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Decentralised Renewable Energy Systems in China, India and Thailand: Assessing the role of Policies and Incentive Structures

Gopal K Sarangi[1], Rajiv Seth[1], Arun Kansal[1], Shobhakar Dhakal[2], Ashish Shrestha[2], Wang Xin[3], Meng Haixing[3]

1- TERI University, India, 2 – Asian Institute of Technology (AIT), Thailand, 3-Tongji University, China

Abstract

Energy sector, globally, is going through a unique phase of transition often quoted as 'sustainable energy transitions'. Emphasis is placed on decentralised renewable energy systems as a technology option which has the potential to make this transition happen. The present study aims at assessing the role of policies and incentive structures in driving the decentralised renewable energy systems in revolutionising the energy sector in three countries of Asia Pacific region i.e. China, India and Thailand. Policy mapping exercise suggests that while China's energy policy making is heavily centralised (Burke et al., 2009), energy policy making in India is more cohesive and federally structured. On the other hand, energy policy formulation in Thailand appears to be somewhere between China and India and structured in a way where responsibility rests both on federal government as well as on provincial governments. Assessment of incentive schemes point to the presence of differences in terms of its form, nature, source of funding, and use of such incentives. For instance, subsidy as an incentive mechanism have been used differently in the study countries. While in Thailand and China, only investment/generation based subsidies are given, in India in addition to investment/generation based subsidies, some form of operational subsidy is also provided.

I. Background

Energy holds paramount importance in realising the developmental goals of any economy. The importance of energy gets more pronounced in an era where the nexus between the energy and climate change has become critical and requires strategic energy sector interventions to minimise the threats posed by climate change. Of late, while decarbonising the energy sector has been a key concern globally, provision of universal energy access has brought an additional layer of challenge - particularly for countries where a significant chunk of people is deprived of basic minimum access to modern energy. It appears that there has been a global consensus to this desired transition as echoed in various declarations by global forums and associations. For instance, SE4ALL talks about doubling of renewable energy generation by 2030 and aims at achieving universal energy access by the same time. In similar vein, Goal 7 of Sustainable Development Goals (SDGs) of UN reiterates the need and urgency to provide universal access to energy by 2030 as well as increasing the share of renewable energy in the global energy mix.

Because of which, energy sector globally, is going through a unique phase of transition often quoted as 'sustainable energy transitions'. Emphasis has been laid on reconfiguring the contours of the energy sector with specific focus on decarbonising the sector and moving to a regime that minimises the threats posed by climate change. Importantly, the process of transition is being fuelled by the introduction of new technologies, experimentation with new source of energy resources such as solar energy, wind energy, geo thermal energy, and hydro carbon energy etc. and devising ways and means of enhancing the efficiency of the energy use and applications. Some of these technological experimentations are disruptive in nature and have led to changes in the contours of energy market to a significant extent. New energy growth trajectories are being envisaged with new forms of energy markets, energy delivery models which have the potential to change the mode of energy generation, pattern of energy consumption and use of energy.

Emergence of decentralised renewable energy systems, often called off-grid energy technologies, have become instrumental in defining this new trajectory. Though the idea of decentralised energy is not new, it has received a new nomenclature and new thrust due to revolution largely in the solar PV technologies, and to some extent in other technologies such as wind, micro-hydro and biomass etc. Solar PV technologies being modular in

character have become widely disseminated as a preferred decentralised energy technology option in many countries.

In this backdrop, the present study aims at assessing the role of policies and incentive structures in driving the decentralised renewable energy systems in revolutionising the energy sector in three countries of Asia Pacific region i.e. China, India and Thailand. The choice of the countries is rationalised with the understanding that there exists high potential of cross-learning and cross-breeding of new knowledge and inter-transfer of existing process of deployment and dissemination of decentralised energy solutions in three heterogeneous country settings. The emphasis is laid on understanding how study countries differ in terms of devising strategic policy and regulatory interventions in the domain of decentralised energy interventions. In addition to this, the paper also assesses various incentive structures that are being put in place to promote decentralised renewable energy systems in the study countries. The study deploys a mixed method research design, built on both qualitative and quantitative research techniques. The method prioritizes collecting, analyzing, and mixing both quantitative and qualitative data at different phases in the research cycle. While the emphasis of qualitative approach is to understand the critical nuances, actors and organizations and policy instruments driving the decentralized renewable energy development in study countries, some aggregated statistical tools/techniques are used to structure the gathered information from the study countries.

The rest of the paper is structured as follows. Section II briefs how energy sector is positioned in the larger political-economic canvass of each of the countries studied. Section III gives an overview of the status of the energy sector, more specifically renewable energy context of the study countries. Fourth section gives specific emphasis on the decentralised energy sector as a key sub-sector of the study countries. Section V takes stock of actors and organisations governing the sector. Section VI presents the policy landscape driving the decentralised energy sector. Seventh section talks about incentive structures supporting the sector on a comparative fashion. Section VIII section concludes the paper.

II. Energy sector in the larger context of economic and political landscape

A cursory glance at the political-economic profile of the study countries reveals the presence of heterogeneous economic and political settings across countries. All the three countries are experiencing rapid economic growth in the recent past. While China and India have been the second and third largest global economies respectively by purchasing power parity (PPP)

terms, Thailand stands ahead of both China and India in per capita terms. Thailand's GDP per capita at PPP stands at 16130.09 USD in 2015 vis-à-vis China's GDP per capita at PPP of about 14339.92 USD and India's GDP per capita PPP was about 6187.23 USD in 2015 (OECD, 2017). In terms of structural shifts, all the three countries are experiencing transitions in multiple dimensions such as rapidly growing urban sector, emergence of a strong market led growth models, use of advanced ICT technologies, and increasing penetration of renewable energy technologies.

An overview of the political systems of the study countries shows that China has a more centralised governance structure compared to India and Thailand, where political systems are structured around federal governance principles. Though, of late, efforts have been made by the Chinese government to move to a more decentralised mode of governance, still the Centre continues to prevail over the provincial governments in key aspects of policy making. On the other hand, India's political system is federally structured which allows substantial economic and social freedom to sub-national governments, while retaining crucial aspects of the country's development at the federal level. On the other hand, the national government of Thailand has three layers of political structure: Central government (which includes ministries, bureaus and departments) at the top, Provincial governments at the middle level (which includes provinces and districts) and Local governments (Bangkok, Pattaya City) at the lower hierarchy. Bangkok and Pattaya are the two specially governed districts.

Interestingly, the broader economic and political landscapes of three countries to some extent have shaped and structured the energy sector in general. For instance, given the political setting of China, energy policies are largely decided at the federal level, whereas given the constitutional status of energy as a 'concurrent item', energy sector governance in India rests equally with both the federal government as well as with the provincial governments. On the other hand, energy policy making in Thailand appears to be somewhere lying between China and India and structured in a way where responsibility rests both with the federal government as well as with provincial governments.

III. Energy sector of China, India and Thailand: a brief overview

Given the scope of the paper, it merits highlighting the energy sector context of the study countries. A deeper observation of energy sector of the study countries offers some interesting insights and understanding. Though sectoral details differ significantly across

study countries, it is interesting to note that all the three countries are experiencing some form of revolution in the energy sector with specific thrust on moving to a clean energy regime.

The momentum of this revolution is built and revolved around the proposition that energy sector is a significant contributor to the challenges of climate change as evident from the energy statistics of the study countries. While China stands as the top emitter of greenhouse gas, sulphur dioxide, nitrogen oxides and particulate matters (Yang et al., 2016), India ranks as fourth global emitter, though debates surround around per capita emission of these highly populated countries. Thailand, though stands distantly in comparison to China and India, still ranks as one of the top 25 GHG emitters. Information on the nexus between energy and climate change of these countries shows that, coal fired power plants alone in China contributes around 48 % of the total CO2 emissions of the country in 2016, whereas it's share in India is almost same (around 47 %) during the same period, (Olivier et al, 2016). On the other hand, GHG emissions from the energy sector in Thailand, consists of about 73 % of the total GHG emissions of the country (ONREPP, 2015).

Energy resource mapping of the all the three countries reveals heterogenous energy resource holdings across countries. While both China and India are rich in coal energy resources; Thailand, on the other hand, is rich in oil and natural gas. Of late, there have been efforts made by all the three countries to transit to cleaner fuel regimes, introduce energy efficiency initiatives, and emphasize on optimising energy resource use by creating necessary enabling environment. In both China and India, there have been emphases laid on phasing out the coal based energy generation. In the same vein, Thailand has strongly promoting renewable energy to arrest its energy related import costs. All the three countries are placing high emphasis on promotion of renewable energy through well-designed policies and incentive mechanisms. This is reflected in ambitious targets set by all the study countries. Both China and India have become global drivers of renewable energy development. China has topped in terms of solar energy installed capacity – holding about 19 % of the global capacity (REN21, 2016), India is striding very fast to develop renewable energy in the energy portfolio and is globally ranked as 5th largest producer of solar and wind energy in 2015 (OECD, 2017). Thailand has been consistently laying emphasis on renewable energy generation by revising the earlier targets and is one of the biggest drivers of renewable energy development in ASEAN region (OECD, 2017). Thailand targets to install 19,635 MW of various renewable energy plants by 2036. It also emerges clearly from the analysis

of policy measures and incentive structures designed to promote renewable energy that a host of economic, fiscal, and regulatory support schemes are provided to promote renewable energy in all the three countries with different degrees and intensities. There has been clear emphasis laid on feed-in-tariffs (FiTs) as a policy instrument driving the renewable energy sector in all the three study countries, though in India, FiT has not been used as a policy instrument for promoting off-grid renewable energy systems. Among the three countries, Thailand is the first mover in introducing feed-in-premium through 'Adder Programme' in 2007. Latest statistics available on renewable energy suggests that, installed capacity in solar, wind and bio-energy in all the three countries indicate that while solar is increasingly emerging as a dominant source of renewable energy in all the study countries, wind as a key source of renewable energy in China and India only, Thailand, however, has relatively better installed capacity in bio-energy (Figure 1)

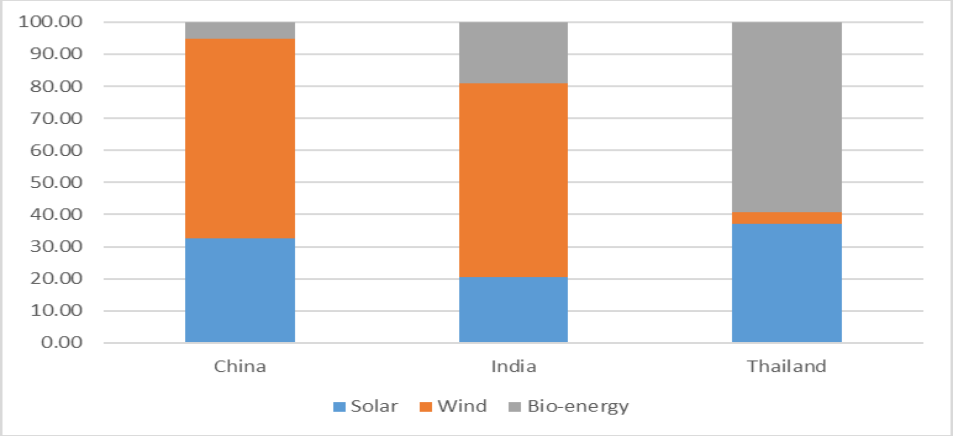

Figure 1: Installed capacity in solar, wind & bio-energy in the study countries in 2016 (% of total), Source: IRENA, 2016

Understanding the energy sector dynamics becomes incomplete without understanding the state of energy access. Despite differences in the ways 'energy access' is defined, measured and monitored, access to modern energy continues to be a challenge for all the three countries studied - with different forms, degrees and intensities. While the challenge is more pronounced in the domain of cooking energy, it is less felt in the provision of basic electricity services. In both the dimensions, China and Thailand are way ahead of India. It can be noticed from the table 1 that while provision of modern cooking energy is a challenge for all the three countries – though relatively less for Thailand, there exist significant differences in terms of provisioning of electricity services. India, in contrast to other two

countries, faces the additional challenge of providing access to modern electricity services to about 244 million people.

Table 1: Energy access situation in China, India and Thailand

	Electricity access				Traditional use of biomass for cooking	
	Population without electricity (millions)	**National Electrification rate (%)**	**Urban electrification rate (%)**	**Rural electrification rate (%)**	**Population relying on traditional biomass (millions)**	**Population relying on traditional biomass (%)**
China	0	100	100	100	453	33
India	244	81	96	74	819	63
Thailand	1	99	100	98	14	21

Source: IEA, 2016

IV. Understanding decentralised renewable energy systems and their typologies

Given the thrust of the paper, it is worthwhile to understand the key aspects of the decentralised renewable energy systems of the study countries – as an emerging sub-sector of the larger energy sector. As mentioned elsewhere in the paper, decentralised renewable energy systems have emerged as a technology option for energy generation in all the three countries. Though, the nature, typology, purpose, use and applicability of these systems differ across countries, there exist some degree of commonality in them. This section highlights the different variants of these systems prevalent in the study countries.

One of the very first observations is related to the definition of 'what constitutes decentralised renewable energy systems' across countries. Assessment of country specific systems reveals that there exists pluralistic interpretation of what constitutes 'decentralised energy systems' and interpretations are largely drawn from the country specific applicability and uses of these systems. In China, decentralized energy system is often quoted as "Distributed Generation". National Energy Administration (NEA) of China defines it as "Generation systems located near to the users, installed a smaller power mainly by the user for personal use and on-site generation facilities using renewable energy, resources or power output of energy cascading utilization system". Besides electricity, the form of end use energy in decentralized energy system in China also includes thermal energy, like the solar water heater. Most of the decentralised energy types in China are grid connected in nature, though some projects of off-grid decentralised energy types operate in the country. In India, decentralised energy, distributed energy, off-grid systems and standalone systems are often

used interchangeably to refer on-site production and consumption of electricity (Mishra et al., 2016). Broadly, two major types of decentralised energy systems are operating in India i.e. grid connected and off-grid. Like other two countries, decentralised energy generation in Thailand refers to systems which necessitate locating the energy production facilities closer to the energy consumption site. Here in Thailand too, decentralised energy is of both grid connected types as well as off-grid types.

A host of technologies have been used as decentralised energy technologies in the study countries, though some degree of differences do exist. A wide variety of energy technologies are covered under the decentralised energy systems. Technologies such as coal CHP, oil CHP, gas CHP, biomass, biogas, solar PV, wind, small-hydro and Waste to Energy (WtE) are considered as decentralised energy technologies. Net metering and co-generation are also being considered as part of these systems. Along with this, standalone Micro/Mini off-grid systems, solar home systems (SHS) are also considered part of the decentralised energy systems in all the three countries.

Various business models are prevalent in the study countries as far as the management and operation of these systems are concerned. China interestingly has several business models such as total grid connected PV power station model, energy performance contracting (EPC) model, self-owned PV power model. All these models are grid connected ones. While in total grid connected PV power station model, the investor is responsible for the PV stations construction, maintenance and operation, in the Energy Performance Contracting (EPC) model, third party is responsible for funding, construction of the PV project. In the first model, the entire energy is sold out to the grid, where as in the EPC model, the energy is meant to energise the local area and the leftover energy is only sold to the grid. In the third model known as ‘Self-own PV power model’, consumers invest in the PV project and use the energy generated. And, the leftover energy could be sold to the grid. In all the models, subsidy provisions are inbuilt. In contrast to this, in the decentralised mini-grid space in India, some interesting business models are worth discussing. These models are largely operational in the off-grid space. Two dominant models are widely prevalent in India in the mini-grid space. One is the publicly supported and NGO/Community managed model. Most of publicly supported programmes such as Village Energy Security Programme (VESP) and Remote Village Electrification Programme (RVEP) follow this model of creating Village Energy Committees (VEC) or Rural Energy Cooperatives to manage such projects. Second one is private investor led model - purely service and demand driven. In this case, the major

component of the management rests with the private developers. Tariffs are decided on negotiation basis. In majority of cases, subsidies are not given. Thailand, on the other hand, is known for its 'Adder Programme'. The "Adder" - a feed-in premium, guarantees higher rates for renewable energy, making the investments profitable. Furthermore, a sophisticated feed-in tariff (FiT) is introduced to control cost, while continuing to offer suitable environment for investments in renewable energy. The models prevalent in Thailand are also grid connected in nature.

Several observations can be made on the above. First, the notion and nomenclature of 'what constitutes decentralised energy systems' differs depending on the country contexts. While decentralised systems in China and Thailand are more of grid connected in nature, it is off-grid based in India. Of course, the decentralised energy interventions of grid connected types such as roof-top systems are a new phenomenon in India. In tune with the typologies of decentralised energy systems, the business models also differ across countries. In China and Thailand, while business models speak of designing various incentive structures for attracting private investors into the sector, in case of India, there has been a clear segmentation between publicly supported model and private investor led model.

V. Governing decentralised renewable energy systems: mapping organisational structure

A detailed assessment of decentralised energy systems of the study countries affirms that they are nurtured by conducive policy environments evolved over years in these countries through a set of organisations placed at different layers of governance. A host of organisations govern these systems depending on the country contexts and status of the decentralised energy systems in the respective countries.

Mapping of organisational artefacts governing the decentralised energy systems of China, India and Thailand shows that how different organisations are placed at different hierarchies for the operation and management of decentralised energy systems. In China, National Energy Administration (NEA), which is under the jurisdiction of the National Development and Reform Commission (NDRC) is the key ministry dealing with the energy policy making in the country. Along with this, the National Energy Commission (NEC) which is chaired by the Prime Minister, is an agency established in 2010 to coordinate the overall energy policies across the federal government. They are also entrusted to deliberate on major issues of energy security and supply. Besides, several other organisations such as

research institutes, state owned enterprise like State Grid Corporation of China and banking institutes such as China Export Import Bank (EXIM Bank) and China Development Bank (CDB) also play important roles in energy policy making of the country. In India, given the constitutional status of energy as a concurrent item, the responsibility rests with the organisations placed both at federal as well as provincial levels. At the federal level, both Ministry of New and Renewable Energy (MNRE) and Ministry of Power (MoP) are responsible for strategic decisions related to the development of decentralised energy. One of the key responsibilities of the MoP, *inter-alia*, is to promote and enhance the rural electrification in the country by designing the electrification schemes and dealing with the issues relating to power supply/development. It aims at promoting decentralised and distributed generation in the states/provinces and Union Territories. Similarly, one of the key tasks of the MNRE is to 'develop and deploy new and renewable energy for supplementing the energy requirement of the country'. Two of the five missions of the Ministry i.e. 'Energy Availability and Access', and 'Energy Equity' are quite relevant for the decentralised renewable energy development of the country. At the state level, state nodal agencies (SNAs) are the prime entities promoting decentralised energy systems. Besides, though independent regulatory authorities exist both at the federal level as well as provincial level, they have very limited role to play as far as off-grid energy systems are concerned as off-grid energy sector is out of regulatory purview. In addition, a host of private sector actors, NGOs and other organisations such as banks play important roles in the domain of decentralised energy sector.

Similarly, in Thailand, Ministry of Energy (MoE) is the key government institution responsible for the overall policy making in the country. Within the Ministry, Department of Alternative Energy Development and Efficiency (DEDE) is entrusted to develop renewable energy in the country. Apart from the above, Energy Regulatory Commission (ERC), created as an independent regulatory authority in 2007, takes care of issues related to regulation. ERC's key responsibilities are monitoring the energy market, electricity tariff regulation, and licensing and dispute settlement. Power Development Fund (PDF) which funds the subsidy for renewable and environment friendly energy systems is also managed by the ERC. Along with this, the state-owned Electricity Generating Authority of Thailand (EGAT) established in 1968, controls most of the power generation and the country's transmission completely. EGAT purchases electricity from public and private producers and sells it to unbundled distribution companies and to a few large direct customers. Provincial

Electricity Authority (PEA) is held responsible for electrification of the provinces including the rural electrification. However, electric power to the Bangkok Metropolitan area and two adjoining provinces is distributed by the Metropolitan Electricity Authority (MEA). Another set of actors in the energy sector of Thailand are private players such as Independent Power Producers, small power producers (SPPs) and Very Small Power Producer Programme (VSPP). Besides, there exist some non-profit organisations such as Border Green Energy Team (BGET), and WADE (World Alliance for Decentralized Energy) differently engaged in promotion of decentralised energy systems.

Mapping of organisational structure for the study countries again reflects that the energy governance structure is in sync with the larger political governance of the country. Most importantly, it emerged from the above that the emphasis on private sector led decentralised energy systems in the study countries have created a host of new private sector actors in the sector. Dwelling deeper into to the actor networks governing the sector reveals that the actor networks governing the decentralised energy sector are more complex in India compared to other two countries, given the constitutional status of energy in India.

VI. Policy landscapes governing the decentralised renewable energy systems

Various policy statements have been declared from time to time in each of the study countries to accelerate the promotion of decentralised renewable energy systems. This section attempts to map country specific policy pronouncements which have implications for the decentralised energy development of the country.

Renewable energy policies in China though started more of a reaction to the increasing environmental concerns as is evident from the assessment of its policies, later commercial drivers led to further growth of the sector. It is reported that China's energy policy is designed to minimise the environmental damages in the process of energy development and utilisation. This also gets reflected in the domain of decentralised energy systems with specific thrust on decentralised renewable systems. China has put forward the concept of distributed energy resources officially in 2004 and its importance has been greatly attached to it since then. The report by NDRC 'The Report on Distributed Energy System', declared in 2004, for the first time spelt out the concept of distributed energy system and its importance for the country's energy sector development. Several other initiatives taken between 2006 and 2010 laid emphasis on co-generation of heat and power. In 2010, technical regulations for the distributed generation were declared to access the power grid by

decentralised energy plants. An important development in the policy front occurred during 2011 where four ministries released a guiding instruction for Developing Natural Gas Distributed Energy. The emphasis was laid on building around 10 decentralised energy demonstration projects of typical features of different kinds. Next milestone was the Natural Gas Using Policy declared in 2012 giving priority to the distributed energy projects for the use of natural gas. The most recent one is the notification in 2014, where the NDRC published the Notification on Regulating Grid Purchase Price of Natural Gas Generation, improving transaction standards for prices of natural gas distributed energy. During the 12th Five Year Plan Period (2011 – 2015) of China, solar PV industry development was emphasized with specific focus on solar roof-top PV systems. Further in 13th Five Year Plan period (2016 – 20), focus was given to accelerate the solar PV based decentralised energy projects.

India's policy landscape governing decentralised energy systems could be traced back to the days of oil crisis in late seventies. Earlier attempts to mainstream the decentralised energy systems in India were sporadic and patchy in approach. Tracing the history of decentralised energy systems in India reveals that there were various committees and missions constituted in the past to promote decentralised energy solutions in a sustained manner. The Rural Electricity Supply Technology (REST) Mission 2002 and the Gokak Committee formed around 2003 laid specific attention to the decentralised energy generation in the country as one of the solutions, *inter alia*, to resolve the energy problem. However, more systematic and structured attempt to mainstream decentralised energy systems in India was made with the declaration of the Electricity Act 2003. Section 2(63) of the Act specifically mentions about promotion of distributed generation through stand-alone energy systems. The Act with its de-licensing provisions opened the door for the private sector. Two specific policies, which evolved as offshoots of the Act i.e. Rural Electrification Policy (REP) and National Electricity Policy (NEP) had provisions to accelerate the process of rural electrification in the country through renewable energy based decentralised energy systems, *inter alia*, other measures. Most recent efforts undertaken in the direction of renewable energy based decentralised system promotion are through the declaration of amendment of Tariff Policy 2006, done in 2016 and National Policy for Renewable Energy based Micro and Mini Grids 2016. Amendment of Tariff Policy 2006 puts emphasis on supply of power to remote unconnected villages through mini/micro grids. The amendment to Section 8 of the Tariff Policy states specifically about promotion of renewable energy based

decentralised energy systems. Promulgation of National Policy for Renewable Energy based Micro and Mini Grids 2016 also highlights the importance of promoting renewable energy based mini-grids for enhancing access to electricity in both un-served as well as under-served regions of the country. It was also envisaged in the Policy that mini-grids too can provide livelihood creation in the local regions by energising the productivity based enterprises. Apart from policy support provided, specific programmes were designed and implemented from time to time to promote off-grid or decentralised energy systems in the country. Programmes such as Remote Village Electrification Programme (RVEP) and Village Energy Security Programme (VESP), Decentralised Distributed Generation (DDG) scheme of *Rajiv Gandhi Grameen Vidyutikaran Yojana* (RGGVY), off-grid component of RGGVY are the major programmes initiated by the Central Government to drive the decentralised renewable energy systems in the country. At the provincial level also, several policy initiatives have been undertaken to promote decentralised energy systems. For instance, the state of Gujarat in India has evolved a scheme called '*Jyotigram Yojana*' in 2003 under the leadership of Mr Narendra Modi, then the Chief Minister of Gujarat. The scheme was envisaged as a participatory scheme between the government and local communities. Similar schemes were also introduced in other states such as '*Biju Gram Jyoti Yojana*' of the state of Odisha introduced in 2007-08. The scheme aimed at electrifying villages having population less than 100. State Government of Odisha provides 100 % budgetary support for the scheme.

In Thailand, several policy level initiatives have been undertaken to mainstream the decentralised energy sector. Policies related to energy, including renewable energy policies are formulated by the Ministry of Energy (MoE), Government of Thailand. Energy Policy and Planning Office (EPPO), under the Ministry, oversees all aspects of the country's energy policy formulation in all fields of energy such as oil, natural gas, and power sectors. The key policies promoting decentralised energy in the country are Alternate Energy Development Plans (AEDP), Power Development Plans (PDP) and Energy Efficiency Development Plan (EEDP). These plans intend to promote renewable energy and thereby decentralised energy systems in the country, which are embedded in the renewable energy system development in the country. The Thailand Energy Conservation Promotion Act (ENCON Act) was enacted in 1992. It is a comprehensive piece of legislation which defines government's institutional and financial arrangements, their duties and responsibilities and requirements for entities within energy consuming sectors, including industry. In addition,

this act promoted and supported production and utilization of high energy efficiency equipment, and the energy conservation by providing financial assistance to entities. Many programs were also designed to stimulate energy conservation investments in factories and buildings. Department of Alternative Energy Development and Efficiency (DEDE) is the main implementing agency under this act. Another set of policies are related to SPP and VSPP regulations declared from time to time. In 2002, Thailand became the first developing country to adopt net metering regulations (known in Thailand as Very Small Power Producer (VSPP) Program) that paved a path for even smaller renewable generators under one megawatt in size. The first four years was successful enough to add 13 MW to the grid. The law was later revised to qualify projects under 10 MW in size. The Net Metering regulation laid sufficient ground for intensive decentralized energy development in Thailand as integration of small scale decentralized renewable energy to national grid was made possible through this program. The "Adder" made the program more lucrative to investors. As solar energy was given priority earlier and higher tariffs were set, it was changed to a fixed FiT program in 2010 and the focus shifted to solar rooftop system only. The future energy outlook will have more decentralized energy in close co-operation and communication with local consumers. Latest one in the policy arena is the long-term energy planning in the Power Development Plan (PDP) 2012-2030, which was later revised in 2014 to PDP (2015-2036). The new plan is based on three principles, energy security, economy and ecology. It focuses mainly on the increase of "cleaner fuels" and 'less reliance on natural gas'. The Alternative Energy Development Plan (AEDP), recently being revised, in 2014, targets an installed capacity of alternative energy at 19,635 MW in 2036 – from around 7,279 MW in 2014.

It emerges from the above policy mapping exercise that while China's energy policy making is characterised as heavily centralised (Burke et al., 2009), in contrast to it, energy policy making in India is more cohesive and federally structured. Energy policy in Thailand on the other hand can be placed between China and India.

VII. Incentive structures for decentralised renewable energy systems

The strategic policy level interventions in the study countries for the promotion of decentralised renewable energy systems involves provisioning of various incentive mechanisms. All the three countries have promulgated various incentive schemes for the

promotion of these systems. The incentive schemes are largely targeted to increase the commercial roll out often called as ‘deployment’ (IRENA, 2012).

An assessment of Chinese decentralised renewable energy sector shows that various incentive mechanisms are in place to accelerate the sector’s growth. One such incentive mechanism consists of investment subsidies for distributed energy systems based on the equipment capacity. An extended form of this financial incentive is the provision of tax concessions on import of key decentralised energy equipment. In addition, decentralised renewable energy systems also receive priority sector lending status by banks. This helps them to get the interest reliefs. Further, decentralised energy producers get the right of tax reduction or tax concessions. Specific funds are allocated by the government for research and development in the domain of renewable energy. By doing this, the government gives priority to improving innovation incentives and security system, the research and development of relevant technology, technology transfer and industrial innovation system. The policy environment has never been more favourable for corporate investment in solar photovoltaic (PV) installations. In August 2013, the Chinese government introduced new feed-in tariffs (FITs), at both state and provincial levels, to fuel the growth of distributed solar rooftop installations. The central government currently provides 20-year subsidies of RMB 0.42 (US$0.06) per kilowatt-hour (kWh) of output from distributed PV rooftop projects. In addition, project owners receive about RMB 0.40/kWh (local benchmark price of coal-fired power) from the state grid, for any surplus power they generate. To spur local solar PV market development, provinces and cities across China are also providing additional subsidies to complement the state FiTs. Government solar subsidies do have the provision to encourage self-consumption because the power generated from distributed solar is often 2-3 times more valuable than electricity sold to the grid. Based on the Supporting Program of Distributed Energy System of Natural Gas and Fuel Gas Development issued in 2012, Shanghai became the first city to support the natural gas energy development. From 2013 to 2015, the government provided RMB 1,000 per KW to equipment of distributed energy resource.

In India, various incentive schemes are present to expand the decentralised renewable energy systems in the country. Like in China, a major incentive scheme for the sector is provided in the form of subsidies. Subsidies come in varying forms such capital subsidies, operational subsidies, and interest subsidies. These varieties serve different purposes. In most of the cases, 90 % of the benchmark capital cost is subsidised. The interest subsidies

are channelled through non-banking financial institutions and scheduled commercial banks like National Bank for Agriculture and Rural Development (NABARD), Small Industries Development Bank of India (SIDBI) etc. Along with this, operational subsidies are designed to ensure the projects are sustained for longer period. In most of the cases, operational subsidies are given for a minimum period of two years and a maximum period of five years. In addition to it, banking system is being incentivised to consider lending to renewable energy as a priority sector lending. Soft loan schemes are in place to provide loans at cheaper rates to investors. Besides, some other fiscal incentives are also provided in the form of tax holidays, tax concessions etc. Excise duty and VAT exemptions on equipment and solar panels have propelled the sector's growth. Though, preferential tariff schemes are not applicable to off-grid energy segment in India, this is applicable for schemes which are grid connected. Most innovative latest scheme is the viability gap funding (VGF) for the off-grid energy projects. Government has earmarked separate funding under viability gap for the promotion of off-grid energy sector.

Similarly, in Thailand, several incentive schemes are in place to promote decentralised energy systems. Through the ENCON Fund that was enacted in 1992, the government has been able to promote and support many energy efficiency and renewable energy programs and projects since 1995 which includes various decentralized energy programs within them. For instance, DEDE supported and promoted 53 hydro power projects at the village level, which is less than 200 kW and located far from the grid system. DEDE provided technical support after completion of the installation. These are operated by villagers through co-operatives and community groups, making them self-reliant and participative in resource sharing. Preferential tariffs for SPPs and VSPPs are one of the major incentive mechanisms. Efforts are made recently to use the subsidies in most effective and smarter way. For instance, in case of biomass SPP, the "adder" was determined through a competitive bidding system. A revolving fund has been created to provide low interest loans to renewable energy investors. In addition, financial incentives through soft loans and investment subsidies were given to selected decentralised renewable energy projects such as biogas in pig farms and factories producing tapioca starch, palm oil, rubber sheet, ethanol and other types of agro-industry, municipal wastes, and micro-hydro. In addition, various tax based and non-tax based incentives are also provided. For instance, exemption or reduction of import duties on machinery and raw materials, corporate tax exemption ranging from 5 to eight years, etc. are offered. The key non-tax benefits include expatriates own land

and take or remit foreign currency abroad. In 2010, National Energy Policy Council approved transitioning from adder to Feed-in-Tariff (FiT), in which a fixed amount per kWh is paid during the life of the PPA. The Energy Regulatory Commission (ERC) ordered Thailand's state-owned electricity distributors (Provincial Energy Authority, Metropolitan Electricity Authority and Electricity Generating Authority of Thailand) to cease offering PPAs to power producers generating less than 10 MW (VSPPs) and instead to issue PPAs based on the ERC's FiT subsidy program. The FiT PPAs are for a 20-year term for all eligible forms of renewable energy with the exception of land fill, for which a ten year PPA is offered. A detailed mapping of incentive schemes is presented in the Table 2 below.

Table 2: Key incentive schemes

Country/Instrument	Subsidies	Preferential tariff	Soft loans	Tax concessions	Priority sector lending	Viability gap funding (VGF)	CDM mechanism
China	√	√	√	√	√	**Ω**	√
India	√	**Ω**	√	√	√	√	√
Thailand	√	√	√	√	**Ω**	**Ω**	√

Ω indicates absence of the incentive scheme & √ indicates presence of incentive scheme

It can be inferred from the above table that significant differences exist in structuring of incentive schemes across the study countries. Incentives in the form of subsidies, tax concessions like tax holidays, relaxation of import tax and other taxes, giving the benefit of priority sector lending are widely used across all the study countries. However, there exist variations in the use of specific financial instruments in creating incentives for decentralised renewable energy systems. For instance, while preferential tariff is one of the key instruments used in China and Thailand, it is not employed in India for decentralised renewable energy systems. Similarly, VGFs as an innovative instrument is widely used in India and has not been considered an effective instrument in other two countries. Differences also can be observed within an incentive scheme in terms of its nature, source of funding, form, and applicability of the instrument. For instance, subsidies as an incentive mechanism have been used differently in the study countries. While in Thailand and China, only investment/generation based subsidies are given, in India in addition to investment/generation based subsidies, some form of operational subsidies is also given.

VIII. Concluding remarks

A detailed assessment of the strategic policy and regulatory interventions, more specifically, the fiscal and financial instruments shaping the development of decentralised energy systems in the study countries presents some interesting insights. Though sectoral details differ significantly across study countries, it is interesting to note that all the three countries are experiencing some form of revolution in the energy sector with specific thrust on moving to a clean energy regime.

It emanates from the analysis that the larger economic and political settings of the countries govern the decentralised renewable energy sector to a significant extent. For instance, given the political setting of China, energy policies are largely decided at the federal level, whereas given the constitutional status of energy as a 'concurrent item', energy governance in India rests with both the federal government as well as provincial government. Moreover, the policy mapping exercise suggests that while China's energy policy making is heavily centralised (Burke et al., 2009), energy policy making in India is more cohesive and federally structured. On the other hand, energy policy formulation in Thailand appears to be somewhere between China and India and structured in a way where responsibility rests both on federal government as well as on provincial governments.

As far as the decentralised energy systems are concerned, it emerged from the assessment that there exists pluralistic interpretation of what constitutes 'decentralised energy systems' and it came out very succinctly that these interpretations are drawn largely from the country contexts. The notion and nomenclature of 'what constitutes decentralised energy systems' differs depending on the country context. While decentralised systems in China and Thailand are more of grid connected in nature, it is off-grid in character in India. Of course, the decentralised energy interventions of grid connected types such as roof-top systems are an emerging phenomenon in India. In tune with the typologies of decentralised energy systems, the business models also differ across countries. In China and Thailand while business models are largely designed to attract private investors into the sector, in case of India, there has been a clear segmentation between publicly supported model versus private investor led models.

It can be inferred from the mapping of incentive structures that there exist significant differences in structuring of incentive schemes across the study countries. Incentives in the form of subsidies, tax concessions like tax holidays, relaxation of import tax and other taxes,

considering the sector a priority sector for bank lending are widely used across all the study countries. However, there exist pronounced variations in the use of specific financial instruments in creating incentives for decentralised renewable energy systems. For instance, while preferential tariff is one of the key instruments used in China and Thailand, it is not employed in India for decentralised renewable energy systems/off-grid energy systems. Similarly, VGF as an innovative instrument, is widely used in India that has not been considered an effective instrument in other two countries. Differences also can be observed within an incentive scheme in terms of its form, nature, source of funding, and use of the instrument. For instance, subsidies as an incentive mechanism have been used differently in the study countries. While in Thailand and China, only investment/generation based subsidies are given, in India in addition to investment/generation based subsidies, some form of operational subsidy is also provided. In sum, the assessment also suggests that there have been efforts by countries to transit to smarter ways of subsidy disbursement. This is evident in each country's subsidy policies. In addition, there has been a clear emphasis to phase out from the subsidies.

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