**Emerging markets and renewable energy**

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Abstract

Emerging markets are the home of more than 80% of the world population. Economic growth is a complex process influenced by the structure of the economy, natural resources, technology, and many other characteristics of the local economy. Significant reductions in the price of solar power make it affordable and available for quick-to-build solutions for on or off grid energy in countries with a growing need for additional electricity generation. Yet many emerging markets face difficulties in developing solar energy projects. This article focuses on the implementation of solar power in the emerging market of India as a case study. India is the second largest emerging economy in the world with more than 1.2 billion people, fast economic growth, and low electricity consumption. In 2014, the Government of India has set an extremely ambitious goal of 100 GW solar power capacity installed by 2022 that would make India a global leader in renewable energy. This study analyzes the effect of the policy and other socio-economic variables on the solar market in India. It unveils a robust correlation between solar market proliferation, state rooftop solar regulation and economic freedom. Beyond the in-depth scrutiny of the case itself, this paper offers new insights on how policy and other variables impact the development of emerging renewable energy markets.

**Keywords**

Solar energy, India, Regulation, Economic Freedom, Emerging markets

**Highlights**

* Solar power is an attractive energy solution for emerging markets
* Economic Freedom index has strong correlation to solar PV capacity in India
* States with solar regulations have better chance to reach goals
* Countries with multilevel governance might have imbalanced solar distribution.

# **Introduction**

Douglass C. North describes the development of economic markets and the process in which human societies change from primitive organizations of villages and individuals to urban units with structural institutions as a complex path influenced by beliefs, social and political structures, religion, technology and more [1]. Developing and emerging markets are the home for more than 5 billion people [2], mostly in developing countries that have access only to unreliable or poor quality electricity [3]. Lack of electricity, fuel, or gas inhibits the provision of basic energy-dependent services, such as water (desalination and purification), sanitation, health, and education. The UN has placed “energy for all” as a central goal in coming years. A continuous and stable supply of electricity and energy has a direct, positive impact on a wide range of areas that contribute to improving the health quality and standard of living in countries around the world. Many studies have found and confirmed the existence of the positive relationship between energy consumption and traditional human development index, as well as a long-run connection between electricity consumption and economic growth in developed and developing countries [4], [5], [6].

To this end, the UN has promoted the Millennium Sustainable Goal (MDG) twenty years ago and again ten years later, the Sustainable Energy for All (SE4ALL) programs that have been implemented in recent decades, and more recently, as part of the agreement signed in 2015 to achieve the challenging aim of bringing electricity to the world’s entire population by 2030, the Sustainable Development Goal (SDG) (SDG No. 7). This goal must be connected to the COP21 Paris climate agreement reached in December, 2015 that sought to reduce the planet’s carbon footprint and to produce cleaner energy for all. The growth in greenhouse-gas emissions is expected to come mainly from emerging markets [7], which require $4 trillion per year to build and maintain renewable energy infrastructure. Hence questions about the public services, experience, education, regulation, economy, and other aspects needed to bring electricity to developing countries is a major issue worldwide.

Renewable energy, a fast and rapidly growing sector that includes solar, wind, and biomass, is constantly dropping in costs and has a shorter time to market compared to fossil or hydro projects. The combined effect of the Paris agreement and the reduced costs of energy production from renewable sources, as well as the economic incentives and a commitment to satisfy energy needs in emerging markets, presents an unparalleled opportunity for the renewable energy industry in the next decade [7].

As of 2016, India was the third largest producer and consumer of electricity in the world after China and the US [8], yet it has the biggest proportion of residents who are not yet connected to the electricity grid. Moreover, a significant portion of the Indian population that is connected to the electricity grid does not receive stable and reliable electricity. Over the past few years, the government has invested heavily in projects linking poor and remote rural areas to the electricity grid, but to date a quarter of India’s population (about 311 million people) live in rural areas that are still not connected [9]. A process that combines inexpensive and efficient renewable energy implementation is of great significance for the quality of life of India’s population; considering the need to preserve our planet and reduce the level of air pollution, it is of equal significance for humankind in general.

## **Economic Freedom of the World**

The Economic Freedom of the World project (EFW) was begun in the 1980s by the Fraser Institute [10] and produces an index that measures the degree to which different countries' policies and institutions support economic freedom. The cornerstones of economic freedom measured by the index are personal choice, voluntary exchange, freedom to enter markets and compete, and the security of person and privately-owned property. Forty-two indicators are used to construct the index measuring the degree of economic freedom in five broad areas:

1. Size of government: expenditures, taxes, and enterprises;
2. Legal structure and security of property rights;
3. Access to sound money;
4. Freedom to trade internationally;
5. Regulation of credit, labor, and business.

The index reveals an enduring empirical relationship between economic freedom and prosperity, growth, and improvements in human well-being. Over the years, the EFW index has been cited in hundreds of academic articles and has made important contributions to the international policy debate. In 2014, a special report [11] examined 402 articles that had cited the EFW and found that in over two-thirds of the studies, economic freedom corresponded to “good” outcomes such as faster growth, better living standards, more happiness, etc.

### **Economic freedom of the states of India**

The Economic Freedom of the States of India Index [12] was published by the Cato Institute based on the Fraser Institute’s Economic Freedom of the World report. The report brings out the significant differences in economic governance between the various states of India. It has thus focused attention on the essential role of state-level reforms in improving inclusive economic growth.

The Indian Index is based on three major indicators:

* Size of government;
* Legal structure and security of property rights;
* Regulation of business and labor.

The EFSI 2013 estimates economic freedom in the 20 biggest Indian states. Data availability prevented scoring the other states and union territories, and certain variables that would be suitable for inclusion in this index could not be included as data was not available for many states. Ultimately 21 variables covering diverse aspects of economic freedom were utilized to construct a composite freedom index with scores ranging between 0 and 1 (with 1 equaling the most freedom). States with higher scores are expected to be wealthier, more educated, more secure, etc. The indicator of Solar RTS regulation is complementary in its effect with economic freedom scores and confirms that better structured and regulated markets foster solar energy maturation.

## **Emerging markets**

Emerging markets or emerging economies are countries that are considered to be in a transitional phase between developing and developed status due to their size and growth rate. The impact of emerging markets on the world’s economy has grown dramatically in the last decades. In fact, without the influence of emerging markets, the present rate of world economic growth would be much lower than it currently is. In the years leading up to 2016, emerging market countries collectively accounted for 60% of global GDP. According to the World Bank, the importance of emerging economies for the growth of both developed countries and the worldwide economy is likely to increase over time [13].

Analysts and researchers view India as a major emerging market due to its immature market structure, rapid growth, large population, economic reforms, political transformation, regional economics, and increasing local and foreign investments [14], [15], [16].

## **Renewable energy in emerging markets**

Increased economic growth and demand for energy in emerging economies generate opportunities to increase usage of renewable energy. According to the International Finance Corporation, the global clean energy marketplace is shifting to the emerging markets. 2015 was the first year that renewable energy investments in emerging economies ($156 billion) surpassed those in developed countries ($130 billion) [17]. Together, China (36%) and India (22%) account for more than half of these investments.

Renewable energy, such as solar, can play a strategic role in meeting an emerging country’s growing energy demands. However, the lack of large-scale funding of solar power is one of the major problems in emerging markets and in emerging industries. The lack of funding stems from the fact that potential investors are risk-averse and the business market in these countries and industries is not yet mature [18].

## **Research question**

Due to the global importance of renewable energy, it is an imperative to increase its utilization in emerging countries such as India. This requires a clear understanding of the various factors affecting the application of renewable energy, in this instance, solar power, and the creation of effective policies to generate accessible and affordable electricity through photovoltaic cells. Unfortunately, since this is a fast growing, dynamic, and young market, very little is known about the specific influences on the implementation of solar power and how public policy can affect its application in developing countries.

The premise of this study is that the vast differences in the adoption of solar power technology among India’s states originate from differences in geographical, economic, educational, and population parameters, as well as from different public policies. These factors may affect the ability to invest and implement as well as build new infrastructure and maintain it, which is essential for the development of solar market.

The main research question of this article is:

***Do better structured and regulated markets foster solar energy maturation?***

The emergence of regulatory policies to promote improved directives for solar power has been an important advancement for public governance in developed and developing countries [19]. Many researchers have examined the importance of policy and regulations to promote the development, expansion, and adoption of emerging technologies and industries.

The specific hypotheses in this article are:

***H1: Higher GDP and better economic status are tied to investments in new clean technology.***

***H2: Regulation and supporting policies influence solar energy adoption on the state level.***

As a representative industry in an emerging country, India’s solar market will be examined to determine the variables that affect the implementation of renewable energy.

# **The case of India**

## **Background**

In 2015, India was the third largest electricity producer after China and the USA [20]. India lies in the high solar insolation region, and has huge solar energy potential. Most of the country enjoys about 300 days of sunshine per year, with annual mean daily global solar radiation in the range of 4 - 6 kWh/m2/day [21]. As a developing country with an average GDP growth rate above 7% during the last decade [22], an electricity market growth rate of 6.21% (5-year average) [23], a population of more than 1.2 billion, and a rapidly growing economy, India needs access to clean, cheap, and reliable sources of energy.

The growth of India’s clean energy market has caused significant price drops in power costs [17]. In recent years, the solar energy sector has undergone phenomenal growth due to technological improvements, price reductions, and government policies that support renewable energy development and utilization [24]. This fact has inspired investors, creating the right conditions for the country to meet its target of raising the installed capacity for solar energy to 100 GW by 2022. To do so, India will need an estimated $250 billion in new investments, with most of the funding coming from the private sector.

## **Central government initiatives to promote solar energy**

The power sector is essential for India’s economic growth. The world energy outlook forecasts strong growth in manufacturing to match the demand for a reliable electricity supply and to meet the ambition to bring electricity to entire population. Installed capacity demand will grow by 4.9% per year, increasing from around 300 GW in mid-2016 to a nearly 1,100 GW forecasted in 2040 [25].

During the last 15 years, India has promoted several electricity policies to encourage renewable energy [26]. Foremost amongst them is the 2003 Electricity Act [27] which regulates stand-alone systems (including those based on renewable sources generation) and the distribution of grid-free systems in rural areas. Also highly influential is the 2005 National Rural Electrification plan and policy [28] that stressed the need for electrification as a part of the fight against poverty and the 2006 Tariff Policy [29] which specified the minimum percentage of energy to be purchased from such sources. The Government of India (GOI) understood that a crucial part of developing the energy sector is the ability to develop in-house manufacturers. A 2007 semiconductor policy encouraged semiconductor and ecosystem manufacturing, of which solar thermos and PVs are essential components [30]. The 2010 National Solar Mission policy initiative set a goal of solar power generation capacity of 20 GW by end of 2022, and was revised upward in 2015 to a target of 100 GW.

### **Roof Top Solar regulations**

An example of the influence of GOI policies on India’s solar program is the Roof Top Solar project (RTS). The government of India committed to the development of 40 GW of RTS power as part of its commitment to the UN Framework Convention on Climate Change (UNFCCC). The government has stressed undertaking RTS projects of all buildings and creating state policy and regulations, including tariffs, for grid-connected rooftop systems [31].

In 2014, the Ministry of New and Renewable Energy (MNRE) published a new program for Grid Connected Rooftops and Small Solar Power Plants with the objective of promoting grid connected RTS and small solar PV power generating plants among residential, community, institutional, industrial, and commercial establishments. The program was intended to be implemented in both urban and rural areas to mitigate the dependence on fossil fuel-based electricity generation, and thus to encourage environmentally friendly solar electricity generation. Furthermore, the program encouraged the installation of rooftop solar photovoltaic power generation plants for individual consumption as well as for the supply/sale of electricity to the grid. The result has been to create a better environment for investment in the solar energy sector by both private funders and state governments. Some states had grid connected RTS regulations before the new program was enacted, whereas others launched new policies as a result of the 2014 MNRE report. As of mid-2015, about half of India’s states and union territories (UTS) had regulations supporting RTS [31].

## **State government impediments to solar energy growth**

The GOI focus on the development of renewable energy is apparent, but India’s constitutional framework prevents the GOI from realizing its vision without the support of the states. Issues related to inter-state connections are in the domain of the GOI, while states are responsible for intra-state electricity policy. The GOI can facilitate and incentivize states to achieve renewable energy targets, but it cannot overstep the bounds of state autonomy to implement projects or penalize for non-compliance. Some states often use this constitutional authority to push back on GOI reforms that do not dovetail with their political agendas. Therefore, the issue of electricity sector reform, which has a significant impact on the renewable energy sector, is a complex one due to constitutional and legal perspectives as well as their political implications and it is modified between promoting and lagging states.

The International Energy Agency (IEA) 2015 special report on India [25] emphasized that, while the provision of electricity is a shared responsibility between the central and state authorities, states have significant independence in electricity prices, the average subsidy level, and control over beneficiaries. The report stressed the large differences in conditions between the various states and a wide range of results across various indicators. Part of the explanation for these results is related to variations in income levels and population density; low-income, densely populated states tend to perform worse than average. States also differ in their attitude to renewable or other energy sources, due to their geographical proximity to fossil fuels, such as coal mining areas and ports. Policy initiatives like the 2003 Electricity Act that are milestones in India’s power regulation and effectiveness of implementation are important steps. Other work has been done by Pargal [33] and others [32] measuring the outcome-based indicators for different states in India in comparison to the activities taken by the state and central governments, such as regulatory commissions and utilities to implement electricity sector reforms.

The National Tariff Policy was amended in January 2011 to prescribe that solar-specific Renewable Purchase Obligations (RPO) be increased from a minimum of 0.25% in 2012 to 3% by 2022. Central Electricity Regulatory Commissions (CERC) and State Electricity Regulatory Commissions (SERC) have issued various regulations on solar RPOs, REC frameworks, tariffs, grid connectivity, forecasting, and other issues, for promoting solar energy [34]. Along with the demand to promote Renewable Energy growth in India (in view of the ongoing efforts by the central government for promoting solar energy), various states have come up with their own state solar policies to provide a framework enabling the growth of solar energy in India. For example, in 2011, Rajasthan published a policy for developing the state as a global hub of solar power for the next 10 years. In contrast, states like Mizuram and Manipur established only very modest targets of solar penetration, and two states – Sikkim and Arunachai Pradesh did not issue any at all.

## **Opportunities and barriers to investment in solar energy in India**

In 2015, India invested $10.2 billion in renewable energy [35]. Most of these funds came from private and local investments, while government financing accounted for only a small part of the total. Overall, India’s green and renewable business investment potential is estimated at $2.1 trillion in the next decades. Of this, IFC [7] estimates that investment in renewable energy will account for more than $320 billion, with nearly two-thirds of this sum ($201 billion) going to solar PV projects.

# **Method**

## **Case study**

The case study technique is a well-known research method [36], [37] that examines a human, group, event, process, or other subject of analysis to extrapolate key themes and results that can predict future trends. Case study research explores issues that can be applied to practice and provides tools for understanding the research problem. In this case, India’s solar energy policy and the variables affecting the penetration pace of solar PV in the different states were examined to study the effectiveness and applicability of policies to other emerging economies.

The aim of this study of the implementation of solar projects in India is to understand the reasons for the variance of the implementation pace in different states. The case of India is important in light of the challenging targets for solar energy set by the government of India and the investments needed to achieve this target. Quantitative methods used to study this case. Data was gathered from a variety of sources and analysed using linear regression and related statistical methods.

## **Data collection**

This study is designed to identify the causes for why some Indian states reach renewable energy implementation targets and others do not. To find correlations between the amount of solar power capacity and independent variables, this study investigated the impact of various geographical, economic, educational, and population parameters on renewable energy implementation. The independent variable data was gathered from a variety of sources, including databases and formal reports, using the most updated data found in reliable sources between the years 2011 (e.g., census, education) and 2014 (e.g., GDP).[[1]](#footnote-1) The data on solar energy (updated quarterly) is from October 31, 2016.

The variables considered in the quantitative analyses are listed below with comments on the rationale for including each of them (for the data, see Appendix).

1. State renewable solar energy potential (MW) – higher solar energy potential might lead to higher implementation [38].
2. Indian states according to their share of national GDP, 2014 (%) – the richest states should have more capital for investment [39].
3. State population by share of national population, 2014 (%) – a larger population needs more electricity [39].
4. State economic freedom grade (between 0 and 1 with 1= most freedom) – this index generally correlates with growth, development, and prosperity [12].[[2]](#footnote-2)
5. State area as a share of national territory, 2014 (%) – solar plants require space that can only be provided by larger states [39].
6. Nominal National State Domestic Product (NSDP) per capita income in US dollars, 2014 ($) – higher income leads to better life conditions and higher electricity consumption [40].
7. State urban\rural population share (%) – urban areas use more electricity while rural areas use more off-grid energy [41].
8. State literacy rate, 2011 (%) – education can lead to the adoption of new technologies [42].
9. NSDP growth rate, 2013-2014 (%) – capital growth needs industry and more energy [43],[44].

These variables were tested as potential predictors of the state installed solar capacity [45] (i.e., installed solar capacity in MW as of July 2016 was considered as a dependent variable). Since the solar market in India is rapidly growing, this study examined the variables compared to the solar data during 2015 – 2016 quarterly reports.

The state solar policy support indicator relates to the states’ announced regulations and policy for grid-connected rooftop systems. These regulations should influence the market. This variable was examined separately.

## **Linear and multiple regression**

Linear regression is a quantitative method to investigate correlations among dependent and independent variables when a study requires analysis of more than two variables. This study investigates the connection between a number of variables related to GDP, population, education, demography, and radiation (as independent variables) and implementation of solar energy in Indian states (as the dependent variable).

The basic form of regression models includes unknown parameters (β), independent variables (X), and the dependent variable (Y). The regression model Y ≈ *f* (X, β) specifies the variation of the dependent variable or variables (Y) as a function of independent variables (X) and unknown parameters (β).

The regression equation utilizes a best fit straight (regression) line to predict the values of *y* if the value of *x* is given and both *y* and *x* are the two sets of measures of a sample size of *n*. The formulae for regression equation would be in the form *y = a + bx*. The significance level that was considered statistically is 0.05.

The t-test method is a statistical test used to compare the means of two populations. A t-test for two independent samples is commonly used with small sample sizes, testing the difference between the samples when the variances of two normal distributions are unknown. A t-test was used in this work to find the difference between the states that announced rooftop solar policy and the ones that did not. Cohen's d test was then used to examine the standardized difference between two means as it reports the effect size for the comparison.

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# **Results**

## **Data analysis**

One inherent problem with any research is the examination of compiled variables that we expect to have a causal relationship with the dependent variable. However, there might be other variables that can better predict the implementation of solar energy in India. By failing to include such variables in the statistical analysis, their effects on solar energy implementation will not be apparent. This work includes the relevant variables that can be found at the state level in India.

The major conceptual limitation of the regression technique is that one can only determine relationships, but never be sure regarding the causal nature of the relationship.

### **Standing solar PRO targets**

Since the publication of the solar PRO targets in 2010, new regulations were introduced and the field of solar energy has changed, due to reductions in cost, improvement in production, and knowledge accumulation. By mid-2016, only five out of 27 states reached or surpassed the target values, with the other 22 states lagging far behind the original goals. Table 2 shows the percentage of the target, defined by MNRE and the Jawaharlal Nehru National Solar Mission, that each state achieved by July 2016 [46]. For example, Gujarat’s target was 849.62MW, while its installed capacity in July 2016 was 1123.36MW, meaning that it achieved 1123.36/849.62 = 132% of the target.

Table 2. 2016 Renewable energy reach of 2010 goals

### **The effects of variables upon solar implementation**

While Table 2 shows that India is certainly heading in the direction for high solar implementation, a significant variance is evident among the states. Further statistical analysis was performed to explain the reasons for the observed variance.

Table 3 shows the results of a bivariate analysis of solar implementation and each of the nine variables. The highly significant correlation with solar implementation was revealed especially for economic freedom (r=0.697, p<0.01). Solar energy potential, GDP share, state area share, and literacy rate showed lower but significant correlation. The other indicators clearly have less influence on solar implementation.



Table 3. Regression correlation with solar implementation

It should be noted that a multivariate linear regression including many variables and only 20-35 observations is imprecise due to the small number of observations. Table 4 demonstrates the dependence of installed solar capacity on five variables (p<0.05). The correlation coefficient (Multiple R=0.818) is high and shows strong dependence of the installed solar capacity on the chosen variables. The adjusted R-square is comparatively low (0.551) because there were five variables in this regression and only 20 observations. Due to the small number of observations, the significance level for correlation of p<0.1 is accepted. However, ANOVA test shows a clear and significant correlation.



Table 4. Multivariate linear regression

### **The Economic Freedom Index**

The Economic Freedom Index [EFI] is built from 21 variables, and the study attempted to determine which variables have a major effect on solar implementation. We found a strong correlation (R-Square of 0.77 and p=0.0013) between the variable “Inverse of Violent Crimes as a Share of Total Crimes” to solar capacity in July 2016. This variable belongs to the Legal Structure and Security of Property Rights category in the index. This category measures the efficiency of the government in protecting human life and property measured by the availability of judges, and the completion rate of court cases and police investigations. The level of safety in the region is measured by the recovery rate of stolen property and by the rate of violent and economic crimes. The variable measures the ratio of violent crimes, including murder, attempted murder, etc., to total crimes under the Indian Penal Code (IPC). The inverse of this ratio relates higher economic freedom to lower incidence of violent crimes.

## **Regulation effect**

The solar policy data [47] supporting grid connected RTS systems (data from July 2015) are available for 36 Indian states and union territories. Since solar capacity data are available only for 30 of them, the analysis was performed only on those states.

Table 5 compares implemented solar PV between 15 states that did and 15 states that did not announce RTS regulations. It shows that RTS states produce, on average, 4.8 times more solar energy. A t-test found this difference to be significant (t (19) = 2.44, p = 0.012, Cohen’s d=0.95). The 15 states with RTS produce, on average (July 2016), 439 MW. The other 15 states have only 92MW capacity. Nine of the 15 states with RTS policy have more than 100 MW. Seven states lack data.

|  |
| --- |
| Solar Policy supporting grid connected rooftop systems |
|
| YES | NO |  State announced RTS policy |
| 15 | 15 | No. of States |
| 439 | 92 | Average solar capacity installed [MW] |
| 9 | 2 | States Above 100 MW |

 Table 5. Solar policy and average MW production

Table 6 shows that the 15 states with RTS policy fulfilled (on average) 61% of the targets set in 2012, with six above 50%. The other 12 states reached an average of 26.2% of the solar PRO target and only one state reached 50% of the target. This result shows significant differences between the groups.

|  |
| --- |
| **States Rooftop Policy and central gov. targets fulfillment** |
| YES | NO | State announced RTS policy |
| 15 | 12 | No. of States |
| 61 | 26.2 | Average Target Completed [%] |
| 6 | 1 | Above 50% of target fulfilled |

 Table 6. 2012 State policy and solar PRO for 2016-17 targets

## **Regulation and economic freedom**

The Economic Freedom Index and the state rooftop solar regulation are two different variables that are not mutually related. However, looking at the correlation between them reveals that there is a link between the states that have RTS and ones with high economic freedom score.

|  |  |  |
| --- | --- | --- |
| **No RTS Policy** | **Have RTS Policy** | **Economic Freedom** |
| 1 | 8 | High (Top 10) |
| 5 | 6 | Low  |
| 14 | 2 | No rank |

 Table 7. Economic freedom and RTS policy

Table 7 shows that states with high rank in economic freedom are more likely to have RTS policy: among nine states with high economic freedom scores, eight had RTS policy. Most of the states that do not appear in the Economic Freedom Index do not have RTS policy. Among the states ranked as having a low economic freedom grade, almost same number have an RTS policy as those who do not.

# **Conclusions**

The main conclusion from this study is that the case of India shows that a determined state government can make significant steps in short time and use the clean-energy market as a major accelerator to empower its economy. In particular, promoting regulations and policy tools such as RTS policy have aided the transformation towards large scale renewable energy generation, enabling higher efficiency and lower costs of generation. States with high economic freedom and with RTS policy lie at the center of the solar revolution in India. This study specifically revealed a strong relationship between a state’s economic freedom, GDP share, solar potential, area, literacy, and RTS policy, and the fulfillment of the Jawaharlal Nehru National Solar Mission targets. These variables are important factors in a state’s development and the promotion of new technologies and economic accelerators like green and low-priced energy.

RTS policy have specially aided the transformation towards large scale renewable energy generation, enabling higher efficiency and lower costs of generation

One of the key conclusions of this study is that central government goal setting and resource allocation is insufficient to reach renewable power goals and that local predisposition and local policy have a significant impact on goal attainment. This conclusion is reflected most clearly in the observation that local education, economic status, and economic freedom scores affect solar energy utilization.

# **Appendix A**



Table 8. States of India Data

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1. The state of Telangana split from Andhra Pradesh and was awarded independent statehood in 2014. Telangana is very significant in the field of solar energy (845MW in July 2016). Telangana’s GDP, population, and some other indicators were available, but others, such as Economic Freedom and literacy, were not. [↑](#footnote-ref-1)
2. The Economic Freedom Index contains information on only 20 states in India due to a lack of complete information. States and territories (except Telangana, mentioned above) that are not listed in this index together contribute approximately 2% of solar capacity, 6.5% of GDP, 3% of the population, and make up 7% of India’s territory. India has 29 states and 6 union territories, such as Chandigarh and Delhi. The territories are taken into consideration in the analysis, but they are not very significant due to their small size and minor influence. [↑](#footnote-ref-2)