“Study of Financial Risk Management in Renewable Energy Sector with reference to Solar Power Projects in India”

Abstract

It is a proven fact that Energy is vital for the economic development of any country. One of the biggest developmental challenges of today is to increase the access to energy services at affordable cost for both productive economic activities as well as domestic use. Due to various pressing reasons the proportion of renewable energy in total energy generation and consumption needs has to be increased substantially. To be more specific, renewable energy now is no more a matter of choice or option. Rather it is the only way to survive. Importance of financing in any change or development or change can hardly be overemphasized. For transition to RE also huge investment is required. Though the growth profile has been impressive, much needs to be done for bridging the gap between the current level of investment and desired level of investment. RE still accounts for small percentage in total energy. Financiers base their decisions on risk return profile of any project. They assess each individual risk and ways of mitigating them.

It has been observed that India's renewable energy sector has been heavily skewed in favor of wind and its solar sector despite of showing abundance potential is under-utilized. One critical Factor identified as coming in the way of development of Solar Power Industry is that there are significant hurdles in the way of arranging finance for solar power projects. Banks and Financial institutions are not yet geared sufficiently to lend to solar projects on decent terms. This study tries to look at the real world problems of Renewable energy Financing. For this solar (PV) has been included for the study. Solar is highly promising but still the most underutilized source within the Renewable Energy basket. This study is a humble attempt to understand the risk related aspects of Debt Financing. Most important aspect of this study is to find out the risk perception of Lenders and Developers and also the perception of lenders regarding effectiveness of available risk management instruments. Following objectives have been set for the study:

1. To study major risks affecting the debt financing for solar power projects.
2. To understand the perception of lenders and developers with reference to vi

selected risks affecting the debt financing.

3. To study the current practices and Instruments of risk management employed in Solar PV Power Projects with reference to selected risks in India.
4. To understand the perception of lenders with reference to the effectiveness of various risk management practices and instruments available and employed for managing selected risks.

Based on the various research studies conducted on the domain areas and also keeping in view the objective of the study, the following hypotheses have been framed and tested.

1. Most critical risk from the perspective of lenders and developers affecting financing is Regulatory Risk.
2. Confidence of lenders in the ability of developers to manage risks varies significantly with risk type

It is a qualitative study based on the perception of developers and lenders. Only 1MW and above grid connected projects for commercial use have been taken into consideration for study purpose. Both primary and secondary data has been used for the study.

Secondary data is obtained from various reports, research articles, books, previous research works conducted, Journals, websites, various working committees reports, five year plan documents. Data bases like EBSCO and Proquest were also referred. Primary data has been collected by means of a Questionnaire from the senior and operational executives working in Developer companies, Banks and Financial Institutions. . A comprehensive literature review has been done to identify various risks affecting the financing of solar power projects and the commonly available tools for managing those risks. Then those common risks are identified which are considered more significant from the perspective of financiers especially debt providers.

MNRE website lists the name of the states of India along with their installed capacity for Solar PV grid connected. From this the researcher identified top 10 states in terms of installed capacity.

Website of the respective renewable energy department of the states along with MNRE and IREDA websites lists the name of developers along with the details of the projects. From this researcher identified 28 companies for collecting data which have plants operating in more than any one of these states on the basis of purposive sampling.

All 28 companies were contacted for data collection, however data could be collected only from 25 companies Though seeing the nature of this sector which is still emerging, it is difficult to come to a conclusion as to the exact number as to the size of the group of developers engaged in solar power production. For the lists of Banks/ FIs similar data is obtained from various government website and also from research papers. For financiers data was collected from 13 banks/FIs after contacting 17 of them.

Processing of data is done using MS Excel. For analysis of data, appropriate tools and techniques such as frequency table, Percentage, Weighted mean, standard deviation, F test, T test, ANNOVA, Correlation etc. are used.

Rating method is used for risk investigation. Frequency table is used for organizing and presenting the frequency of selected variable so as to understand their distribution pattern.

Following are the major findings of the study:

1. Analysis of the secondary literature indicates that the main risks affecting debt financing are Regulatory risk, Construction risk (it includes Time over run and Cost overrun), Counter party risk (Construction contractor and O& M contractor), Finance and Economic Risk, Power off Taker risk, Resource Assessment risk and Force Majeure Risk.

2. In depth analysis based on the primary survey indicates that lenders and developers perceive regulatory risk to be most critical risk followed by Power off taker risk when it comes to financing.

3. Only four out of the 9 identified risks have been experienced by the developers in a major way and they are regulatory risk, finance and economic risk, power off taker risk and also time over run.

4. Close to 40% of respondents feel that their company is extremely successful when it comes to risk identification, whereas this % is substantially low when it comes to other aspects of risk management.

5. Only 7.7% of lenders perceive that companies are extremely successful when it comes to identification of risk and assessment of risk. Close to 70% considering them to be very successful. Weakest area as per lenders is risk transference where none of the lenders are considering companies to be extremely successful and only 7.7% to be very successful. More than 90% of the lenders consider them average and below average and approx. 15.38% to be not at all successful when it comes to risk transfer.

6. Another objective of the study was to understand the current practices and instruments of risk management commonly employed by developers and the perception of lenders with reference to those practices and instruments.

    a. For construction risk almost 92% of developers are using proven technology followed by close 88% are using insurance for risk transfer. Both of these are considered to be quite effective risk management practice.

    b. For counter party risk companies are relying in strictly following due diligence process and are depending on performance bank guarantees and liquidation damages as risk management tools which are also considered effective if measured in terms of risk management score.

    c. For power off take risk around 80% of the developers are rely on bank guarantees followed by good 72% relying on LC which are also perceived to be high on effectiveness rating by lenders in their individual capacity.

    d. For resource assessment risk, almost all the companies are relying on several years data and combining it with ground measured data and only

1/5 of the surveyed companies are relying on captive insurance to handle deviation and less than 10% of the companies are relying on self-insurance for the same. But on effectiveness rating, first measure is considered to be average and the remaining two from poor to very poor.

e. For force majeure risk insurance is the only option available and almost all the companies are using it. It is also rated highly effective with a mean score of 4.38.

f. For Finance and economic risk, almost 80% of the developers are relying on SPV and DSCR with approx. 48% relying on Standard derivative products like hedging etc. and less than 1/5th are using self-insurance and captive insurance. But in terms of effectiveness, standard derivatives products are considered to be more effective and SPV and DSCR are rated just slightly above average based on their mean score.

g. For Regulatory risk, there are no predesigned instruments available in India. More than 80% of developers rely on communication with policy makers. Industrial bodies and regulators to handle the risk and close to 48% rely on statement of assurance from regulators. But both of these are rated only average in terms of effectiveness by lenders

7. 100% financiers feel the need of well-designed FRMs for regulatory risk.

8. Based on the availability of risk mitigating measures and choice of developers as to the practices and usage of risk management tools and instruments, confidence of lenders in the ability of developers varies with the risk type significantly. They are so high on confidence when it comes to construction risk and lowest for power off taker risk.

9. For lenders most significant barriers when it comes to risk management is lack of options, this clearly highlights the need to develop appropriate tool for risk management when it comes to Solar PV projects. Developers feel that they lack information about the magnitude of certain categories of risk. This identifies risk assessment to be a weaker area.

This study proves statistically by means of an empirical research that regulatory risk is the most critical risk bothering financiers and also that the confidence of lenders in the ability of developers to manage risks varies significantly with risk types.

Based on the findings and conclusions of the study researcher suggests a simple risk management mechanism to be applied to solar PV projects for securing financing.

This thesis is organized into the following six chapters: Introduction, Overview of Indian Power Sector and the growing significance of Renewable Energy, Review of Literature, Research Methodology, Data Analysis and Findings and finally Conclusions and Recommendations.

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Chapter 1

Introduction

Chapter1

Introduction

1.1 Prelude

Energy is that basic natural resource which is indispensable for mankind[1].As per Satyanarayana (1989), "Energy is the basic element of human activity and an indispensable input to socio- economic development of a country"[2].

Thus it goes beyond doubt that energy is the key driver of social and economic development of any country. Direct correlation has been established between the per capita energy consumption with the quality of life of citizen. Thus the role of power sector in the development of economy of any country needs no emphasis.

There is an increasing demand of energy to sustain the needs of growing economy worldwide. Increasing awareness of environmental risk coupled with sustainable energy has led to the discussion regarding more and more use of renewable energy. Increasing the investment in renewable energy requires a deep understanding of risk perception of financiers. It is comparatively a new domain and lack of detailed understanding may lead to over estimation of risk and this may ultimately lead to lack of funds and even if available then not on suitable terms affecting the financial viability of the project. For example at present RE projects in India are generally financed for tenure of 10-12 years and at the rate of interest is 12-13%, whereas in Europe and United States, duration of funding is 17-18 years and rate of interest being 4-5 %. Present chapter highlights briefly the trends in renewable energy development, description about common renewable energy technologies and also a brief overview of risk and risk management.

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[1] Odum,H.T, and Odum E.C. (1985), Energy Bases for man and Nature London, Mcgraw Hill Book Company, p7.

[2] Satyanarayana,K., (1989), Visualizing Future Power Demands. Yojana, Vol .XXXIII No. 17, p4.

1.2 The Context

The demand for energy is only increasing year by year globally. Energy can be derived from fossil fuels which are non-renewable and also from renewable sources such as solar, wind, biomass, hydro etc. Presently Fossil fuels are the primary sources of electricity generation globally. Fossil Fuels are depleting fast and it also has severe threatening implications for example, environmental risk such as climate change. Due to growing awareness of environmental risk along with the need of energy source which is sustainable has led to the discussion regarding more and more use of renewable energy.

Increasing the proportion of renewable in power generation is considered very seriously in many countries. Developed countries are interested in renewable based power generation due to environmental reasons whereas for developing countries, reasons are mostly economical. One of the possible solutions to deal with the environmental risk due to increasing energy demand is to immediately consider changing the energy resource portfolio[3].

In all at present there is a severe situation of energy dilemma characterized by:

- Global energy deficit coupled with ever growing population.
- Conventional Technologies are considered to be commercially viable but their increased usage would lead to fast depletion of limited stock coupled with severe environmental problems posed by them like climatic change.
- RE is available in plenty and is environmental friendly, but there are plenty of difficulties in harnessing it to a significant level in terms of finance, technical knowhow suitable policy support especially in developing countries.

[3]Abulfotuh, F. (2007) Energy efficiency and renewable technologies: the way to sustainable energy future. Desalination, 209(1), 275-282.

Various national targets are being set and attempts are made to frame various new policies. For example European Union has set the target of minimum 20% of renewable energy in their total energy consumption by the year 2020[4].

Data clearly shows that global investments in RE has increased substantially over last few years. Investment in RE in 2004 was USD 46.6 billion which has reached around 286 billion USD in 2015 which is six times the value in 2004.[5] Future projections about renewable energy prospects are also very bright. As per IEA (2008)[6], 'Blue Map' Scenario Projections, it is expected that by 2050, total share of renewable will be almost 50% in the total power sector. As per another projection by Green Peace International (2008)[7], it is projected that by 2050, the contribution of renewable energy will be approximately 77% of total electricity generation. They have projected that there will be 3000 times increase in electricity production by solar based technology in comparison to 2005 level. In fact there are plans proposed for powering the world completely with wind, solar and hydro power by the year 2030[8]. All these projections in a way are highlighting one thing for sure that there is an enormous potential in Renewable Energy Technology.

Wind has been the driver of growth in RE since a decade with a major share in RE investment. But Solar today is the fastest growing sector within the RE basket.

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[4]Noothout, P., de Jager, D., Tesnière, L., van Rooijen, S., Karypidis, N., Brückmann, R., Jirouš, F., Breitschopf, B., Angelopoulos, D., Doukas, H. and LEI, I.K. (2016). The impact of risks in renewable energy investments and the role of smart policies. DiaCore project final report work package, 3. Retrieved on 31.03.2016 from www.ecosys.com: www.ecofys.com/files/files/diacore-2016-**impact-of-risk**-in-res-**investments**.pdf*:*

[5]McCrone, A., Usher, E., Moslener, U., Gruning, C., D'Estais, F. (2016). Global Trends in Renewable Energy Investments 2016. United Nations Environment Programme. Retrieved on 25.04.2016 from www.unep.org:http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf.

[6]Birol, F. (2008). World energy outlook. *Paris: International Energy Agency*. Retrieved on 21.12.2014 from http://www.worldenergyoutlook.org/media/weowebsite/2008-1994/weo2008.pdf:

[7]Teske, S., Schaefer, O., Zervos, A., Beranek, J., & Tunmore, S. (2008). *Energy [r] evolution: a sustainable global energy outlook*.

[8]REN21 (2010). Renewables 2010 Global Status Report p. 13-17 Retrieved on 21.12.2014 from http://www.ren21.net/Portals/0/documents/activities/gsr/REN21_GSR_2010_full_revised%20Sept2010.pdf:

But despite the encouraging trend a lot needs to be done to achieve the set targets. Despite the impressive growth profile, renewable energy is still far away from their full potential and the set targets. Even today they account for a small percentage in total energy share. Financing is a key for commercialization of any new technology. For example for meeting the target set by European Union total annual investment to the extent of €60-70 billion is estimated.[9] As per IEA (2010)[10] approximately 6 trillion$ would be required to be invested in RE sector only for meeting emission reduction commitments. As per Sonntag-O-Brien U and Usher (2008)[11], faster growth of Renewable Energy sector is hindered by many Finance related risks. RE projects are typically characterized by relatively high upfront cost and comparatively lower rate of return. This goes against the basic fundamental of finance, high risk, and low return thus making investors unwilling to invest money. This is even more evident in case of developing country which requires almost half of the global investment in RE. For example even in the Indian scenario, government has revised the target of power to be generated from various renewable sources. For solar revised target stands out to be 1,00,000 MW till 2022and the funding required for meeting this target works out to be approximately Rs. 6,00,000 Cr over the next five years[12]. Seeing the quantum of funds, it's imperative for the government to make various changes in its policy of financing.

Following reasons have been stated for the financing problems in renewable energy projects[13]**:**

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[9]De Jager, D., Klessmann, C., Stricker, E., Winkel, T., de Visser, E., Koper, M. & Panzer, C. (2011). Financing renewable energy in the European energy market. Final report by Ecofys, Fraunhofer ISI, TU Vienna EEG and Ernst &Young, Ecofys, Utrecht. Retrieved on 20.12.2014 from https://ec.europa.eu/energy/sites/ener/files/documents/2011_financing_renewable.pdf:

[10]Birol, F. (2010). World energy outlook 2010. International Energy Agency, Retrieved on 19.12.2014 from http://www.worldenergyoutlook.org/media/weo2010.pdf:

[11]Sonntag-O'Brien, V., & Usher, E. (2006).Mobilizing finance for renewable energies. Renewable Energy: A Global Review of Technologies, Policies and Markets, Earthcan, London, 169-195.

[12]www.pib.nic.in

[13]Kulkarni, A. (2010). Report on barriers for solar power development in India. South Asia Energy Unit, Sustainable Development Department, The World Bank. Retrieved on 19.01.2014 from www.esmap.org:https://www.esmap.org/sites/esmap.org/files/The%20World%20Bank_Barriers%20for%20Solar%20Power%20Development%20in%20India%20Report_FINAL.pdf:

1. Large capital cost
2. Low PLF
3. Several policy and regulatory issues.
4. Intermittent nature of power generated.
5. Problems in access to funds/ subsidy from Government.
6. Knowledge barrier about renewable energy technology among financing institutions like banks.

Suitable measures needs to be undertaken to deal with the financing issues in Renewable energy sector.

1.3 Renewable Energy

Renewable Energy basically means energy coming from various natural sources like solar, wind, hydro, biomass etc. All these sources of energy either come directly from sun or indirectly from sun (hydropower, wind, bio energy) and there can be non-solar sources also such as geothermal and tidal.

As per another probably more exhaustive definition, "Renewable Energy is any naturally occurring, theoretically inexhaustible source of energy such as biomass, solar, wind, tidal, wave and hydroelectric power that is not derived from fossil or nuclear fuel"[14].Green Power is basically a subset of Renewable Energy.

Common forms of Renewable Energy: Generally as stated above most of the Renewable Energy originates from the sun, some directly, some indirectly. Following are the common types of renewable energy:

1. **Solar Energy**: It is the energy coming directly from the sun. It is defined as," That source of energy that can be directly attributed to the light of the sun or heat that sun light generates"[15].It is a well-known fact that solar energy potential is about thousand times more than annual energy consumption of the entire mankind.

[14] www.dictionary.com

[15] Bradford, T. (2006). Solar Revolution. The Economic Transformation of the Global Energy Industry. Cambridge, MA: The MIT Press.

There are two active technologies for generating electricity from solar energy:

1. Solar Thermal
2. Solar Photovoltaic(PV)

In Solar thermal, sunlight is concentrated and then the energy is used to generate stem. This in turn is used to run a generator to produce electricity. Working fluid used can be water, nitrogen, salt, helium etc. Various different engine type used can be steam engine, gas turbines etc. They require large open area of land for installing collectors and equipment for collecting solar energy. Approximately 3-4ha of land requirement is estimated for each MW of installed capacity[16].

In Solar Photovoltaic technology, there is a direct conversion of sunlight into electrical energy

Solar PV technology is basically a, "technique of converting radiation from sun into electricity using a semiconductor exhibiting PV effect"[17].

Solar PV application has been divided into following four categories[18]:

1. Off Grid domestic
2. Off Grid Non domestic
3. Grid connected distributed
4. Grid connected centralized

The dominance of PV technology amidst several others RE technology is mainly due to its noiselessness, no toxic emissions and comparatively simple O&M[19].

[16]Sukhatme, S. P. (2011). Meeting India's future needs of electricity through renewable energy sources. Current Science (Bangalore), 101(5), 624-630.

[17]Khare,V.,Nema,S.,& Baredar,P.,(2013).Status of solar wind renewable energy in India Renewable and Sustainable Energy Reviews, 27, 1-10.

[18]Nema, S., Nema, R. K., & Agnihotri,G. (2011). Inverter topologies and control structure in photovoltaic applications: a review. Journal of Renewable and Sustainable Energy, 3(1), 012701

[19]Moosavian, S. M., Rahim, N. A., Selvaraj, J., & Solangi, K. H. (2013).Energy policy to promote photovoltaic generation. Renewable and Sustainable Energy Reviews, 25, 44-58.

2. **Wind Energy**: Here the kinetic energy of the wind is converted into electrical energy. Convection currents of the earth's atmosphere powered by heat coming from the sun causes the wind. Thus this form of energy also originates from the sun though indirectly. The cost of wind energy depends upon the installation costs of wind turbines, interest on capital and on the amount of energy which is produced.

3. **Hydro Energy**: Here the energy of the moving water is converted into electrical energy. There are various ways of harnessing the energy of water for example by creating large scale dams, small hydro projects etc. Hydro energy is generated by using the water cycle of earth for electricity generation.

4. **Bio Energy**: Here the energy is derived from Biomass. Biomass technically means organic matter. It is stated that," Bio energy consists of organic matter derived from trees, plants, crops or from humans, animals, municipals and industrial wastes"[20].

Biomass can be used to produce energy either directly by burning or indirectly by converting into various types of bio fuels. Wood is the largest source of Biomass energy. There are various other sources also of Biomass now for example, Plant, agricultural residues, and also the various components of industrial and municipal waste. Biomass increases the energy diversity. Bio energy can be used for electricity generation, production of heat and even for bio fuel production. Bio energy is carbon neutral. Bio energy can be produced through combustion or through gasification. Generally 2MW or more capacity power plants use combustion to produce electricity whereas small scale power plant produces electricity through gasification.

5. **Geo thermal Energy**: Here the internal heat of the earth is used to produce energy. It is another source of energy which is clean and reliable. It is a source of energy which can be utilized both for on grid and off grid

Following types of plants can be developed for harnessing geo thermal energy:

[20] Meshram, J. R., & Mohan, S. (2007). Biomass power and its role in distributed power generation in India. 25 Years of Renewable Energy in India. Ministry of New and Renewable Energy, New Delhi, 109-134.

1. Flash Stem Plant: This plants are used when temperature at or above 150degree c is available. Here high pressure stem is released from extremely hot water to rotate the turbines.

2. Binary Stem Plant: These Plants are set up when temperature between 100 -150degree C is available. Here heat of geothermal water is transferred to a secondary liquid. It is the vapor from the secondary liquid which is used to rotate the turbines.

3. Dry stem plant: These plants are suitable for those geothermal reservoir which produces stem and very little water.

4. Hybrid Power plant: These plants are used in that geothermal reservoir which produces both boiling water as well as stem. It is a combination of flash and binary power plant.

Renewable Energy based Generation Projects can be divided into following three categories:

1. Grid connected system
2. Off Grid System
3. Decentralized system

Renewable Energy: Advantages and Disadvantages

Following points highlights the advantages of renewable energy:

- Most significant advantage of renewable energy as the name suggests is renewability. It will never run out. It is sustainable whereas the conventional sources like oil, gas, coal are limited in supply and deplete very fast.

- Another significant advantage of renewable energy is their minimal negative effect on the environment. There is minimal or absolutely nil carbon or green house emission. It has been found from the data that there is minimal global warming emission during the entire life cycle of renewable energy

technology[21]. In addition to this no water pollution is caused by wind and solar energy power plants as they do not require any water to operate thereby do not strain the water supply. Whereas the conventional technology significantly affect the water sources by using and polluting the water.

- In addition to above there are significant economic benefits like job creation which are associated with the development of renewable energy technology.
- Renewable energy facilities require less maintenance and operations costs as compared to conventional power plants.
- Development of renewable energy projects can also possibly lead to stability in energy pricing as price of energy in this case is not dependent on changing price of natural resources like coal etc.

Following are the disadvantages of RE:

- They are very site specific. For example, wind energy cannot be installed at all sites because of low wind. However India is blessed to have a huge potential of renewable energy. This disadvantage can be overcome in wide variety of ways for example by combined utilization in a planned manner of various Renewable Energy Sources.
- Another Major disadvantage of renewable energy projects is their high initial capital cost as compared to conventional energy systems. Though there is almost nil fuel cost and low O&M cost, the high ratio of initial capital cost to O&M cost indicates a very high initial burden to be financed over the entire project life making risk exposure a long term challenge.
- Another disadvantage of renewable energy sources is that of low power density (watt/sq. m) as compared to conventional coal based power generation and also nuclear power generation. It is equivalent to 25 W/ Sq. m for solar,

[21] Mitigation, C. C. (2011). IPCC special report on renewable energy sources and climate change mitigation. Retrieved on 12.12.2014 from http://www.uncclearn.org/sites/default/files/inventory/ipcc15.pdf:

approx. 1-2 W/Sq.m for wind as compared to 3000-4000 W/Sq.m for coal and nuclear.[22]

- It is generally observed that large tract of land is required in case of Renewable Energy technology like Solar etc. in comparison to conventional technology involving fossil fuels

1.4 Risk and Risk Management

Meaning of term,' Risk': Risk is something we cannot escape in any business.

There are various definitions of the word 'Risk' which has been given in literature. Risk is stated as," the chance of injury, damage or loss"[23].

Risk is also stated as, "Hazard, chance of a bad consequence, loss, exposure to chance of injury or loss"[24].

Risk is also defined as, "the variation in possible outcomes in a given situation"[25].

In guide to the Project management Body of Knowledge, risk has been defined as, "an uncertain event or condition that if it occurs, has a positive or negative effect on a project objective"[26].

Generally there are three elements in the definition of risk, Consequences (it may be positive or negative), impact on tangible or intangible wealth, probability of an event and the specific context in which risk might occur[27].

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[22] Alam, M., Yasin, S. M., Gain, M., & Mondal, S. (2014). Renewable Energy Sources (RES): An Overview with Indian Context. IJECS Volume 3 Issue 10, Page No.8871-888. Retrieved on 01.12.2015 from http://www.ijecs.in/issue/v3-i10/71%20ijecs.pdf:

[23] www.webster-dictionary.org/

[24] www.oxforddictionaries.com

[25] William, C.A and Heins, M.R. (1976) Management and Insurance; New York, McGraw-Hill Books Co.

[26] PMBOK (2003). A guide to the Project Management body of Knowledge. Project Management Institute. http://www.pmi.org

[27] Renn, O. (2008). Concept of Risk: An interdisciplinary Review. Proceedings of the ISA Conference, Barcelona, September 2008, pp. 3-10.

Rivza S., Pilvere I. (2012) [28] divided the various definitions of risk into following three categories:

1. Definition focusing only on probability without mentioning the possible consequences.
2. Definitions which state consequences, i.e. only positive, only negative, either positive or negative consequence.
3. Definitions combining probability and consequence both.

And they suggested the following definition of risk," Risk is the multiplication of probability of an event occurrence and its significance level of potentially unfavorable consequences".

Risk in relation to investments in Renewable Energy Projects can be described by, "the negative impact which uncertain future events may have on the financial value of a project or investment"[29].Risk is actually the counterpart of upward potential. Risk plays a dominant role in investment decisions as investors are risk averse.

Financial Risk is said to be the, "umbrella terms for different types of risks associated with financing"[30].

The Following definition of risk is especially important for this study, "Risk is uncertainty of loss….. It can be viewed as a Psychological Phenomenon that is meaningful in terms of human reactions and experiences"[31].

Above definition holds special importance for this study as in this definition, risk is

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28Rivza, S., Pilvere, I. (2012). Historical and theoretical aspects of the term "Risk". In Economics Science for Rural Development: Proceedings of the International Scientific Conference, No.27 (Integrated and Sustainable Development). Jelgava: LLU, pp. 210-215ISSN 1691-3078 ISBN 978-9934-8304-0-2

[29]Cleijne, H; Ruijgrok, W. (2004). in Green –X Report titled," Modeling Risks of Renewable Energy Investments" Within the 5th Framework Programme of the European Commission Supported by DG Research.
Retrieved on 21.12.2014 from http://www.green-xat: http://www.green-x.at/downloads/WP2%20-%20Modelling%20risks%20of%20renewable%20energy%20investments%20%28Green-X%29.pdf:

[30]www.**investopedia**.com/

[31]Denenburg, H.S., (1974) Risk and Insurance (2nd ed.), Prentice- Hall Inc., Englewood Cliffs, New Jersey.

viewed as Psychological Phenomenon based on perception which may vary for the individuals or companies.

Risk is generally a term which is used to refer to negative consequence which may be in terms of return uncertainty or probable financial loss. From the review of existing literature, it is observed that the term 'risk' and 'uncertainly' is often used interchangeably. Term 'risk' is generally used when probability of occurrence of each outcome is known whereas the term 'Uncertainty' is used when probability of occurrence of each outcome is unknown.

Risk Management: While the risk is inescapable, its management is extremely important so as to reduce its overall impact. The objective of risk management is to minimize the impact of risk at the least possible cost. Risk management is extremely important to keep the risk within the acceptable limits, if it cannot be completely eliminated.

Risk is said to be, "a multidimensional concept and risk management is a continuous activity"[32].

Risk management is defined as," the process of identifying and evaluating risks and selecting and managing techniques to adapt to risk exposures"[33]. Project Risk Management involves two stages and they are[34]:

1. Risk Assessment
2. Risk Control

Each of the above mentioned stages have various sub steps:

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[32]Godse, V. T. (1996). Conceptual Framework for risk management. IBA Bulletin.18.(7).22-28.

[33]http://www.thefreedictionary.com/

[34]T. Olivier, C.C. Capital, D.N. Veritas.(2004) Scoping Study on Financial Risk Management Instruments for Renewable Energy Projects United Nations Environment Programme. Retrieved on 07.01.2014 from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.114.4465&rep=rep1&type=pdf:

1. Risk Assessment: It includes
    a. Identification of risks
    b. Analysis of risks
    c. Prioritization of risks.
2. Risk Control: There are following four sub steps in this stage:
    a. Risk Mitigation
    b. Risk Planning
    c. Risk Register
    d. Risk Communication protocol.

Risk Management is also defined as, "a systematic approach to identify insurable and non-insurable risks, evaluating the risk of loss versus the cost of insurance and minimizing the possibility of loss through well planned and regularly followed systems and procedure"[35].

Risk Management is an ongoing process or there is a risk management cycle.

There are four basic elements in Risk Management Cycle[36]:

1. Identification of aims and contents
2. Identification of Risk
3. Assessment of Risk and Risk Level
4. And finally the implementation of risk management activities.

Risk monitoring and prevention are to be implemented at all stages of the cycle.

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[35]Evans, D., & Evans, O. W. (2007). The Complete Real Estate Encyclopedia. The McGraw-Hill Companies, Inc. ISBN-13:9780071510233.

[36]Rivza, S., & Rivza, P. (2012).Risk management in renewable energy production. In International Scientific Conference: Renewable Energy and Energy Efficiency, Jelgava (Latvia), 28-30 May 2012. Latvia University of Agriculture. Retrieved on 12.12.2014 from http://agris.fao.org/agris-search/search.do?recordID=LV2012000724:

Financial Risk Management is defined as, "the process of evaluating and managing current and possible financial risk at a firm as a method of decreasing the firm's exposure to the risk. Financial Risk Manager must identify the risk, evaluate all possible remedies and then implement the steps necessary to alleviate the risk"[37].

Financial Risk Management is considered to be a key element in any commercial investment whether it is conventional energy or infrastructure project. But little attention has been given to its use in RE projects especially in developing countries[38].

In Renewable Energy, FRM is considered to be one of the key elements[39].

However even today, there is limited availability of FRM instruments for RE due to various reasons.

At this point it is important to know the specifics of RE Financing. Financing a RE project is quite different from financing a conventional energy project. Keeping in mind the investment decision making process of financiers, first of all, RE financing is an entirely new concept which needs new thinking. This is further compounded by the fact that there are issues of financial structure as well as the fact that RE projects are typically characterized by high upfront cost and lower operational cost. It means that investment cost of majority of renewable energy projects is higher than the conventional projects. For example in case of wind energy project, investment cost is approximately 80% of the total cost, whereas for gas power it works out to be 15% approximately[40]. Thus most of the investment needs to be done before system operationalizes. This increases the investment risk of the project. Now, if the fund

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[37] www.investorwords.com/

[38] T. Olivier, C.C. Capital, D.N. Veritas. (2004) Scoping Study on Financial Risk Management Instruments for Renewable Energy Projects United Nations Environment Programme. Retrieved on 07.01.2014 from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.114.4465&rep=rep1&type=pdf:

[39] Sonntag-O'Brien, V., & Usher, E. (2006) .Mobilizing finance for renewable energies. Renewable Energy: A Global Review of Technologies, Policies and Markets, Earthcan, London, 169-195.

[40] Waissbein, O., Glemarec, Y., Bayraktar, H. & Schmidt, T. S., 2013. Derisking Renewable Energy Investment. A Framework to Support Policymakers in Selecting Public Instruments to Promote Renewable Energy Investment in Developing Countries, New York: United Nations Development Programme. Retrieved on 12.06.2015 from www.undp.org: http://www.undp.org/content/undp/en/home/librarypage/environment-energy/low_emission_climateresilientdevelopment/derisking-renewable-energy-investment.html:

providers perceive the project to be risky, it will lead to increase in cost of capital. Seeing the capital intensive nature of the project, the cost of capital is very crucial element in influencing the financial viability of the projects ultimately affecting the set targets. More ever limited track record of developers increases the risk perception of financiers. RE has to compete with conventional projects for financing and there is a tendency of understating the risk associated with conventional power projects. Cost of capital can be brought down significantly by addressing the risk and its perception[41].

For on grid RE, it is easy to assess the return whereas assessing and managing risk is difficult[42].

Renewable energy drivers have been policy incentives by way of support schemes and also technological improvement[43]. However renewable energy investment risks are also becoming increasing complex and it is extremely important to de risk the project cash flow by ensuring the adequate availability of insurance and other risk management instruments for ensuring the growth of renewable energy in a sustainable manner[44].

1.5 Framework of the Thesis

This thesis is organized into the following six chapters:

Chapter1: Introduction: In this chapter, the fundamental concepts related to renewable energy, risk, risk management etc. have been discussed.

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[41]Noothout, P., de Jager, D., Tesnière, L., van Rooijen, S., Karypidis, N., Brückmann, R., Jirouš, F., Breitschopf, B., Angelopoulos, D., Doukas, H. and LEI, I.K. (2016). The impact of risks in renewable energy investments and the role of smart policies. DiaCore project final report work package, 3. Retrieved on 31.03.2016 from www.ecosys.com: http://www.ecofys.com/files/files/diacore-2016-impact-of-risk-in-res-investments.pdf:

[42]Sonntag-O'Brien, V., & Usher, E. (2006). Mobilizing finance for renewable energies. Renewable Energy: A Global Review of Technologies, Policies and Markets, Earthcan, London, 169-195

[43]Turner, G., Roots, S., Wiltshire, M., Trueb, J., Brown, S., Benz, G., Hegelbach, M. (2013): Profiling the risks in solar and wind: A case for new risk management approaches in the renewable energy sector. Swiss Reinsurance, Zurich. Retrieved on 08.01.2015 from http://about.bnef.com/white-papers/profiling-the-risks-in-solar-and-wind/:

[44]Gatzert, N., Kosub, T. (2014): Insurers' Investment in Infrastructure: Overview and Treatment under Solvency II, Geneva Papers on Risk and Insurance - Issues and Practice, 39(2): 351-372.

Chapter 2: Overview of Indian Power Sector and the Growing Significance of Renewable Energy: In this there is a general overview of Indian Power sector and the growing significance of Renewable Energy sector in it has been studied. This chapter also discusses the significance of solar within the basket of Renewable Energy.

Chapter 3: Review of Literature: In this the review of already available literature related to the topic has been done.

Chapter 4: Research Methodology: This chapter discusses in detail the methodology adopted in the study.

Chapter 5: Data Analysis and Findings: In this chapter result of data analysis of the primary survey has been presented. Data Analysis is done using statistical tools and techniques and then the findings are also presented here.

Chapter 6: Conclusions and Recommendation: After presentations of findings, interpretations of findings are done which will lead to various conclusions. This chapter also lists various recommendations. Also included in this chapter are various limitations of the study along with the future scope or research in this area.

Appendices: It includes copy of the questionnaires and list of developer companies and financiers which participated in the study.

1.6 Conclusion

Renewable Energy now is no more a matter of choice or option. Rather it is the only way to survive. It can be said that benefits of renewable energy technology certainly outweighs the disadvantages of renewable energy technology if not immediately than certainly in future. Limitation or disadvantages will be certainly overcome in the near future seeing the technological advancements and ongoing research in the field.

Transition to RE technology requires significant volume of investment. Much needs to be done for bridging the gap between the current investment and desired level of investment. Financiers base their decisions on risk return profile of any project. They assess each individual risk and ways of mitigating them. Thus this aspect needs to be taken care of very well if the proportion of renewable energy needs to be increased substantially.

Chapter 2

Overview of Indian Power Sector and the Growing Significance of Renewable Energy

Chapter 2

Overview of Indian Power Sector and the Growing Significance of Renewable Energy

2.1 Introduction

Significance of Power Sector in economic growth of any country can not be debated. This chapter discusses the current scenario of Indian Power sector highlighting the growing significance of RE in the Indian Power Sector due to various reasons. This chapter also discusses the enormous potential of solar subsector within the basket of Renewable Energy.

2.2 Indian Power Sector: Current Scenario and Challenges

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2.2.1 Current Scenario

Power sector is one of the crucial component of India's Infrastructure . Over the last six decades or more, India has achieved significant progress in terms of enhancing the generation of power and in its efforts to make power available both for domestic needs and for economic development with an objective of sustainability and environmental concerns. In terms of sources of Power Generation, power sector of India is very diversified. All sources of generating power right from conventional (coal, oil, nuclear etc) to non conventional such as wind, solar, bimass etc are used.

Following table shows the total Power generation installed capacity as on 31st March 2016 in India[1]:

1Ministry of Power, Government of India (2016). Power Sector at a Glance All India .Retrieved, 25.04.2016 from http://www.powermin.nic.in/:

Table 2.1: Total installed capacity for power generation as on 31.03.2016

Fuel	MW	Percentage
Total Thermal	211420	69.81
Coal	185993	61.42
Gas	24509	8.09
Oil	919	.3
Hydro(Renewable)	42,783	14.13
Nuclear	5780	1.9
RES(MNRE)	42849	14.15
Total	302833	100

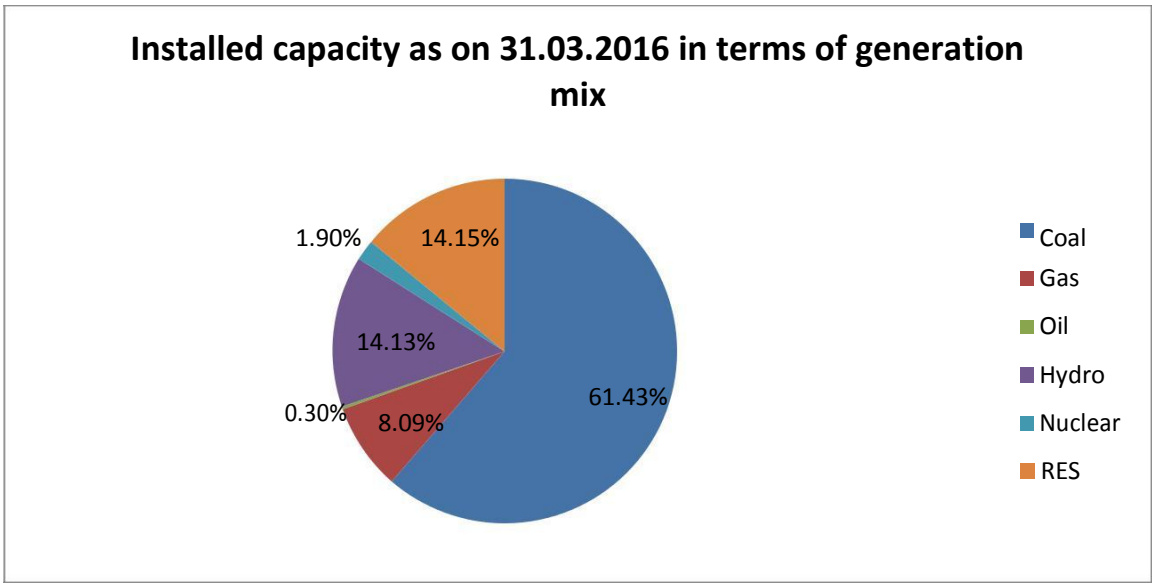

Figure 2.1:Installed Capacity as on 31.03.2016 in terms of generation mix

Thus it can be seen that coal is the main stay when in comes to power generation by supplying more than 60% of the power of the country.

Following table shows the addition in power capacity during various five year plan periods[2].

2 Central Electricity Authority (2014). Retrieved 21 .03.2015 from **www.cea.nic.in**:

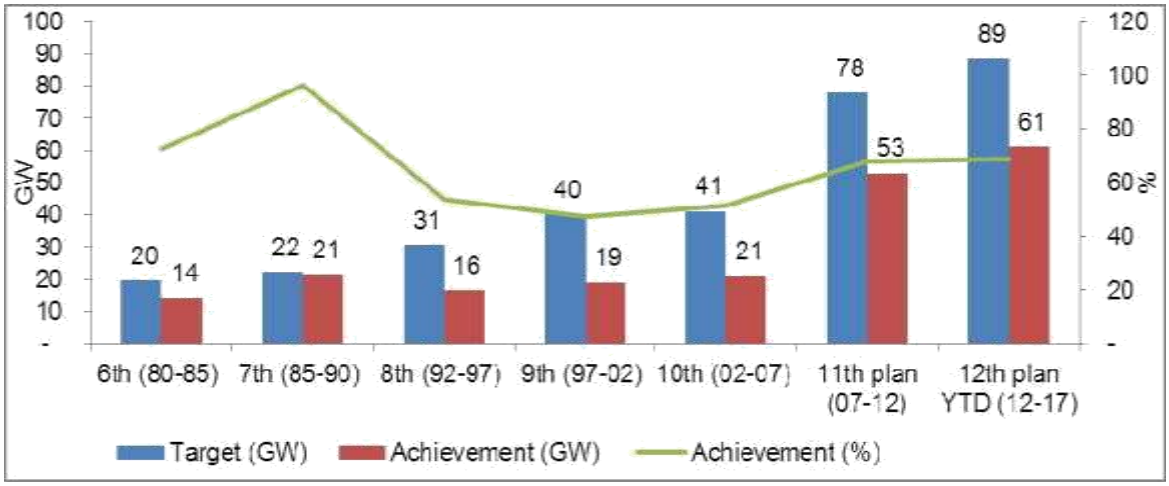

Figure 2.2: Power capacity additions during various five year plans

In Financial Year 2015, Indian Power sector grew by 8.4% on year to year basis. Highest ever power generation capacity has been added in 12th five year plan.

This capacity addition and improved transmission has gone a long way to reduce the deficit to 3.6% in year 2014-2015to even a lower 2.6 % in 2015-2016 as compared to 6.3% in June 2013[3]. Thus what we can see and say is that India's power sector has progressed significantly.

But there is yet another side to this. Though on a rising trend, but per capital power consumption of India is still amongst the lowest in the World. As per CEA (Central Electricity Authority), per capita electricity consumption in India was 915 kWh in 2012-2013, 957 kWh in 2013-2014 reaching 1010 kWh in 2014-2015, whereas for China it is approx.4500 kWh and developed nations have per capita consumption of around 15,000 kWh[4]. This is coupled with the fact that even today about 25% of households does not have access to electricity. This percentage is higher (close to 30%) in some eastern and north eastern states.

[3]Central Electricity Authority (2015). Load Generation Balance Report 2015-2016. Retrieved. 04.05.2016 from http://www.indiaenvironmentportal.org.in/files/file/lgbr_report.pdf:

[4]Bhaskar, U. (2015). India's Per Capita electricity consumption touches 1010Kwh Retrieved 04.05.2016 from www.livemint.com : http://www.livemint.com/Industry/jqvJpYRpSNyldcuUlZrqQM/Indias-per-capita-electricity-consumption-touches-1010-kWh.html:

Around 280 million people in India are without electricity. There is an energy deficit though on a reducing spree. It is anticipated that despite capacity addition of the order of 20 GW, there will be a probable energy shortage[5]. This shortage of power is considered to be one of the greatest barriers to India's development. Indian Businesses have considered the unreliable as well as expensive power to be a main barrier in business. Thus there is a need to provide power from a source which is cost effective as well as reliable for the economic development. This problem is further complicated by the rising population of the country.

It is expected that energy demand will be approximately 1640 billion units by 2020, demanding a major increase in generation capacity from the present status[6].

Figure 2.3: Energy demand forecast

As per Planning Commission (2006)[7] , it is estimated that for 8% GDP growth, total energy requirement of country in 2031-2032 comes out to be 1351-1702 MTOE that is Million tons of oil equivalent. Considering the pace of domestic production of oil, natural gas and coal amidst various other factors it is estimated that up to 90% oil, 50% natural gas and 11-45% coal would be required to be imported.

[5]Central Electricity Authority (2015). Load Generation Balance Report 2015-2016. Retrieved.04.05.2016 from http://www.indiaenvironmentportal.org.in/files/file/lgbr_report.pdf:

[6]Pratap, A., Ram, M., & Pathanjali, A. P. (2013). Powering Ahead with Renewables: Leaders and Laggards. Report by. Greenpeace India. Retrieved 25.04.2016 from www.greenpeace.org:http://www.greenpeace.org/india/Global/india/report/2013/powering-ahead-with-renewables.pdf:

[7]Planning Commission of India (2006). Integrated Policy Report

2.2.2 Challenges in Indian Power Sector

Technically speaking installed capacity of more than 275GW is much higher than 140GW which is the peak demand, but still there is acute power shortage in several part of the country.

Despite the increase in power generation, India has been failing to meet the power sector targets both in terms of Generation as well as transmission side by a considerable margin[8]. Following are the major challenges in Indian Power sector:

- Fuel security is the major concern of Indian Power sector. Several power projects are being severely affected because of the rising imported coal price and there is a limited availability of domestic coal supply due to lack of new mines[9]. Most important problem is that the price of imported coal is not regulated and recently it has been observed that imported coal has been expensive as compared to domestic coal putting significant pressure on distribution companies to revise the tariff. Many utilities have decided not to buy power at high cost resulting in shortage. Gas based capacity to the extent of 20,000 MW is idle due to the gas being non available[10].

- There are several macroeconomic implications also. India's import coal bill in 2014-15 was already more than 1 L Cr Rs for about 212 million ton[11].

- Present pattern of energy generation has got severe environmental implications. There is an agreed scientific opinion that approx. 70% of the GTG emission is due to the fossil fuel combustion leading to increase in earth

[8]Dubey, D. K. (2015). Issues and challenges in electricity sector in India. The Business & Management Review, 5(4), 132.

[9]Pal, A. (2013, Power Sector in India: Growth, Policies and Challenges. International Journal of Emerging Technology and Advanced Engineering, 3(3).

[10]Puri, R. (2014, April). India's Power Sector: Five key challenges and solutions. Retrieved 04.05.2016 from www.hindustanpowerprojects.com: http://www.hindustanpowerprojects.com/media/media-coverage/indias-power-sector-five-key-challenges-solutions/:

[11]Siddhartha, P. (2015, October). FY15 coal import bill spills over Rs 1L crore. Retrieved 05.05.2016 from www.indianexpress.com: http://indianexpress.com/article/business/business-others/fy15-coal-import-bill-spills-over-rs-1-l-crore/:

temperature. As per World Resource Institute, India ranks 4th in the world in the list of top 10 emitters of greenhouse gas, contributing approx. 6.96% of the total emission[12].

- Electricity grid in India shows high voltage fluctuation and there is power outage for several hours in several part of the country.

- Another major challenge relates to the poor financial health of state distribution companies because of operational inefficiency, populist tariff and increasing AT&C losses. It is stated in a report that Rs. 545,922 Cr is the amount which state electricity utilities own collectively to Indian Banks[13]. In the financial year 2013-14, electricity utilities were in a net loss of Rs 62,154[14].

Thus it can be seen that power market in India is facing major challenges both in terms of quantity as well as quality. On the quantity side there is a need of stable fuel supply and on the quality side voltage fluctuations and power outage needs to be handled and not to forget the environmental concerns. For an all-inclusive growth, there has to be a provision for electricity for all, which requires a significant increase in installed capacity.

Thus there is an urgent need to switch over from the present power generation system to the system which is based on sources that are sustainable and also environment friendly.

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[12] Mohan, V. (2015, June). Greenhouse gases: India fourth biggest emitter, but lags far behind top three .Retrieved on 05.05.2016 from www.timesofindia.indiatimes.com;http://timesofindia.indiatimes.com/home/environment/global-warming/Greenhouse-gases-India-fourth-biggest-emitter-but-lags-far-behind-top-three/articleshow/47807927.cms:

[13] Power Finance Corporation Limited (2015). The Performance of State Power Utilities for the year 2011-12 to 2013-14. Retrieved on 03.04.2016 from www. Pfcindia.com : http://www.pfcindia.com/writereaddata/userfiles/file/Operations/state_performance/Report%20on%20the%20Performance%20of%20State%20Power%20Utilities%202011-12%20to%202013-14.pdf:

[14] Bhandari, A. (2015, October). India's Power Utilities Owe Banks $ 90 billion, cripple Future. Retrieved on 07.04.2016 from www.indiaspend.com : http://www.indiaspend.com/cover-story/indias-power-utilities-owe-banks-90-billion-cripple-future-75392:

Multiple steps are being continuously taken to improve the output of power sector and to benefit the customers. One such step is to use renewable energy aggressively for electricity generation.

2.3 Significance of RE in Indian Power Sector

It is clearly visible that coal is the mainstay of power production in India with approximate contribution of 60% in total power production. Approx. 86% of thermal power generation is coal based. But there are various issues relating to this pattern of power generation depending heavily on conventional energy projects. One major issue relates to exhaustion of reserves. For example it is anticipated that known coal reserves would exhaust within another hundred years and known petroleum deposits are expected to exhaust within next few decades. In addition to this, there are several environmental concerns related to conventional energy projects. These include global warming, ozone depletion etc. Thermal power plants are emitting greenhouse gases like CO2, SO2, etc. which are believed to be the cause of global warming. Another source of power generation is through nuclear power plants. They are not emitting greenhouse gas but the fact remains that nuclear fuel is very dangerous and it is very expensive to dispose nuclear waste which is radioactive in nature.

Thus need of hour is to look for energy source which is sustainable. Sustainability means keeping in mind what nature safely offers.

Globally it is the reduction of emissions which is considered to be the main driver of RE promotion. In India, though there is an increasing awareness about the environment, it is the long term energy security couple with the stability of energy supply which is the main driving force. Also the increasing dependence on imports for oil and coal continues to be a cause of concern.

Thus Renewable Energy sources are the only option left when we try to meet the twin objective of meeting the increasing energy demand for economic growth and also of environmental protection. It is stated in the World Bank report that CO2 emission can be reduced by 3.3 million tons yearly by adding 1GW of renewable energy[15].

[15] Bhatia, M. & Banerjee, S. G. (2011). Unleashing the potential of renewable energy in India. World Bank Publications.

RE can also significantly reduce the import fossil fuel bill of India..

Significance of RE in employment generation is also noteworthy especially in India where unemployment has been a major socio economic issue. Following is the projected employment scenario of 2020, based on actual jobs in 2010[16]:

Table 2.2: Projected Employment Scenarios of 2020

	Actual number of Jobs in 2010(‘000)	Projected in 2020 (in ‘000)
Coal	1142	467
Gas oil and diesel	165	131
Nuclear	33	7
Solar	78.3	453
Wind	67	280
Biomass	825	654
Small Hydro	85	48
Total	2405	2412

While massive job cuts are expected in conventional power sector due to improved efficiency, significant new jobs are expected to be created in RE sector due to significant capacity addition, keeping the number of jobs to be same but shift in terms of facts that RE becoming a major employer to the extent of 74%. Now, with scaling up of the targets, that is 100GW from solar and 60GW from wind by the year, 2022, it is anticipated that approx. 1 million jobs will be created in Renewable Energy sector.

[16]Teske, S. (2012). Energy (r) evolution. A SUSTAINABLE INDIA ENERGY OUTLOOK. Retrieved on 02.03.2016 from www.greenpeace.org: http://www.greenpeace.org/india/Global/india/image/2012/Energy%20Revolution%202nd%20Edition/Energy%20[R]evolution%202nd%20edition.pdf:

It is generally stated that cost of renewable energy is high as compared to power generation using coal and it acts as a deterrent. But reality is that electricity generated using renewable is cheaper as compared to those produced using most of the conventional sources such as diesel, gas and even imported coal. There is a continuous reduction in real power generation tariff of renewable[17].

Moreover Renewable energy resources can be deployed in a very short timeframe for example even less than three years whereas conventional power projects require a much longer duration(approx. 10 years).Solar PV projects takes even less than a year.

Renewable energy can go a long way in solving the problem of rural electrification in India. Delay in development of rural India comprising approximately 65% of the total population is primarily due to lack of energy supply and for this RE is the only option and within this also Solar is the most viable option[18].

There is a significant untapped renewable energy potential.

As per Press Information Government of India, a potential of above 896602 MW of renewable energy from various sources has been estimated[19].

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17 NITI Aayog (2015, December). Report of the Expert group on 175GW RE 75G by 2022. Retrieved on 03.03.2016 from www.niti.gov.in: http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf:

18 CHADHA, A. R. (2012) . FUTURE OF SOLAR ENERGY IN INDIA AND EFFICIENCY IMPROVEMENTS BY OPTIMISATION. Research and Development (IJCSEIERD), 2(2), 41-46.

19 Ministry of New and Renewable Energy (2015). Annual Report 2014-15.Retrieved on 03.04.2016. from www.mnre.gov.in: http://mnre.gov.in/file-manager/annual-report/2014-2015/EN/Chapter%201/chapter_1.html:

Table 2.3: Potential from various Renewable Resources

Resources	Estimated Potential(MW)
Solar Power(30-50 MW/Sq Km)	748990
Wind Power (at 80 M height)	102772
Small hydro power (up to 25 MW)	19749
Bio Power (agro residue)	17,536
Bio Power(Cogeneration and bagasse)	5,000
Waste to energy	2554
Total	896602

Out of these installed capacity till31st March 2016, from various sources stands out to be 42849.38MW[20]. It clearly means that large amount of untapped potential is there.

Table 2.4: Installed grid connected power from various renewable energy sources

Sector	**Cumulative Achievement(as on 31.03.2016) in MW**
Wind Power	26866.66
Solar Power	6762.85
Small Hydro Power	4273.47
Bio-Power (Biomass & Gasification and Bagasse Cogeneration)	4831.33
Waste to Power	115.08
Total	42849.38

[20] Central Electricity Authority (2016). Retrieved 21 .05.2016 from **www.cea.nic.in**

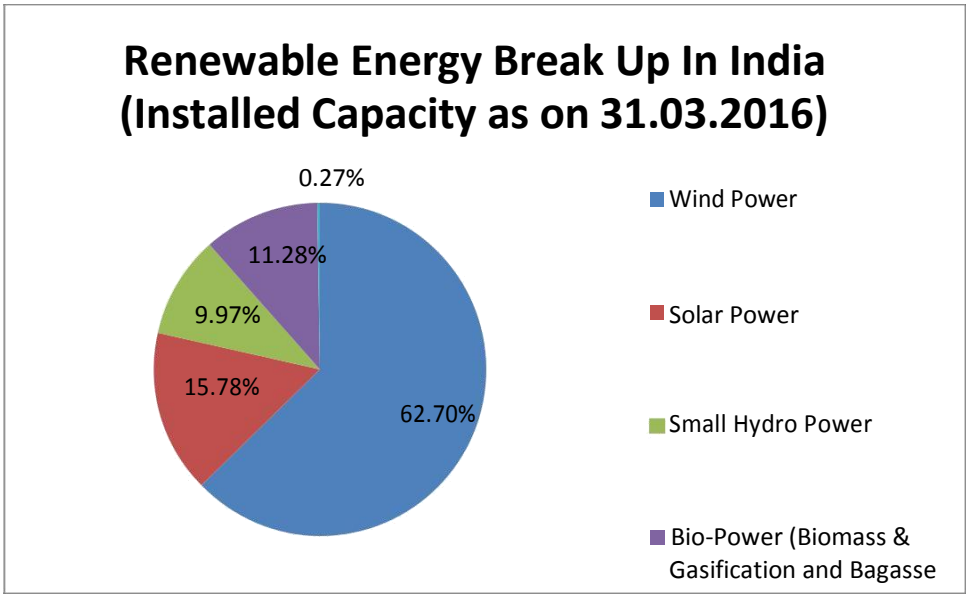

Fig 2.4: RE Installed Capacity Breakup in India as on 31.03.2016

Following table shows Off Grid power from various sources (cumulative achievement)[21].

Table 2.5: Off- grid power from various sources (cumulative achievement)

Off-Grid /Captive Power(as on 31.03.2016)	In MW
Biomass(non-bagasse) Cogeneration	651.91
SPV System>1kW	313.88
Waste to Power	160.16
Biomass Gasifiers	182.39
Water mills/ Micro Hydels	18.71
Aerogenerator/Hybrid Systems	2.69
Total Off grid/Captive Power	1329.74

The majority of power generated from renewable energy source is through grid connected system.

[21]Wikipedia (2016). Electricity Sector in India. Retrieved on 21.05.2016 from https://en.**wikipedia**.org/ : https://en.wikipedia.org/wiki/**Electricity_sector_in_India**

As per Indian Energy Security scenario 2047, there exists the possibility of achieving as much as 410GW of wind and 479GW of Solar PV by the year 2047[22]. India has a separate ministry by the name of MNRE that is Ministry of New and Renewable Energy. India has to its credit to be the first the entire world to set up a separate ministry for nonconventional energy.

IREDA (Indian Renewable Energy Development Agency) was set up in 1987. It is a financial company owned fully by the Central Government for the promotion of Renewable Energy commercially. Recognizing the significance and growth of Renewable Energy, Government has revised the target of Power to be generated from various Renewable Energy Resources.

Following table shows the revised targets[23].

Table 2.6: Revised RE Targets Till 2022

Capacity in MW

Source	**Revised Targets till 2022**
Solar Power	**1,00,000**
Wind power	**60,000**
Biomass Power	**10,000**
Small Hydro	**5,000**
TOTAL	**1,75,000**

However the week financial condition of distribution companies continues to remain the biggest challenge.

Wind Energy: Of the various renewable energy options, Wind is considered to be the most successful Renewable Energy options in India. This is considered to be one of

[22]NITI Aayog (2015). Indian Energy Security Scenario 2047. Retrieved on 03.05.2016 from www.indiaenergy.gov.in : http://indiaenergy.gov.in/docs/Renewable.pdf:

[23]Ministry of New and Renewable Energy (2015). Renewable Energy in India: Growth and Targets. Retrieved 22.05.2016 from www.cseindia.org : http://cseindia.org/docs/photogallery/ifs/Renewable%20Energy%20in%20India%20Growth%20and%20Targets.pdf:

the cleanest and safest energy options available. Wind energy is a free resource but is quite intermittent. On Cost comparison, it is a cheaper sources as compared to solar but costlier than hydro. In India, full-fledged wind power programme started only in the year 1983-84. Market oriented strategy was adopted since the beginning which proved to be highly successful. Total installed capacity up to 31st March 2016 is 26866.66 MW. This is approx. 63% of the total grid connected RE installed capacity.

Within India, Tamil Nadu is the leading state in India in terms of installed capacity generating approx. 35% of the total capacity installed. Following table shows the state wise wind power installed capacity in India[24]:

Table 2.7: State Wise Wind Power Installed Capacity as on 31.03.2016

S. No.	State	Cumulative Wind Power Installed Capacity as on 31.03.2016 in MW
1	Andhra Pradesh	1431.45
2	Gujarat	3948.61
3	Karnataka	2869.15
4	Kerala	43.5
5	Madhya Pradesh	2141.1
6	Maharashtra	4653.83
7	Rajasthan	3993.95
8	Tamil Nadu	7613.86
9	Telangana	77.7
10	Others	4.3

Following Table shows the wind power potential in India[25]:

24 Ministry of New and Renewable Energy (2016). State wise % of Wind Power Potential Utilized .Retrieved on 03.06.2016 from www.mnre.gov.in: http://mnre.gov.in/file-manager/UserFiles/State-wise-wind-power-potential-utilized.pdf :

25 Ministry of New and Renewable Energy (2015). Annual Report 2014-15.Retrieved on 03.02.2016. from www.mnre.gov.in: http://mnre.gov.in/file-manager/annual-report/2014-2015/EN/Chapter%201/chapter_1.html**:**

Table 2.8: Wind Power Potential in India

Estimated

State/UTs	50m	80m(to be validated)
Andaman and Nicobar	2	365
Andhra Pradesh	5394	14495
Arunachal Pradesh	201	236
Assam	53	112
Bihar	-	144
Chhattisgarh	23	314
Diu and Daman	-	4
Gujarat	1060	35071
Haryana	-	93
Himachal Pradesh	20	64
Jharkhand	-	91
Jammu and Kashmir	5311	5685
Karnataka	8591	13593
Kerala	790	837
Lakshadweep	16	16
Madhya Pradesh	920	2931
Maharashtra	5439	5961
Manipur	7	56
Meghalaya	44	82
Nagaland	3	16
Odisha	910	1384
Pondicherry	-	120
Rajasthan	5005	5050
Sikkim State/UTs	98	98
Tamil Nadu	5374	14152
Uttarakhand	161	534
Uttar Pradesh	137	1260
West Bengal	22	22
Total	4913	102788

Wind Energy has gone much beyond the established targets in five year plans. During the 10th five year plan, target set was 1500 MW whereas the actual installation was 5,427 MW. Target set during 11th plan was 9,000MW and actual installation was 10,260, MW. Target set for 12th plan is 15,000MW. During the Financial year 2015-16, against the set target of 2.4GW, the total capacity addition was 3.3 GW.

Wind energy was contributing approx. 2% of the total electricity in the year 2012. By the end of the year 2015, this has gone up to 8%. Wind energy has the potential to meet up to 25% of the India's electricity demand by the year 2020[26].

IREDA has been providing various incentives for wind power development in India. Accelerated depreciation, excise exception etc. have been major motivation for development of wind energy in India. High borrowing cost has been identified to be a major economic factor obstructing wind power growth in India[27]. Project financing methodology as applied to wind power projects are planned with 70: 30 debt equity ratios. This coupled with high interest rate makes debt financing very expensive.

Solar Power: From approx. 1% of the total installed capacity in renewable in 2010 to the present approx. 15.78% of the total installed renewable capacity in March 2016; solar energy has shown a significant progress. As on 14th Jan 2016, solar installed capacity crossed 5000 MW, a milestone.

It can be seen that Rajasthan is the leading state in terms of installed capacity with 1269.932 MW followed by Gujarat and Madhya Pradesh with installed capacity of 1119.173 MW and 776.370 MW respectively. Following table shows the installed capacity of solar state wise[28].

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[26]Pratap, A., Ram, M., & Pathanjali, A. P. (2013). Powering Ahead with Renewables: Leaders and Laggards. Report by. Greenpeace India. Retrieved 25.04.2016 from www.greenpeace.org: http://www.greenpeace.org/india/Global/india/report/2013/powering-ahead-with-renewables.pdf:

[27]Singh, M., & Singh, P. (2014l). A Review of Wind Energy Scenario in India. International Research Journal of Environment Sciences. ISSN 2319–1414Vol. **3(4),** 87-92.

[28]Ministry of New and Renewable Energy Sources (2016). Retrieved on 04.06.2016 from www.mnre.gov.in

Table 2.9: Installed Capacities of Solar State Wise

Sr. No.	State/UT	Total commissioned capacity as on 31.03-16 (MW)
1	Andaman & Nicobar	5.1
2	Andhra Pradesh	572.966
3	Arunachal Pradesh	0.265
4	Bihar	5.100
5	Chandigarh	6.806
6	Chhattisgarh	93.580
7	Daman & Diu	4
8	Delhi	14.280
4	Gujarat	1119.173
5	Haryana	15.387
6	Jharkhand	16.186
7	Karnataka	145.462
8	Kerala	13.045
22	Lakshadweep	0.75
9	Madhya Pradesh	776.370
10	Maharashtra	385.756
11	Odisha	66.92
23	Pondicherry	0.025
12	Punjab	405.0623
13	Rajasthan	1269.932
14	Tamil Nadu	1061.820
15	Telangana	527.843
16	Tripura	5
17	Uttar Pradesh	143.495
18	Uttarakhand	41.145
19	West Bengal	7.772
	Others	58.311
TOTAL		**6762.853**

During the Financial year 2015-2016, approximately 3GW was added to the grid connected solar power generation capabilities.

Biomass: This is a third major renewable energy source in India. India being an agricultural dominated country, biomass is available in plenty without temporal or spatial limitation observed in case of wind and solar. Of the total 42849.38 MW of grid connected installed RE, Biomass accounts for 4831.33 MW at the end of 31st March 2016, which is quite far from the estimated potential of 17,000MW from agro residues and 5,000 MW from cogeneration and bagasse in India. Total Biomass resource in India is approx. 500 million metric ton. As per MNRE estimate, 120-150million metric ton is biomass is available per annum for power generation covering both agricultural and forestry residues and another 5000 MW of power generation is estimated through bagasse based cogeneration[29]. There is abundance of this source of energy in India and this is getting significant attention in recent times as a significant substitute of fossil fuels. Additional 30,000MW of power can be produced if only 50% of waste land in India can be used for energy plantation for producing biomass power[30]. Thus it is clear that biomass is a resource which is largely untapped with great potential for meeting energy needs of India. In India majority of bio energy is produced through combustion.

Various barriers identified for poor exploitation of bio energy potential in India are technical, financial, institutional and also regulatory. This source of energy is free from fluctuation. But there are issues with biomass supply chain which is considered to be one of the primary reasons hampering this source of energy. In India, Biomass is primarily based on agricultural waste which is available only for 2-3 months in a year after the harvesting period. Thus biomass needs to be procures and stores within this time. Also transportation cost is a very significant component of total cost in running a biomass power plant and it needs to be managed. Some of the leading states in India

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[29]Ministry of New and Renewable Energy Sources (2016). Retrieved on 18.05.2016 from www.mnre.gov.in: http://mnre.gov.in/schemes/grid-connected/biomass-powercogen/:

[30]Kumar, A., & Bernwal, A. (2010). The Future of Biomass Energy in India. Bio Energy India, Issue 4, 27-30. Retrieved on 30.04.2016 fromwww.undp.org:http://www.undp.org/content/dam/india/docs/bioenergy_issue4.pdf:

in terms of Biomass energy are Karnataka, Andhra Pradesh, Maharashtra, Uttar Pradesh etc.

Recognizing the potential of bio energy, various financial incentives are provided by the government both at the central and state level. MNRE is strongly supporting the bio energy programme of the country since middle of 90s. MNRE aims to cover 10,000 villages through biomass based system by the year 2022.

Seeing the various innovations and development especially in the area of procurement and development of fuel, it can be safely stated that biomass is going to be a very significant contributor in RE both in terms of capacity as well as spread.

Hydro Power: India has one of the greatest hydroelectric power potential in the world. Total hydro power potential of the country is estimated to be above 150,000 MW and globally India has been ranked fifth on the basis of exploitable hydro potential. In India, hydro projects are classified into two categories:

1. Small Hydro project
2. Large hydro Project

   Small hydro projects are hydro projects till 25 MW of capacity and projects with capacity exceeding 25MW are classified as Large Hydro Projects. Large Hydro Projects falls within the purview of Ministry of Power whereas small hydro Projects are classified as renewable energy projects falling within the purview of MNRE.

Small hydro projects are "run of the river" types. Dams need not to be constructed for them. First small hydro power plant came into existence in 1987 in India. Total small hydro projects potential in India is estimated to be 20,000MW whereas total installed capacity as on 31st March 2016 is 4273.47 MW. More than half of the potential of small hydro are in hilly states of Uttarakhand, Jammu and Kashmir, Himachal Pradesh, and Arunachal Pradesh. Other prominent states having significant potential are Maharashtra, Karnataka and Chhattisgarh. There is a significant private

participation in this sector. As per Amitabh Sinha (2015)[31], construction cost of the projects have increased from 5-6 Cr per MW to 8.5- 9.5 Cr per MW and this probably is one the reason hampering the development of small hydro projects.

MNRE aims to increase the Installed capacity of small Hydro Projects to be around 7,000MW at the end of 12th five year plan[32].Target set by MNRE is that around 2% of the grid connected power should come from SHP. For this about 2100MW of capacity addition has been planned in the 12th five year plan (2012-2017). Characteristic feature of SHP in India is that it is driven by private investment.

Government has set up a National Mission with the target of 5000 MW of small hydro projects in coming five years. Rs 386.5 Cr have been approved for the first phase of the mission for providing various incentives for development of SHP.

MNRE is providing financial assistance for setting up of small hydro projects. State governments are also provided financial support for various activities related to SHP like project report preparation, potential site identification and also for renovation and modernization of existing old projects.

Geo Thermal Energy: It is another clean and reliable source of energy. India has significant potential of geothermal energy which remains unexploited. Geological survey of India has identified some 340 potential locations for geo thermal energy in India having a total potential of 10,600 MW. This 340 hot springs are grouped into seven geothermal provinces:

1. Himalaya
2. Sahara Valley
3. Cambay Basin
4. Son-Narmada-Tapti lineament belt
5. West Coast
6. Godavari Basin
7. Mahanadi basin

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31 Sinha, A. (2015, March). Govt. turns to small hydro projects to meet power needs. Retrieved on 31.03.2016 from www.indianexpress.com:http://indianexpress.com/article/india/india-others/govt-turns-to-small-hydro-projects-to-meet-power-needs/:

32 Ministry of New and Renewable Energy Sources (2016). Retrieved on 12.05.2016 from www.**mnre**.gov.in: http://mnre.gov.in/schemes/grid-connected/small-hydro/:

GSI has prepared a geothermal atlas which is updated regularly by GSI. As of now, India does not have any operational geothermal plant. But this untapped sector has started getting attention with MNRE drafting a national policy setting up a target of 100 MW to be generated using geothermal resource by the end of the year 2022. To aggressively promote this sector, 30% subsidy on capital has been proposed for project installation and 50% subsidy is proposed for research and innovation purpose.

2.4 Solar Energy: A Promising Sector

Within the Basket of RE, Solar Energy is considered to be a promising sector. Solar Sector has seen the rapid growth with installed capacity increasing from 18MW to 5000MW during 2010-2016. Revision of target of 20,000MWto 1, 00,000MW shows the enthusiasm and initiative of the Government. Following are some of the important reasons for considering solar energy as a promising sector:

- In India the potential of solar energy is highest in comparison to other renewable energy sources**.** India lies between 8◦4'N and 37◦6'N latitudes and 68◦7'E and97◦25'E longitudes and is located between Tropic of Cancer and Equator.

Due to the advantageous location of Indian subcontinent, average temperature in India ranges from 25c to 27.5 c and India receives ample of sunlight. As Per IEA Report (2011)[33], India has around an average 300 sunny days per annum and yearly irradiation of 200W/M^2.

As per India Energy Portal approx. 12.5% of total India's Landmass can used to produce solar energy[34].

India receives solar radiation equivalent to 5,000 trillion kWh per year.

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[33]IEA (2011). Technology Development Prospect for Indian Power Sector. OECD/IEA, Paris. Retrieved on 31.01.2016 from www.iea.org: https://www.iea.org/publications/freepublications/publication/technology_development_india.pdf:

[34]Arora, D. S., Busche, S., Cowlin, S., Engelmeier, T., Jaritz, J., Milbrandt, A., & Wang, S. (2010). Indian Renewable Energy Status Report: Background Report for DIREC 2010 (No. NREL/TP-6A20-48948). National Renewable Energy Laboratory (NREL), Golden, CO.

On an average country is receiving an average hourly radiation of 200MW/Km2 and the annual global radiations are varying between 1600 to 2200 KWh/m2[35].

Solar Resource Map of India released by NREL shows that for most part of India (58%), the annual DNI (Direct Normal Irradiance is greater than 5KWh/m2/day[36]. Map also shows that there are large areas in the state of MP, Maharashtra, Chhattisgarh showing annual average DNI more than 5.5 KWh/m2/day[37]. This can go a long way in meeting the increasing power requirement in an efficient and sustainable manner.

- There has been a significant reduction in the bench mark cost of solar power plant[38].

Table 2.10: Bench marks capital cost per MW in Rs Cr

Year	Bench marks capital cost per MW in Rs. Cr
2011-2012	14.42
2012-2013	8
2013-2014	7.97
2014-2015	6.70
2015-2016	6.05
2016-2017(proposed)	5.01

[35]Tyagi, A. P. (2009). Solar radiant energy over India. India Meteorological Department, New Delhi, India.

[36]Ramachandra, T. V., Jain, R., & Krishnadas, G. (2011). Hotspots of solar potential in India. Renewable and Sustainable Energy Reviews, 15(6), 3178-3186

[37]Gupta, S. K., & Anand, R. S. (2013). Development of solar electricity Supply system in India: an Overview. Journal of Solar Energy, 2013.

[38].Central Electricity Regulatory Commission (2016). http://cercind.gov.in/

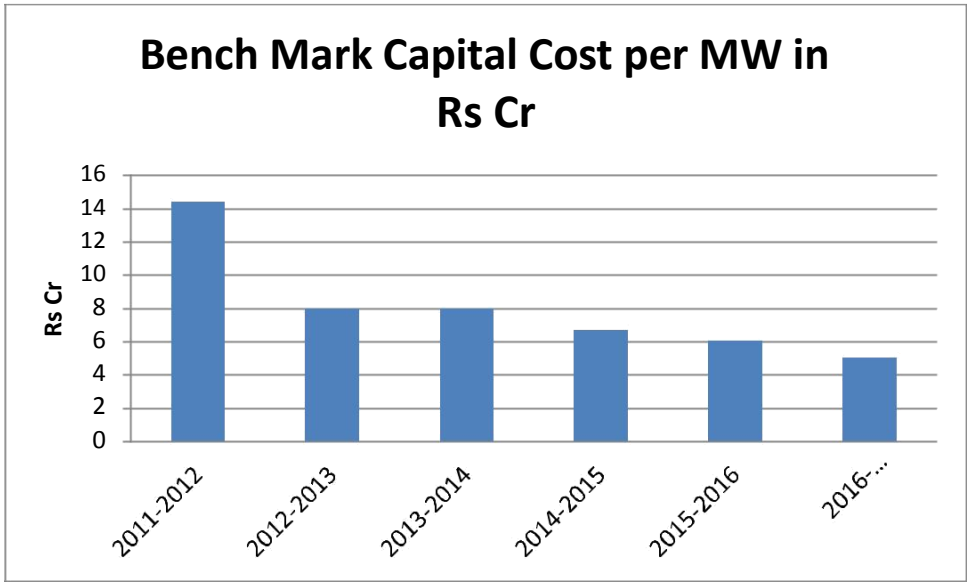

Figure 2.5 Bench Mark capital cost per MW in Rs Cr.

Thus it can be seen that there is a significant reduction in Bench marks cost of solar power projects. In 2014-2015, there was a reduction in cost to the extent of 15-16% and in 2015-2016; cost is reduced to the extent of 9.68% in comparison to the previous year.

- There is a significant reduction in the price of PV modules. Price has fallen by 80% since 2008.
- Cost of solar power is also significantly coming down over a period of time. From Rs. 17.90 per unit in 2010 to the latest bidding of Rs. 4.63 per unit in Andhra Pradesh. With the average price of coal based power to be around Rs 3 per unit, it can be very safely said that solar is very close to achieving grid parity. It is stated that this significant reduction in the solar power tariff is due to reduction in cost of capital and also due to the reason that equipment modules, inverter, and balance of plant cost have come down by around 40-50% over the last 3-4 years[39].

[39]Bhaskar. U. (2015). Is Rs.5 per kWh the new normal for Indian solar power tariffs? **Retrieved on 01.01.2016 from** www.livemint.com : http://www.livemint.com/Industry/x76Wi4Ny41ld4Nds4EdfNP/Is-Rs5-per-kWh-the-new-normal-for-Indian-solar-power-tariffs.html:

In fact solar PV generation cost is less as compared to natural gas based generation cost[40].

- With more than 5000Mw of installed capacity, solar power market is slowly moving towards a state of maturity.
- In addition to the above, zero fuel cost, O&M cost being very low and of course no adverse impact on the environment are also very significant aspects of solar energy. Environmental issues are picking up grounds as India ranks third in the greenhouse gas emitter list, only after US and China.
- Increasing the proportion of solar would also improve the demand supply balance considering the solar and peak demand.
- Since last few years, Government has also started giving significant attention to solar power. A very ambitious JNSSM was initiated so as to achieve a target if 20GW by the year 2020. In addition to it several other policy measures are also being taken to promote solar sector such as RPO impositions, system of FIT etc. Following Target was set in the 12th five year plan for Grid connected RE projects[41]:

Table 2.11: Target in 12th five year plan for Grid Connected RE projects

Wind Power	11000 MW
Biomass Power Bagasse Co-generation Biomass Gasifies	2100 MW
Small hydro	1600 MW
Solar Power	3800 MW
Total	18500 MW

[40] NITI Aayog (2015, December). Report of the Expert group on 175GW RE 75G by 2022. Retrieved on 03.03.2016 from www.niti.gov.in: http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf :

[41] Planning Commission of India (2012. January). Report of the Working Group on Power for Twelfth Plan (2012-17). Retrieved on 31.01.2016 from www.planningcommission.gov.in: http://planningcommission.gov.in/aboutus/committee/wrkgrp12/wg_power1904.pdf:

From the above set targets it can be clearly understood that Government planned to increase the share of solar within Renewable projects to the extent of 20% of the total installed capacity of RE projects. Now the recent revision of targets for Solar to 1, 00,000MW shows the enthusiasm of the government is promoting this sector. Out of this 60 GW is aimed to be generated through ground mounted grid connected mechanism and remaining 40 GW through roof top grid interactive projects. In addition to setting up these targets, ministry (MNRE) has fixed the year wise targets to monitor the progress.

- Government is providing encouragement to solar developers in various ways. Government is trying to help them in even arranging finance. Renewable energy sector has been added in priority sector for lending by RBI. Financing Institutions which are providing debt to Solar developers can be classified as follows[42]:

Fig. 2.6: Classification of financing Institutions providing debt to solar developers

But there are certain important hurdles which needs to be overcome for achieving the renewable energy targets and one such hurdle relates to the state of risk management in India.

[42] Adhana, D. K. (2015). SOLAR ENERGY MISSION: PAVING THE WAY FOR INDIA'S TRANSFORMATIONAL FUTURE. International Journal of Advanced Research in ISSN: 2278-6236 Management and Social Sciences, 4(12).

2.5 Conclusion

Energy planning in India is based on the objective of high economic growth and energy for all. But in the present scenario, these objectives are possible in a sustainable manner only by gradually increasing the proportion of renewable energy in a significant level considering the ample potential of renewable energy in India. What is visible is that though the growth statistics are optimistic but for better development, certainly additional attention is required as the share of renewable energy is still only 14% of the total power generation. Within the basket of various renewable energy resources, solar has the greatest unexploited potential which if adequately exploited can go a long way in ensuring energy security for the country.

Chapter 3

Review of Literature

3.1 Introduction

3.2 Review of Studies Conducted in International Context/Global Context

3.3 Review of Studies Conducted in Indian Context

3.4 Conclusion

3.4.1 Researchers Observation

3.4.2 Research Gap

Chapter 3

Review of Literature

3.1 Introduction

Here the review of already available literature related to the topic has been done. Renewable Energy Sector has been gaining attention of scholars due to various reasons. Most of these studies have been conducted abroad in International context although many of these studies have been India centric also. Of late Indian Scholars have also conducted studies exploring the Renewable Energy Sector and its dynamics. Literature related to the topic in hand includes books, thesis, research articles and various reports published by academicians, researchers and various government and nongovernmental agencies worldwide.

Study related to the topic can be divided into two categories:

1. Study conducted in International context/Global Context
2. Studies conducted in Indian Context.

3.2 Review of Studies Conducted in International Context

Johansson, Kelly, Reddy, Williams (1993)[1] have highlighted the significance of Renewable energy as a source of power in future, They have stated that by 2050, 60% of electricity supply globally would be done through RE Sources that too at a price which would be much lower than the forecasted price of electricity generated through conventional sources.

[1]Johansson, T. B., Kelly, H., Reddy, A. K. N., & Williams, R. H. (1993). Renewable energy: Sources for fuels and electricity. Island Press, Washington DC, USA.

As per Ahmed,K. (1994)[2], there might be a declination in the cost of Renewable Energy in times to come due to increase in R&D, commercialization as well as increase in production scale and capacity.

Drennen, Erickson, Chapman (1996) [3]have clearly stated that of all the viable alternatives of the available clean energy sources, it has been observed that solar has the highest potential for global warming mitigation. Authors tried to examine the economic competitiveness of PV systems in their paper and concluded that wide spread adoption of this technology at this stage is not possible without a major technological breakthrough. There should be a sustained R&D programme for improvement.

Wiser and Pickle (1998)[4] have stated that, "the cost of electric power projects utilizing renewable energy technology are highly sensitive to financing terms". They have concluded in their paper that lowering risk is an important feature of policy design because of its impact on financing cost. Using case studies for RE projects, they reviewed the power plant financing process and made an estimate of the impact of financing terms on the cost of energy.

Langniss (1999)[5] has clearly stated that when it comes to policy development, risk mitigation is certainly an alternative to increasing the compensation level.

Martinot (2001)[6] tried to assess the RE investment strategy of the World Bank on the basis of interviews with various stake holders. Author has stated that in addition to Traditional Project Risks such as Procurement, Construction, Future Energy Prices and Cost over runs, RE faces several other challenges such as new inexperienced

[2]Ahmed, K., & Anderson, D. 1994) . Renewable energy technologies: a review of the status and costs of selected technologies. World Bank technical paper (ISSN 0253-7494, (240) . Retrieved on 12.01.2014 from http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/1999/08/15/000009265_3970716144852/Rendered/PDF/multi0page.pdf:

[3]Drennen, T. E., Erickson, J. D., & Chapman, D. (1996). Solar power and climate change policy in developing countries. Energy Policy, 24(1), 9-16.

[4]Wiser, R. H., & Pickle, S. J. (1998). Financing investments in renewable energy: the impacts of policy design. Renewable and Sustainable Energy Reviews, 2(4), 361-386.

[5]Langniss, O. (Ed.) (1999). Financing Renewable Energy Systems, DLR, Stuttgart.pp112.

[6]Martinot, E. (2001). Renewable energy investment by the World Bank. Energy Policy, 29(9), 689-699.

technology, new mechanisms of financing and challenges of technology acceptance by financier as well as various stake holders. Risk taking mentalities as well as incentives are required for handling this non-traditional risk. Authors have also stated that private developers are not concerned about technical risks. There real challenge is commercial risk such as cash flow, contractual enforcement mechanism, uneven competition, currency issues etc.

As per Beck and Martinot (2004)[7], one of the biggest barrier when it comes to development of Solar Energy Technologies especially in developing country is initial capital cost which is considerably high and also the lack of easy and consistent availability of fund is an issue.

Cleijne, Rujigrok (2004)[8], have clearly stated that risk plays a very significantly dominant role in investment decisions as investors are risk averse. They have listed various risk elements which are considered to be more relevant for investors and they are:

1. Operational risk
2. Market risk
3. Regulatory risk
4. Technological risk

Mentioning the banker's perspectives they have stated that they are concerned about the repayment capabilities and are very keen to ensure that various risks affecting the incoming cash flows are properly managed.

Other important projects risks are per them are:

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[7]Beck, F., & Martinot, E. (2004). Renewable energy policies and barriers. Encyclopedia of energy, 5(7), 365-383.

[8]Cleijne, H; Ruijgrok, W. (2004). in Green –X Report titled," Modeling Risks of Renewable Energy Investments" Within the 5th Framework Programme of the European Commission Supported by DG Research. Retrieved on 21.12.2014 from http://www.green-xat: http://www.green-x.at/downloads/WP2%20-%20Modelling%20risks%20of%20renewable%20energy%20investments%20%28Green-X%29.pdf:

1. Development and Construction risk
2. Operation and maintenance
3. Financial Risk
4. Force majeure

Study aimed to construct a model describing the dynamics of RE in Europe. They have recognized that the risk perception by stakeholders is a major factor in investment decision making. Questionnaire survey and interview was done to know the perception of various stakeholders and risk return relationship. Result of the survey identified the following as the most relevant risks for the purpose of investments. Regulatory and Political Risk followed by Resource availability Risk, Technological Risk and Planning/ Permitting Risk of the project.

Marsh Ltd. (2004) [9]have listed the followings as the key risks associated with all size of RE projects:

1. Project Risk
    a. Lead time Risk
    b. Construction Risk
    c. Performance Risk: Its Element can be:
    d. Operational Risk
    e. Fuel Supply Risk/Resource Risk
    f. Technology Risk
    g. Natural Hazard Risk
    h. Permit Delivery Risk

2. Political/Institutional Risk
    a. Country Risk
    b. Regulatory Risk
    c. Kyoto Project Risk
    d. Administrative Risks

[9]T, Olivier. , C.C., Capital. , D.N. Veritas. (2004) Scoping Study on Financial Risk Management Instruments for Renewable Energy Projects. United Nations Environment Programme. Retrieved on 07.01.2014 from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.114.4465&rep=rep1&type=pdf:

e. Legal Risks
f. Business Risk
g. Financial Risk
h. Economic Risk
i. Counter Party Risk

Out of these following were identified as more critical risks considered more suitable for analysis:

1. Resource Technology and Operational Risks
2. Regulatory Risk
3. Political Risk
4. Counter Party Risk
5. Scale and Return
6. Relative Costs
7. Lead time
8. Transmission and Distribution
9. Valuing Social and Environmental Costs and Benefits
10. Sustainable Responsible Investments
11. Carbon Finance

From Investment Perspectives, Key risks relates to small scale of projects, technology efficacy, operational risk, regulatory uncertainty. As per their analysis Resource, Technology and Operational risks are not at all significant in case of Solar PV projects. Study also says that regulatory uncertainty is also a key barrier coming in the way of RE projects financing.

The study also highlighted the fact that the application of Financial Risk Management Instruments is limited in developing countries in the context of RE projects. Study categorically states that there exists distance between developers, advisors of developers and various institutional investors.

Goldman et al (2005)[10] have stated that Investment Risks in Solar (PV) Projects are considered to be unusually high by certain financial institutions while assessing the credit worthiness. This is because of their short history, long payback period and their relatively small revenue stream.

Dinica (2006)[11], while taking an investor oriented approach tried to analyze the various support system of RE technology in terms of their diffusion potential. She has also stated that it is policy maker's perspective which is taken into consideration while classifying and analyzing the characteristics of various support systems of RE. She has also stated that financial aspects of these support systems are not described in the way it should have been to attract the potential investors.

Mitchell, Bauknechtetal (2006),[12] have stated that Risk for investments in RE includes among other things the uncertainty about market price, the sold quantity and the Balance of Power.

As per Sonntag-O-Brien U and Usher E (2006)[13], lending and investing decisions are made by financiers on the basis of risk and return analysis. Financiers assess each individual risks and ways to mitigate them. Lenders typically focus on the ability of borrowers to repay the loan. They have also stated clearly that for on grid RE, it is easy to assess the return, whereas assessing and managing risk is difficult. They have also stated that RE financing requires new risk management approach. FRM is also considered to be one of the key elements for RE deployment. If used appropriately, then it can mitigate the perceived risks in RE projects which can affect quantum and terms of investment. However even today there is limited availability of FRM for RE due to various reasons.

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[10]Goldman, D. P., McKenna, J. J., & Murphy, L. M. (2005). Goldman, D. P., McKenna, J. J., & Murphy, L. M. (2005). Financing projects that use clean-energy technologies: an overview of barriers and opportunities. National Renewable Energy Laboratory. Retrieved on 07.01.2015 from http://www.nrel.gov/docs/fy06osti/38723.pdf:

[11]Dinica, V. (2006). Support systems for the diffusion of renewable energy technologies—an investor perspective. Energy Policy, 34(4), 461-480.

[12]Mitchell, C., Bauknecht, D., & Connor, P. M. (2006). Effectiveness through risk reduction: a comparison of the renewable obligation in England and Wales and the feed-in system in Germany. *Energy Policy*, *34*(3), 297-305.

[13]Sonntag-O'Brien, V., & Usher, E. (2006). Mobilizing finance for renewable energies. Renewable Energy: A Global Review of Technologies, Policies and Markets, Earthcan, London, 169-195.

Marsh Ltd. (2006) [14] prepared a comprehensive list of associated risks in case of RE projects especially in developing countries were prepared. The study was conducted in nine countries which includes India as well. From the list so prepared the risks which could be managed by FRM instruments were identified. A survey was also conducted of FRM instruments including both insurance and non-insurance with the aim of studying the instruments currently available in developing countries.

Table 3.1: Risk and available Instruments, Marsh (2006)

Risk	FRM Instruments
Risk associated with Large scale projects:	
Project Development/Pre Construction Phase	
a. Concept to Implementation	Grants/Contingent Grants
Construction Phase	
b. Construction/Completion Risk	Insurance/CAR
c. Counter Party Risk	Surety Bond/Performance Guarantees, Liquidation damages
Operating Phase	
d. Performance Risk	Insurance
e. Counterparty Risk	Surety Bond/Performance Guarantees, Liquidation damages
f. Fuel Supply Risk	Weather Insurance/ Derivatives
g. Credit Risk	Guarantees/Credit Derivatives
Generic All phases:	
h. Financial Risk	Standard Derivatives Products
i. Political Risk	Political risk insurance/MFI guarantees, Export Credit guarantees
j. Force Majeure	Insurance/ Catastrophe bonds
Risk associated with small scale project:	
Project Developer:	
a. Development(Credit Risk)	Guarantees Funds
End User	
b. Risk of physical damage including theft	Micro Insurance
c. Credit Risk	Guarantees/Credit lines
Risk associated with carbon finance projects	
a. Market Risk	Standard derivative products to hedge against price

[14] Marsh Ltd. (2006) . Financial Risk Management Instruments for Renewable Energy Projects. UNEP Working Group 1 Study Report, UNEP, Nairobi. Retrieved on 01.01.2014 from http://www.unep.org/pdf/75_Risk_Management_Study.pdf

They also conducted a survey of Insurance/ Non Insurance Financial Risk Management instruments to find out its availability. Following are the main findings of the survey:-

1. Most commonly utilized risk management instrument in the surveyed countries are secured contracts, insurance products, equipment warranties and various kinds of government guarantees.
2. Most crucial and difficult phase of RE finance is front end of deal.

Leuthi S. (2008) [15]tried to empirically test the significance of various aspects of solar energy policies using a risk return framework in influencing a firm's decision to invest in any given country. As a first step of the research methodology, author conducted qualitative interviews with various PV project developers and also with various PV project developers and also with other solar or project development specialists. The experts interviewed were all active only in Europe. It was confirmed from interview that above a certain level of return, the risk related factors (for example. Policy instability) is considered to be more important than return related factors (for example, Incentive payment level), when it comes to influencing investment decision.

De Jager and Rathmann et al (2008)[16] in their study have mentioned that lowering risks is an extremely important feature of policy design due to its impact on financing cost in case of RE projects. They have stated that making an investment comes with cost as both lenders as well as investors have set financial criterion and risk assessment has a major impact on cost of capital. Higher perceived risk results in

[15]Lüthi, S. (2008) . Investment behavior of solar companies—Determinants of foreign direct investment in an emerging cleantech industry. Proceedings of the 9th oikos PhD Summer Academy, St. Gallen, Switzerland. Retrieved on 01.01.2014 from http://backup.oikos-international.org/fileadmin/oikos-international/international/oikos_PhD_summer_academy/Papers_2008/Luethi_Paper.pdf:

[16]De Jager, D., Rathmann, M., Klessmann, C., Coenraads, R., Colamonico, C., & Buttazzoni, M. (2008). Policy instrument design to reduce financing costs in renewable energy technology projects. Ecofys, by order of the IEA Implementing Agreement on Renewable Energy Technology Deployment (RETD), Utrecht, ther Netherlands. Retrieved from 01.01.2015 from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.592.3720&rep=rep1&type=pdf:

higher cost of capital. They have discussed about six levels of risk which can affect a projects cost of capital:

1. Project level
2. Regulatory risk
3. Financial Risk and Market risk
4. Legal risk
5. (Geo)Political risk
6. Force Majeure risk

As per them project level risk, regulatory risk and financial risk are more important.

Project level risk had been classified further as per phase of development of project for the purpose of analysis:

Table 3.2: Project Level Risks as per phases of Development (De Jager and Rathmann, 2008)

Project Phase	Risk	Risk Mitigation
Project Development and Financial closure	a. Acquisition of Permit not successful b. Issues with electricity grid connection c. Power purchase agreement not reached or not meeting the conditions put by lenders d. Delay in project development due to various reasons	Updating the stake holders and/ or offering them chance to participate in the project
Construction Phase	a. Construction Risk b. Counter Party Risk	a. Insurance, Turnkey contract, b. Performance guarantees, liquidated damages on nonperformance, due diligence process for subcontractors
Operation Phase	a. Performance Risk b. Resource Risk c. Market Risk d. Regulatory Risk	a. For performance risk it can be outsourcing of O&M e.g. to same EPC, incentives, equipment warranty, insurances b. Insurances for resource risk c. For market Risk it can be long term PPA and Long term contracts for renewable energy certificates
Decommissioning Phase	No budget available	Decommissioning fund

Project development and financial closure:

1. Construction Phase
    a. Construction Risk
    b. Counter Party Risk
2. Operation Phase:
    a. Performance Risk
    b. Resource Risk
    c. Market Risk
    d. Regulatory Risk
3. Decommissioning Phase

As per their study, risk during construction phase and operation phase significantly affect cost of capital.

Lower (perceived) risks results into lower financing costs in case of RE projects by influencing investor's cost of capital. They have also stated categorically that debt term negotiated by lenders clearly involves assessment of risk mitigation measures. Perceived effectiveness of risk mitigating measures is very crucial in determining the financial parameters applied by the lenders and investors for the concerned project.

Study was with reference to OECD countries.

Burer and Wustenhagen (2009)[17] have conducted a survey of venture capitalist and private equity funds for the purpose of analysing the investor's preference for various kinds of available support mechanisms. About 60 venture capitalist and private equity investors were surveyed from Europe and North America. Result of their study concluded that Fit is the best perceived support mechanism. Investors were also asked to rank the possible major drivers of RE industry.

[17] Bürer, M. J., & Wüstenhagen, R. (2009). Which renewable energy policy is a venture capitalists best friend? Empirical evidence from a survey of international cleantech investors. Energy Policy, 37(12), 4997-5006.

Komendantova, N. et al. (2009)[18] conducted an empirical study in order to understand the risk perception and barriers in development of large RE projects in North African region. This study which is basically a stake holder driven empirical research in North Africa aims to identify the risks which are coming as barriers in the way of private investment in North Africa in RE capacities. Researchers identified nine classes of risks based on literature survey and preliminary interview. They are technical, construction, operating, revenue, financial, force majeure, regulatory, environmental and political. They also tried to estimate the likelihood of their happening. Findings of the study suggested that regulatory risk, political risk and force majeure risk are considered to be of grave concern by the experts. Six remaining risks are considered to be of medium to low importance.

Menichetti E. (2010)[19] in her doctoral thesis has stated that Solar PV is the fastest growing technology when it comes to Renewable Energy. Thus and in depth analysis of investors perception as to solar PV would be extremely beneficial. It is also stated that," policy plays a paramount role in increasing investor's confidence and decreasing the investment risk.

At the same time, however, policy can be perceived as an additional risk factor for investors. The study was based on a sample of European Investors.

Sophie Justice (2010)[20] states that the approach of finance sector is same when it comes to investment in RE sector or any other investment and central to any investment decision is the concept of risk and return. Financiers always want a return which is proportional to the risk which they undertake. That is more risk means

[18]Komendantova, N., Patt, A., Barras, L., & Battaglini, A. (2012). Perception of risks in renewable energy projects: The case of concentrated solar power in North Africa. Energy Policy, 40, 103-109.

[19]Menichetti, E. (2010). Renewable Energy Policy Risk and Investor Behaviour An Analysis of Investment Decisions and Investment Performance (Doctoral dissertation, University of St. Gallen).Graduate School of Business Administration, Economics, Law and Social Sciences. Retrieved on 12.12.2014 from http://verdi.unisg.ch/www/edis.nsf/SysLkpByIdentifier/3836/$FILE/dis3836.pdf:

[20]Justice, S. (2009). Private financing of renewable energy: A guide for policymakers. UNEP Sustainable Energy Finance Initiative. Retrieved on 12.12.2014 from http://fs-unep-centre.org/sites/default/files/media/financeguide20final.pdf:

greater return expectation. It is also stated that before investing in RE projects, both equity as well as provider of debt will do a detail risk assessment. Generally following risks are assessed:

1. Country and Financial Risks
    a. Country risks
    b. Economic risks
    c. Financial risks
    d. Currency risks
    e. Political risks
    f. Security risks

2. Policy and Regulatory Risks

3. Technical and Project Specific Risk
    a. Construction risk
    b. Technological risk
    c. Environmental risk
    d. Operation and Management risk

4. Market Risk

Richardson, R. and Wilkins. M. (2010)[21] in Standard and Poor's Report titled , "Can Capital Market Bridge the Climate Change Financing Gap" which is based on a Financing Round Table discussion held in London, clearly states that there is a stumbling block in the way of institutional investors allocating substantial capital to RE projects in developing countries. They have stated that institutional investors have both the ability as well as capacity to provide funds but funds from them can be mobilized only by providing sufficient risk adjusted return. Participants examined risks involved in providing capital for climate change financing and also identified barriers preventing institutional investors from investing. They analyzed and classified risks into various categories like:

[21]Richardson, R; and Wilkins. M. (2010). Can Capital Markets Bridge the Climate Change Financing Gap? Retrieved on 12.12.2014 from http://www.oecd.org/env/cc/49694789.pdf:

1. Most severe and highest probable risk
2. Most severe but less probable risks
3. Most probable but less severe risks etc.

Risks included in category 1) includes longevity, risk/reward imbalance, transaction cost risk, human and operational risk, economic risk and commodity price volatility

Risks included in category 2) includes unexpected policy changes, institutional and property rights, enforcement risk and scale risk.

Risks included in category 3) as identified by round table participants are Multitude risk, Inconsistency risk and Aggregation/commoditization risk.

The report also stated that this risk ranking exercise is a useful way to illustrate the obstacles in the way of capital deployment. Type of identified risks may not change substantially but the risk ranking may differ due to changes in global, economic and environmental conditions.

As per IEA(RETD) Report(2010)[22] it is categorically stated that as a result of years and years of research in the field of RE, there are number of technologies which are now matured and ready for market introduction. But despite this the progress is constrained due to the perception of associated risk and as a result of this there is still a gap existing between the promoters of Renewable Energy Systems and financing organization. It is also stated that for overcoming one of the key challenges which is obtaining finance and that too at a reasonable rate requirement is the ability of quantification and management of various elements of risk. They have suggested a RBS (Risk Break Down Structure) using PEST classification that is classifying risk into following four categories: Political, Economic, Social and Technical.

With Reference to Solar PV technology, specifically stated risks are:

1. Bottle necks in supply capacity and price volatility(E)

[22]Michelez, J., Rossi, N., Blazquez, R., Martin, J.M., Mera, E., Christensen, D., Peineke, C., Graf, K., Lyon, D. and Stevens, G. (2010). Risk quantification and risk management in renewable energy projects. Risk quantification and risk management in renewable energy projects. Retrieved on 20.12.2014 from http://www.iea-retd.org/files/RISK%20IEA-RETD%20(2011-6).pdf:

2. Medium term availability/cost when it comes to some of the key raw material from the module supplier angle(for example glass, silicon)(E)
3. Low entry barrier for entering into module manufacturing leading to unevenness in module quality(E)
4. Heavy dependence on a low cost component that is invertors. Due to its low cost, invertors gets neglected many a times affecting production negatively(T)
5. Price and Market Risk(E)
6. Vandalism(S)
7. Instability of support policies(P)
8. Overestimation of efficiency due to lack of in-field power rating of modules/systems(T)

It is stated that Risk Numbers 5,6, 7 have relatively high impact on ROE whereas 4,3,1,8 and 2 have medium to low impact on ROE. Risk numbers 5,6,7,8 also have significantly high impact on the debt leverage capacity whereas risk number 1,2,3,4 have medium to low impact on debt leverage capacity.

They also listed the possible options to control risk for each of these categories.

Table 3.3: Measures to Address Political Risk (IEA-RETD Report 2010)

Name of the measure	Type of measure	Impact on financing cost
Country(CDS)	Avoid	-->
Risk sharing schemes	Transfer	Reduce
Political risk insurance	Transfer	Reduce
Lobbying local government	Accept	→
Guarantee by the developer of an income start date that is that date after which investor would receive base case income	Transfer	Reduce
Engagement with government and articulating economic impact of delays	Avoid	Increase

Table 3.4: Measures to Address Economic Risk (IEA-RETD Report 2010)

Name of the measure	Type of measure	Impact on financing cost
JV and such other arrangements	Avoid	Reduce
Insurance	Transfer	Reduce
Guarantees	Transfer	Reduce
Derivatives and risk transfer approaches	Transfer	Reduce
Cash management options	Avoid	→

Table 3.5: Measures to address Social Risk (IEA-RETD Report 2010)

Name of the measure	Type of measure	Impact on financing cost
Integrated impact assessment	Avoid	Reduce
Specific measures of monitoring and mitigation identified through assessment	Avoid	Reduce
Stakeholder engagement	Avoid	Reduce

Table 3.6: Measures to address Technical Risk (IEA-RETD Report 2010)

Name of the measure	Type of measure	Impact on financing cost
Product Guarantee Insurance		Reduce
Insurance Weather		Reduce
Service Level Agreements		Reduce
		Reduce

Christopher Watts (2011)[23] has done a study based on the survey conducted by the Economic Intelligence Unit in West Europe, North America and Australia of companies operating RE Power Plant and also of those in distributing and selling power. Interview was also conducted of RE executives and other risk management experts. Finding of the study concludes that early stages of RE projects are more risky as compared to later ones. It is stated that funding is a major challenge for RE projects and also that sound risk management is very crucial for arranging finances. Following risks were considered in the study: Financial risk, Business/Strategic risk, Building and Testing risk, Operational risk, Environmental risk, Political/ Regulatory risk, Market risk and Weather related volume risk. Following are the findings of the study:

1. Financial risk is the most significant risk and regulatory and weather related volume risk is also very significant as stated by respondents.
2. Study states that RE sector is facing severe obstacles in risk management.
3. Insurance is commonly used to transfer risks. Contract is also used and use of financial derivatives is also increasing.
4. Study also states that in many instances companies are retaining regulatory risk and weather based volume risk, because of the lack of risk transfer product which can be considered as effective.

It is clearly stated in the report that funding is a challenge for RE projects and also that sound risk management is crucial for arranging funds.

As per David de Jageret.al(2011)[24] in Ecofys Report have clearly stated that Risk Management can be considered to be one of the keys for the deployment of RE as it influences the availability of finance. Following list is given by them as the main risks affecting access to finance. They have presented risks by technology and by country.

[23] Watts, C. (2011): Managing the Risk in Renewable Energy. A Report from the Economist Intelligence Unit Sponsored by Swiss Re. Retrieved on 10/05/2014 from www.economistinsights.com:

24 De Jager, D., Klessmann, C., Stricker, E., Winkel, T., de Visser, E., Koper, M. & Panzer, C. (2011). Financing renewable energy in the European energy market. Final report by Ecofys, Fraunhofer ISI, TU Vienna EEG and Ernst &Young, Ecofys, Utrecht. Retrieved on 20.12.2014 from https://ec.europa.eu/energy/sites/ener/files/documents/2011_financing_renewable.pdf:

1. Specific Risk by Technology:
    a. Planning and Development
    b. Access to grid/infrastructure
    c. Construction risk
    d. Operation Risk
    e. Resource Quality Risk

2. Risk by country
    a. PPA security
    b. Stability (Policy Risk)
    c. Uncertainty

They have concluded that Renewable Energy Projects being very capital intensive access to capital and its financing is the main issue and also that risk is a key parameter. They have also stated citing some previous works that availability of commercial insurance policies for certain specific technology and operational risk can increase the private sector investment in the RE sector more than 4 times. They have summarized various risk mitigation measures and have also stated that risk can be removed by removing barriers and sharing risk. Risk can be shared by Financial Instruments such as government loan guarantees, project participation etc.

They have clearly stated that for increasing the access of low cost finance involves measures to reduce financing risk.

This clearly highlights the significance of FRM in attracting Finance in RE sector.

S.Apak, E Atay and G Turner (2011)[25] have concluded that, "the risk challenges facing the renewable energy sector can be addressed through adequate technical assistance programmes that help project developers and others understand the benefits of financial risk management".

Study was conducted with reference to European Union and Turkey.

[25] Apak, S., Atay, E., & Tuncer, G. (2011). Financial risk management in renewable energy sector: Comparative analysis between the European Union and Turkey. Procedia-Social and Behavioral Sciences, 24, 935-945. Retrieved on 21.12.2015 from http://www.sciencedirect.com/science/article/pii/S1877042811015412:

Timilisina, Shvili, Narbel (2011)[26] have tried to analyse the various aspects of solar energy development for example technical, economical, policy etc. Despite the phenomenal growth and also the decline in the cost of solar energy, it is still costlier than conventional energy. There are still number of technical and financial barriers which we need to overcome, if we want a market driven deployment of solar energy and also discontinuation of costly policy support.

Muller, Brown and Olz (2011)[27], in their information of IEA have reviewed the strategic drivers for renewable energy and they have also identified the barriers to the deployment of RE technologies. They have identified following three principle reasons to be the strategic:-drivers for Renewable Energy

- Improvement of Energy Security
- For encouraging economic development
- Climate Protection

They have also stated categorically that challenges in deployment of Renewable can be summarized using the concepts of risk and return and for attracting investment, there should be right balance between the two. Higher the risk, higher the return. Public debate and political disclosure have been highlighting only the returns which are provided to investors whereas risk tends to be less prominent.

In the same report it has been stated that risks associated with RE Projects arises from both economic as well as non-economic barrier. Following is the broad classification of various Barriers for deployment of RE:

1. Techno economic barrier
2. Non-economic barrier: It includes:
    a. Regulatory and Policy Uncertainty Barriers
    b. Institutional and administrative barrier

[26] Timilsina, G. R., Kurdgelashvili, L., & Narbel, P. A. (2011). A Review of Solar Energy: Markets, Economics and Policies. World Bank Policy Research Working Paper Series. Retrieved on 12.12.2014 from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2011/10/17/000158349_20111017113749/Rendered/PDF/WPS5845.pdf:

[27] Ölz, S. (2011). Renewable energy policy considerations for deploying renewables. Retrieved on 12.12.2014 from http://environmentportal.in/files/file/Renew_Policies.pdf:

c. Market Barrier
d. Financial Barrier
e. Infrastructure Barrier
f. Lack of awareness and skilled personnel
g. Public acceptance and environmental barriers.

B. Rivza, S. Rivza, P. Rivza (2012)[28] have stated that specific features of each risk group should be taken into consideration while choosing suitable or preferable risk management option. For example in case of property risk, there has to be a risk transfer by means of property insurance whereas for management of legislative risk, the requirement is to monitor it. For production, personnel or environmental risk, they refer to risk reduction and at times risk acceptance.

They have researched on the risk assessment and on the choice of risk management alternatives in case of RE production from agriculture biomass in Latvia.

S. Rivza, P Rivza (2012)[29] have tried to summarize the various risk management studies in Renewable Energy production. As per them, "Risk is the multiplication of probability of an event occurrence and its significance level of potentially unfavourable consequences". They have also stated that there is no unanimous definition or classification of risks. Though there are various ways classifying risk, like according to class, risk force and also risk condition, but when it comes to sector of Renewable Energy Production, risk classification is mostly related to the cause of risk.

[28]Rivza, B., Rivza, S., & Rivza, P. (2012, January). Risk assessment in renewable energy production from agriculture biomass in Latvia. In Proceedings of the Latvian Academy of Sciences. Section B. Natural, Exact, and Applied Sciences. (Vol. 66, No. 1-2, pp. 54-58). Retrieved on 12.12.2014 from http://www.degruyter.com/dg/viewarticle.fullcontentlink:pdfeventlink/$002fj$002fprolas.2012.66.issue-1-2$002fv10046-011-0047-8$002fv10046-011-0047-8.pdf?t:ac=j$002fprolas.2012.66.issue-1-2$002fv10046-011-0047-8$002fv10046-011-0047-8.xml:

[29]Rivza, S., & Rivza, P. (2012). Risk management in renewable energy production. In International Scientific Conference: Renewable Energy and Energy Efficiency, Jelgava (Latvia), 28-30 May 2012. Latvia University of Agriculture. Retrieved on 12.12.2014 from http://agris.fao.org/agris-search/search.do?recordID=LV2012000724:

Authors in the research paper have classified the risks in RE production into basic five groups based on the cause of Risk. They are: personnel, production, property, environment and legislative risks.

They have also stated that this is a generic classification subject to modification for specific need of RE production.

Risk Management cycle has got four basic element:

1. Identification of aims and context
2. Identification of risk
3. Assessment of risk/ risk level
4. And finally implementation of risk management activities.

Whereas risk monitoring and prevention are to be implemented at all stages. In field of RE, quantitative risk assessment methods are commonly used though semi quantitative methods can also be used as the method of risk assessment here is based on aim and context of specific risk assessment. After this steps measure needs to be developed and implemented for the future management of identified and assessed risk.

Okro and Madueme (2012)[30] have stated that whether it is developing or developed country, the electrical energy can be considered to the pivot of all developments. Because of the fact that conventional sources of energy is finite and also depleting faster, researchers have started considering solar as a source of RE. They have also stated that higher investment cost of solar technology might be a deterrent to investors. They have highlighted the merits of solar energy technology for a developing country. They have studied the state of traditional source of energy generation and the state of solar energy research in Nigeria.

Jon Warren (2012) [31]has mentioned the list of risks which affect solar power projects

[30]Okoro, O. I., & Madueme, T. C. (2012). SOLAR ENERGY: A NECESSARY INVESTMENT IN A DEVELOPING ECONOMY. Nigerian Journal of Technology, 23(1), 58-64.Retrieved on 10.12.2014 from http://www.ajol.info/index.php/njt/article/viewFile/123333/112876:

[31]Warren. J. (2012). Assessing the Risks in Solar Project Development. Retrieved on 10.12.2014 from www.Renewable Energy World.com : http://www.renewableenergyworld.com/articles/2012/02/assessing-the-risks-in-solar-project-development.html:

in the entire life time of the project. They are:

1. Construction risk.
2. Company risk
3. Environmental risk.
4. Financial risk
5. Market risk
6. Operational risk
7. Technology risk
8. Political and regulatory risk
9. Climate and weather risk
10. Sabotage, terrorism and theft risk

These risks add to uncertainty in the revenue and profitability.

Schwabe,P et al(2012)[32] in their NREL technical report have stated that lack of historical and publicly available data which can address the RE risks is considered to be one of the greatest challenges in attracting untapped capital. The historical data can be used to assess risk and can lead to development of solution through financial innovation.

This report clearly concludes that in order to improve the ability of developers to raise low cost capital, risks in RE investment needs to be understood better as this will lead to improved evaluation of risk and thus risk can be appropriately mitigated.

Luethi, S.; Wuestenhagen, R. (2012)[33] have suggested that investors while taking a decision of PV investment in different countries weigh returns induced by Feed in Tariff against a set of policy risk and then choose the country which has most favourable risk return profile. Authors empirically tested this on the basis of preference survey conducted of European PV project developers. The finding of the

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[32]Schwabe, P., Mendelsohn, M., Mormann, F., & Arent, D. (2012). Mobilizing Public Markets to Finance Renewable Energy Projects: Insights from Expert Stakeholders. National Renewable Energy Laboratory Technical Report No. NREL/TP-6A20-55021. Retrieved on 12.12.2014 from www.nrel.gov/docs/fy12osti/55021.pdf*:*

[33]Lüthi, S., & Wüstenhagen, R. (2012). The price of policy risk—Empirical insights from choice experiments with European photovoltaic project developers. Energy Economics, 34(4), 1001-1011.

study confirmed the significance of non-economic barriers such as political instability and length of administrative process when it comes to deployment of RE. Their analysis shows that project developers consider the duration of Administrative Process followed by Feed in Tariff as the significant attribute when deciding about investment in Solar Project in any given country. They showed that price tag can be attached to any given specific policy risk. For any given policy risk, their study provided of the evidence for the level of risk premium that can be demanded by project developers.

The paper also states that there is very little empirical evidence as to how policies and risks are perceived actually by project developers and investors.

Wustengen, R; Menichetti, E. (2012)[34] have concluded that for investment decisions risk and returns are important drivers. Hence policy makers when aiming at increasing the share of renewable energy should do everything, they can for reducing risk and providing adequate return. In this world of bounded rationality, perception matters. Thus surveying investor's attitude and preference can help in identifying those risks which are perceived as more relevant in particular. This paper clearly states that the investor/ project developer perspective need to be taken into consideration. Author also suggests that seeing the heterogeneous nature of Renewable Energy investors, there has to be a segmentation of policies.

It also states that investment in RE has grown significantly in past decade and this is to a greater extent due to support of policy. But this support is creating opportunities but at the same time also posed risk for investors.

Griffith Jones; S, Ocampo , J.A. and Spratt, S. (2012)[35]have reviewed the financing instruments currently used in developing countries and tried to analyse the reasons as to why the flow of investment in RE sector is not to the extent required. They have identified following three obstacles in the way of RE private projects:

[34]Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. Energy Policy, 40, 1-10.

[35]Griffith-Jones, S., Ocampo, J. A., & Spratt, S. (2012). Financing renewable energy in developing countries: mechanisms and responsibilities.European Report on Development. Retrieved on 10.08.2013 from http://www.stephanygj.net/papers/Financing_Renewable_Energy_in_Developing_Countries.pdf:

1. RE Economics: Economics of RE which is not generally competitive that is cost of production per unit of energy is generally higher than that for conventional energy

2. Inadequate Investment: Though RE investment has increased (total of Private and Public), from US$41 billion in 2004 to US$ 268 billion in 2010, it is still much below the desirable level due to variety of factors, some global and some local.

3. Uncertainty and Risk: Following are important points regarding this-

    a. Investors are most bothered with the apparent mismatch between nature of capital commitment which is long term (20-50 years) and of time frame of climate change regulations which is mostly short term.

    b. There is a severe Risk Reward imbalance. Investors consider risk to be severely high.

Paper also recommends various alternatives for the above mentioned barriers like raising the cost of fossil fuels, lowering the cost of Renewable, ways to boost the return from renewable and also various mechanisms for increasing the supply of suitable financing for RE projects like Green Bonds and also various options for public finance mechanisms like Corner stone Funds, Challenge Funds etc. They have also recommended various mechanisms for reducing risk and uncertainty like guarantees, insurance etc.

Paper concludes that for motivating private investors to substantially increase their investment in risky and relatively unprofitable activities like RE, attractiveness of these RE investments should be increased by suitably changing the underlying economics.

IRENA (2012)[36] in Renewable Energy Technologies: Cost Analysis Series have stated that the relative cost disadvantage can be expected to reduce due to rising demand for

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[36]IRENA (International Renewable Energy Agency) (2012). Renewable Energy Technologies: Cost Analysis Series. Volume 1: Power Sector. Issue 4/5, Solar Photovoltaics, June 2012, Abu Dhabi. Retrieved on 12.12.2014 from www.irena.org : https://www.irena.org/DocumentDownloads/Publications/RE_Technologies_Cost_Analysis-SOLAR_PV.pdf:

power and also due to increasing trend in increase of fuel price. As calculated by IRENA, due to economies of scale in production and increasing deployment results in lowering of international PV module cost by 22% with every doubling of production capacity. Thus there is a rationale in promoting solar technology and attempt should be to reach grid parity as soon as possible.

Kaminker, C.H; Stewart, F. (2012)[37] have stated that there is a limited institutional investment in clean energy projects. Reasons identified for these includes lack of information, expertise and lack of appropriate investment vehicles providing appropriate risk return profile needed by institutional investors for managing specific risks of RE projects. It is estimated that not even 1% of pension fund's assets are allocated globally to infrastructure projects. Following are some of the reasons identified as acting as barriers for institutional investment in clean energy:

1. Inappropriate risk/ return profile
2. Special species of risk
3. Lack of appropriate investment vehicle.

Paper also cites Technology risk and buyer risk as the main barrier coming in the ways of institutional investors financing clean energy projects.

Mendelsohn, M. et al (2012)[38] in the NREL Report have stated that financial structure having project level debt generally tend to have lower cost of capital and also power cost. Study which is based on interview with RE industry financing experts in US also concluded that selection of a financial structure is more often based on various non-cost considerations or risk parameters which are project specific.

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[37] Kaminker, C., & Stewart, F. (2012). The role of institutional investors in financing clean energy. *OECD* Working Papers on Finance, Insurance and Private Pensions, (23), 1. Retrieved on 12.12.2014 from http://www.oecd.org/environment/WP_23_TheRoleOfInstitutionalInvestorsInFinancingCleanEnergy.pdf:

[38] Mendelsohn, M., Kreycik, C., Bird, L., Schwabe, P. & Cory, K. (2012). The Impact of Financial Structure on the Cost of Solar Energy. *Contract*, *303*, 275-3000. Retrieved on 12.12.2014 from http://www.nrel.gov/docs/fy12osti/53086.pdf:

As per BNEF Report (2013)[39], Sound risk management is extremely important for attracting capital. Financial Risk Transfer Mechanism will compliment several other risk management measures in a significant way. This study was conducted in a six leading market for RE, Australia, China France, Germany, UK and US. Report also states that solar sector has seen maximum insurance activity. With a focus on Wind and Solar Projects, they have listed a complete set of risks which needs to be managed along with the various possible options of managing them.

Table 3.7: Set of Risk affecting Solar and Wind Power Projects as per BNEF Report (2013)

1. Construction Risk a. Loss or damage b. Delay in start up	a. Due diligence, insurance over b. Insurance cover
2. Operational Risk a. Loss, damage and failure b. Business Interruption(due to equipment failure or natural catastrophe)	a. Insurance, manufacturer warranties, O&M contract b. Insurance, manufacturer warranties, O&M contract
3. Market Related Risk a. Weather b. Curtailment c. Power Price d. Counter Party risk	a. Insurance Cover b. Insurance Cover c. Production contingent, weather contingent , power price hedging d. There is less demand for the products covering this risk as this risk is considered to be very unlikely to happen as per developers and owners. However product might be similar to credit risk cover
4. Policy Risk	This situation is slightly more difficult to predict and hence probably more expensive to insure. Product with all inclusive cover caters for this category of risk.

Report concludes that as RE sector is evolving, management of risk becomes more significant. All the issues which put the projects return into risk become more and more important.

[39]Turner, G., Roots, S., Wiltshire, M., Trueb, J., Brown, S., Benz, G., & Hegelbach, M. (2013). Profiling the risks in solar and wind: A case for new risk management approaches in the renewable energy sector. *Swiss Reinsurance, Zurich*. Retrieved on 08.01.2015 from http://about.bnef.com/white-papers/profiling-the-risks-in-solar-and-wind/:

Nelson, D; Pierpont, B. (2013)[40] in CPI report titled," The Challenge of Institutional Investment in Renewable Energy" have stated that policy makers are now looking towards Private Capital to be a key source for funding climate change related Infrastructure Projects that is RE projects. They on the basis of interview of more than 25 pension funds, insurance companies, as well as RE developers, consultants, bankers in North America, Austria, Europe have stated that Institutional investors are important as they offer a huge sum of investment for a long time horizon as well as aid in reducing the financing cost as they have different risk/ return expectation when compared to other market participants.

Waissbein, O.; et.al (2013)[41] in have clearly stated that globally many developing countries are struggling to meet their energy demand. Renewable Energy seems to be a viable option due to various reasons. But they have clearly stated that a barrier for a complete transition lies not only in technology cost but in securing long time finance which is affordable. They have also stated that financing cost is the key determinant of cost of power generation from RE sources as RE sources requires huge upfront investment and private sector has to be in for front for scaling up RE development in developing countries. This higher financing cost in the developing country is the reflection of large number of perceived or actual technical, regulatory, financial, information and administrative barriers and their associated investment risk.

Key conclusion of the report is that it is extremely important to address the risk in an integrated and systematic manner. It is clearly shown in the report that there are ranges of risks in RE investment environment. Report also concludes that it is more cost effective to bring down the financing cost of RE by investing in de risking measures than to give direct financial incentives for compensating investors for higher risks. Task of addressing investors risk has led to development of wide range of public instruments which can be divided into two categories:

[40] Initiative, C. P., Nelson, D., & Pierpont, B. (2013).The Challenge of Institutional Investment in Renewable Energy. CPI, San Francisco. Retrieved on 12.10.2014 from http://climatepolicyinitiative.org/wp-content/uploads/2013/03/The-Challenge-of-Institutional-Investment-in-Renewable-Energy.pdf:

[41] Waissbein, O., Glemarec, Y., Bayraktar, H., & Schmidt, T. S. (2013). Derisking renewable energy investment. A framework to support policymakers in selecting public instruments to promote renewable energy investment in developing countries. United Nations Development Programme (UNDP), New York, NY (United States). Retrieved on 12.12.2014 from http://re.indiaenvironmentportal.org.in/files/file/Derisking-Renewable-Energy-Investment.pdf:

1. Policy de risking instruments
2. Financial de risking instruments

Based on their modeling exercise in Kenya, Panama, Mongolia and South Africa, for wind power they have suggested a framework for increasing RE investment. They in their modeling exercise have considered the following categories of risks as those affecting the cost of financing, that is cost of equity and cost of debt.

Associated risks affecting the cost of equity

1. Power market risk
2. Permits risk
3. Social Acceptance risk
4. Grid Integration risk
5. Counter party risk
6. Financial Sector Risk
7. Political risk
8. Currency/ Macro- economic risk

Risk Affecting cost of debt

1. Power market risk
2. Social acceptance risk
3. Grid integration risk
4. Counter party risk
5. Political risk
6. Currency/ Macro Economic Risk

As per conclusions from south Africa which is a country with high sovereign ratings power market risk and currency/ macroeconomic risks have high impact on financing costs whereas permit risk, grid integration, counter party risk and financial and political risk have low impact on financing cost.

Lowder, T. et al (2013)[42] have specifically mentioned with reference to US that as the Solar (PV) industry approaches maturity, importance of successful risk management practices in ensuring the investor's confidence, cost control and in facilitating further growth increases. Risk Management tools in PV sector offers significant cost reduction opportunities. PV projects today are subjected to higher financing cost partially due to market's perception of associated risk. If these risks can be successfully managed leading to enhancement of investors' confidence, this will lead to significance reduction in cost of capital ultimately leading to lower cost of energy, enhancing the competitiveness of Solar PV and also reducing the reliance on subsidies. As per them, the first step in risk management is identification of risk. They have divided PV project risk into two categories:

1. Technical Risk
2. Non-Technical Risk

Both the categories of risk have been further divided into Development stage risk and operational risk.

Following is the list of technical risks during project development:

Resource Estimation, Component specifications, System Design, Performance Estimates and Acceptance/ Commissioning Testing, Site Characterization, Transport/ Installation Risks. Of all these risks it is resource estimation and performance estimates and acceptance / commission testing which could probably affect the debt servicing capability directly.

The technical risk during the operational phase includes Operations and Maintenance Risk (O&M) Risks and Off-Taker Infrastructure Risks.

Following is the list of nontechnical development risk:

Transmission/ Distribution and Interconnection, Developer Risk, Power Purchase Agreement and Pricing, Construction Risks, Policy/ Regulatory Risks, Insurability, Site control.

[42] Lowder, T., Mendelsohn, M., Speer, B., & Hill, R. (2013). Continuing Developments in PV Risk Management: Strategies, Solutions, and Implications. Contract, 303, 275-3000. Retrieved on 12.12.2014 from http://www.nrel.gov/docs/fy13osti/57143.pdf:

Non-Technical Operational Risks includes Credit/ Default risk, Power Purchase risk, off- taker risk, Duration of revenue support, Insurance. Weather and resource risk.

As per then, almost all the risk which is non-technical can affect the financier's commitment to provided money as well as hurdle rate. Study clearly states that since financiers depend upon the cash flow of any project, any risk adversely affecting revenues is relevant in their decision to borrow or lend as investors are highly risk averse.

Frisari G. et al (2013)[43] have stated that, "Risk whether it is perceived or real is considered to be the single most important factor coming in the way of projects finding its investors or escalating the return expected by investors. The risk and its perception changes from project to project basis, from technology to technology, from one industry to another and also from one country to another country. The difference in financing cost comes from this variation between projects risks. Green Investments are perceived to be more risky as they depend a lot on public policy, use relatively immature and unproved technology, industry and market. In their study risk was grouped into following four categories:

1. Political, policy and social risk: This category includes following risk types:

Public Governance/ Corruption, Legal and Ownership rights, permitting/Sitting, Policy, private governance/ Reputation/Social Opposition. Of all these impacts of policy risk is to lower the revenues and increases the required rate of return as a response.

2. Technical, physical risk: It includes Constructions, Environmental (Impacts/Acceptance), Reliability of output, Operations and Management, Decommissioning. These risks also lead to increase in the required rate of return.

3. Market, commercial risk: This category includes following risk types: Currency risks, Output price volatility, Market based Environmental Instruments Volatility,

[43] Frisari, G., Hervé-Mignucci, M., Micale, V., & Mazza, F. (2013). Risk Gaps: A Map of Risk Mitigation Instruments for Clean Investments. Climate Policy Initiative. Retrieved on 12.06.2014 from http://climatepolicyinitiative.org/:http://climatepolicyinitiative.org/wp-content/uploads/2013/01/Risk-Gaps-A-Map-of-Risk-Mitigation-Instruments-for-Clean-Investments.pdf:

Access to Capital, counter party/credit risk, Investment Liquidity/ Exit. All these risks are born by project sponsors and debt investors leading to increase in required rate of return.

4. Outcome risk.

They have also identified six categories of risk mitigation instrument:

1. Bilateral Contracts (For construction and O&M risks, Reliability of output, Currency, Out price, Environment market risks etc.)
2. Credit enhancement instruments like guarantee funds(Access to capital, Counter party)
3. Insurance (Political risk, private governance, Construction and O&M, environment)
4. Revenue support policies (Environment markets, output price)
5. Direct concessional investment (Currency, access to capital, currency)
6. Indirect political/institutional support (Political, Private governance, reputation and social, Environment, Reliability of output, outcome risk).

They have concluded that overall level of perceived risk is higher in developing market as compared to developed market. Risk mitigation instruments seem to address only political and not policy risk. Perception of financing risk is more due to perceived weakness of domestic markets and financial institutions. These financing risk are mostly addressed using concessional resources which neither improves liquidity of investment nor serve to attract private finance.

As per the report there is a gap in the risk coverage both in developed as well as developing markets. Their analysis is based on several workshops, interviews with investors, insurers, bankers etc.

David Nelson; Gireesh Shrimali (2014)[44] have clearly stated that RE financing in developing countries faces many daunting challenges. Debt is more expensive and also its availability is restricted in developing countries due to higher risks, inflation, immature financial markets and also lower saving rate of young population. In Solar PV the initial capital cost comprises around 90% of the total project cost, whereas in case of coal and gas, the proportion depends on fuel expenses which come in operating cost. Thus initial capital cost and its financing are approximately 60% more significant for RE projects and since most RE projects use debt directly at project level or indirectly for reducing financing cost, it can be said that one of the critical driver of RE cost is the availability of low cost debt.

Gatzert N and Kosub, T. (2014)[45] have presented in a very comprehensive manner, the current risk and risk management options in case of renewable energy projects from the investor's perspective. They have focused on onshore and offshore wind projects in European markets. As per their study, Policy and regulatory risk is the major barrier coming in the way of investments in Renewable Energy Projects. They have also concluded that there is a limited insurance coverage and also the limited availability of alternative risk mitigation instruments.

Cucchiella, F., D'Adamo, I., & Gastaldi, M. (2015)[46] have used NPV technique to analyse the profitability of potential investment in Renewable Energy Electrical power facilities of small medium and large size. This analysis can be used for strategic decision on energy portfolio and plant size. Authors have applied this to Italian cases.

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[44] Nelson, D. & Shrimali, G. (2014). Finance mechanisms for lowering the cost of renewable energy in rapidly developing countries. Climate Policy Initiative. Retrieved on 21.07.205 from http://climatepolicyinitiative.org/: http://climatepolicyinitiative.org/finance-mechanisms-for-lowering-the-cost-of-renewable-energy-in-rapidly-developing-countries/:

[45] Gatzert, N., & Kosub, T. (2014). Risks and Risk Management of Renewable Energy Projects: The Case of Onshore and Offshore Wind Parks. Retrieved on 21.08.2015 from :http://www.actuaries.asn.au/Library/Events/ASTINAFIRERMColloquium/2015/3aThomasKosubRisk.pdf:

[46] Cucchiella, F., D'Adamo, I., & Gastaldi, M. (2015). Financial analysis for investment and policy decisions in the renewable energy sector. Clean Technologies and Environmental Policy, 17(4), 887-904 Retrieved on 21.12.2015 from http://link.springer.com/article/10.1007/s10098-014-0839-z:

Ecofys report (2016)[47] a study was conducted across European Union Member states focusing on shore wind projects. They have identified 9 categories of risks influencing investment decision of fund providers. They are, "country risk, social acceptance risk, administrative risk, financing risk, technical & management risk, grid access risk, policy design risk, market design & regulatory risk and sudden policy change risk". Other than country risk, policy design risk is ranked to be in the category of most severe risk. Other risks which were mentioned frequently in the category of top three include administrative, market design and regulatory risk and also grid access risk. In some countries, risk of sudden policy change was also given very high ranking. They have included both debt and equity providers in their study.

3.3 Review of Studies conducted in Indian Context

Jain (1986)[48] estimated while forecasting the demand for non-conventional source of energy that approximately after every fifteen year the demand of energy doubles its present consumption rate.

Devdas (1988)[49] stated that plenty of sunshine is available in India for approx. 8 months in a year. It comes out to be around 3000 hour of sunshine per annum. Thus India has significant chance of producing solar energy.

Moorthy R.C (1990)[50] has discussed the technological development in India in the various nonconventional sources of energy such as Solar, Wind, Ocean, Thermal, Biogas etc.

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[47] Noothout, P., de Jager, D., Tesnière, L., van Rooijen, S., Karypidis, N., Brückmann, R., Jirouš, F., Breitschopf, B., Angelopoulos, D., Doukas, H. and LEI, I.K. (2016). The impact of risks in renewable energy investments and the role of smart policies. DiaCore project final report work package, 3. Retrieved on 31.03.2016 from www.ecosys.com: www.ecofys.com/files/files/diacore-2016-impact-of-risk-in-res-investments.pdf*:*

[48] Jain, H.C, (1986), Non Conventional Source of Energy, New Delhi, Sterling Publishers Pvt. Ltd, 1986, pp 1-3.

[49] Devadas R.P, (1988), Management of development Programmes for Women and Children, Vol.II. Coimbatore. Saradalaya Press.

[50] Moorthy R.C. (1990). Indian Energy Scenario. Yojana,,Vol 34/ No. 21 November 1990 pp 4-6.

Ghosh, D., Shukla, P.R., Garg, A. and Ramana, P.V. (2001)[51], have stated that high risk perception in most of the Renewable Energy Technology comes due to uncertainty about performance of technology and also due to low level of information and awareness about technology. This is especially true for solar.

Peter, R. and Dickie, L. (2004)[52], in their empirical study have tried to identify and empirically examine the barriers coming in the way of adoption of RE Technology especially Solar Based. Grouping of Barriers can be done into three different categories:

1. Financial Barriers
2. Lack of Awareness
3. Technical Barriers

They have clearly stated that the high initial cost of PV system is a major financial barrier. This clearly highlights the necessity of availability of sufficient finance through soft loans and that too at low interest rates.

Study also showed that lack of awareness and insufficient promotion support are also barriers in the way of commercialization of PV systems. Other noticeable barriers are related to apprehensions related to reliability of PV systems, high maintenance costs and also as to lack of performance standards.

They have clearly concluded that in Indian scenario, where there is chronic power shortage, PV systems are viable options and that there is an urgent need to remove the barriers coming in the way of adoption of PV systems.

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[51] Debyani, G., Shukla, P. R., Amit, G., & Ramana, P. V. (2001). Renewable energy strategies for Indian power sector. Retrieved online from 12.12.2014 from http://www.decisioncraft.com/energy/papers/new/strategy.pdf:

[52] Raja Peter and Laurence Dickie (2004). An Exploratory Study of the Barriers to Commercialization of Solar Based Technology in Indian Business Environment. Academy of World Business, Marketing & Management Development Conference Proceedings Vol 1, No. 1. Retrieved on 01.06.2014 from https://www.massey.ac.nz/massey/fms/Colleges/College%20of%20Business/Communication%20and%20Journalism/Staff/Staff%20research%20files/RPeter/An%20exploratory%20study%20of%20the%20barriers%20to%20commercialisation%20of%20solar%20based%20technology%20in%20the%20Indian%20business%20environment.pdf:

Kesari J.P. (2008)[53] has stated that RE sector has great potential. India has abundance of sunshine and also possesses the capability to leverage this source of energy. Private Player's participation is required in a big way to bring in the requisite change by bringing new technology and also increasing volumes. This will ultimately bring down the cost of generating electricity.

SC Bhattacharya and Chinmoy Jana (2009)[54] have discussed the historical development of various renewable energy technologies in India and have compared the development in India with the development taking place in various other countries. They have concluded that the significance of Renewable Energy in India is expected in increase in future. As per them, Private sector participation, favourable environment created by the government and the low cost of wind power are the factors making wind power the most successful Renewable Energy Programme in India. They have also stated that Solar Installation has been low in India when compared the outside world.

As per World Bank Report (2010)[55] approximately 37% of the developers felt and recognized that solar irradiation data is one of the significant barrier having key effect on solar power project financing in India. They have classified barriers into following categories:

1. Policy and Regulatory Barrier
2. Infrastructure Barriers
3. Solar irradiation data related barriers
4. Technology and Financing Barrier

[53] Kesari. J.P, (2008). SOLAR Evalgelist, Solar Energy Review, December, pp-36-38.

[54] Bhattacharya, S. C., & Jana, C. (2009). Renewable energy in India: historical developments and prospects. *Energy*, *34*(8), 981-991. Retrieved on 12.12.2015 from http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue45/bibliography/Renewable%20energy%20in%20India%20Historical%20developments%20and%20prospects.pdf:

[55] Kulkarni, A. (2010). Report on barriers for solar power development in India. South Asia Energy Unit, Sustainable Development Department, The World Bank. Retrieved on 19.01.2014 from https://www.esmap.org/;https://www.esmap.org/sites/esmap.org/files/The%20World%20Bank_Barriers%20for%20Solar%20Power%20Development%20in%20India%20Report_FINAL.pdf:

Sixty three percent of respondents believe that policy and regulatory barriers is most significant. Once all barriers are taken care of, financing should not be a problem. As per them the main risks affecting financing as per developer is PPA risks that is poor bankability of PPA and solar radiation data risk .This study was conducted by World Bank in order to understand the barriers on the ground level faced by developers. 25 developers were interviewed as a part of the study.

Shah (2010)[56] have clearly stated that , "Banks have expressed concerns about lending to this new sector, including worries that solar equipment may not perform as expected under Indian climatic conditions, which would affect projects ability to produce enough power to pay back loans".

In article, "Switching in India's Solar Future" published in Indian Express (2010)[57], it is clearly stated that for improving the success rate of solar, Government of India should create a clear and very consistent regulatory environment.

G. Sargsyan et al (2011)[58] in World Bank Study have clearly stated that India has about 150 GW of RE potential and developing this source of energy can go a long way in increasing the energy security, reducing the adverse impact on the environment as well as reducing the carbon emissions and can also contribute towards regional development as well as development of high tech industries. This study which is based on the data from approx. 180 Renewable Energy Developers across 20 Indian States are has tried to analyze the relevance of RE development in Indian Context and also as to the economic feasibility of RE development and steps needed to realize the RE potential.

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56 Shah, A. (2010, December). India solar energy headed for a crash as unknown firms win JNNSM solar PV auction. Retrieved on 03.04.2012 from: www.greenworldinvestor.com: .http://greenworldinvestor.com/2010/12/08/india-solar-energy-headed-for-a-crash-as-unknown-firms-win-jssm-solar-pv-auction/:

57 Indian Express (2010, November), Switching on India's solar future. Retrieved on 12.12.2014 from www.indianexpress.com:http://archive.indianexpress.com/news/switching-on-india-s-solar-future/714123/:

58 Sargsyan, G; Bhatia, M; Banerjee, S.G., Raghunathan, K., Soni, R. (2011), Unleashing the Potential of Renewable Energy in India. World Bank Study. ISBN: 978-0-8213-8780-1. Retrieved on 13.06.2014: http://www.energyaccess.in/sites/default/files/Unleashing%20the%20Potential%20of%20Renewable%20Energy%20in%20India.pdf:

Study clearly concludes that there are significant financial as well as non-financial barriers to RE development in India. They grouped the barriers into three categories:-

1. Financial Viability
2. Support Infrastructure
3. Regulatory approval.

Based on discussions with various stakeholders, study clearly concludes that Recognition and Management of Risk is Crucial for RE development.

As per Engelmeier, T.et al. (2011)[59], an estimate suggests that only even if 1% of India's land mass is used for installing solar capacity, the solar capacity in India would reach 800 GW. However solar power prices yet cannot compete when it comes to conventional source of energy. In July, 2011 cost of solar power from utility scale system was three times more as compared to that of coal power.

As per WISE Report (2011)[60], it is clearly stated that:

1. High untapped solar potential is extremely important from the energy security angle.
2. Report also states that banks are reluctant to lend to RE sector due to some real, some imagined risk perceptions.
3. Lenders are also not willing and very reluctant to provide non-recourse project financing for RE projects.
4. To improve lenders perception, risk mitigation measures are essential
5. Prevailing interest rate in debt are prohibitive and is the single most important factor making the Renewable Energy Projects not viable. Interest rate should be brought down.

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[59]Engelmeier, T., Anand, M., Basant, S., Tyagi, Shivansh. (2011). The Indian Solar Market: Strategy, Players and Opportunities, Boston, Mass: Greentech Media.

[60]WISE (2011). Achieving 12% Green Electricity by 2017. Retrieved on 11.10.2014 from http://wisein.org/:http://wisein.org/WISE_Projects/Final_12_RE_Report.pdf:

Siddharth Gaurav et al (2011)[61] have clearly stated that there is a history of targets being missed in case of solar energy projects in India. They have done an extensive literature analysis about the target achievement of solar projects. They have also identified the need of future research for ranking and categorizing the risk to identify the reasons for missing the targets. They have clearly stated that that there is high risk of time and cost overrun in solar projects. However this risk can be moderated by standard insurance cover and by transferring the risk through a turnkey contract to construction contractor. They have concluded that one important hurdle coming in the way of achievement of renewable energy target is the poor state of risk management in India. The paper also recommends the research to examine the risk management strategies adopted in solar project. They have classified major risks associated with Solar Power Projects into following four categories:

1. Political
2. Financial
3. Social
4. Technical.

Sharma, N.K. et al (2012)[62] have stated that:

1. India is facing severe problem of electricity shortage. Various Renewable Energy Sources have potential to provide solution for various kinds of energy problems of developing countries like India.
2. Solar Energy can be genuinely considered to be an important part in capacity addition as well as for increasing the energy security.
3. Development of solar energy can also be an important tool for regional economic development in India as there are many underdeveloped Indian states which are having very high potential for solar power generation.

[61] GAURAV, S., CHILESHE, N., & M.A, T (2011). Project Risk Analysis of Solar Energy Project Delays in India. Solar 2011, the 49th AuSES Annual Conference. on 10.08.2015 from https://www.researchgate.net/profile/Nicholas_Chileshe/publication/265729356_Project_risk_analysis_of_solar_energy_project_delays_in_India/links/541a5ae00cf203f155ae2320.pdf:

[62] Sharma, N. K., Tiwari, P. K., & Sood, Y. R. (2012). Solar energy in India: Strategies, policies, perspectives and future potential. Renewable and Sustainable Energy Reviews, 16(1), 933-941.Retrieved on 12.05.2015 from http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue45/bibliography/Solar%20energy%20in%20india%20strategies%20policies%20perspectives.pdf:

4. Western Rajasthan has the maximum irradiance whereas North Eastern region of country have the least.

Authors concluded that photovoltaic power system will have important share in future electricity in India as well as all over the world.

Anuj R Chadha (2012)[63] has described the usefulness of Solar Energy and also technological innovations for making it more affordable. They have also stated that since solar energy is more expensive as compared to conventional energy, government needs to take measures for financing and should also establish R&D centers for promoting technological innovation in the sector.

Nelson D. et al. (2012)[64] have clearly stated that, despite of India having cost advantage in renewable energy in terms of cheap labor and construction cost, cost of Renewable Energy is as high in India as in US or even higher and that is due to higher financing cost. High cost of debt is the most significant problems in the field of Renewable Energy Financing. They have concluded that the high interest rate and relatively short term durations amounts to additional 24-32% increase in cost of renewable energy here in India as compared to the projects of similar nature in US or Europe.

It is also categorically stated that in the report that domestic banks generally restrict the funds to be lend to RE power projects. They have stated that less than 1/3 of Public Sector Banks and less than 1/5 of private sector banks lend to RE projects. Banks have cited unfamiliarity with the RE sectors and perceived riskiness of RE project as the reasons for the same. It is also stated that there is a clear distinction between lenders and equity providers when it comes to RE finance. Debt financiers are more conservative as compared to equity investors.

[63] CHADHA, A. R. (2012) . FUTURE OF SOLAR ENERGY IN INDIA AND EFFICIENCY IMPROVEMENTS BY OPTIMISATION. Research and Development (IJCSEIERD), 2(2), 41-46. Retrieved on 01.02.2015 from http://pakacademicsearch.com/pdf-files/env/243/41-46%20Vol.2,%20Issue%202%20June%202012.pdf:

[64] Nelson, D., Shrimali, G., Goel, S., Konda, C., & Kumar, R. (2012) .Meeting India's renewable energy targets: The financing challenge. CPI-ISB Report, Climate Policy Initiative. Retrieved on 01.02.2014 http://climatepolicyinitiative.org/:http://climatepolicyinitiative.org/publication/meeting-indias-renewable-energy-targets-the-financing-challenge/:

Sun-JooAhn and Dagmar Graczyk (2012)[65], "Understanding Energy Challenges in India: Policies, Players and Issues" have stated that:

1. One of the significant feature of RE power in India is that the proportion of private ownership is high
2. Private investment is the key driver of the growth of Renewable in India.
3. Land acquisition has been identified to be a major barrier for RE projects. With the increasing numbers of Re projects being executed, there is a tough competition for suitable land and this increases the capital cost.
4. Investment barrier including lengthy administrative processes and lack of adequate infrastructure should be removed.
5. There is a need of clearer strategy in order to increase the Renewable capacity if India and also to build a competitive Renewable Industry.

Sandeep Kumar Gupta and Raghubir Singh (2013)[66] studied the various state and national level schemes, incentives offered for promoting solar PV. They concluded that JNNSM first phase performed below expectations and in comparison state level policies have done much better. Keeping this in mind, JNNSM phase II has given more weightage to state schemes as compared to central scheme in terms of installation of target capacity.

David Appleyard (2013)[67], stated that the most pressing issue is the cost of debt and interest rate on capital when it comes for renewable energy development and also infrastructure development in India.

[65] Ahn, S. & Graczyk, D. (2012). Understanding Energy Challenges in India: Policies. Players and Issues, International Energy Agency (IEA), Partner Country Series. Retrieved on 12.12.2014 from http://www.iea.org/publications/freepublications/publication/India_study_final_WED.pdf

[66] Gupta, S. K., & Anand, R. S. (2013) . Development of solar electricity Supply system in India: an Overview. Journal of Solar Energy, 2013. Retrieved on 06.05.2015 from http://www.hindawi.com/journals/jse/2013/632364/

[67] David Appleyard (2013). Financing India's Small Hydro Capacity. Retrieved on 13.06.2015 from http://www.renewableenergyworld.com/articles/print/volume-16/issue-4/hydropower/financing-indias-small-hydro-capacity.html:

As per Deloitte Report(2013)[68] it is clearly highlighted that keeping in mind the proposed capacity addition of 30,000 MW in 12th five year plan in RE sector, it is calculated that investment required for the same works out to be 1.37 trillion Rs. Seeing this quantum of investment, challenge is to overcome the financing issues in RE sector. Report says that:

1. RE sector should be treated as a distinct sector from conventional power when it comes to sector limited determination for scheduled commercial banks.
2. It is also categorically mentioned in the report that risk in RE sector is high as compared to conventional power sector.
3. With special reference to Solar Power Project report highlights that poor bankability of solar project is a major concern. Most of the Projects under JNNSM have been financed using non-recourse basis. Despite of several of these projects accessing foreign capital, none of them have hedge cover.
4. There needs to be more participation of commercial banks that too on non-recourse basis and for this Central Government needs to create suitable risk intermediation measures so that commercial capital can flow into the sector.
5. Across the globe, Pension and Insurance funds play a lead role in long term Infrastructure Financing, but in India their participation is limited due to relatively fewer avenues. These funds prefer staying away from RE projects as these projects are considered risky.

Nexant Inc, Emergent Ventures India and SRC global Inc in their USAID report (2013)[69] have tried to identify various key issues needed to scale up RE financing in India. This report is based on research and inputs from various stakeholders. They have listed following as the major barriers for RE financing in India:

1. Policy level Barriers

[68] Deloitte, IEC (2013). Securing tomorrow's energy today: Policy and Regulations- Meeting the Financing Challenge in the Energy Sector in India. Retrieved on 12.04.2015 from http://www2.deloitte.com/in/en/pages/energy-and-resources/articles/meeting-the-financing-challenge-in-the-energy-sector-in-india.html:

[69] Nexant Inc (2013). Financing Renewable Energy in India: A review of current status and recommendation for innovative mechanism. USAID Report. Retrieved on 11.04.2015 from https://www.climatelinks.org/resources/financing-renewable-energy-india-review-current-status-and-recommendations-innovative:

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2. Market Based Barriers: It includes:
    a. Off – Taker Risk
    b. Fuel Risk
    c. Technology Risk
    d. Evacuation Risk
    e. Community Risk
    f. Lack of Exit Option

They have clearly mentioned the requirement of mechanism and products to reduce risk in RE investments. Based on interviews with practitioners in RE sector, this report gives various recommendations so that RE financing needs can be met. They have clearly recommended the designing of Insurance instruments for covering various risks faced by RE projects such as PPA, off Taker, resource, technology and project development risk. These instruments can help in attracting large scale, risk

averse lenders to invest in RE sector. They have listed following as Insurable risks for Indian RE projects:

1. Resource Risk
2. Technology Risk
3. Project implementation risk
4. Political risk, Regulatory risk
5. Machine Break down risk
6. Financial risks
7. Risk against force majeure risks.

Khanna, A; Garg, K. (2013)[70] in a World Bank Report have tried to evaluate the key objectives of Jawaharlal National Solar Mission(JNNSM) and identified the following key barriers coming in the way of meeting the target of 20GW of grid connected solar power by 2022:

1. Inadequate participation of Scheduled Commercial Banks when it comes to solar financing.

[70]Khanna, A and Garg, K. (2013). Paving the Way for a Transformational Future: Lessons from Jawaharlal National Solar Mission Phase I. World Bank –ESMAP Report. Retrieved on 09.03.2015 from https://www.esmap.org/sites/esmap.org/files/ESMAP-World%20Bank%20Publication%20-%20Paving%20the%20Way%20for%20a%20Transformational%20Future%20-%20Lessons%20from%20JNNSM%20Phase%20I.pdf:

2. Various Procedural and Technical Bottlenecks like delay in land acquisition, approval, clearances, limited availability of field level data on solar irradiation etc.
3. Lack of payment security for future projects.
4. Issues pertaining to REC and RPO.
5. Limited growth of domestic Solar PV manufacturing facility etc.

Authors have clearly stated in the report which is based on a stake holders oriented study conducted on the basis of interview conducted with various stakeholders like developers, manufacturers, financiers, industry experts etc. that there is a need now to promote financing of Solar Power Projects by commercial banks, developing substantial infrastructure facilities such as solar park and also promoting Indian Manufacturing Industries in the supply chain.

Jasmeet Khurana (2013)[71] has stated that, "Recovery of debt and legal enforceability of non-recourse debt in India is a key risk to the lenders."

Following are the significant finding of the study:

1. Solar Projects in India are still struggling to get debt finance.
2. Non availability of non-recourse finance is a key hurdle.
3. It has been recognized that conventional bank financing is not sufficient and various innovative finance mechanisms needs to be worked out.
4. Indian banks, NBFCs are charging close to 13% and more for financing solar projects. This escalates the solar power costs.
5. It is the lender who assesses risk of the project and decides whether to lend or not. Thus project developer along with other stake holders must work towards mitigating all risks which are considered to be critical at project level in order to secure financing at suitable terms.

[71] Khurana, J. (2013) . Bankability and Debt Financing for Solar Projects in India. Bridge to India Report. Retrieved on 11.12.2015 from http://dev.bridgetoindia.com/wp-content/themes/newbridge/pdf/BRIDGE%20TO%20INDIA_Bankability%20and%20Debt%20Financing.pdf:

6. They have classified project risks into three categories from lenders perspectives and also mentioned the steps which could be taken to mitigate them. They are:

Table 3.8: Classification of Project Risks and Mitigations Strategy as per Jasmeet Khurana (2013)

Risk	Mitigation Strategy
1. Risk related to long term payment security a. Power off taker risk b. Regulatory risk	a. In-depth assessment of Off taker b. Project selection to be done after in depth assessment of market and clarity in policy
2. Risk related to long term plant quality and power generation a. Resource data risk b. Technology risk with regards to data and performance	a. Quantification of Irradiation data and irradiation data for a period more than 10 years should be taken into consideration for accurate prediction model. b. Selection of right EPC partner, appropriate O&M etc.
3. Permission and construction risk	Setup projects in Government backed solar parks and appropriate tie up with government agencies

Vikas Khare, Savita Nema and Prashant Baredar (2013)[72] have also identified financial barrier to be a significant barrier. They have clearly stated that higher capital cost to O&M ratio indicates a very high initial burden to be financed over the entire project life making risk exposure a long term challenge. They have also stated that subsidies may be considered to be the lifeline of RE Projects and there is a significant risk of non-provision of subsidy because of limited or non-availability of resources with the government.

[72]Khare, V., Nema, S., & Baredar, P. (2013). Status of solar wind renewable energy in India. Renewable and Sustainable Energy Reviews, 27, 1-10.

Karan Kapoor, Krishan K.Pande, A.K. Jain, Ashish Nandan (2014)[73] have highlighted the evolution of solar energy since 1950 in India. They have also identified and listed the following categories of barriers coming in the way of fulfilling the targets set by the government of India and they are:

1. Technical barrier
2. Policy and regulatory barrier
3. Socio Economic Barrier
4. Institutional Barrier.

Authors have also given various suggestive measures for overcoming the barriers.

Shrimali G., Nekkalapudi (2014)[74] have tried to analyze the performance of JNNM phase I. They have concluded that Phase I of NSM failed in deploying Solar thermal whereas deployment of Solar PV has been successful in cost effective manner. They have focused on following three specific risks for examining the variable performance. They are:

1. Technology risk
2. Developer risk
3. Off Taker Risk

They have stated that the success of Solar PV in the first phase of JNNSM was due to the low technology, developer and off taker risk. All the projects in phase I had signed PPA s for 25 years with NVVM which is the power trading arm of NTPC having a market capitalization of $ 35 billion and net worth of $114 billion. This PPA enjoyed strong bankability resulting in these projects securing timely funding. But this would not had been the situation if off taker would be SEB. They concluded that mechanism lowering off taker risk is crucial for solar deployment. From Phase II onwards NVVM as Power Off taker is not guaranteed. They have also stated that resource risk is low for Solar PV. Estimation of Output in case of Solar PV plant is done using GHI. In JNNSM, GHI values based on satellite data provided by NREL in US is used for

[73] Kapoor, K., Pandey, K. K., Jain, A. K., & Nandan, A. (2014). Evolution of solar energy in India: A review. Renewable and Sustainable Energy Reviews, 40, 475-487.

[74] Shrimali, G., & Nekkalapudi, V. (2014). How Effective Has India's Solar Mission Been in Reaching its Deployment Targets? Economic and Political Weekly, 49(42).Retrieved on 11.02.2015 from http://eprints.exchange.isb.edu/305/

Solar PV plant designing and determination of energy output. The variation which is actually termed as risk between the satellite data and ground data is less than 5% for GHI.

Shrimali G; et al (2014)[75] in their CPI-ISB report have clearly stated that India's solar and wind energy financing policy is not as cost effective as they can be made to be. It means that there is a need to adjust the green energy financing policies in India. According to this report, the most effective policy is the one which can both reduce the cost of debt and also extend its tenor.

Mehebub Alam; et al (2014)[76] have clearly concluded that in the present scenario, renewable energy is the most elegant choice for meeting the energy demand. It is also stated that India has plenty of renewable energy potential and India must keep on putting effort to harness the renewable energy potential.

As per the latest Report of the Expert Group on, "175 GW RE by 2022" in 2015,[77] it is clearly stated that in India RE project developers are often seen struggling for financing and even if it is available its cost is often high. For meeting that Target of RE, financing is certainly a challenge. Since RE technology have high capital cost and less operating cost as compared to conventional power projects, cost of capital here is one of the most significant cost in the delivery of clean energy. Cost of debt in India ranges between 12-14% (in developed country the range is 3-7%) and cost of equity is even higher. RE tariff which has 70% of financing cost will reduce if they get loan at reduced interest rates. Report states that de risking of the sector is needed for procuring finance at market based risk free rate.

Selected literature on RE power project risks:

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[75]Shrimali, G., Goel, S., Srinivasan, S., & Nelson, D. (2014). Solving India's Renewable Energy Financing Challenge: Which Federal Policies can be Most Effective? Climate Policy Initiative. Retrieved on 05.06.2015 from http://eprints.exchange.isb.edu/307/:

[76]Alam, M., Yasin, S. M., Gain, M., & Mondal, S. (2014). Renewable Energy Sources (RES): An Overview with Indian Context. IJECS Volume 3 Issue 10, Oct, 2014 Page No.8871-8887. Retrieved on 01.12.2015 from http://www.ijecs.in/issue/v3-i10/71%20ijecs.pdf:

[77]NITI Aayog (2015, December). Report of the Expert group on 175GW RE 75G by 2022. Retrieved on 03.03.2016 from www.niti.gov.in: http://niti.gov.in/writereaddata/files/writereaddata/files/document_publication/report-175-GW-RE.pdf :

Table 3.9: Selected Literature on Renewable Energy power Project Risk

Cleijne,Rujigrok(2004)	Marsh(2004)	Marsh(2006)
Following broad categories of risks: 1. Operational risk 2. Market risk 3. Regulatory risk 4. Technological risk In addition to above following project risks are also important: 1. Development and Construction risk 2.Operation and maintenance 3.Financial Risk 4.Force majeure	They have listed the following key risks associated with all size of RE projects: 1. Project Risk a. Lead time Risk b. Construction risk c. Performance risk Its elements can be: a. Operational Risk b. Fuel Supply Risk/Resource Risk c. Technology Risk d. Natural Hazard Risk e. Permit Delivery Risk 2. Political/Institutional Risk a. Country risk b. Regulatory risk c. Kyoto project risk d. Administrative risk e. legal risks 3. Business Risk a. Financial risk b. Economic Risk c. Counter party risk	They have listed the following risks associate with large size of projects: 1. Preconstruction phase a. Concept to implementation 2. Construction phase: b. Construction/completion risk c. Counter party risk 3. Operating risk d. Performance risk e. Counter party risk f. Fuel supply risk g. Credit risk 4. Generic all phases: h. Financial risk i. Political risk j. Force majeure
Most significant risk identified after their study: Regulatory and political risk followed by resource availability, technological risk, planning and permitting risk	Following were identified as critical risk considered suitable for analysis: 1. Resource, technology and operational risk 2. Regulatory risk 3. Political risk 4. Counter party risk 5. Scale and return 6. Relative cost 7. Lead time 8. Transmission and distribution 9. Valuing social and environmental cost and benefits 10. Sustainable responsible investment 11. Carbon finance Regulatory risk is a key barrier in RE financing and Resource technology and operational risks are not at all significant	

Table 3.10: Selected Literature on Renewable Energy power Project Risk

De Jager and Rathmann (2008)	Komendantova,N. et al (2009)	Sophie Justice (2010)
Six level of risks: 1. Project level 2. Regulatory 3. Financial risk and market risk 3. Legal risk 4. Political risk 5. Force Majeure risk Project level risk is classified as follows: 1. Project development and financial closure 2. Construction risk a. Construction risk b. Counter party risk 3. Operations Phase: a. Performance risk b. Resource risk c. Market risk d. Regulatory risk 4. Decommission phase	Nine classes of risks were identified: 1. Technical 2. Construction 3. Operating 4. Revenue 5. Financial 6. Force Majeure 7. Regulatory risk 8. Environmental 9. Political	Following risks are assessed: 1. Country and financial risks a. Country risks b. Economic risks c. Financial risks d. Currency risks e. Political risks f. Security risks 2. Policy and regulatory risks 3. Technical and project specific risks: a. Construction risk b. Technological risk c. Environmental risk d. Operation and Management risk 4. Market risk
As per them, project level risk, regulatory risk and financial risk are more important. Within project level risk, risk during construction and operation phase significantly affects cost of capital.	As per their findings, regulatory risk, political risk and force majeure risk are of grave concern.	

Table 3.11: Selected Literature on Renewable Energy power Project Risk

Christopher Watts(2011)	David de Jager et. al(2011)	IEA(RETD) Report(2011)
Followings risks were considered for study: 1. Financial Risk 2. Business/ Strategic risk 3. Building and Testing risk 4. Operational risk 5. Environmental risk 6. Political / regulatory risk 7. Market risk 8. Weather related volume risk	Following list is given by them as the main risks affecting access to finance. 1. Specific Risk by Technology: a. Planning and Development b. Access to grid/ Infrastructure c. Construction risk d. Operation risk e. Resource quality risk 2. Risk by country a. PPA security b. Stability(Policy Risk) c. Uncertainty	They have classified risk into following four broad categories: 1. Political(P) 2. Economic (E) 3. Social(S) 4. Technical(T) With reference to Solar PV technology, specifically stated risks are: 1. Bottle necks in supply capacity and price volatility(E) 2. Medium term availability /cost when it comes to key raw material(E) 3. Low entry barrier in modules manufacturing (E) 4. Heavy dependence on inverters(T) 5. Price and Market Risk(E) 6. Vandalism(S) 7. Instability of support policies(P) 8. Overestimation of efficiency(T)
Financial risk is most significant. Regulatory and weather related volume risk is also very significant		Risk number 5, 6, 7 have relatively high impact on ROE, whereas 4,3,1,2 have medium to low impact on ROE. 5,6,7,8 have significantly high impact on debt leverage capacity, whereas Risk number 1,2,3,4 have medium to low impact on debt leverage capacity

Table 3.12: Selected Literature on Renewable Energy power Project Risk

Jon Warren (2012)	BNEF Report (2013)	Waissbein,O.; et. al(2013)
They have listed the following Risks as affecting the solar power projects in the entire life time of the project and adding to revenue and profitability: 1. Construction risk 2. Company risk 3. Environmental risk 4. Financial risk 5. Market risk 6. Operational risk 7. Technology risk 8. Political and regulatory risk 9. Climate and weather risk 10. Sabotage, terrorism and theft risk	They have listed the following risks with a focus on Wind and Solar Projects: 1. Construction risk a. Loss or damage b. Delay in start up 2. Operational risk a. Loss, damage and failure b. Business interruption 3. Market Related Risk a. Weather b. Curtailment c. Power price d. Counter Party risk 4. Policy risk	They in their modeling exercise have considered following: risks as those affecting cost of equity : 1. Power market risk 2. Permits risk 3. Social Acceptance risk 4. Grid integration risk 5. Counter party risk 6. Financial sector risk 7. Political risk 8. Currency/ macroeconomic risk As per them all risks except 2 and 6 affect cost of debt
As per them technology risk and buyer risks are more significant in case of institutional investors		

Table 3.13: Selected Literature on Renewable Energy power Project Risk

Lowder, T. et al (2013)	Frisari. G. et. Al (2013)
Project risks is divided into two broad categories: 1. Technical risk a. Development stage risk: resource estimation, components specifications, system design, performance estimates and acceptance/ commissioning testing, site characterization, transport/ installation risks. b. Operational Phase: Operations and Maintenance Risk(O&M) risks and Off-Taker Infrastructure Risks 2. Non-Technical risk a. Development stage: Transmission/ distribution and interconnection, developer risk, power purchase agreement and pricing, construction risks, policy / regulatory risks, insurability and site control b. Operational stage: credit/default risk, power purchase risk, off- taker risk, duration of revenue support, Insurance, Weather and resource risk.	In this study, risk was grouped into following four categories: 1. Political, policy and social risk: it includes public governance/ corruption, legal and ownership rights, permitting/sitting, policy, private governance/ reputation/social opposition 2. Technical, physical risk: it includes constructions, environmental (Impacts/Acceptance), Reliability of output, Operations and Management, Decommissioning. 3. Market. Commercial Risk: This category includes following risk types: currency risks, output price volatility, market based environmental instruments volatility, access to capital, counter party/ credit risk, investment liquidity/ exit. 4. Outcome risk
As per them resource estimation and performance estimates and acceptance and commission testing could affect the debt servicing capability directly. Almost all the risks which are non-technical can affect the decision of financier as well as hurdle rate.	

3.4 Conclusion

In this part conclusion of the literature survey has been presented by way of researcher's observation and then the research gap has been identified.

3.4.1 Researcher Observations

From review of the above work done in the field of Renewable Energy, it is very clear that RE sector is gaining attention from the scholars all over the world. There is a unanimous opinion that within the RE sector, solar is a viable option.

In Global context significant work has been done in the area of Renewable Energy in general and Solar in Particular. Approach of finance sector is same when it comes to RE investment or any other investment and that is the concept of risk and return. Thus Effective Risk Management is key for deployment of fund in this sector. Existing literature also points out that in public debates and political disclosures; return provided to the investors is being highlighted whereas risks tend to be less prominent

Existing research also concludes in no uncertain term that lowering cost is extremely important for growth of RE sector. Cost of power from projects utilizing RE technology is extremely sensitive to financing terms. Lowering risk or in other words managing risk is extremely important because of its impact on the financing cost. Survey of existing literature also highlights that for developing countries in general, application of Financial Risk Management is limited. A generic list of various risks affecting the financing of RE projects has been prepared.

From the review of India centric studies, there is a unanimous agreement among the scholars that RE is a viable option for the country seeing its huge potential and within RE, solar is undoubtedly very promising source. Survey of the existing study also reveals that private investment has been the key driver of growth of renewable and it needs to be increased in order to achieve the set targets and as it is already mentioned that private sector believes in the concept of risk and return. Existing literature also reveals that there are financing issues in solar power sector like reluctance of lender in providing funds and also the high cost of funds where available. This is a clear indication of need of appropriate financial risk management in this sector. Researcher

has observed that following risks are featuring in most of the existing studies conducted:

1. Regulatory Risk
2. Construction Risk
    a. Time Over run
    b. Cost Over run
3. Counter Party Risk
    a. Construction Contractor
    b. O&M Contractor
4. Finance and Economic Risk
5. Power Off Taker Risk
6. Resource assessment Risk
7. Force Majeure Risk

3.4.2 Research Gap

Various existing studies have mentioned a comprehensive list of various risks affecting the financing of RE sector in general and solar sector in specific and also the risks concerning lenders is also highlighted but there is no study which includes the perception of various stakeholders like developers, lenders as to various risks affecting debt financing. Similarly though there is a comprehensive list of risk management options and instruments but there is no study which refers to the extent of usage of actual tools employed to manage risks and also about the effectiveness of various risk mitigating measures available and employed. This study is a humble and maiden attempt to study the process of Risk Management of risks specifically affecting debt financing in Renewable Energy Sector with reference to Solar Power Projects (PV) exclusively in India.

Chapter 4

Research Methodology

Chapter 4

Research Methodology

4.1 Introduction

This chapter describes the research methodology of the study. To be more specific, research questions, objectives of the study, hypotheses, research design, research methodology and data processing tools have been stated along with the relevance of study in the present scenario.

Entire procedure followed for achieving the objectives has also been stated.

4.2 Research Questions

Despite various attempts to promote solar energy and for this trying to involve more and more funds at appropriate cost it is already been proven that risk is a barrier. The most important point here remains is to which risks. The purpose of this study is to answer this question by conducting a stake holder driven empirical research. We have also considered two closely related questions and they are the various risk management measures commonly utilized and the perception of fund providers (lenders) about the effectiveness of these measures.

4.3 Objectives of the Study

Following objectives have been outlined:

1. To study major risks affecting the debt financing for solar power projects.
2. To understand the perception of lenders and developers with reference to selected risks affecting the debt financing.
3. To study the current practices and Instruments of risk management employed in Solar PV Power Projects with reference to selected risks in India.

4. To understand the perception of lenders with reference to the effectiveness of various risk management practices and instruments available and employed for managing selected risks.

4.4 Hypotheses

Based on the various research studies conducted on the domain areas and also keeping in view the objective of the study, the following Hypotheses have been framed and tested.

H1 Most critical risk from the perspective of lenders and developers affecting financing is Regulatory Risk.

H2 Confidence of lenders in the ability of developers to manage risks varies significantly with risk type.

4.5 Research Design

Research design of the study can be said to be deductive where in empirical research is conducted for testing of the hypotheses in a logical manner.

4.6 Research Methodology

It is a qualitative study based primarily on the perception of developers and lenders.

4.6.1 Data Source

Both primary and secondary data has been used for the study:

Secondary Data: Secondary data is obtained from various reports, research articles, books, Journals, websites, various working committees' reports, five year plan documents. Data bases like EBSCO and Proquest were also referred.

Primary Data: Primary data has been collected by means of a Questionnaire. Separate Questionnaires has been designed for collecting data from developers companies and from banks and financial institutions.

4.6.2 Research Instrument

Questionnaire has been prepared comprising of both closed ended and open ended questions for collecting primary data. Separate Questionnaire has been prepared for collecting data from developers and lenders.

Questionnaire was mailed to collect data from companies distantly located. For this researcher created a separate email id. This also helped in following up responses from them. However most of the data is collected by the researcher through personal visits.

Questionnaire Structure: Since Solar Power is comparatively a new sector being explored, there is a lack of adequate information that has led to this Questionnaire survey. Questions for the Questionnaire has been devised based on text and on the basis of researchers experience which comes from the discussions with various executives and consultants active in the sector. Questionnaire was refined by pilot testing the questionnaire for clarity and informational content. . This was done by contacting five developer companies and five lenders financing Grid Connected Solar PV projects through personal visit. And then the final version of the questionnaire was decided. Questionnaire prepared for getting data from developer companies consists of 16 questions whereas those from lenders consist of 13 questions.

Questionnaire uses simple yes/no as well as six degrees ranking scale. Very few open ended questions are kept.

Questionnaire has been prepared in two parts.

Part A refers to technical questions sufficing the objectives of research, whereas Part B deals with respondent's information.

Rating System: For improving the reliability of survey replies, a six degree rating system is used.

Table 4.1: Rating System

Ratings	Growth Prospects	Risk criticality	Effectiveness of Risk Mitigating measures	Confidence levels	Success level	Risks Materialized
0	Don't know/NA	Don't know/NA	Don't know/NA	Don't know/NA	Don't know/NA	Don't know/NA
1	No growth	Not at all critical	Not at all effective	Not at all confident	Not at all successful	Not at all
2	Low growth	Slightly critical	Slightly effective	Slightly confident	Slightly successful	Very slightly
3	Moderate	Critical	Effective	Confident	Successful	Yes, Slightly
4	High	Very critical	Very Effective	Very confident	Very successful	Yes, On an average way
5	Very high	Extremely Critical	Extremely Effective	Extremely confident	Extremely successful	Yes, in a major way

Validity and Reliability: Validity is basically testing whether the instrument is actually measuring what it intends to measure. In this attempt is made to ascertain the accuracy of instruments. Content validity was used to ascertain whether questionnaire measures what it intends measuring. This is done by taking the opinion of respondents during pilot survey and finally by validation by experts.

Reliability basically means estimation of consistency. Chronbach Alpha has been used for estimating internal consistency.

4.6.3 Sampling Design

Scope of the study is restricted to the companies operating grid connected solar PV projects more than 1MW at PAN India Level (minimum two states) for commercial purpose. For financiers, banks/ FIs financing Grid connected solar PV projects are considered to be our population. Study is being conducted in India.

MNRE website (www.mnre.gov.in), lists the name of the states of India along with their installed capacity for Solar PV grid connected Projects. From this the researcher identified top ten states in terms of installed capacity. They are:

Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Andhra Pradesh, Punjab, Tamil Nadu, Karnataka, Telangana and Uttar Pradesh. Website of the respective renewable energy department of the states along with MNRE and IREDA websites lists the name of developers along with the details of the projects. From this researcher identified 28 companies for collecting data which have plants operating in more than any one of these states on the basis of purposive sampling. Though seeing the nature of this sector which is still emerging, it is difficult to come to a conclusion as to the exact number as to the size of the group of developers engaged in solar power production.

For the lists of financiers, domestic banks and FIs were only chosen. For Banks/ FIs, similar data is obtained from various government website and also from research papers. Approximate. Number is: 20

Purposive sampling is used for the purpose of study. Selection of sample is done keeping in mind the generic nature of the study at PAN India level.

4.6.4 The Procedure

At first stage a comprehensive literature review has been done to identify various risks affecting the financing of solar power projects and the commonly available measures for managing those risks which is followed by validation by experts.

From the initial list, those common risks are identified which are considered more significant from the perspective of fund providers. This is followed by questionnaire survey.

The risk perceptions in terms of criticality in decision making of lenders for the selected risks are found by means of questionnaire survey. Then the extent of usage of risk management measures commonly available for managing selected risks is also found by means of Questionnaire survey from developers. Then the effectiveness of various risk management measures commonly employed is assessed from the perspective of fund providers on the basis of information provided in questionnaire

survey. This research is focusing on the following seven categories of risks which have been identified from extensive literature survey. All risks are considered post signing of PPAs.

1. Regulatory Risk
2. Construction Risk
    a. Time Over run
    b. Cost Over run
3. Counter Party Risk
    a. Construction Contractor
    b. O&M Contractor
4. Finance and Economic Risk
5. Power Off Taker Risk
6. Resource assessment Risk
7. Force Majeure Risk

Table 4.2: Definition of Risks

Risk	Brief Description	Source
Regulatory Risk	It is the risk of adverse change in policy which might affect significantly the project profitability. For example there might be the modification of general support scheme affecting the cash flow of the project	DeJager, D; M. Rathmann (2008)[1]
Construction Risk(time and cost overrun)	"It is the risk that borrowers and contractors may not complete the project on time, according to specifications, capable of delivering the output within the programmed budget"	Owens, G. (2002)[2]

[1]De Jager, D., Rathmann, M., Klessmann, C., Coenraads, R., Colamonico, C., & Buttazzoni, M. (2008). Policy instrument design to reduce financing costs in renewable energy technology projects. Ecofys, by order of the IEA Implementing Agreement on Renewable Energy Technology Deployment (RETD), Utrecht, ther Netherlands. Retrieved on 12.12.2014 from www.ecofys.com: http://www.ecofys.com/files/files/report_policy_instrument_design_to_reduce_financing_costs_in_renewable_energy_technology_pro.pdf:

[2]Owens, G. (2002). Best practices guide: Economic & financial evaluation of renewable energy projects. Energy and Environment Training Program Office of Energy. Environment and Technology Global Bureau. Center for Environment. United States Agency for International Development. Retrieved on 12.01.2014 from http://pdf.usaid.gov/pdf_docs/Pnadb613.pdf:

Table 4.2 (Contd.)

Counter Party Risk (construction contractor and O& M contractor)	"Risk that construction contractor does not perform as per the contract" "Risk that O&M contractor does not perform as per the contract".	Marsh Ltd(2006)[3]
Finance and Economic Risk	"It occurs due to change in availability of funds and change in cost of capital" In includes currency exchange rate fluctuations, interest rate fluctuations, inflation etc. this can significantly affect a projects economics. There is a high probability of fluctuation in these factors. The extent of impact is directly linked to the extent of fluctuation.	1.SavitaJangale & AA Suryawanshi (2014)[4] 2. Marsh Ltd (2006)[5]
Power off taker risk	It is basically the risk of delay or default of payment from the off taker.	Khurana, J. (2013)[6]
Resource Assessment Risk	It is basically variability in the availability of resource for example Solar irradiation	DeJager, D; M. Rathmann(2008)[7]
Force Majeure Risk	It is about the risk of any natural catastrophes and manmade interruptions for example flooding, war strike etc.	1.DeJager,D; M. Rathmann (2008)[8], 2. Marsh Ltd (2006)[9]

3Marsh Ltd (2006). Financial Risk Management Instruments for Renewable Energy Projects. UNEP Working Group 1 Study Report, UNEP, Nairobi. Retrieved on 01.01.2014 from www.unep.org/pdf/75_Risk_Management_Study.pdf

4Jangale, S. A., & Suryavanshi, A. A. (2014, June). Risk Assessment in BOT Project Financing. International Journal of Engineering Research & Technology (IJERT), 3(6).

5Marsh Ltd (2006). Financial Risk Management Instruments for Renewable Energy Projects. UNEP Working Group 1 Study Report, UNEP, Nairobi. Retrieved on 01.01.2014 from http://www.unep.org/pdf/75_Risk_Management_Study.pdf:

6Khurana, J. (2013), Bridge to India Report. Bankability and Debt Financing for Solar Projects in India. Retrieved on 12.12.2014 from http://dev.bridgetoindia.com/wp-content/themes/newbridge/pdf/BRIDGE%20TO%20INDIA_Bankability%20and%20Debt%20Financing.pdf:

7De Jager, D., Rathmann, M., Klessmann, C., Coenraads, R., Colamonico, C., & Buttazzoni, M. (2008). Policy instrument design to reduce financing costs in renewable energy technology projects. Ecofys, by order of the IEA Implementing Agreement on Renewable Energy Technology Deployment (RETD), Utrecht, ther Netherlands.: Retrieved on 12.12.2014 from www.ecofys.comhttp://www.ecofys.com/files/files/report_policy_instrument_design_to_reduce_financing_costs_in_renewable_energy_technology_pro.pdf

8De Jager, D., Rathmann, M., Klessmann, C., Coenraads, R., Colamonico, C., & Buttazzoni, M. (2008). Policy instrument design to reduce financing costs in renewable energy technology projects. Ecofys, by order of the IEA Implementing Agreement on Renewable Energy Technology Deployment (RETD), Utrecht, ther Netherlands. Retrieved on 12.12.2014 from www.ecofys.comhttp://www.ecofys.com/files/files/report_policy_instrument_design_to_reduce_financing_costs_in_renewable_energy_technology_pro.pdf:

9Marsh Ltd (2006). Financial Risk Management Instruments for Renewable Energy Projects. UNEP Working Group 1 Study Report, UNEP, Nairobi. Retrieved on 01.01.2014 from http://www.unep.org/pdf/75_Risk_Management_Study.pdf:

4.7 Data Processing and Analysis:

Processing of data is done using MS Excel. For analysis of data, appropriate tools and techniques such as frequency table, Percentage, Weighted Mean, Standard deviation, F test, T test, ANNOVA, Correlation etc. are used.

Rating method is used for risk investigation. For Reliability analysis, Chronbach's Alpha is used.

Frequency table is used for organizing and presenting the frequency of selected variable so as to understand their distribution pattern.

Percentage is used for better understanding as it expresses a number as a fraction of 100.

Weighted mean also called as weighted average is that average where in each quantity to be averaged is assigned a weight based on the relative importance. This has been the most significant tool of our analysis.

Standard deviation is used to measure the uncertainty and to understand the distribution of data around the mean value.

For testing hypothesis, T test is used for testing equality of means and ANNOVA (Analysis of Variance) is used for testing the difference of means. F test is used before applying T test to know about the equality or inequality of variance. Correlation technique is also used to identify the strength of relationship between two chosen variables. Karl Pearson's coefficient of correlation is used for this purpose.

4.8 Relevance of the Study

Study aims to view the Risks in RE projects with reference to solar PV projects from the perspective of lenders. Study tries to look at the real world problems of Renewable energy Financing. For this solar (PV) sector has been included for the study. Solar is highly promising but still the most underutilized source within the RE basket.

It has been observed that India's renewable energy sector has been heavily skewed in favour of wind and its solar sector despite of showing abundance potential is underutilized. One critical Factor identified which is coming in the way of development of Solar Power Industry is that there are significant hurdles in the way of arranging finance for solar power projects. Banks and Financial institutions are not yet geared sufficiently to lend to solar projects on decent terms.

Question remains as to why there are so many apprehensions in the mind of Financiers when it comes to financing the Renewable energy projects. This study is a humble attempt to understand the risk related aspects of Debt financing. Most important aspect of this study is to find out the risk perception of Lenders and Developers and also the perception of lenders regarding available risk mitigation instruments. Hence this would give us an insight into as to how different aspects of risks influence the decision making of lenders. This would go a long way in helping increase the share of Renewable Energy Sector in total Power Sector that too at reasonable cost.

This research is very relevant for the developers operating in solar PV market. A clear understanding of perception of financiers as to various risk elements can help them take a balanced view as to various risks. This research will also help in better understanding of perception of financiers and their concerns and probably can help the developers in aligning the risk management practices in line with the expectations of financiers. It can also help policy makers in designing of financial risk management instruments which can support the deployment of solar energy by ensuring the increasing availability of finance.

Chapter 5

Data Analysis and Findings

5.1 Introduction

5.2 Data Analysis and Findings

Chapter 5

Data Analysis and Findings

5.1 Introduction

Researcher had administered questionnaire to about 28 developers companies, out of which 25 responses were obtained after lots of follow up and personal visits. So data analysis is done for 25 responses. For financiers data was collected from 13 banks/FIs after contacting 17 of them. This response rate is considerably high for any survey because most of the companies were contacted by researcher through personal visit. The same was true for banks/FIs.

5.2 Data Analysis and Findings

Data was collected by means of two separate questionnaires prepared for developers as well as lenders. Questionnaire prepared for getting data from developers companies consists of 16 questions whereas that from lenders consists of 13 questions.

Analysis of the Responses obtained from the Questionnaire is presented below:

Question number 1 of developer's questionnaire just ratifies sample selection.

Table 5.1: Breakup of Respondent Developers presence in number of states

Number of states in which solar projects are installed	Frequency	Percentage
Only1	0	0
2-4	11	44
More than 4	14	56
Total	25	100

Thus it means that 44% of developers included in the sample size have plants operating between 2-4 states whereas 56% of developers have plants operating in more than 4 states.

Next researcher tried to assess the perception of both developers as well as lenders for growth prospects within different sectors within the basket of RE energy.

Table 5.2: Developers perception as to growth prospects of different sectors

	Very high	High	Moderate	Low	No growth	Don't know/NA	Weighted score	Weighted mean	Standard deviation	Rank
	5	4	3	2	1	0				
Solar	17	8					117	4.68	.4665	1
Wind		8	11	3		3	71	2.84	.7256	2
Hydro		3	11	3	3	5	54	2.16	.9388	3
Bio energy			8	5	9	3	43	1.72	.8524	4
Geo thermal			2	8	12	3	34	1.36	.6391	5

Growth Prospects	Solar	Wind	Hydro	Bio Energy	Geo Thermal
Very high	68%				
High	32%	32%	12%		
Moderate		44%	44%	32%	8%
Low+		12%	12%	20%	32%
No growth			12%	36%	48%
Don't know		12%	20%	12%	12%

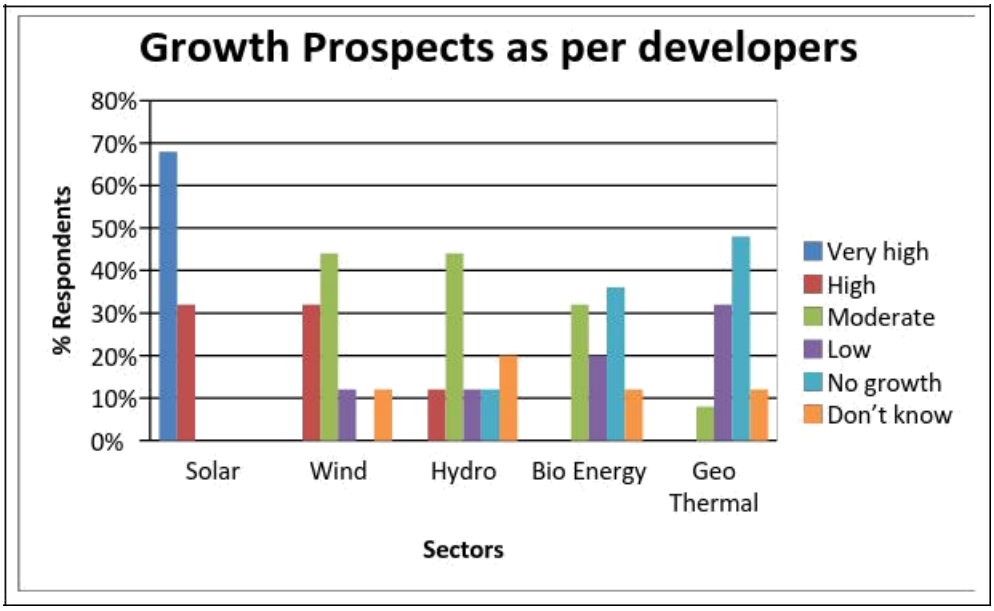

Figure 5.1: Developer's perception as to growth prospects of different sectors

From the above survey it was clear that there is significant growth potential as perceived by the developers in solar sector as compared to other sectors within RE Basket .Based on weighted mean score, highest ranking has been given to solar. Lowest standard deviation also shows that lesser variation in opinion in case of solar.

A further analysis was done by researcher only of those responses which are provided by those developers which are operating in sectors other than solar also within the basket of RE. Out of 25 responses 14 are such developers. Following table summarizes the result. Result is similar to that of above.

Table 5.3: Perception of developers operating in more than one renewable energy sector

	Very high	High	Moderate	Low	No growth	Don't know	Weighted score	Weighted mean	Rank
	5	4	3	2	1	0			
Solar	10	4					66	4.714	1
Wind		4	9	1			45	3.214	2
Hydro		3	7	3	1		40	2.857	3
Bio energy			3	7	3	1	26	1.857	4
Geo thermal			2	4	4	4	18	1.286	5

Growth Prospects	Solar	Wind	Hydro	Bio Energy	Geo Thermal
Very high	71.42%				
High	28.57%	28.57%	21.43%		
Moderate		64.28%	50%	21.43%	14.28%
Low		8.33%	21.43%	50%	28.57%
No growth			7.14%	21.43%	28.57%
Don't know/NA				7.14%	28.57%

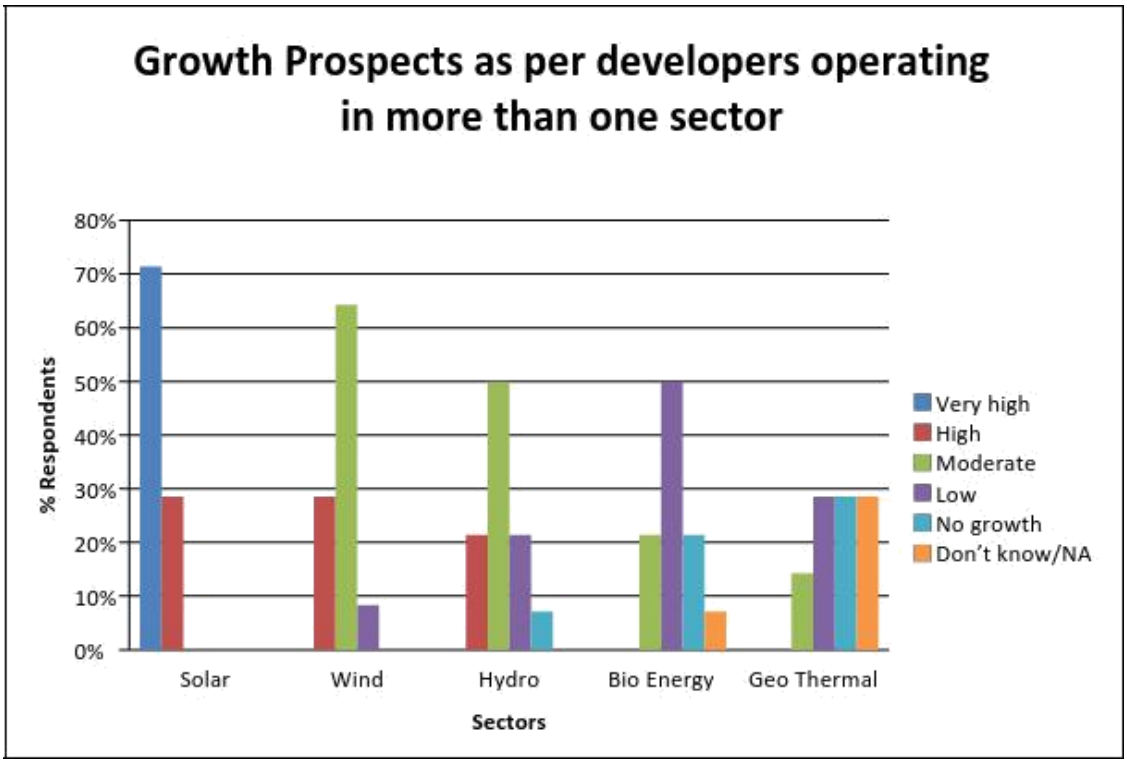

Figure 5.2: Perception of developers operating in more than one renewable energy sector

Thus it is clearly visible from the table that more than 71.42% of respondents have very high growth expectations from solar.

It is very clear that there is a significance growth potential as perceived in solar sector vis-à-vis other sectors.

Next table summarizes the lenders response for growth prospects within different sectors within the basket of RE energy.

Table 5.4: Lenders perception as to growth prospects of different sectors

	Very high	high	moderate	low	No growth	Don't know	Weighted score	Weighted mean	Standard deviation	Rank
	5	4	3	2	1	0				
Solar	11	2					63	4.846	.361	1
Wind	4	5	4				52	4	.785	2
Hydro	2	4	4	3			44	3.385	1.003	3
Bio energy			6	4	2	1	28	2.154	.737	4
Geo thermal			4	3	3	3	21	1.615	.844	5

Growth Prospects	Solar	Wind	Hydro	Bio Energy	Geo Thermal
Very high	84.62%	30.77%	15.38%		
High	15.38%	38.46%	30.77%		
Moderate		30.77%	30.77%	46.15%	30.77%
Low			23.07%	30.77%	23.08%
No Growth				15.38%	23.08%
Don't know/NA				7.69%	23.08%

Thus it is clearly visible from the table that close to 85% of lenders have very high growth expectations from solar.

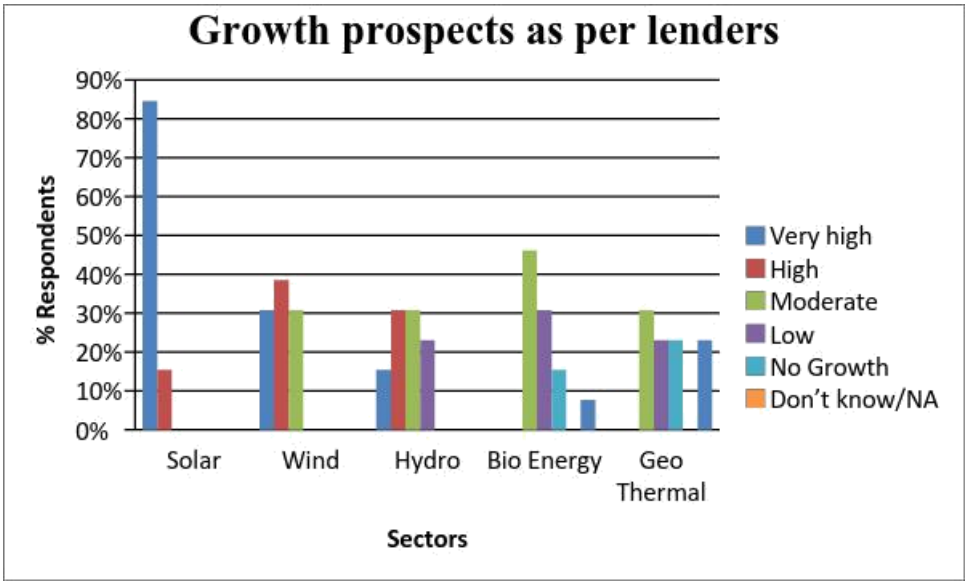

Figure 5.3: Lenders perception as to growth prospects of different sectors

Thus it is very clear that there is a significance growth potential as perceived in solar sector vis-à-vis other sectors even by lenders.

From the above survey it was clear that there is significant growth potential as perceived in solar sector vis-à-vis other sectors within RE Basket both by the developers as well as lenders. Based on weighted mean score, highest ranking has been given to solar. Lowest standard deviation also shows that lesser variation in opinion in case of solar

Criticality of Risks in Solar projects Financing

There was a question in the questionnaire both of lenders as well as developers wherein researcher tried to ascertain the criticality of certain risks in Solar Power Project debt Financing by listing various types of risks identified from literature survey and then asking the respondents to rate them. The seven different categories of risks are Regulatory Risk, Construction Risk (it includes time over run and cost overrun), Counter party risk (Construction contractor and O&M contractor), Finance and Economic Risk, Power Off Taker risk. Resource Assessment and Force Majeure risk.

Table 5.5: Risk Criticality in solar power project financing from developers perspective

	% Respondents									
	Extremely Critical	Very critical	critical	Slightly critical	Not critical	don't know/ NA	Weighted score	Weighted Mean	Standard deviation	Ranking
	5	4	3	2	1	0				
Regulatory Risk	32%	52%	12%	4%			103	4.12	.7652	1
Construction Risk (TO)	20%	28%	32%	8%	12%		84	3.36	1.2290	4
Construction Risk (CO)	16%	24%	32%	20%	8%		80	3.2	1.1661	6
Counter party Risk (CC)	8%	28%	52%	12%			83	3.32	.7859	5
Counterparty Risk (O&M)		16%	52%	32%			71	2.84	.6741	8
Finance and Economic Risk	12%	48%	28%	12%			90	3.6	.8485	3
Power Off taker Risk	12%	52%	36%				94	3.76	.6499	2
Resource Assessment Risk	8%	20%	40%	32%			76	3.0	.9156	7
Force Majeure Risk		12%	24%	56%	81%		60	2.4	.8	9

Thus regulatory risk is perceived to be the most significant with a mean value of 4.12 as compared to other risks. It is followed by power off taker risk with a mean value of 3.76 and third most significant risk influencing financing is finance and economic risk with a mean value of 3.6. Counter party risk (O & M), resource assessment, force majeure risk have a mean score below 3, so they are being perceived to be of low significance.

For regulatory risk as it is visible from the table, more than 80% replies are stacked heavily towards the extremely critical and very critical end of the scale with a good 32% respondents saying that it is extremely critical. This is followed by power off taker risk wherein approx. 65% and finance and economic risk where close to 60% replies are stacked towards very critical and extremely critical end of the scale.

If we compare this with lenders perception, regulatory risk is perceived here also most critical with a mean score of 4.61 and a lesser standard deviation.

Table 5.6: Risk Criticality in solar power project financing from lenders perspective

	% Respondents									
	Extremely Critical	Very Critical	Critical	Slightly critical	Not at all critical	don't know/ NA	Weighted score	Weighted Mean	Standard deviation	Ranking
	5	4	3	2	1	0				
regulatory	76.92%	7.69%	15.38%				60	4.6153	.7378	1
Const (TO)		15.38%		76.92%	7.69%		29	2.2308	.7994	8
Const (CO)			15.38%	76.92%	7.69%		27	2.0769	.4742	9
CP (CC)	30.77%	15.38%	15.38%	38.46%			44	3.3847	1.2733	5
CP (O&M)	15.38%		15.38%	69.23%			34	2.6153	1.0769	6
Finance and Economic	15.38%	53.85%	30.77%				50	3.8462	.6617	3
Power Off taker	23.08%	76.92%					55	4.2308	.4213	2
Resource Assessment	7.69%	46.15%	30.77%	15.38%			45	3.4615	.8427	4
Force Majeure		7.69%	15.38%	76.92%			30	2.3077	.6057	7

However lenders are stronger and firm in their opinion with a high mean value of 4.62 and lesser standard deviation. This is followed by power off taker risk with higher mean value of 4.213 and lowers standard deviation. Third most critical risk here also is finance and economic risk. The mean value is more than 4 for first two ranking risk.

Thus as observed that risk ranking is comparable but intensity varies for lenders and developers. It can be seen that more than 75% of respondents in case of lenders feel that regulatory risk is extremely critical. This is much higher as compared to 32% in case of developers.

Least ranking in terms of criticality has been assigned to force majeure risk by developers with a mean score of 2.4. This is followed by counterparty risk(O&M)

with a mean score of 2.84.Whereas for lenders least critical risk is construction risk (cost overrun)followed by time over run risk. Thus it can be said that construction risk is perceived to be slightly critical by lenders. Whereas it is considered to be of average in terms of criticality by developers with a mean score of more than 3 in both the cases. Thus lenders and developers have a conflicting view here. Over all correlation coefficient of .76 is observed.

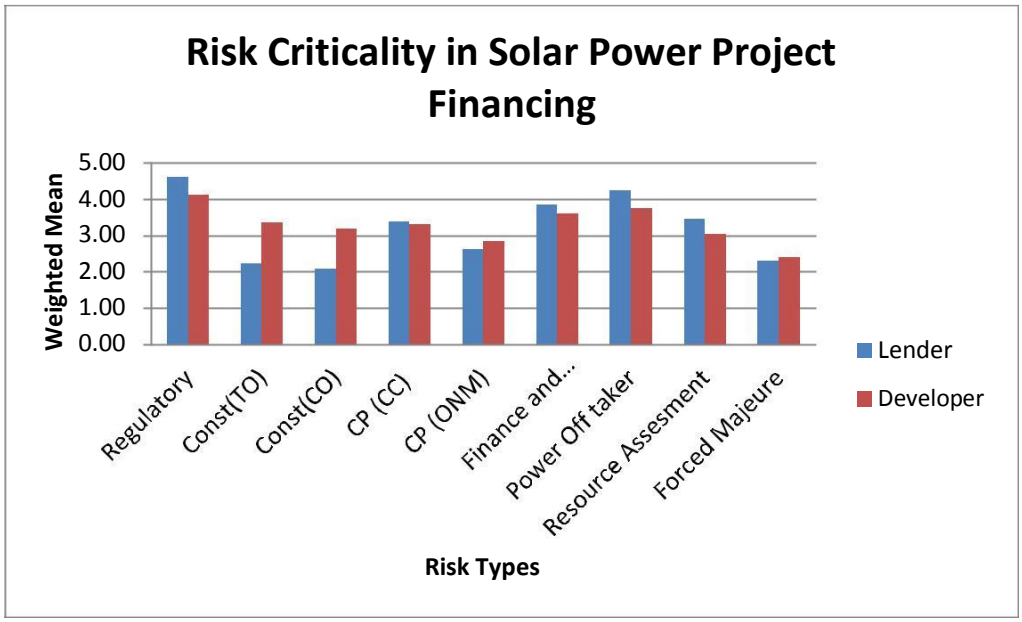

Figure 5.4: Risk Criticality in Solar power project financing

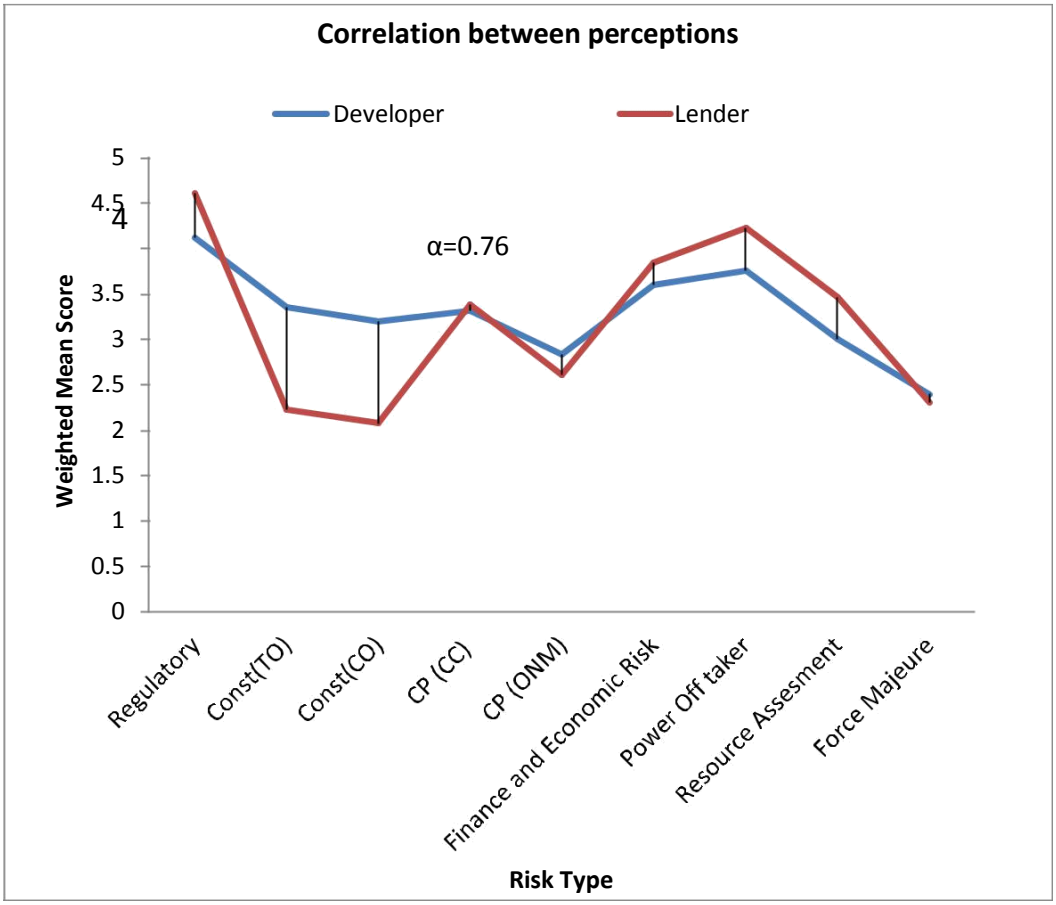

Figure 5.5: Correlation between Lenders and Developers Perception

For further confirmation, a T test was performed. But before that an F test was performed to test the equality of variance.

Table 5.7: F-Test Two-Sample for Variances

	Variable 1	*Variable 2*
Mean	3.196581197	3.293333333
Variance	0.865548981	0.2596
Observations	9	9
Df	8	8
F	3.334164025	
P(F<=f) one-tail	0.054126283	
F Critical one-tail	3.438101233	

Source: Developed using MS Excel 2010.

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Since F< F Critical one tail, we conclude that variances of the two population are equal.

Further a t test assuming equal variance was also performed to test the equality of mean of risk perception of lenders and developers.

Table 5.8: t-Test: Two-Sample Assuming Equal Variances

t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	3.196581197	3.293333333
Variance	0.865548981	0.2596
Observations	9	9
Hypothesized Mean Difference	0	
Df	12	
t Stat	-0.27363825	
P(T<=t) one-tail	0.393931789	
t Critical one-tail	1.745883669	
P(T<=t) two-tail	0.787863578	
t Critical two-tail	2.119905285	

Source: Developed using MS Excel 2010.

Since the absolute value of t stat that is t^{obs}= 0.27363825<2.119905285 = t crit, Thus it is very clear that population means are equal for the two sample at .05 significance level.

Risks actually materialized

There are questions in the questionnaire with a purpose to find out the risks which have actually been experienced by developers at some point of time in past. Following table summarizes the response:

Table 5.9: Risks actually experienced by proportion of developers

	Regulatory Risk	Construction Risk (time over run)	Construction Risk (cost overrun)	Counter party Risk (Construction contractor)	Counter party Risk (O&M contractor)	Finance and Economic Risk	Power off taker Risk	Resource assessment Risk	Force majeure Risk
In a Major way	12%	4%				8%	8%		
On an average way	40%	32%	12%	28%	12%	8%	8%		
Slightly	20%	8%	28%	24%	16%	36%	32%	8%	8%
Very slightly	12%	16%	28%	8%	8%	20%	12%	24%	20%
Not at all	16%	40%	32%	36%	60%	28%	40%	68%	72%
Don't know/ NA				4%	4%				

From the table it can be clearly seen that only regulatory, time over run, financial, power off takers risks are experienced in a major way by respondents with 12% only experiencing it in a major way followed by less than 8% respondents in other three categories. Whereas power off taker risk which has been ranked as second most critical risk by both lenders and developers has been experienced slightly and very slightly or rather not experienced at all by more than 80% of respondents. Same is the case for finance and economic risk. Only total 16% of respondents say that they have experienced power off taker and finance and economic risk in a major or average way. Similarly construction risk (cost overrun), counter party risk (construction contractor and O&M contractor), resource assessment and force majeure risk have never been experienced in a major way.

Table 5.10: Perception of developers as to their own success level to manage various aspects of risk

	Risk Identification	Risk Assessment	Risk Mitigation	Risk Transfer
Extremely successful	40%	12%	28%	20%
Very successful	36%	40%	20%	24%
Successful	8%	36%	12%	16%
Slightly successful	8%	4%	20%	24%
Not at all successful	8%	8%	20%	16%
Weighted Mean Score	3.92	3.44	3.16	3.08

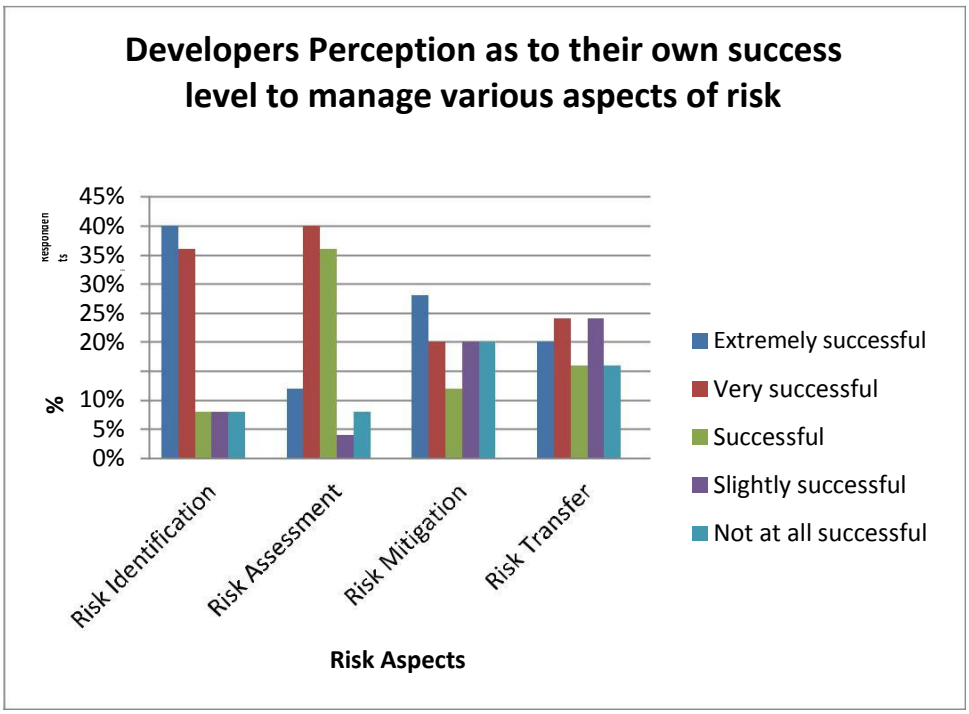

Figure 5.6: Perception of developers as to their own success level to manage various aspects of risk

As it is evident from the table that close to 40% of respondents feel that their company is extremely successful when it comes to risk identification, whereas this % is substantially low when it comes to other aspects of risk management.

However if we see lenders perception, this situation is different with only 7.69% believing that companies are extremely successful when it comes to risk identification and risk assessment. Weakest area as per lender is risk mitigation and risk transference where none of the lenders considers companies to be highly successful. More than 90% of the lenders consider them average and below average and approx. 15.38% to be not at all successful in case of risk transfer.

Table 5.11: Lenders Perception as to success level of developer companies to manage various aspects of risk

	Risk Identification	Risk Assessment	Risk Mitigation	Risk Transfer
Extremely successful	7.69%	7.69%		
Very successful	69.23%	38.46%	38.46%	7.69%
Successful	23.07%	30.77%	30.77%	38.46%
Slightly successful		23.07%	30.77%	38.46%
Not at all successful				15.38%
Weighted Mean Score	3.846	3.30	3.07	2.385

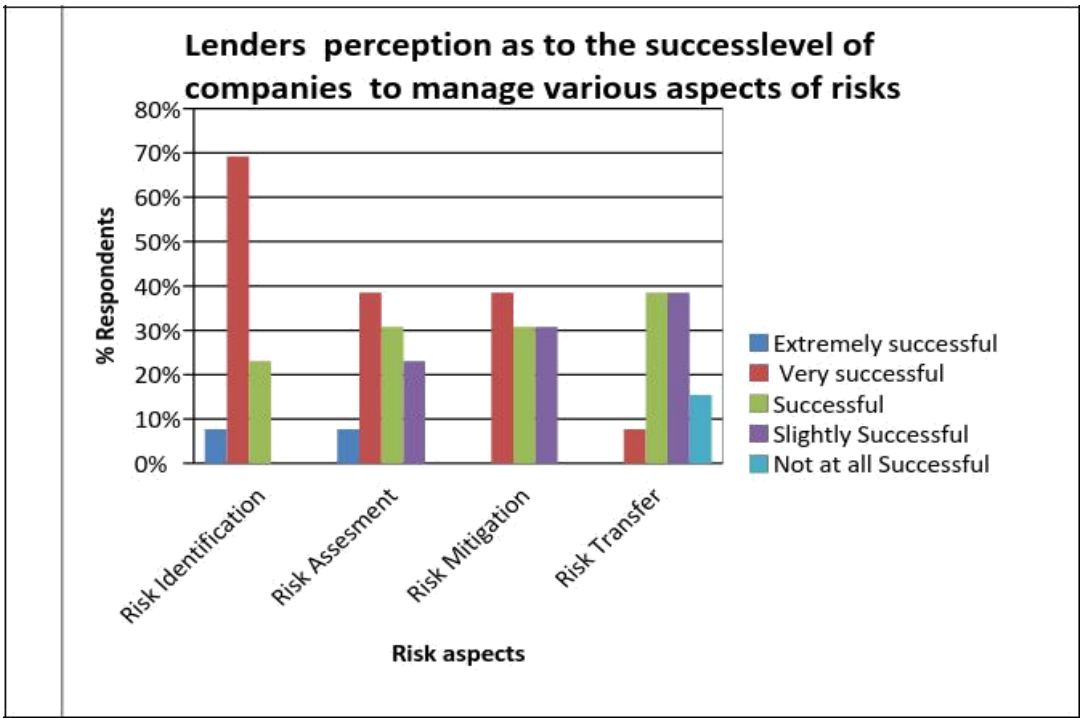

Figure 5.7: Lenders Perception as to success level of developer companies to manage various aspects of risk

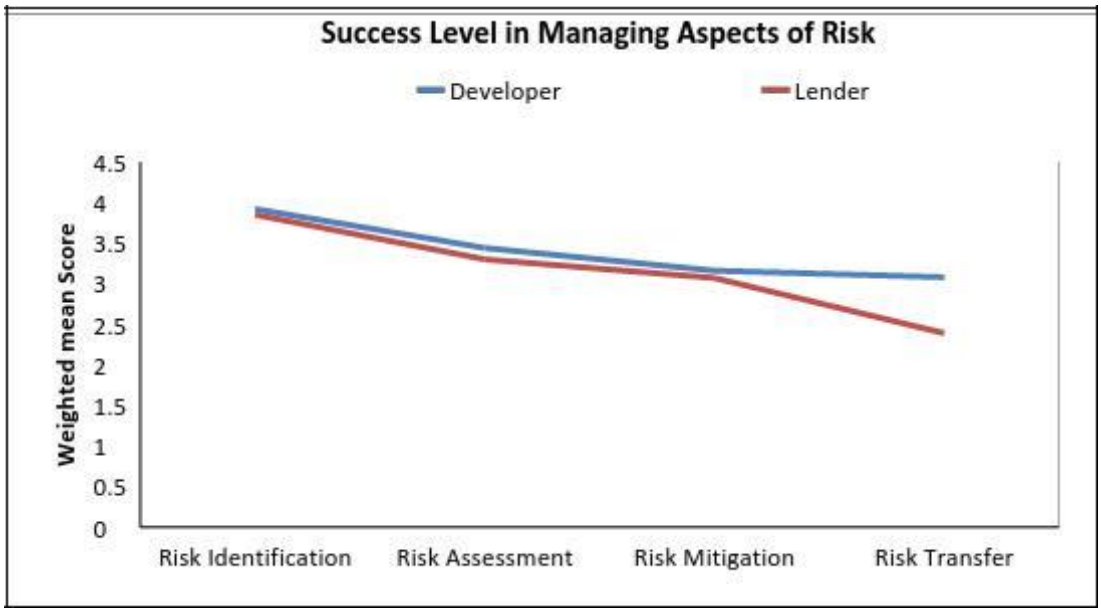

Figure 5.8: Lenders and developers perception as to success level of developer companies to manage various aspects of risk

After this there were certain questions, where the purpose was to understand the current practice of risk management followed by companies.

Table 5.12: Measures taken by the companies to manage construction risk

Measure	Frequency	%
Insurance	22	90%
CAR	15	60%
Using only proven technology	23	92%
Construction through turnkey projects	16	72%
Any other	4	16%

Because of multiple responses, the total % may be more than 100.

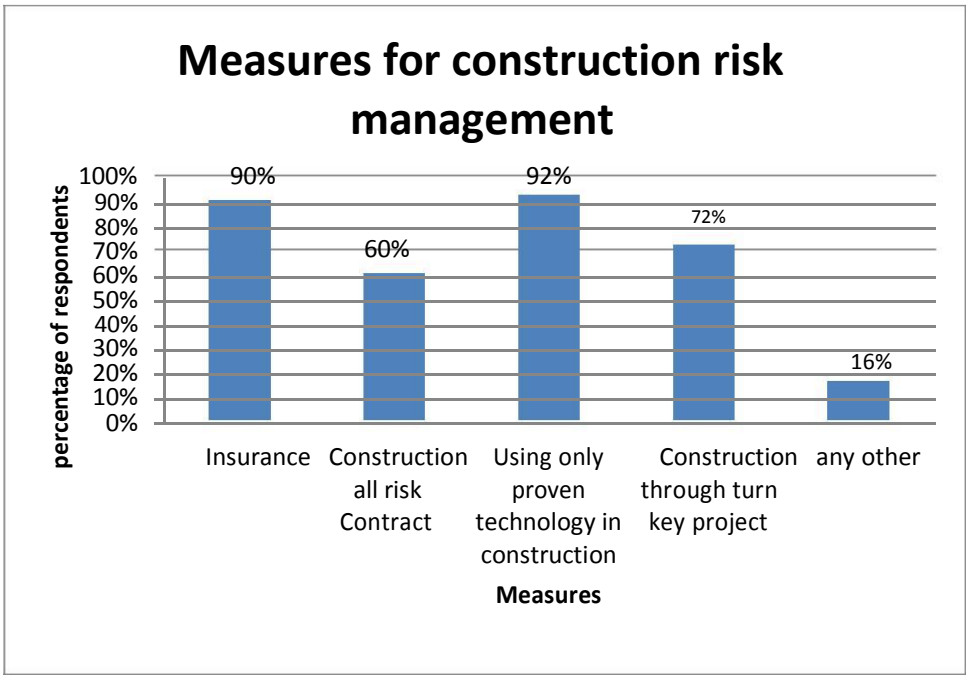

Figure 5.9: Measures taken by companies to manage construction risk

Table 5.13: Measures taken by companies to manage counter party risk

Measure	frequency	%
Performance Bank Guarantees	22	88
Liquidation Damages	20	80
Due Diligence Process	20	80
Any other	2	8

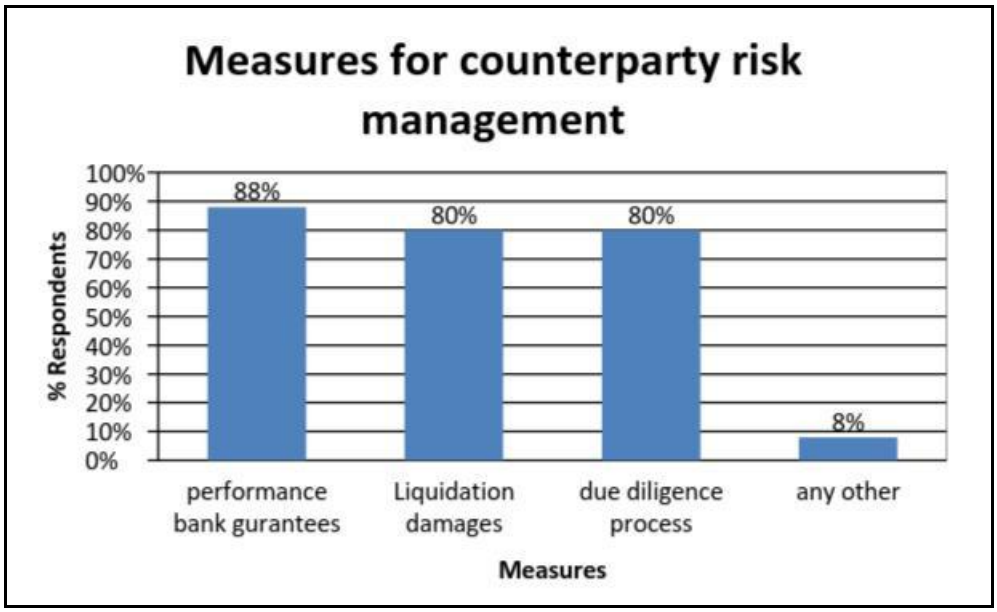

Figure 5.10: Measures taken by companies to manage counter party risk

Table 5.14: Measures taken by companies to manage Power off taker risk

Measure	frequency	%
Bank Guarantees	20	80
LC	18	72
Escrow	8	32

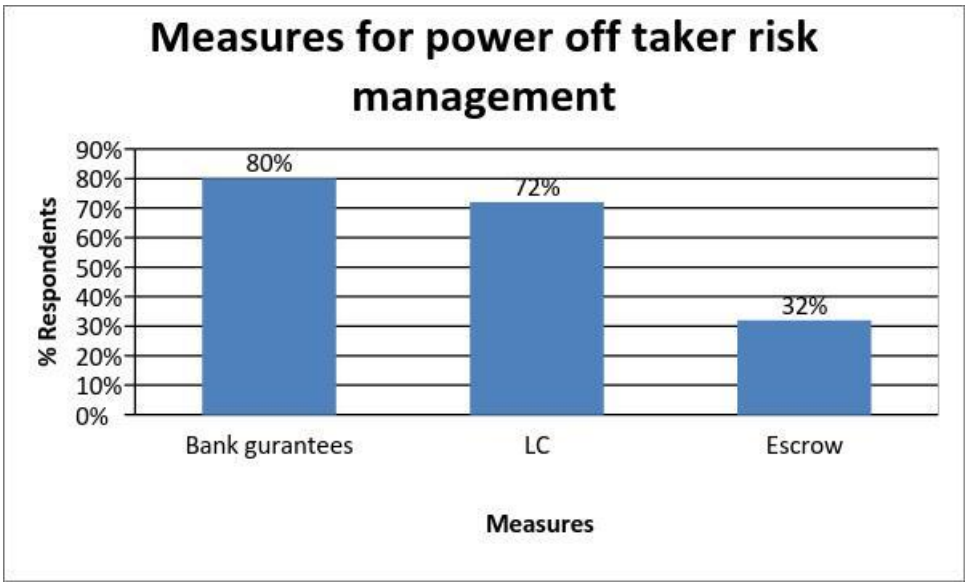

Figure 5.11: Measures taken by companies to manage Power off taker risk

Table 5.15: Measures taken by companies to manage Resource Assessment risk

Measure	frequency	%
Captive Insurance	5	20%
Using several year data and combining it with ground measured data	25	100%
Self-Insurance	2	8%

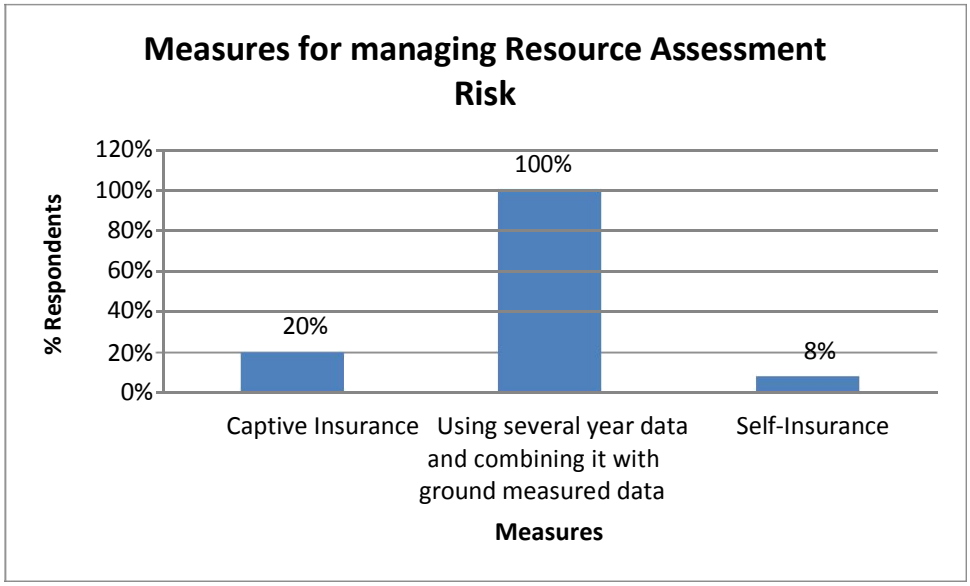

Figure 5.12: Measures taken by companies to manage Resource Assessment risk

Table 5.16: Measures taken by the companies to manage Force Majeure Risk

Measure	frequency	%
Insurance	25	100
Any other	0	

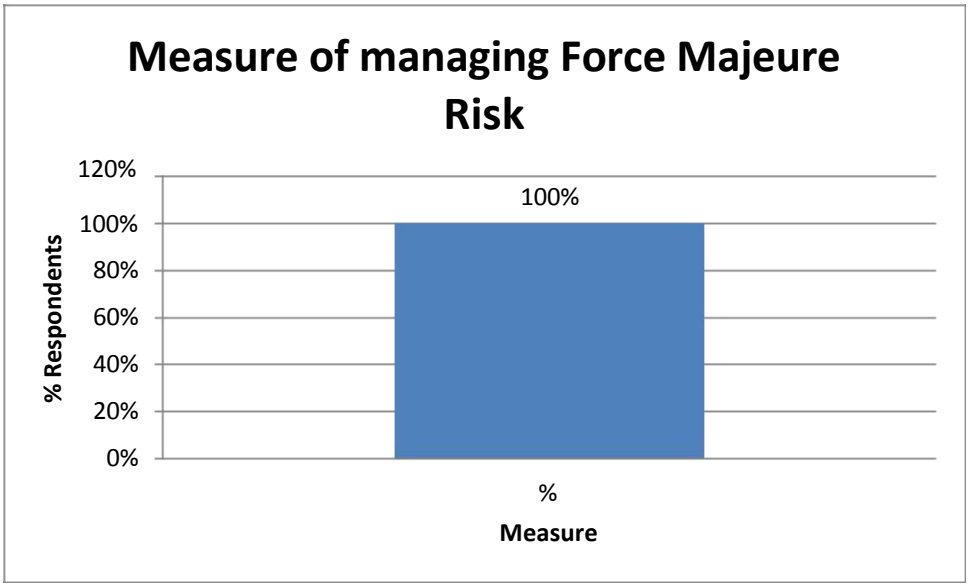

Figure 5.13: Measures taken by companies to manage force majeure risk

Table 5.17: Measures taken by companies to manage finance and economic risk

Measure	frequency	%
Standard derivative products	12	48%
Self Insurance	4	16%
Captive Insurance	3	15%
SPV	20	80%
DSRA	20	80%

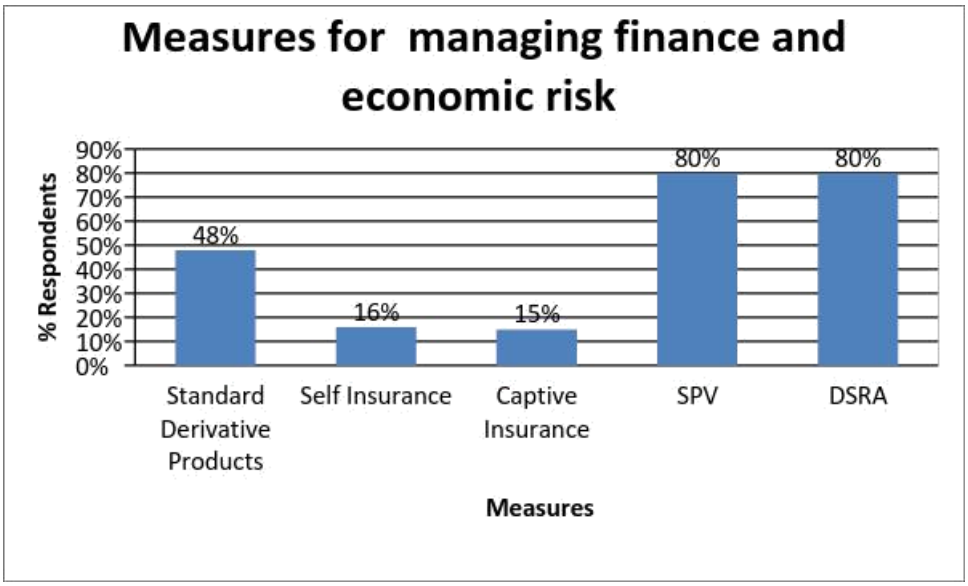

Figure 5.14: Measures taken by companies to manage finance and economic risk

Table 5.18: Measures taken by the companies to manage Regulatory Risk

Measure	frequency	%
Frequent and detailed communication with policy makers/ Industry bodies and regulators	21	84
Statement of assurance from regulators regarding policy direction	12	48

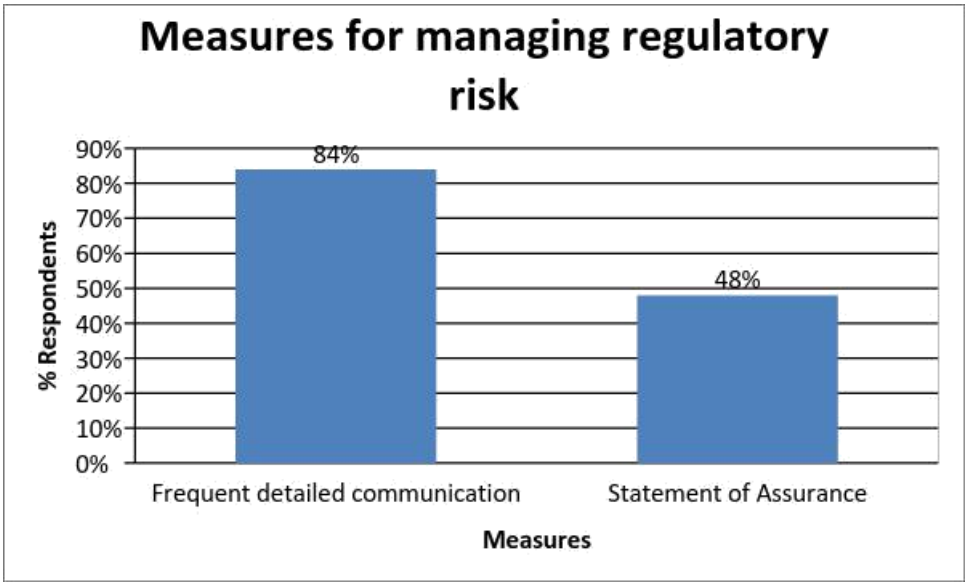

Figure 5.15: Measures taken by the companies to manage Regulatory Risk

Table 5.19: Need for FRM for regulatory risk as per developers

When asked the developers whether there is a need of introduction of FRM for regulatory risk, following response was obtained:

	Frequency	%
Yes	16	64
No		
Don’t know/NA	9	36

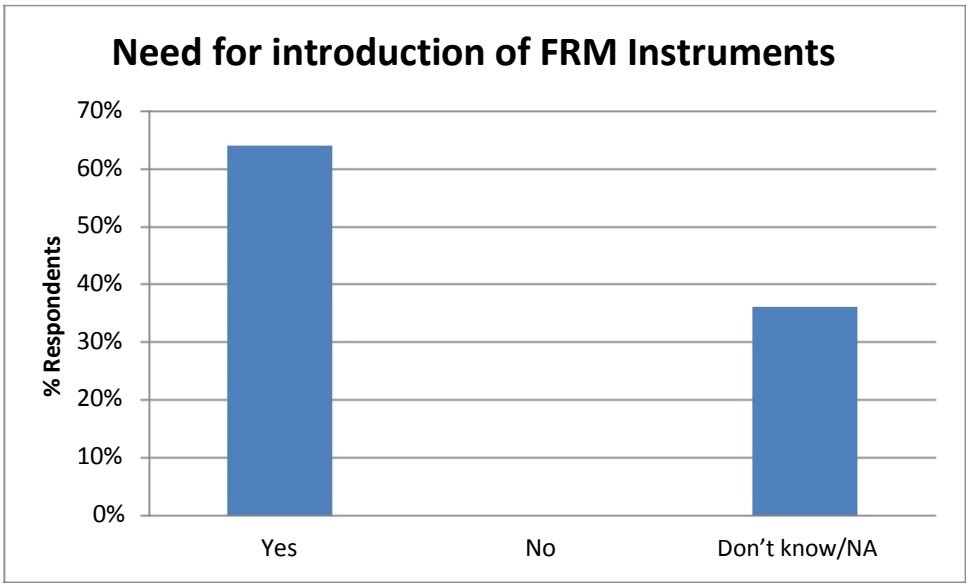

Figure 5.16: Need for Financial risk management instruments for Regulatory risk as per developers

When same question was put to lenders following response was obtained:

Table 5.20: Need for FRM instruments for regulatory risk as per lenders

	Frequency	%
Yes	13	100
No		
Don't know/NA		

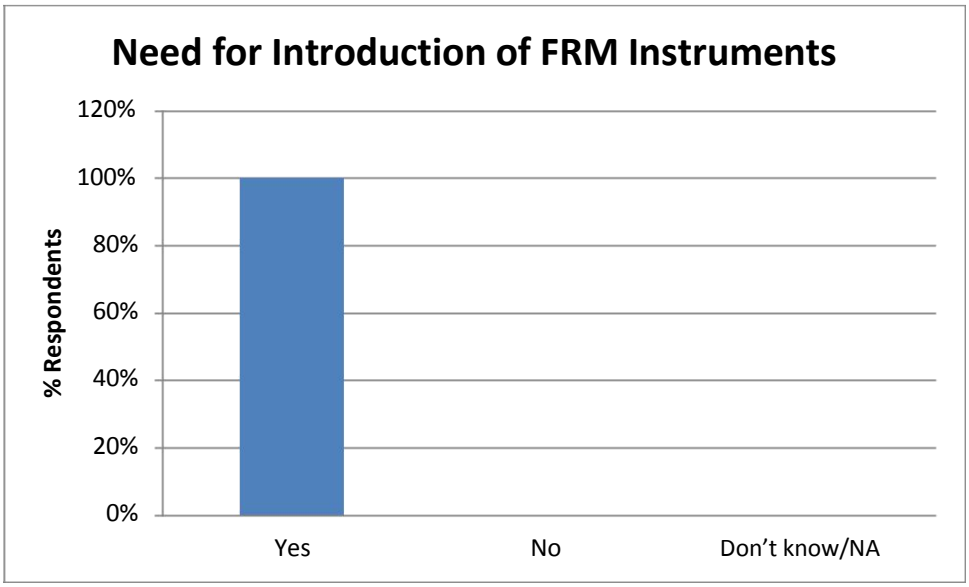

Figure 5.17: Need for Financial risk management instruments for Regulatory risk as per lenders

Confidence in the ability of companies to manage various risks: When asked the developers as to their confidence in the ability of their companies to manage various risks, following response was obtained:

Table 5.21: Developers Perception as to their own ability to manage various risks

% Respondents									
	Extremely confident	Very Confident	Confident	Slightly confident	Not at all confident	don't know/ NA	Weighted score	Weighted Mean	Standard deviation
Construction risk	56%	24%	16%	4%			108	4.32	.8818
Counter party risk	20%	44%	32%	4%			95	3.8	.8
Finance and Economic risk	28%	44%	16%	8%	4%		96	3.84	1.046
Power off taker risk	16%	36%	32%	8%	8%		86	3.44	1.098
Resource assessment risk	28%	32%	36%	4%			96	3.84	.88
Regulatory risk	8%	36%	28%	12%	16%		77	3.08	1.197
Force Majeure risk	12%	36%	44%	8%			80	3.36	.68585

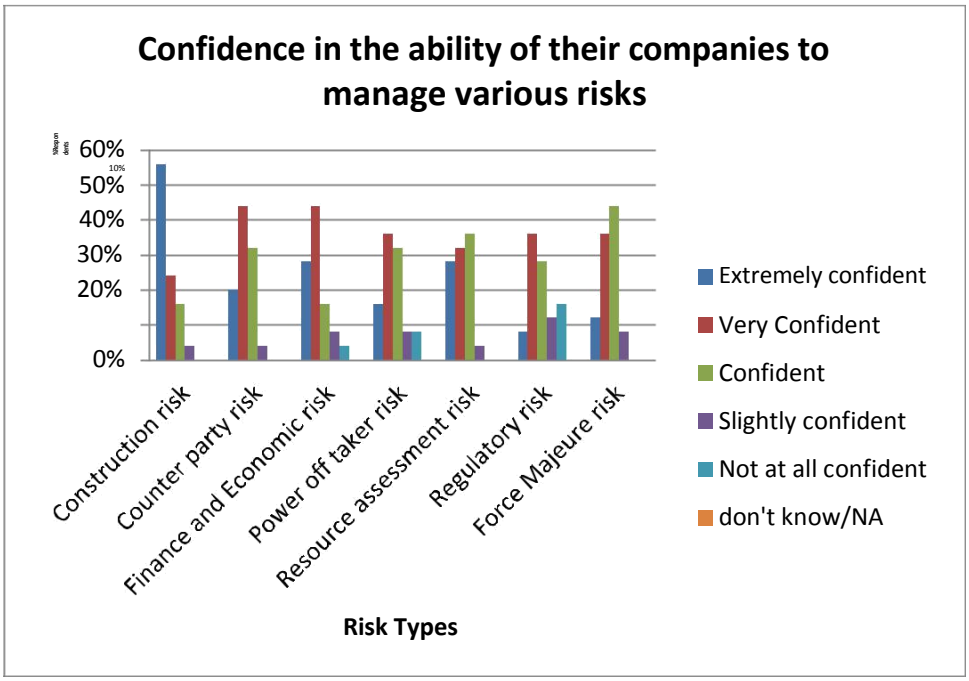

Figure 5.18: Developers Perception as to their own ability to manage various risks

Broadly it can be seen that weighted mean score is more than three for all categories of risk as per responses given by developers. Thus we can say that developers are confident on an average level as to their capabilities to manage all risks.

Following table shows the lenders response in the ability of companies to manage various risks:

Table 5.22: Lenders confidence in the abilities of companies to manage various risks

% Respondents									
	Extremely confident	Very Confident	confident	Slightly confident	Not at all sure	don't know/ NA	Weighted score	Weighted Mean	Standard deviation
Construction risk	38.46	61.53					57	4.38	.4865
Counter party risk		30.77	53.84	15.38			41	3.15	.6617
Financial risk		15.38	84.62				41	3.15	.360
Power off taker risk			38.46	61.53			31	2.38	.4865
Resource assessment risk		69.23	30.77				48	3.69	.4615
Regulatory risk			46.15	53.85			32	2.46	.4985
Force Majeure risk	15.38		38.46	46.15			37	2.85	1.15

Figure 5.19: Lenders confidence in the abilities of companies to manage various risks

Like developers lenders also have the highest confidence when it comes to managing construction risk with a mean score of 4.38 but he confidence level is lowest for power off taker risk and regulatory risk with a mean score of 2.38 and 2.46 respectively.

Thus it is very clear from the table that there is a significant variation in perception of lenders in the ability of companies with various risks. ANOVA was performed to test this further. Following results are obtained:

Table 5.23: ANNOVA Table

ANOVA: Single Factor						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Column 1	13	57	4.384615	0.25641		
Column 2	13	41	3.153846	0.474359		
Column 3	13	41	3.153846	0.141026		
Column 4	13	31	2.384615	0.25641		
Column 5	13	48	3.692308	0.230769		
Column 6	13	32	2.461538	0.269231		
Column 7	13	37	2.846154	1.141026		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	38.61538462	6	6.435897	16.26852	2.45E-12	2.208553806
Within Groups	33.23076923	84	0.395604			
Total	71.84615385	90				

Since F > F critical we can safely conclude that confidence of lenders varies significantly with risk types.

Most significant Barriers as to risk management

Respondents (both lenders and developers) were asked to rate the most significant barrier as per them when it comes to risk management from 1to 3 with first rank being

given to the one which is most significant as per them. Following is the developer's response.

Table 5.24: Significant Barriers to risk management as per developers

Options	Rank I Frequency	Rank II	Rank III
a.	3	1	5
b	4	2	4
c.	2	2	
d.	11	7	3
e.	1	5	5
f.	5	8	6

Option number d which is insufficient information about the magnitude of certain categories of risk is rated as the most significant barrier maximum number of times.

Following table summarizes the response of lenders:

Option number f which is lack of options is rated as the most significant barrier maximum number of times by lenders.

Table 5.25: Significant Barriers to Risk Management as per lenders

Options	Rank I Frequency	Rank II	Rank III
a.	3		
b		5	4
c.	2		
d.	2	4	4
e.		2	1
f.	8	2	2

Lenders perception as to Effectiveness of measures commonly employed for managing various risks:

Lenders were asked to evaluate the available risk mitigating measures for various identified risks. Response is tabulated below:

Table 5.26: Effectiveness of measures for construction risk management

Measures	Weighted Mean Score	Ranking
Insurance	4	3
Construction all risk contract	4	3
Using only proven technology in construction	4.62	2
Construction through turnkey projects	4.69	1

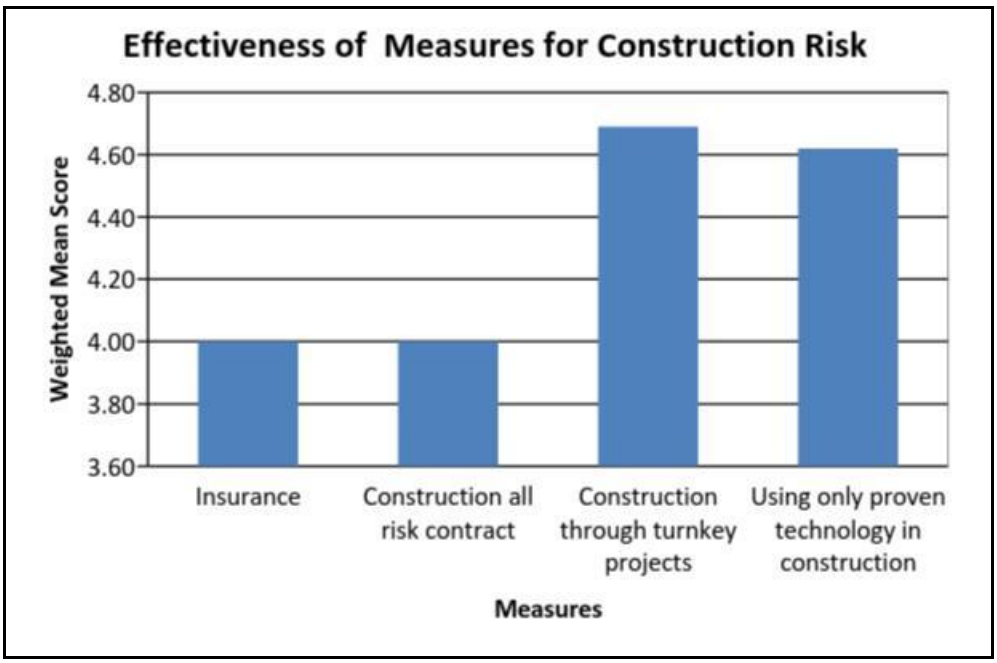

Figure 5.20: Effectiveness of measures for construction risk management

As shown in the table, construction through turnkey projects is perceived as the most effective measure in terms of effectiveness followed by using only proven technology in construction.

Table 5.27: Effectiveness of measures for counterparty risk management

Measures	Weighted Mean Score	Ranking
Performance guarantees	4.69	1
Liquidation damages	4.31	2
Due diligence process	4.23	3

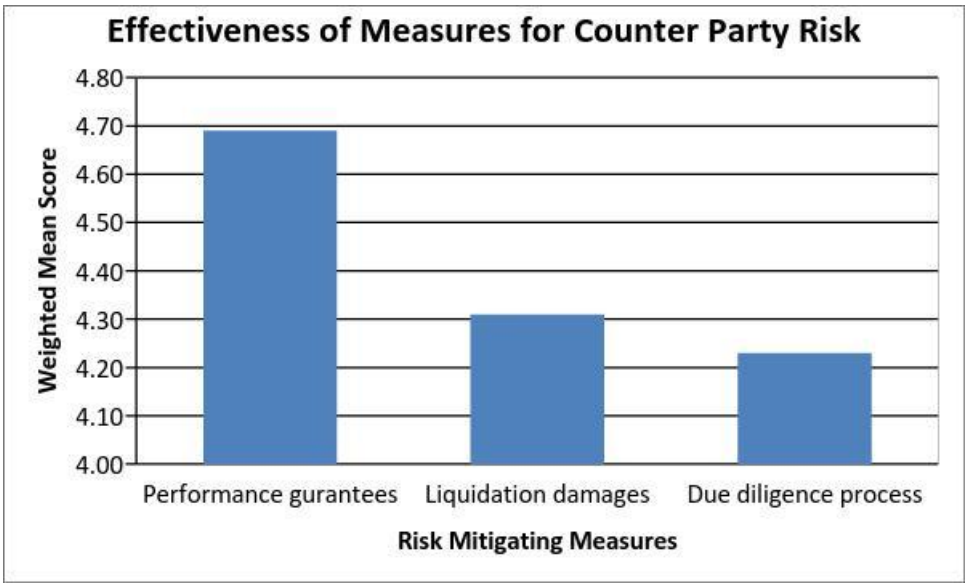

Figure 5.21: Effectiveness of measures for counterparty risk management

As shown in the table, performance guarantees is perceived as the most effective measure in terms of effectiveness followed by performance guarantees.

Table 5.28: Effectiveness of measures for finance and economic risk

Measures	Weighted Mean Score	Ranking
Usage of standard derivatives products	4.31	1
Self-insurance	3.15	4
Captive insurance	3.07	5
SPV	3.85	2
DSRA	3.69	3

As shown in the table, standard derivatives products is perceived as the most effective measure in terms of effectiveness followed by SPV.

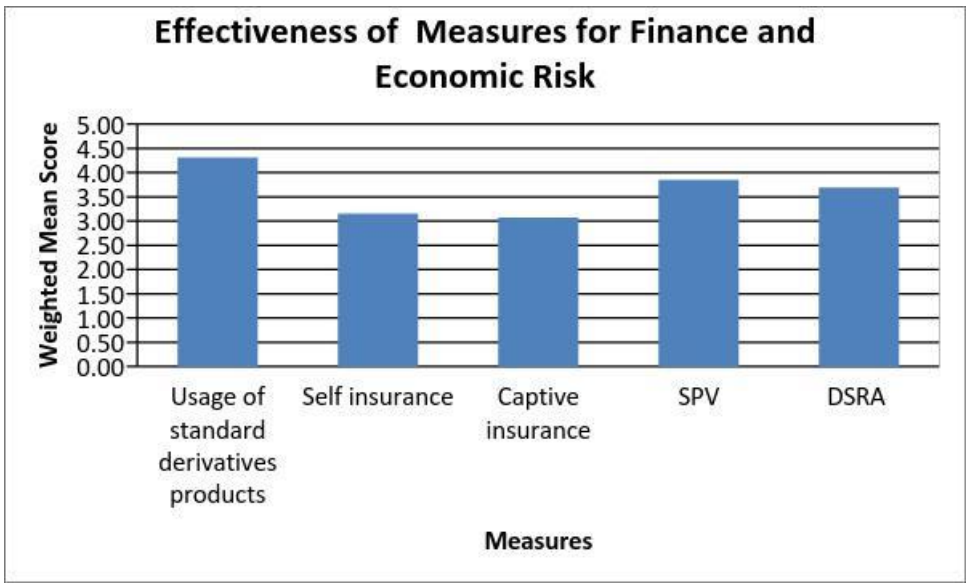

Figure 5.22: Effectiveness of measures for Finance and Economic risk

Table 5.29: Effectiveness of measures for Power off taker risk

Measure	Weighted Mean Score	Ranking
Letter of credit	4.31	2
Bank guarantees	4.46	1
Escrow	3.77	3

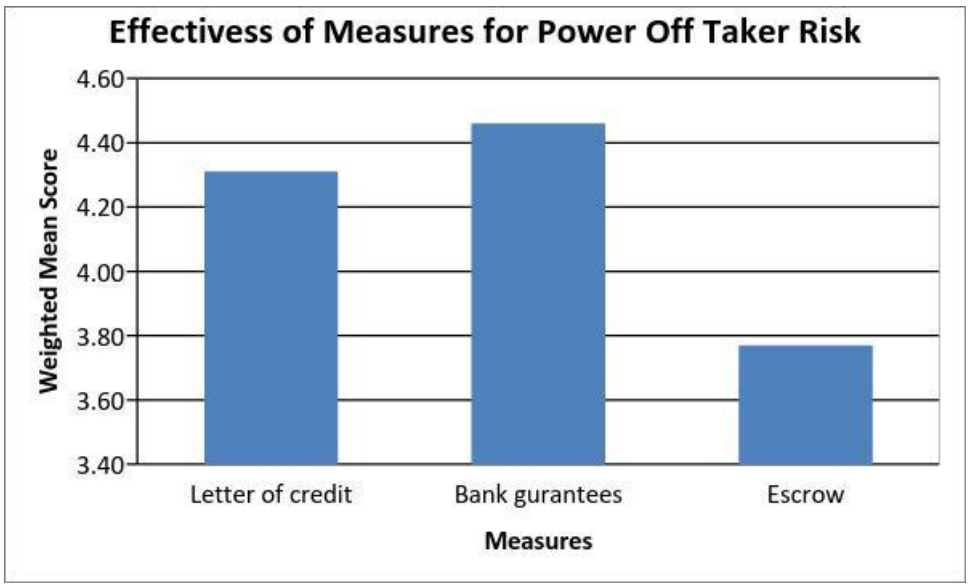

Figure 5.23: Effectiveness of measures for Power off taker risk

As shown in the table, Bank guarantees are perceived as the most effective measure in terms of effectiveness followed by letter of credit and Escrow.

Table 5.30: Effectiveness of measures for Resource Assessment risk

Measure	Weighted Mean Score	Ranking
Using more than 10 years data and combining it with ground measured data	3.235	1
Self-Insurance	1.94	2
Captive Insurance	1.88	3

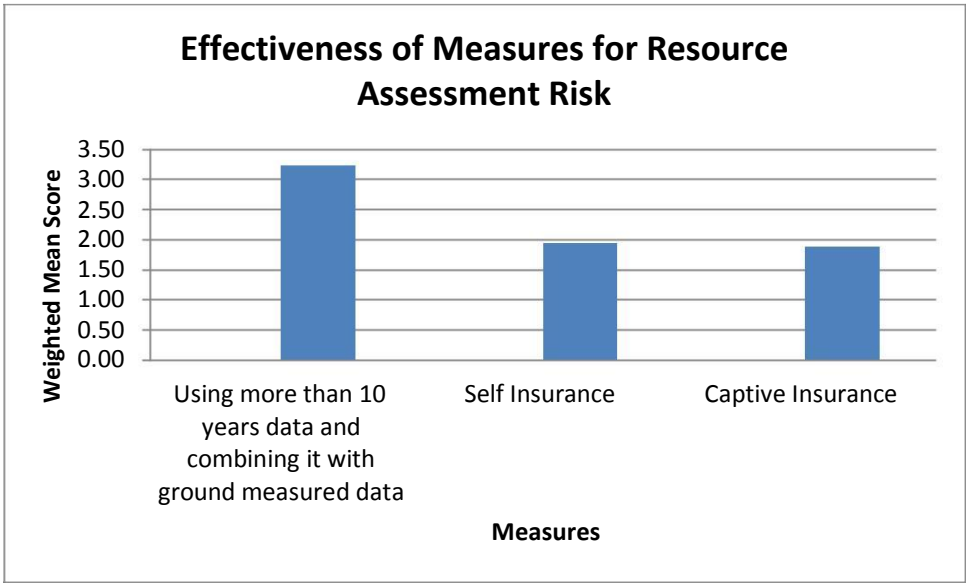

Figure 5.24: Effectiveness of measures for Resource Assessment risk

As shown in the table, Using more than 10 years data and combining with ground measured data is perceived as the most effective measure in terms of effectiveness followed by self-Insurance and captive insurance.

Table 5.31: Effectiveness of measures for Force Majeure risk

Measure	Weighted Mean Score	Ranking
Insurance	4.38	1

Insurance is the only mitigating measure available with a high mean score of 4.38.

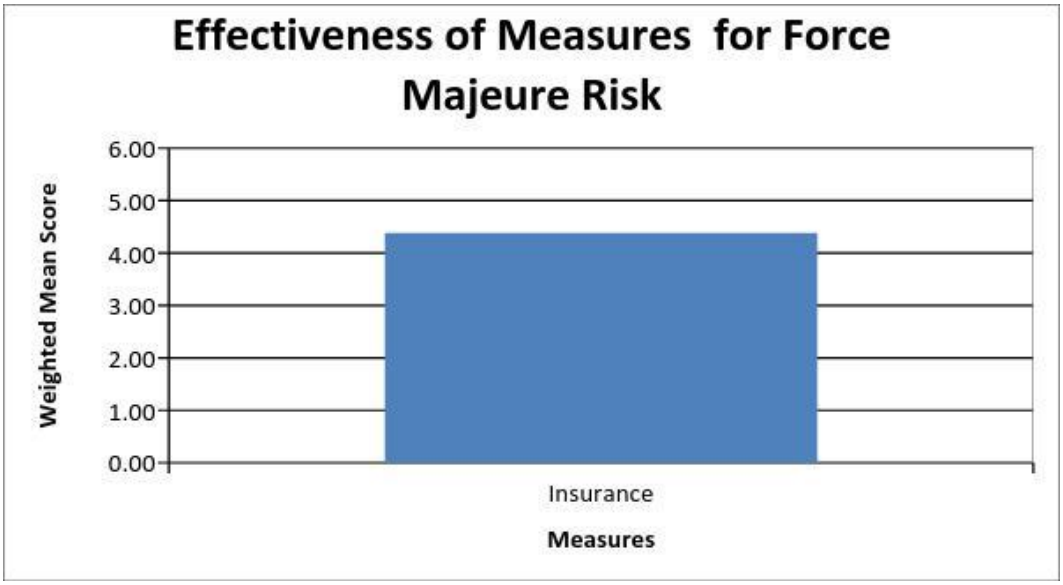

Figure 5.25: Effectiveness of measures for Force Majeure risk

Table 5.32: Effectiveness of measures for Regulatory risk

Measures	Weighted Mean Score	Ranking
Frequent and detailed communication with policy makers/ industry bodies and regulators	3.62	1
Statement of Assurance from regulators regarding policy direction	3.15	2

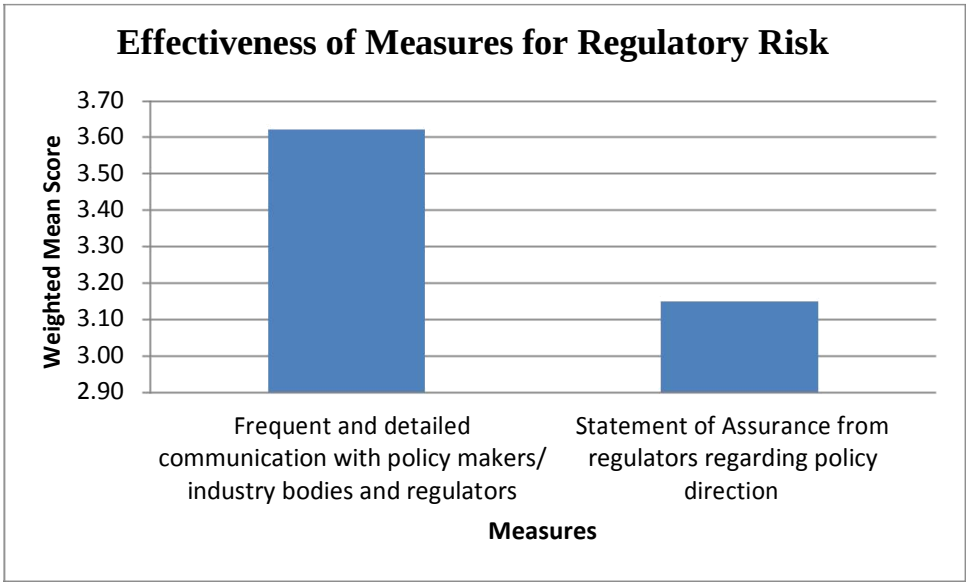

Figure 5.26: Effectiveness of measures for Regulatory risk management

As shown in the table, frequent and detailed communication with policy maker is perceived as the most effective measure in terms of effectiveness followed by statement of assurance from regulators regarding policy direction.

Karl Pearson's Coefficient of correlation between effectiveness of risk mitigating measures and its usage for various risk types:

Table 5.33: Correlation between effectiveness of risk management measures and its usage of risk for construction risk

Measure	Effectiveness as perceived by Lenders (weighted mean score)	% usage by developers
Insurance	4	90%
CAR	4	60%
Using only proven technology	4.62	92%
Construction through turnkey projects	4.69	72%

Overall coefficient of correlation works out to be .2237.

Table 5.34: Correlation between effectiveness of risk management measures and its usage for counter party risk

Measure	Effectiveness as perceived by Lenders (weighted mean score)	% usage by developers
Performance guarantees	4.69	88
Liquidation damages	4.31	80
Due diligence process	4.23	80

Overall coefficient of correlation works out to be .9866.

Table 5.35: Correlation between effectiveness of risk management measures and its usage for Finance and Economic risk

Measure	Effectiveness as perceived by Lenders (weighted mean score)	% usage by developers
Usage of standard derivatives products	4.31	48%
Self-insurance	3.15	16%
Captive insurance	3.07	15%
SPV	3.85	80%
DSRA	3.69	80%

Overall coefficient of correlation works out to be .64511

Table 5.36: Correlation between effectiveness of risk management measures and its usage for power off taker risk

Measure	Effectiveness as perceived by Lenders (weighted mean score)	% usage by developers
Letter of credit	4.31	80
Bank guarantees	4.46	72
Escrow	3.77	32

Overall coefficient of correlation works out to be .93.

Table 5.37: Correlation between effectiveness of risk management measures and its usage for Resource assessment risk

Measure	Effectiveness as perceived by Lenders (weighted mean scores)	% usage by developers
Using more than 10 years data and combining with ground measured data	3.235	100%
Self-Insurance	1.94	8%
Captive Insurance	1.88	20%

Overall coefficient of correlation works out to be .98731.

Table 5.38: Correlation between effectiveness of risk management measures and its usage for Regulatory risk

Measure	Effectiveness as perceived by Lenders (weighted mean scores)	% usage by developers
Frequent and detailed communication with policy makers/ industry bodies and regulators	3.62	84
Statement of Assurance from regulators regarding policy direction	3.15	48

Overall coefficient of correlation works out to be 1

Table 5.39: Summary of risk types and their Coefficient of Correlation between risk management measures and usage

Risk Type	Coefficient of Correlation
Construction risk	.2237
Counter party risk	.98667
Finance and Economic	.64511
Power off taker risk	.93436
Resource assessment risk	.98731
Regulatory risk	1
Force Majeure risk	-

Strongest correlation is observed in case of Regulatory risk whereas the weakest correlation is observed in case of construction risk.

Based on the analysis following is the result:

Table 5.40: Hypotheses Testing

No.	Hypothesis	Result	Explanation
1	H1 Most critical risk from the perspective of lenders and developers affecting financing is Regulatory risk	Accepted	Table number 5.5, 5.6, 5.7 and 5.8
2	H2 Confidence of Lenders in the ability of developer to manage risks varies significantly with the risk type.	Accepted	Table number 5.22 and 5.23

Chapter 6

Conclusions and Recommendations

Chapter 6

Conclusions and Recommendations

6.1 Introduction

The Purpose of Empirical study conducted in the preceding chapter is to understand the various risk affecting solar power projects debt financing in India, to know the perception of both lenders and developers as to the most critical risk affecting the availability of debt finance and to know and understand the current practices and instruments of risk management along with their effectiveness with reference to Commercial grid connected Solar PV Projects. This chapter reviews the set of conclusions based on the study conducted. These conclusions though indicative of broad trend may lead to some suggestions which may benefit academicians, industry as well as also lead to identification of future scope and extension of study.

6.2 Conclusions from the Study

1. Analysis of the secondary literature indicates that the main risks affecting debt financing are Regulatory risk, Construction risk(it includes time over run and cost overrun), Counter party risk (construction contractor and O&M contractor), Finance and Economic Risk, Power Off Taker risk, Resource Assessment and Force Majeure Risk.

2. In depth analysis based on the primary survey indicates that lenders and developers perceive Regulatory risk being the most critical risk followed by Power off taker risk when it comes to financing. Comparable ranking is given by both lenders and developers, however intensity varies. Least ranking in terms of significance for financing is given to force majeure risk by developers whereas lenders consider construction risk (cost overrun) followed by time over run to be least significant. Thus lenders and developers have a conflicting view here. But despite this, there is a strong correlation (alpha=.76) observed in their perception.

Table 6.1: Risk ranking as per lenders and Developers

Risk Ranking	As per developers	As per lenders
1	Regulatory Risk	Regulatory Risk
2	Power Off taker Risk	Power Off taker Risk
3	Finance and Economic Risk	Finance and Economic Risk
4	Construction Risk(time over run)	Resource Assessment Risk
5	Counter Party Risk(construction contractor)	Counter Party Risk(construction contractor)
6	Construction Risk(cost overrun)	Counter Party Risk(O&M)contractor
7	Resource Assessment risk	Force Majeure Risk
8	Counter Party Risk(O&M) Contractor	Construction Risk(time over run)
9	Force Majeure Risk	Construction Risk(cost overrun)

This ranking is also in line with many previous studies conducted. For examples As per World Bank Report (2010)[1]Titled, "Report on Barriers for Solar Power Development in India" approx. 63% of respondents believe that policy and regulatory barriers is most significant barrier for the solar power development. As per them, the main risk affecting financing is PPA risks that are poor bankability of PPAs and solar radiation data. Poor bankability of PPAs is reflected in power off taker risk. Low ranking given by developers to resource assessment risk is in line with the study conducted by ShrimaliG., Nekkalapudi (2014)[2]where they have stated that Resource risk is low for Solar PV because the variation between satellite data and data on ground station is less than 5% for

1Kulkarni, A. (2010). Report on barriers for solar power development in India. South Asia Energy Unit, Sustainable Development Department, The World Bank. Retrieved on 19.01.2014 from https://www.esmap.org/;https://www.esmap.org/sites/esmap.org/files/ The%20World%20Bank_ Barriers%20for%20Solar%20Power%20Development%20in%20India%20Report_FINAL.pdf:

2Shrimali, G., &Nekkalapudi, V. (2014). How Effective Has India's Solar Mission Been in Reaching its Deployment Targets? Economic and Political Weekly, 49(42).Retrieved on 11.02.2015 from http://eprints.exchange.isb.edu/305/

GHI. Lenders are also not considering this risk to be in top three categories but still they have given it a comparatively higher ranking as compared to developers.

3. Only four out of the 9 identified risks have been experienced by the developers in a major way and they are regulatory risk, finance and economic risk, power off taker risk and also time over run with 12% respondents experiencing it in a major way followed by only 8% in other two categories and 4% in time over run. This probably is the reason why time over run is given high ranking in terms of criticality by developers as compared to lenders. Lenders are not bothered much about this risk probably because of availability of appropriate risk management measure for the risk. Resource assessment risk and force majeure risk has never been experienced by in a major or even average way by the developers. Whereas power off taker risk which has been ranked as second most critical risk by both lenders and developers has been experienced slightly and very slightly or rather not experienced at all by more than 80% of respondents. Same is the case for finance and economic risk. Only total 16% of respondents say that they have experienced power off taker and financial risk in a major or average way.

   This also leads to a very important conclusion that even if a risk exists or is experienced, it is not bothering the financiers if there are suitable risk mitigating measures as shown by the low ranking given lenders to construction risk(time over run).

4. Only 7.69% of lenders perceive that companies are highly successful when it comes to identification of risk and assessment of risk. This is in contradiction to our findings as regulatory risk is perceived to be the most critical risk and comparable rankings are given by both developers and lenders to various risks. Weakest area as per lenders are risk mitigation and risk transference where none of the lenders considers companies to be highly successful. More than 90% of the lenders consider them average and below average and approx. 15.38% to be not at all successful in case of risk transfer.

5. Another objective of the study was to understand the current practices and instruments of risk management commonly employed by developers.

    a. For construction risk almost 92% of developers are using proven technology followed by close 88% are using insurance for risk transfer. Both of these are having a mean score of 4.62 and 4 respectively which are considered to be quite effective risk management practice.

    b. For counter party risk companies are relying in strictly following due diligence process and are depending on performance bank guarantees and liquidation damages as risk management tools which are also considered effective if measured in terms of risk management score.

    c. For power off take risk around 80% of the developers are rely on bank guarantees followed by good 72% relying on LC which are also perceived to be high on effectiveness rating by lenders in their individual capacity. But despite this power off taker risk is considered to a critical risk. This leads to conclusion that all aspects of this risk is not covered by the available instrument and though they are effective in their individual capacity.

    d. For Resource assessment risk, almost all the companies are relying on several years data and combining it with ground measured data and only 1/5 of the surveyed companies are relying on captive insurance to handle deviation and less than 10% of the companies are relying on self-insurance for the same. But on effectiveness rating, first measure is considered to be average with a means score of 3.2 and the remaining two from poor to very poor with a mean score of less than 2. This also ratifies the ranking given to the resource assessment risk as the 4^{th} most critical risk bothering lenders.

    e. For Force majeure risk insurance is the only option available and almost all the companies are using it. It is also rated highly effective with a mean score of 4.38.

f. For Finance and economic risk, almost 80% of the developers are relying on SPV and DSCR with approximately 48% relying on Standard derivative products like hedging etc. and less than 1/5 are using self-insurance and captive insurance. But in terms of effectiveness, standard derivatives products are considered to be more effective with a comparatively high mean score of 4.31 and SPV and DSCR are rated just slightly above average based on their mean score. This also explains probably as to why finance and economic risk is considered to be third most critical risk bothering financiers. This also highlights the need of development of more standard derivatives products at competitive cost and to encourage its usage at the end of developers.

g. For Regulatory risk, there are no predesigned instruments available in India. More than 80% of developers rely on communication with policy makers. Industrial bodies and regulators to handle the risk and close to 48% rely on statement of assurance from regulators. But both of these are rated only average in terms of effectiveness by lenders. this coupled with the finding that almost 100% financiers feels the need of well-designed FRMs instruments explains and ratifies the findings that regulatory risk is considered to most critical risk by financiers.

h. Insurance used to transfer risk to a third party is widely used by developers wherever available. But the product is available only for few selected risks in India. It is also rated by lenders high on effectiveness with a weighted mean score of 4 and more.

6. Based on the availability of risk mitigating measures and choice of developers as to the practices and usage of risk management tools and instruments, confidence of lenders in the ability of developers varies with the risk type significantly. They are so high on confidence when it comes to construction risk with a high mean score of 4.38 and lowest for power off taker risk with a mean score of 2.38 followed by regulatory risk with a mean score of 2.46 which is below average. Developers themselves are quite confident that they can handle construction risk

and they are least confident that they can manage regulatory risk with a mean score of less than 3.

7. Coefficient of correlation is 1 for Regulatory risk followed by .98667 for counter Party risk and for resource assessment risk it is .98371.These are indicators of very strong positive correlation. Correlation is least for construction risk which is .2237 and for financing and economic risk it is moderate with the value of. 6411. As per lenders and developers both top three risks affecting financing are regulatory risk, power off taker risk and finance and economic risk. So probably developers in an attempt to manage the regulatory risk are following the most effective ways as shown by coefficient of correlation, but despite this the confidence level of lenders is second lowest in ability of lenders to manage this risk with a mean score of 3. This highlights the need for appropriate risk mitigating measures for regulatory risk, this is also highlighted by the response of lenders where in almost 100% of them have state that there is a need of FRM for regulatory risk. This is also substantiated by the fact that as per lenders lack of option is considered to be the most significant barrier of risk management.

   For power off taker risk also the high positive correlation with the lowest confidence level of lenders in the developers abilities to manage this risk hints toward the risk coverage gaps in the existing measures which though are considered effective in their individual capacity to mitigate certain aspects of this risks leaving other aspects uncovered.

   In case of finance and economic risk, moderate correlation is observed. Developers need to use more of standard derivative products which are perceived to be highly effective with a mean score of 4.31.

   Very low correlation is observed in the case of construction risk which may be due to the fact that all the mitigating measures in this category are considered to be high and very high effective with a mean score of more than 4in terms of effectiveness. Lenders are also least concerned for this risk and the risks are given 4^{th} and 6th ranking as per developers. Difference in the usage pattern has resulted in such a low correlation.

8. For lenders most significant barriers when it comes to risk management is lack of options, this clearly highlights the need to develop appropriate tool for risk management when it comes to Solar PV projects. Developers feel that they lack information about the magnitude of certain categories of risk. This identifies risk assessment to be a weaker area.

Present study makes a significant contribution to the existing body of knowledge. This study proves statistically by means of an empirical research that regulatory risk is the most critical risk bothering financiers. This is in lines with the existing literature globally and this is understandable also because renewable energy market is strongly supported by various policy schemes. This research is very relevant for the developers operating in solar PV market. A clear understanding of perception of financiers as to various risk elements can help them take a balanced view as to various risks. This research will also help in better understanding of perception of financiers and their concerns and probably can help the developers in align the risk management practices in line with the expectations of financiers. It can also help policy makers in designing of financial risk management instruments which can support the deployment of solar energy by ensuring the increasing availability of finance.

6.3 Recommendations

On the basis of study which includes Primary survey and secondary data analysis, a risk management framework is suggested by the researcher. Since it has been an established fact on the basis of finance theories as well as existing literature that the perceived effectiveness of the risk mitigating measure plays a crucial role in deciding financial parameters to be applied by financiers (De Jager ,Rathman, 2008)3. Considering this along with the risk ranking, authors suggests a mechanism to be applied to solar PV projects. All risks which are of the concern to the financiers should be listed in the order of significance in terms of criticality.

Most significant being Regulatory risk and least being force majeure as per developers and as per lenders it is Regulatory risk being considered most significant and construction risk being the last. This is proven in the study statistically.

For each of the listed risks, all corresponding mitigating measures should be listed in the order of effectiveness. The most effective measure should be adopted subject to other subjective considerations. Combination of various mitigating measure is also required many a times.

Most significant being Regulatory risk and least being force majeure as per developers and as per lenders it is Regulatory risk being considered most significant and construction risk being the last. . This is proven in the study statistically.

Special mention here of Power off taker risk, regulatory risk , finance and economic risk, which are considered very critical coupled with the fact that lenders confidence level is also very low in the ability of companies to manage this risk. For power off taker risk for example companies are relying on LCs, Bank Guarantees which are considered to be effective, but seeing the low level of confidence of the companies, it highlights the needs for introduction on improved versions of existing or new risk mitigating measures which can focus on uncovered aspects of these risks. For regulatory risk appropriate measures should be introduced to increase the confidence level of lenders. For finance and economic risk, company should resort to increased usage of standard derivative products like hedging which are considered to be effective by lenders.

[3]De Jager, D., Rathmann, M., Klessmann, C., Coenraads, R., Colamonico, C., &Buttazzoni, M. (2008). Policy instrument design to reduce financing costs in renewable energy technology projects. Ecofys, by order of the IEA Implementing Agreement on Renewable Energy Technology Deployment (RETD), Utrecht, ther Netherlands. Retrieved from 01.01.2015 from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.592.3720&rep=rep1&type=pdf:

Table 6.2: Risk ranking and mitigating measures listed in the order of effectiveness

Risk Ranking	As per lenders	Mitigating measures in the order of effectiveness
1	Regulatory risk	1. Frequent and detailed communication with policy makers/industry bodies and regulators 2. Statement of assurance from regulators regarding policy direction
2	Power Off taker risk	1. Bank Guarantees 2. Letter of Credit 3. Escrow
3	Finance and Economic risk	1. Usage of standard derivative products 2. SPV 3. DSRA 4. Self-Insurance 5. Captive Insurance
4	Resource assessment risk	1. Using more than 10 years and combining it with ground measured data 2. Self-Insurance 3. Captive Insurance
5	Counter party risk	1. Performance 2. Guarantees 3. Liquidation damages 4. Due diligence process
7	Force majeure	Insurance
8	Construction risk	1. Construction through turnkey projects 2. Using only proven technology in construction 3. Insurance 4. CAR contract

Another important point which is important is regarding Resource assessment risk. Previous studies have stated it technically that Resource risk is low for Solar PV. But still lenders have given it comparatively higher ranking signifying that lenders are being bothered by this risk. This also identifies the need of appropriate updation of lenders to change the perception of lenders.

The fundamental principal that risk should always be borne by the party most capable in handling should be practiced. Detailed negotiation with the government and various bodies through various forums needs to be done from time to time seeing the present state of FRM which needs a significant improvement and development in terms of risk

management instruments. For example Insurance is the mostly widely used product for transferring risk to a third party wherever available and it is also perceived to be high on effectiveness rating by developers but its availability is restricted only to few selected risks in India.

6.4 Limitations of the Study

Like the majority of the research study, this research study is also subjected to various limitations which require specific mention.

1. Study is focused only on solar power projects. Within Solar also only Solar (PV) projects are taken into consideration. This restricts the applicability of conclusions of this study to certain extent.
2. Only Grid connected projects for commercial purposes have been taken into consideration. They can be assumed to be of medium to large scale. Non Grid and Standalone projects are likely to be of small scale. Characteristics of Projects, their financing needs as well as risk perceived by financiers differ for different project scale.
3. Study is based on the Questionnaire survey. Here the response obtained is the opinion of one individual. They may or may not reflect the stand of the concerned company.
4. Only banks and FIs have been included which constitute one of the many sources financing solar PV projects.
5. It has been observed during the survey that most of the respondents have limited experience in terms of number of years in the solar sector. This is expected as this is a new sector. But this might limit the credibility of information provided by them on the basis of their limited experience.

6.5 Scope for further Research

During the course of this study, researcher came across various areas which could not be studied in depth because they were beyond the scope of the present study, but which definitely constitute an area of further research. Study is a empirical study focusing on a country wide situation. A more in-depth analysis based on state level can be done to have a more focused understanding.

Researcher has only included banks and FIs which constitutes one of the many sources of funds for Renewable energy projects. Additional research including wider investor category is strongly suggested. Those lenders which have not been into solar financing can also be studied to have an understanding of their perspectives. Difference in perception of public and private sector lenders can also be an area of further investigation.

Study empirically and statistically concludes that regulatory risk, power off taker risk, and financial risks are top three critical risks affecting financing. In-depth study considering various variables within each of these risk categories can be done in future to get a detailed insight within each of these risk categories and this can be considered to be an extension of the present study. A similar study can also be done for off grid solar considering the growing significance of this sector.

Detailed investigation into regulatory risk and expectation of financiers for various solar PV policies can be another area of analysis which can be very beneficial.

APPENDICES

APPENDIX I

Questionnaire for the Study on topic
"Study of Financial Risk Management in Renewable Energy Sector with reference to Solar Power Projects in India"

The Purpose of this Questionnaire is to understand the current practices of risk management in solar power projects (PV). It is a very significant part of the doctoral research on the above mentioned topic and the conclusions of the study would be based on the information provided by you to the great extent.

Survey is entirely for the purpose of academic research and the strict confidentiality of the information provided by you would be maintained. However, Researcher would be glad to share the research outcome provided you desire.

Sushma Verma

Section A

1. In how many sectors within the Renewable Energy basket you have been operating: Please Tick
   a. Solar Power ☐
   b. Wind Power ☐
   c. Hydro Power ☐
   d. Bio Energy ☐
   e. Geo thermal Energy ☐

2. In how many Indian states you have solar power projects :Please Tick
   a. Only one
   b. Between 2-4
   c. More than four ___

3. Taking Renewable Sector as a whole, how significant can be the growth in installed capacity in the following sectors. Please rate by ticking:

   Ratings: 1.VeryHigh [30% or more] 2. High [20%-30%] 3.Moderate [10-20%] 4. Low[less than 10%] 5. No growth 6. Don't know/ Not Applicable

Solar Power	1	2	3	4	5	6
Wind Power						
Hydro Power						
Bio Energy						
Geo thermal						

4. How would you rate the criticality of each of the following risks when it comes to lending money to solar power projects : Please rate by ticking:

   Ratings 1 -Extremely Critical 2-Very Critical 3- Critical 4-Slightly critical 5-Not at all Critical 6- Don't know/Not applicable

	1	2	3	4	5	6
Regulatory Risk						
Construction Risk: Time Over Run						
Construction Risk: Cost Over run						
Counterparty Risk: Construction Contractor						
Counter Party Risk(O&M Contractor)						
Finance and Economic Risk						
Power Off taker risk						
Resource Assessment Risk						
Force Majeure Risk						

5. Which of the following types of risk has actually materialized in your solar power projects? Please rate by ticking:

Ratings 1. Yes, in a major way 2. Yes on an average way3.Yes, slightly 4. Very slightly 5.Not at all 6. Don't know / not applicable

	1	2	3	4	5	6
Regulatory Risk						
Construction Risk: Time Over Run						
Construction Risk: Cost Over run						
Counterparty Risk: Construction Contractor						
Counter Party Risk(O&M Contractor)						
Finance and Economic Risk						
Power Off taker risk						
Resource Assessment Risk						
Force Majeure Risk						

6. According to you, how successful your feel is your company when it comes to managing risk in following aspects: Please rate by ticking :
   Ratings : 1. Extremely successful 2. Very successful 3. Successful 4. Slightly successful 5.Not at all successful 6. Don't know/Not Applicable

	1	2	3	4	5	6
Risk Identification						
Risk Assessment in terms of scale and scope						
Risk Mitigation						
Risk Transference to Third Parties						

7. What steps/ measures are taken by your company to mitigate/ manage construction risk associated with solar power plant? Please tick.You may tick the multiple measures also if used.

   a. Insurance ☐
   b. Construction all risk ☐
   c. Using only proven technology in construction ☐
   d. Construction through turn key projects ☐
   e. Any other please specify:

8. What measures are taken by your company to manage counter party risk? Please tick.You may tick the multiple measures also if used.

   a. Surety bonds
   b. Performance guarantees ☐
   c. Liquidation damages
   d. Due diligence process
   e. Any other please specify:

9. What measures are taken by your company to manage power off taker risk? Please tick. You may tick the multiple measures also if used.

    a. Bank Guarantees ☐
    b. LC ☐
    c. Escrow ☐
    d. Any other please specify:

10. What measures are being taken by your company to manage Resource Assessment Risk? Please tick. You may tick the multiple measures also if used.

    a. Self-Insurance ☐
    b. Captive Insurance ☐
    c. Using several years data and combining it with ground measured data ☐
    d. Any other please specify:

11. What measures are being taken by your company to manage force majeure risk? Please tick. You may tick the multiple measures also if used.
    a. Insurance ☐
    b. Any other please specify:

12. What measures are taken by your company to manage finance and economic risk? Please tick. You may tick the multiple measures also if used.

    a. Usage of Standard derivatives products ☐
    b. Self-Insurance ☐
    c. Captive Insurance ☐
    d. SPV ☐
    e. DSRA ☐
    f. Any other please specify:

13. What measures are being taken by your company to manage regulatory risk? Please tick. You may tick the multiple measures also if used.

    a. Frequent and detailed communication with policy makers / industry bodies and regulators ☐
    b. Statement of Assurance from regulators regarding policy direction ☐
    c. Any other please specify:

14. Do you feel the need of introduction of FRM for Regulatory Risk? Please tick
    a. Yes ☐
    b. No ☐

15. How confident you are in the ability of your company to manage following risk? Please rate by ticking:

Ratings: 1. Extremely confident 2. Very confident 3.Confident 4.Slightly confident 5.Not at all confident 6.Don't know

	1	2	3	4	5	6
Regulatory Risk						
Construction Risk: Time Over Run						
Construction Risk: Cost Over run						
Counterparty Risk: Construction Contractor						
Counter Party Risk(O&M Contractor)						
Finance and Economic Risk						
Power Off taker risk						
Resource Assessment Risk						
Force Majeure Risk						

16. What as per you could be the three most significant barrier when it comes to the management of risk in a very effective manner. Rank them. 1 for the most significant and 3 for the least significant
    a. Lack of awareness about the role of risk management ☐
    b. Lack of fund for risk management ☐
    c. Absence of commitment from top management ☐
    d. Insufficient information about the magnitude of certain categories of risk ☐
    e. Lack of awareness about various available options ☐
    f. Lack of options ☐
    g. Any other please specify:

Section B: Details of the Respondent:

Name:

Exact Designation:

Number of years of Work Experience with the present company:

Name of the Company:

Solar Industry experience of developers:

Appendix II

Questionnaire for the Study on topic

"Study of Financial Risk Management in Renewable Energy Sector with reference to Solar Power Projects in India"

The Purpose of this Questionnaire is to understand the Perception of lenders as to the Prospects of Solar within the Basket of RE sector, various risks affecting financing and also the effectiveness of various risk management measures used in solar power projects. It is a very significant part of the doctoral research on the above mentioned topic and the conclusions of the study would be based on the information provided by you to the great extent.

Survey is entirely for the purpose of academic research and the strict confidentiality of the information provided by you would be maintained. However, Researcher would be glad to share the research outcome provided you desire.

Sushma Verma

Section A

1. Taking Renewable Sector as a whole, how significant as per you can be the growth in installed capacity in the following sectors: Please rate by ticking:

   Ratings: 1. Very High [30% or more] 2. High [20%-30%]
   3. Moderate [10-20%] 4. Low[less than 10%] 5. No growth
   6. Don't Know/Not Applicable

Solar Power	1	2	3	4	5	6
Wind Power						
Hydro Power						
Bio Energy						
Geo thermal						

2. How would you rate the criticality of each of the following risks when it comes to lending money to solar power projects? : Please rate by ticking:

   Ratings: 1. Extremely critical 2. Very critical 3.Critical 4.Slightly critical
   5. Not at all Critical 6. Don't know/Not Applicable

	1	2	3	4	5	6
Regulatory Risk						
Construction Risk: Time Over Run						
Construction Risk: Cost Over run						
Counterparty Risk: Construction Contractor						
Counter Party Risk(O&M Contractor)						
Finance and Economic Risk						
Power Off taker risk						
Resource Assessment Risk						
Force Majeure Risk						

3. How successful are companies when it comes to managing risk in following aspects: please rate by ticking:

   Ratings: 1.Extremely successful 2. Very successful 3.Successful 4.Slightly successful 5.Not at all successful 6. Don't know/Not Applicable

	1	2	3	4	5	6
Risk Identification						
Risk Assessment in terms of scale and scope						
Risk Mitigation						
Risk Transference to Third Parties						

4. How would you rate the effectiveness of the following risk measure for managing construction risk associated with solar power plant? Please rate by ticking:

   Ratings: 1. Extremely effective 2. Very effective3.Effective 4.Slightly effective 5.Not at all Effective 6. Don't know /Not Applicable

	1	2	3	4	5	6
Insurance						
Construction all Risks Contracts						
Using only proven technology in construction						
Construction through turnkey projects						

5. How would you rate the effectiveness of following risk measures for managing counterparty risk associated with solar power plant? Please rate by ticking:

   Ratings: 1. Extremely effective 2. Very effective 3.Effective 4.Slightly effective 5. Not at all Effective 6. Don't know /Not Applicable

	1	2	3	4	5	6
Performance Guarantees						
Liquidation damages						
Due diligence process						

6. How would you rate the effectiveness of following risk measures for managing power off taker risk associated with solar power plant? Please rate by ticking:

   Ratings: 1. Extremely effective 2. Very effective 3.Effective 4.Slightly effective 5. Not at all Effective 6. Don't know /Not Applicable

	1	2	3	4	5	6
LC						
Bank Guarantees						
Escrow						

7. How would you rate the effectiveness of following measures for managing resource assessment risk associated with solar power plant? Please rate by ticking:

   Ratings: 1. Extremely effective 2. Very effective 3.Effective 4.Slightly effective 5.Not at all effective 6. Don't know /Not Applicable

	1	2	3	4	5	6
Using more than 10 years data and combining it with ground measured data						
Self-insurance						
Captive Insurance						

8. How would you rate the effectiveness of following measure for managing force majeure risk associated with solar power plant? Please rate by ticking:

   Ratings: 1.Extremely effective 2. Very effective 3.Effective 4.Slightly effective 5. Not at all Effective 6. Don't know /Not Applicable

	1	2	3	4	5	6
Insurance						

9. How would you rate the effectiveness of following risk measures for managing finance and economic risk associated with solar power plant? Please rate by ticking:

   Ratings: 1. Extremely effective 2. Very effective 3. Effective 4.Slightly effective 5. Not at all effective 6. Don't know /Not Applicable

	1	2	3	4	5	6
Usage of standard derivatives products						
SPV						
Self-Insurance						
Captive Insurance						
DSRA						

9. How would you rate the effectiveness of following risk measures for managing regulatory risk associated with solar power plant? Please rate by ticking:

   Ratings: 1. Extremely effective 2. Very effective 3.Effective 4.Slightly effective 5. Not at all Effective 6. Don't know /Not applicable

	1	2	3	4	5	6
Frequent and detailed communication with policy makers/ industry bodies and regulators						
Statement of Assurance from regulators regarding policy direction						

10. Do you feel the need of introduction of FRM for Regulatory Risk? Please tick

    a. Yes ☐
    b. No ☐

11. How confident you are in the ability of companies to manage the following risks? Please rate by ticking:

    Ratings: 1. Extremely confident 2. Very confident 3.Confident 4.Slightly confident 5.Not at all confident6. Don't' know/NA

	1	2	3	4	5	6
Regulatory Risk						
Construction Risk: Time Over Run						
Construction Risk: Cost Over run						
Counterparty Risk: Construction Contractor						
Counter Party Risk(O&M Contractor)						
Finance and Economic Risk						
Power Off taker risk						
Resource Assessment Risk						
Force Majeure Risk						

12. What could be the three most significant barriers when it comes to the management of risk in a very effective manner? (Rank them)1 for the most significant and 3 for the least significant

a. Lack of awareness about the role of risk management ☐
b. Lack of fund for risk management ☐
c. Absence of commitment from top management ☐
d. Insufficient information about the magnitude of certain categories of risk ☐
e. Lack of awareness about various available options ☐
f. Lack of options ☐
g. Any other please specify:

Section B:
Details of the

Respondent Name:

Exact Designation:

Number of years of Work Experience with the present Bank/FIs:

Name of the Bank/FIs:

Appendix III

List of Companies Participated

1. ACME Telepower limited
2. Aditya Birla (Solar)
3. AES Solar energy Private Limited
4. Alex Green Energy private limited
5. Astonfield Solar Private limited
6. Atha Power Limited
7. Azure power Private Limited
8. Essel Infra Projects Limited
9. Fortum Finsurya Energy Private Limited
10. Ganges Enterprises private Limited
11. Giriraj Enterprises Ltd
12. Hero Future Energies
13. Hindustan Power Projects limited
14. Lanco Infratech limited
15. Mahindra Solar One
16. Reliance Power Limited
17. Renew Power Ventures private limited
18. Roha Dyechem Private Ltd
19. SembCorp Limited(Previously Green Infra)
20. Solarfield Energy Private Limited
21. Sun Edison Energy India Private Limited
22. Sunborne energy private limited
23. Tata power solar
24. Waa Solar Private Limited
25. Welspun Solar Private limited

Appendix IV

List of Financier's participated

1. State Bank of India
2. Bank of Baroda
3. Yes Bank
4. Axis Bank
5. Bank of Baroda
6. IDBI bank
7. ICICI bank
8. L&T Infrastructure Finance Company
9. Power Finance Corporation
10. IDFC
11. Mahindra Finance
12. Canara Bank
13. Vijaya Bank

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