	<i>[Signature]</i>
17	Bansode Archana Bhimashankar	<i>[Signature]</i>
18	Bansode Sandip Shidaram	<i>[Signature]</i>
19	Bansode Sneha Sanjeev	<i>[Signature]</i>
20	Belpawar Shubhangi Anil	<i>[Signature]</i>
21	Bhaiyya Surbhi Rahul	<i>[Signature]</i>
22	Bhalerao Stefy Robert	<i>[Signature]</i>
23	Bhalerao Supriya Sunil	<i>[Signature]</i>
24	Bhandari Radha Hanmantu	<i>[Signature]</i> N.S.
25	Bhurke Akshay Ravindra	<i>[Signature]</i>
26	Birajdar Naina Dinkar	<i>[Signature]</i>
27	Boddu Venkatesh	<i>[Signature]</i>
28	Boga Deepa Ambadas	<i>[Signature]</i>
29	Chanda Misbah Akhlaque Ahmed	<i>[Signature]</i>
30	Chandramore Vanita Sanjay	<i>[Signature]</i> N.S.
31	Chanmal Mayuri Shrinivas	<i>[Signature]</i>
32	Chavan Swapnil Ratulal	<i>[Signature]</i>
33	Chumalkar Samart Kalpesh	<i>[Signature]</i>
34	Dalal Amruta Rajesh	<i>[Signature]</i>
35	Dalvi Bhagwat Pandhari ✓	<i>[Signature]</i>
36	Dange Poornima Dattatray	<i>[Signature]</i>

37	Davada Manisha Paresh	GP
38	Deshmukh Namita Amol	
39	Dhanwade Manali Shashikant	HB
40	Dhavane Pooja Gahininath	GP
41	Dhawale Pratiksha Milind	Fr MS
42	Dhaware Neha Ramdas	GP
43	Dhonake Kirti Vishwas	GP
44	Dhone Bhujappa Shidappa	GP
45	Dhupargude Visha Prafulla	Fr MS
46	Dhutenavaru Dipali Shrimant	HB
47	Dindore Onkar Arvind	GP
48	Dongaraje Parameshwar Shrishail	HB
✓49	Dr. Bhosale Baban Dada	GP
50	Dr. Hiranandani Kiran L.	GP
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52	Gadagi Vaishnavi Tukaram	GP
53	Gade Akshay Suresh	GP
54	Gaigavali Yashoda Vishal	GP
55	Gaikawad Kirti Sudhakar	Sonneri N.S
56	Gaikawad Shatabdi Arjun	Sonneri N.S
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66	Gharge Swati Dattatraya	GP
67	Ghodake Vanita Annarao	Sonneri N.S
68	Godam Pooja Murlidhar	GP
69	Golekar Anjali Ambadas	Sonneri N.S
70	Golekar Asmita Ambadas	Sonneri N.S
71	Gore Vaidehi Chandrashekhar	GP
72	Gubayad Shivam Shivling	Fr MS
73	Gujale Akanksha Vijaykumar	Akanksha.

74	Gujale Mangal Khajappa	PT MS
75	Gund Shivani Ganesh	OP
76	Gurav Pooja Appasaheb	OP
77	Harhare Swapnil Sunil	Harhare
78	Hattarge Ashwini Shivanand	Ashu
79	Hibare Nitin Ashok	PT MS
80	Hirke Amol Laxman	OP
81	Honamore Dipali Dharappa	HS
82	Honmane Pallavi Dattatray	OP
83	Hotgi Farhat Jahan Iqbal	HS
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86	Jadav Amit Anil	PT MS
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90	Jetithor Surekha Navnath	OP
91	Jirage Siddharam Basvanappa	OP
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107	Kankure Sushmita Satish	OP
108	Kantode Rajaram Laxman	OP
109	Karajagikar Tahsin Hamid	OP
110	Kargule Mamta Prashant	OP

111	Kasabe Nikita Mahalappa	Sule
112	Kasar Mahesh Chandrakant	Mahesh.C. Kasar
113	Katkar Amruta Rajkumar	OP
114	Keshav Amruta Shriniwas	Sule
115	Khairate Rupali Chanabasappa	OP
116	Khalsode Dip Bharat	Pr. OP
117	Khandekar Mallikarjun Raju	MS
118	Khandekar Mayura Rajgopal	OP
119	Khandekar Nikita Santosh	OP
120	Kharadi Saniya Javeed	OP
121	Khare Ashwini Sopan	OP
122	Kirtane Aparna Manikrao	MS
123	Kodam Raju	OP
124	Kokate Priti Chandrakant	OP
125	Koli Jayashree Balbheem	Sule
126	Koli Priyanka Vitthal	Sule
127	Koli Rajashree Sunil	Sule
128	Koli Shrutika Ashok	MS
129	Koli Vidya Sunil	Sule
130	Kore Louis Anil	MS
131	Kore Rupali Shivsharan	Rupal
132	Korwan Mansi Sidharud	OP
133	Kshirsagar Amita Pandurang	OP
134	Kshirsagar Manisha Krushnant	OP OP
135	Kumbhar Shambhuling Sudhakar	MS
136	Kumbhar Vidyashree R.	OP
137	Lakhade Rahul Dhondiba	OP
138	Lamkane Punam Rajkumar	OP
139	Lamkane Sanam Suresh	OP
140	Lasure Akshata Bharat	OP
141	Limaye Mukund S.	Limaye.mf
142	Lokhande Snehal Shrikant	MS
143	Londhe Abhijeet Hemchandra	MS
144	Magar Vaibhav Vishnu	MS
145	Mahule Shweta Ramesh	MS
146	Maisur Vaishnavi Krishnahari	OP
147	Mandal Aarup Anup	Pr. OP

148	Mandolikor Shruti Shankar	GP
149	Mane Karuna Vilas	GP
150	Mane Poonam Shankar	HB ⁱⁱ
151	Mane Pratiksha Dhananjay	GP
152	Mane Renuka Tipanna	for GP
153	Mane Reshma Nagnath	GP
154	Mankuskar Preeti Tulsidas	GP
155	Manlor Vijayalakshmi Siddaram	GP
156	Manthen Mayuri Umakant	GP
157	Mareddi Priti Anand	HB ⁱⁱ
158	Masali Anand Shivsharan	HB ⁱⁱ
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160	Maske Aishwarya Avinash	GP
161	Maske Rupali Margappa	for GP
162	Mehatre Tara Chandappa	GP
163	Mhamane Snehal Sangappa	GP
164	Mhetre Anita Muneppa	for GP
165	Mhetre Laxmi Mareppa ✓	Sonari N.S
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169	More Archana Jeevan	GP
170	More Mamata Devanand	Sonari N.S
171	Moulvi Safwan Akhlaque Ahmed	GP
172	Mulaje Pritee Pandit	GP
173	Mule Krutika Nitin	GP
174	Mulla Samir Nasir	HB ⁱⁱ
175	Mutekar Renuka Mahadev	HB ⁱⁱ
176	Nadaf Ruhinaaz Saleem	HB ⁱⁱ
177	Nannaware Prajakta Vyankat	GP
178	Nashte Akash Nagnath	HB ⁱⁱ
179	Natkar Rohini Bhimasha	Sonari N.S
180	Navindgikar Nikhil Nitin	GP
181	Nikambe Rachana Ramchandra	GP
182	Nilgar Snehal Ashok	GP
183	Ohal Amrapali Dadarao	Sonari N.S
184	Page Hrishikesh V.	GP

185	Pandarkar Sarita Dattatray	GP
186	Pandav Sneha Rajkumar	GP Pandar
187	Pandirolu Sonali Ambadas	Sonali N.S
188	Pansare Meghana Madhusudan	GP
189	Paralkar Mallikarjun Pandurang	
190	Paralkar Sumedh Dhananjay	GP
191	Patel Afsana Kutub	MB
192	Patel Gazala Saifan	GP
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210	Pawar Supriya Suresh	GP
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218	Purad Jagadeshwri S.	GP
219	Rajput Swati Narayansing	GP
220	Rankhambe Preeti Shivputra	GP
221	Rathod Ashwini Gorakhnath	MB

	222	Rathod Manoj Jyotiba	OP HD
	223	Rathod Shashikala Dhanaji	OP
	224	Rathod Shubhangi Kundlik	OP
	225	Reure Priti Revansidha	OP
	226	Saibolu Vedika Shrikant	Sapori N.S
	227	Sajjan Roshani Abraham	Sule
	228	Salar Sana Khaleed	OP
	229	Salgar Megha Hari	OP
	230	Salutagi Vikram Shashikant	HD
	231	Salvade Komal Madhukar	Sule
	232	Sambharambh Manisha Nagnath	HD
	233	Sangepagolu Soni Ambadas	Sapori N.S
	234	Sartape Vaishali Shivraj	Dunlop
	235	Sathe Yuvraj Yashwant	HD
	236	Shaikh Aarzo Ismail	OP
	237	Shaikh Ameena bi Hasansab	HD
	238	Shaikh Amirsohel Moulali	OP
	239	Shaikh Nigarsultana Yunus	HD
	240	Shaikh Ruksar A. Jabbar	HD
	241	Shaikh Shaista Bano Inyat Ali	HD
	242	Shaikh Simran A. Jabbar	Sule
242	243	Shaikh Simran Allabaksha	OP
243	244	Shaikha Parveen Rajahmad	OP
244	245	Shendge Akshada Rajesh	OP
245	246	Shendge Priyanka Prakash	HD
246	247	Shinde Aishwarya Ramakant	OP
247	248	Shinde Bhagyshri Sahebrao	Sule OP
248	249	Shinde Chakuli Tanaji	
249	250	Shinde Geetanjali Ramkrushna	HD
250	251	Shirawar Monika Mallikarjun	OP
251	252	Shivsharan Abhinay Siddharth	HD
252	253 251	Shivsharan Utkarsha Sukhdev	OP
253	254	Singipag Prathmesh Nagraj	
254	255	Sonar Suraj Raju	HD
255	256	Sonkamble (Maske) Pooja Suresh	Sapori N.S
256	257	Sonwane Sonali Naganath	Sapori N.S
257	258	Sugure Priyanka Jagannath	OP

222	Rathod Manoj Jyotiba	<u>OP</u> <u>CLD</u>
223	Rathod Shashikala Dhanaji	<u>OP</u>
224	Rathod Shubhangi Kundlik	<u>OP</u>
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241	Shaikh Shaista Bano Inyat Ali	<u>HB</u>
242	Shaikh Simran A. Jabbar	<u>OP</u>
242	243 Shaikh Simran Allabaksha	<u>OP</u>
243	244 Shaikha Parveen Rajahmad	<u>OP</u>
244	245 Shendge Akshada Rajesh	<u>OP</u>
245	246 Shendge Priyanka Prakash	<u>HB</u>
246	247 Shinde Aishwarya Ramakant	<u>OP</u>
247	248 Shinde Bhagyshri Sahebrao	<u>OP</u> <u>OP</u>
248	249 Shinde Chakuli Tanaji	<u>OP</u>
249	250 Shinde Geetanjali Ramkrushna	<u>HB</u>
250	251 Shirawar Monika Mallikarjun	<u>OP</u>
251	252 Shivsharan Abhinay Siddharth	<u>HB</u>
252	253 25 Shivsharan Utkarsha Sukhdev	<u>OP</u>
253	254 Singipag Prathmesh Nagraj	<u>OP</u>
254	255 Sonar Suraj Raju	<u>HB</u>
255	256 Sonkamble (Maske) Pooja Suresh	<u>Special NIS</u>
256	257 Sonwane Sonali Naganath	<u>Special NIS</u>
257	258 Sugure Priyanka Jagannath	<u>OP</u>

259	Surekar Varsha Sidram	MB
260	Survase Tai Vasant	MB
261	Survase Priti Revansidha	OP
262	Suryawanshi Anuja Anilrao	OP
263	Suryawanshi Kiran Goutam	OP
264	Sutar Aishwarya Prashant	OP
265	Swami Monali Amol	Sule
266	Swami Prashant S.	OP
267	Swami Priti Rajkumar	OP
268	Swami Vidyavati Irayya	MB
269	Tachi Shahista Rafiq	Sule
270	Tallari Venkatesh Mareppa	OP
271	Tamboli Parveen Iqbal	MB
272	Tangsal Sabiha Liyaqat Ali	OP
273	Tate Rutuja Savata	
274	Thakur Rushikesh S.	MB
275	Udanshiv Prachi Sanghmitra	Sule
276	Udansinha Kanchan Surendra	Sule
277	Vadlakonda Nikita Shrinivas	MB
278	Vangunde Laxmi Prakash	OP
279	Vhankade Harshali Vijaykumar	OP
280	Vhatkar Parshuram Mallinath	MB
281	Wadekar Shraddha Santosh	MB
282	Waghchavre Vitthal Mohan	OP
283	Waghmare Ashwini Mahesh	Sule
284	Waghmare Chetana Ramesh	Sule
285	Waghmare Sakshata Vinesh	Sule
286	Waghmode Aishwarya Aappasaheb	OP
287	Waghmode Kiran Vitthal	MB
288	Waghmode Rajashri Suresh	OP
289	Wakade Stuti Steven	MB
290	Wale Laxmikant S.	MB
291	Yadav Geetanjali Srinivas	OP
292	Yamnure Shivraj Anil	Pr MB
293	Zambare Shrinivas Sanjay	Pr MB
294	Zunjar Ankita Nagesh	OP

294 Shaikh Simran A. Jabbar

295	Shinde Tanuja Laxman	
296	Bhos Indira Ganesh	
297	Kulkdhariya Neha G.	
298	Pujari Kiran Kumari B.	
299	Gote Sharmila A.	
300	Shinge Jagannath Saibanna	
301	Kurulkar Aishwarya	
302	Dr. Dantkale Sanjay Baburao	
303	Bhosale Deepak Sopan	
304	Soma Nikhil Govind	
305	Bakle Mayuri Rajendra	
306	Sahastrabudhe Rucha Deepak	
307	Tipe Unnati Sanjay	
308	Ankam Sheetal Giridhar	