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Innovation in Indian energy policy-Case studies on solar energi and energy efficiency technology deployment

Denna rapport analyserar två konkreta exempel på hur Indien arbetar med energiteknik: National Solar Mission som syftar till att öka produktionskapaciteten av solenergi i Indien med 20 000 MW till år 2022 samt programmet Perform Achieve and Trade inom ramen för strategin National Mission on Enhanced Energy Efficiency. I dessa exempel görs observationer som är relevanta att beakta i arbetet med att utveckla Sveriges politik för miljöteknik, förnybar energi och minskad klimatpåverkan.

tillväxtanalys

Dnr 2013/104
Myndigheten för tillväxtpolitiska utvärderingar och analyser
Studentplan 3, 831 40 Östersund
Telefon 010 447 44 00
Telefax 010 447 44 01
E-post info@tillvaxtanalys.se
www.tillvaxtanalys.se

För ytterligare information kontakta Martin Flack
Telefon 010 447 44 77
E-post martin.flack@tillvaxtanalys.se

Förord

Förnybar energi och energieffektivisering utgör två hörnstenar i politiken för en mer hållbar utveckling. I Europa, och i Sverige, är målsättningen att 20 procent av EU:s energikonsumtion ska komma från förnybara källor år 2020 och andelen biodrivmedel ska samma år vara minst 10 procent. Dessutom ska EU nå ett mål om 20 procents energieffektivisering till år 2020.

I snabbväxande länder som Kina, Indien och Brasilien är tillgången till billig och säker energi en förutsättning för fortsatt ekonomisk utveckling och här ses den förnybara energin, liksom energieffektivisering, som ett sätt av diversifiera energimixen och minska beroendet av fossila bränslen.

Trots till viss del skilda motiv pågår i såväl Europa som i de snabbväxande ekonomierna ett intensivt arbete för att utforma insatser och styrmedel med syfte att skapa incitamentsstrukturer som befrämjar investeringar i utveckling och implementering av ny energiteknik.

Möjligheterna till utökat forsknings- och innovationssamarbete samt ökad handel i båda riktningarna är därför troligen goda. För att förverkliga möjligheterna krävs emellertid ökad kunskap om dels vilka policystrategier som sätter agendan för investeringar de kommande åren, dels kunskap kring specifika förutsättningar för teknikutveckling och innovation i dessa stora och potentiellt intressanta marknader för svenskt forskningskunnande och miljöteknik.

Denna rapport analyserar två konkreta exempel på hur dessa strukturer ser ut i Indien: *National Solar Mission* (NSM) som syftar till att öka produktionskapaciteten av solenergi i Indien med 20 000 MW till år 2022 samt programmet *Perform Achieve and Trade (PAT)* inom ramen för strategin *National Mission on Enhanced Energy Efficiency* (NMEEE). Strategin i sin helhet syftar till att mellan 2012 och 2017 spara motsvarande 23 miljoner ton olja samt 19 000 MW elektricitet.

Projektet har bedrivits på uppdrag av och i nära samarbete med Energimyndigheten och kopplar till dess arbete med att utveckla ett tätare och mer långsiktigt samarbete med Indien inom energiområdet.

Rapporten har huvudsakligen författats av Arati Davis, analytiker vid Tillväxtanalys kontor i New Delhi. Projektledare har varit Martin Flack som även skrivit det inledande kapitlet.

Stockholm, mars 2013

Enrico Deiaco

Avdelningschef, Innovation och globala mötesplatser

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Introduktion och sammanfattning

Bakgrund – Innovationspolitik för en hållbar utveckling i en globaliserad värld

Innovationer och innovationspolitik beskrivs ofta som en hörnsten i utformningen av en långsiktigt hållbar tillväxt. Regeringens innovationsstrategi[1] som lanserades under hösten 2012 tar till exempel upp innovation som avgörande för att möta framtidens samhällsutmaningar, däribland hållbar utveckling, och i Framtidskommissionen rapport om den gröna ekonomin som publicerades den 24 januari 2013[2] konstateras att *”Hållbar tillväxt kräver /…/ forskning och innovationer”*.

Vidare blir det allt mer uppenbart att innovationspolitiken inte kan ses uteslutande som en nationell angelägenhet, i synnerhet inte för ett litet land som Sverige. Globala värdekedjor, inom både tillverkning och kunskap, växer i betydelse[3] och innovationspolitiken bör utformas utifrån detta förhållande om Sverige ska kunna stärka sin konkurrenskraft.

De myndigheter i Sverige som verkställer Regeringens innovationspolitik, Vinnova och Energimyndigheten med flera, har också till viss del redan anpassat sin verksamhet för att möta denna verklighet. Vinnova har till exempel under 2012 genomfört en utlysning inom miljöområdet för internationellt samarbete med Brasilien eller Kina och planerar att fortsätta detta arbete även framöver, till exempel inom ramen för programmet *Internationell samverkan för miljöinnovationer*. Denna rapport, som skrivits på uppdrag av Energimyndigheten, är ett ytterligare ett exempel då den syftar till att öka kunskapen om Indiens politiska landskap inom energiområdet med målsättningen att identifiera trender och praktiska tillvägagångssätt som öppnar upp för fördjupat innovationssamarbete mellan Indien och Sverige framöver.

Indien hör till den grupp länder som spelar en särskilt stor roll i detta sammanhang. Som ett av världens, sett till befolkning och yta, största länder och med en tillväxttakt på i genomsnitt sex procent per år det senaste årtiondet kan landet framöver komma att utvecklas till en ekonomisk stormakt. Indien är därför viktigt både som framtida marknad, i en situation där Europa, USA och övriga industrialiserade länder uppvisar stagnerande tillväxt, och som samarbetspartner för att utveckla ny kunskap och nya produkter av relevans i den globala ekonomin.

Även ur ett klimat- och miljöperspektiv är Indien en helt central aktör. Landets kolberoende ser ut att bestå under överskådlig framtid och endast med en teknikutveckling som förmår omvandla landets energistruktur kan målsättningarna om fortsatt ekonomisk utveckling och ökad klimathänsyn kombineras. Sverige kan, genom att tillsammans med Indien, utveckla framtidens energiteknik således också bidra till att lösa klimatproblematiken.

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[1] *http://www.regeringen.se/sb/d/14440/a/201247*

[2] *http://www.framtidskommissionen.se/dokumentation/delutredning-pa-vagen-till-en-gronare-framtid-utmaningar-och-mojligheter*

[3] *För en diskussion om detta, se till exempel Beltramello, A., K. De Backer and L. Moussiegt (2012), "The Export Performance of Countries within Global Value Chains (GVCs)", OECD Science, Technology and Industry Working Papers, No. 2012/02, OECD Publishing, och De Backer, K. and N. Yamano (2012), "International Comparative Evidence on Global Value Chains", OECD Science, Technology and Industry Working Papers, No. 2012/03, OECD Publishing.*

Syfte och tillvägagångssätt

Tillväxtanalys har Regeringens uppdrag att analysera hinder och förutsättningar för grön strukturomvandling. Särskilt prioriterat är att förstå hur styrmedel och politiska insatser för minskad miljöpåverkan (utsläpp, resursanvändning mm) påverkar det Svenska näringslivet i olika dimensioner – resurs- och utsläppseffektivitet, sysselsättning, näringslivsdynamik och strukturomvandling, exportförmåga, innovationsförmåga med mera. Målet är att ta fram bättre kunskapsunderlag för en aktiv närings- och innovationspolitik som driver på en grön strukturomvandling utan oönskade negativa effekter på ekonomin.

Som en komponent i detta övregripande uppdrag genomför Tillväxtanalys en serie studier av andra länders strategier, policys och styrmedel för grön strukturomvandling i syfte att:

- Bättre förstå de strategier som utformas i stora och inflytelserika länder som Kina, Japan, USA och Brasilien och vilka konsekvenser det kan få för Sverige; vilka utmaningar och möjligheter växer fram och vad Sverige kan göra för att anpassa sig respektive dra nytta av utvecklingen.
- Identifiera områden eller konkreta erfarenheter där Sverige kan lära av vad andra länder har gjort för att främja innovation för hållbar utveckling.

Denna rapport är en del av det arbetet och innehåller fallstudier av politik i Indien för att driva på en utbyggnad av solenergi (*National Solar Mission*) samt för att öka energieffektiviteten, med fokus på papper- och massaindustrin (*National Mission on Enhanced Energy Efficiency*).

En förebild för analysen har varit TIS-ramverket, vilket bygger på sju grundläggande funktioner som behövs i ett innovationssystem för att möjliggöra ny teknik och innovation. En mer utförlig beskrivning av TIS och hur detta tillämpats i denna rapport finns i bilaga 1.

Sammanfattning av resultat

National Solar Mission

Syftet från den Indiska regeringens sida med National Solar Mission (NSM) är att öka takten på utbyggnaden av förnybar energi i Indien, i en situation där behovet av energidiversifiering är mycket stort och tidigare energipolitik dragits med stora problem i form av skenande kostnader och stagnerade teknikutveckling. Huvudinriktningen är att stärka den inhemska marknaden för solenergi (solar PV) och att kombinera detta med näringslivsfrämjande och jobbskapande. Målsättningen är att öka produktionskapaciteten från solenergi med 20 000MW fram till 2022, jämfört med dagens totalt 6 000 MW förnybar energi.

Table 0-1 India´s NSM targets

	Phase 1 (2010-2013)	Phase 2 (2013 -2017)	Phase 3 (2017-2022)
Grid Connected	1,100 MW	10,000 MW	20,000 MW
Off Grid	200 MW	1,000	2,000 MW
Solar Thermal Collectors	7 million m^2	15 million m^2	20 million m^2

Source: C-Step, 2010

Det främsta instrumentet för detta är ett system med elcertifikat liknande det som finns i Sverige, men med vissa viktiga skillnader, kanske framförallt att det finns en tvingande reglering om inhemskt producerad teknik och kringtjänster.

Ytterligare en skillnad är det upplägg med omvänd auktionering av licenser för de projekt som ingick i den första fasen av NSM, där de ansökande aktörerna tävlade om ett begränsat antal licenser med framförallt kostnad som utslagsgivande faktor. Samtidigt var alla ansökare tvungna att garantera produktion av en viss volym under projektperioden, vilket sätter gränser för hur låg kostnaden kan bli. Trots denna begränsning har priset per kilowattimme sjunkit betydligt under den första fasen (som delats in i två utlysningar av licenser).

Table 0-2 Falling price of solar PV in NSM

	Batch 1 – November 2010	*Batch 2 – December 2011*
No of bids	300	130
Final Selection	30	22
Cut off price by CERC	Rs 12.66/kWh (1.51 SEK)[4]	Rs 9.44/kWh (1.13 SEK)
Lowest bid price	Rs 10.85/kwH (1.3 SEK)	Rs 7.48/kWh (0.9 SEK)

Source: CSE, 2012, Facing the Sun

Erfarenheter och vägen framåt

Den första fasen av NSM är avslutad och fas två utformas under våren 2013. Vissa viktiga lärdomar har dragit av de inblandade aktörerna som kommer att påverka implementeringen av NSM framöver. Två områden som är särskilt prioriterade att reformera är kravet på inhemsk teknik samt designen av elcertifikatsystemet för att minska kostnader, bland annat genom att tillåta en bredare uppsättning tekniska lösningar (till exempel tunnfilmssolceller). Huvudslutsatserna sammanfattas i tabellen nedan.

Table 0-3 Phase II NSM Main Points

Lessons – Phase I	**Way Forward – Phase II**
Domestic Content Requirement has not fulfilled objective of robust local manufacturing	Domestic Content Requirement to stay, but with support given to R&D
Market mechanisms not strongly enforced. Contributing to loss of market confidence	Market mechanisms of RPO/REC to have stronger enforcement
NVNN not capacitated to effectively monitor project development	Solar Energy Research Council set up with sector experts for monitoring and enforcement
Use of unallocated power useful in bringing down average unit cost of power	Unallocated power to be discontinued, replaced by the money with National Clean Energy Fund to continue market incentive

En ytterligare komponent i framtida faser av NSM är att tonvikten vid innovation och teknikutveckling, inom till exempel smarta nät och distribuerad produktion, ökar och policydesignen förväntas reflektera detta än tydligare framöver. I relation till detta finns en policyinnovation värd att nämna här; en låg (12,5 öre per ton) skatt på all kol som bryts eller importeras vilken genererar intäkter till en särskild fond, *The National Clean Energy Fund*.

[4] *All currency conversions done at http://www.xe.com/ucc/convert/*

Fondens medel, vilka 2012 uppgick till omkring 4,7 miljarder SEK, ska användas till energiprojekt som syfte till att öka utbyggnadstakten av förnybar energi i Indien. Hur dessa medel allokeras och hur projekten som finansieras fortlöper är exempel på frågor som är intressanta att försöka besvara framöver.

I sammanhanget kan det vara intressant att jämföra detta instrument med den i USA nu föreslagna fonden på USD 2 miljarder över tio år för investeringar i ny avancerad energiteknik, vilken är tänkt att finansieras med avgifter för olje- och gasindustrin.[5]

Perform, Achieve and Trade Scheme – en fallstudie av energieffektivisering i papper –och massaindustrin

Vid sidan av förnybar energi är energieffektivitet ett av de mest prioriterade områdena för Indien i ambitionen att öka energitryggheten och därmed skapa förutsättningar för en fortsatt hög ekonomisk, inkluderande, tillväxt. Från regeringens sida är *National Mission on Enhanced Energy Efficiency* (NMEEE) en viktig insats för att uppmuntra utpekade nyckelsektorer inom industrin att genomföra de investeringar som kommer att bli nödvändiga för att minska energiintensiteten och därmed beroendet av, till stor del importerad, fossil energi i framtiden. Målsättningen med strategin är att, genom ny teknik och bättre styrning, spara motsvarande 23 miljoner ton olja samt 19 000 MW av elenergi mellan 2012 och 2017.

Table 0-4 NMEEE Initiatives and objectives

Initiative	Objective
Perform Achieve and Trade (PAT)	Marked based mechanism for improvements in energy efficiency through certificated and trading
Market Transformation for Energy Efficiency	Market Transformation for Energy Efficiency (MTEE) to accelerate the shift to energy efficient appliances in designated sectors through innovative measures to make the products more affordable with focus on leveraging international financial instruments, including Clean Development Mechanism (CDM) to make energy efficient appliances affordable and increase their levels of penetration
Energy Efficiency Financing Platform	To help stimulate necessary funding for Energy Service Company (ESCO) based delivery mechanisms for energy efficiency. The costs will be recovered from the energy savings, which will also reduce the subsidy bill of the state government
Framework for Energy Efficient Economic Development	Fiscal instruments to promote energy efficiency including Partial Risk Guarantee Fund, and Venture Capital Fund for Energy Efficiency

Source: Ministry of Power, PAT Scheme Document

Det främsta av de fyra initiativen inom ramen för NMEEE är PAT, *Perform, Achieve and Trade*, vilket är en marknadsbaserad mekanism som möjliggör för handel av energibesparingscertifikat mellan företag och enheter inom de utpekade industrierna. Systemet bygger på att varje enhet (arbetsställe) noggrant redovisar energiåtgången och att den konsumtion som överstiger det fastlagda taket måste kompenseras genom att enheten i fråga köper

[5] *http://www.whitehouse.gov/infographic/energy-security-trust?utm_source=email203&utm_medium=graphic&utm_campaign=energy*

energibesparingscertifikat på marknaden, vilket skapar en efterfrågan som genererar extra intäkter till de företag som lyckas bättre.

PAT-ramverket har föregåtts av omfattande konsultationer och avvägningar mellan olika gruppers intressen med målsättningen att skapa ett effektivt och flexibelt instrument som bidrar till betydande energibesparingar samtidigt som näringslivets villkor inte försämras. Det är för tidigt att säga vilka effekter PAT kommer att få, ramverket sjösattes i juli 2012 och handeln med certifikat beräknas inte inledas på allvar förrän 2015, men preliminära bedömningar visar att förutsättningarna för detta är relativt goda, även om det naturligtvis finns hinder på vägen. I denna studie har ett antal berörda aktörer intervjuats och utifrån detta har ett antal utmaningar utkristalliserats, vilka sammanfattas i tabellen nedan.

Table 0-5 Feedback from Stakeholders on PAT

Energy Service Companies	Pulp and Paper Sector stakeholders
Weak Contracts: More investigation needed into viable contracts models that share risk between ESCO and client. Performance based contracts leave ESCOs at risk of 'trusting' the client	Enforcement of a Flexible Scheme is hard to predict: Flexibility of PAT has also introduced confusion on industry about the actual enforcement of PAT. This has delayed actual uptake of efficiency measures, beyond business as usual action.
Insufficient timeline to break existing vendor/client relation: DCs have existing relationships with service providers/vendors. As the results of efficiency actions cannot be guaranteed ex-ante, DCs are unwilling to break relationships for unknown results.	Process Optimization too expensive to invest in without guarantees: The biggest savings in Pulp and Paper are from changes in process optimisation. However this requires expensive technology, with no knowledge of in-country returns. Process optimization relies on reporting, and there is a large degree of variation between DCs
Venture Capital Fund and Partial Risk Guarantee Fund are too small to incentivise the selected Paper Mills and/or ESCOs	
Government requested to take on project demo sites, per selected sector, to build confidence on the ability of meeting targets	

Source: Stakeholder Interviews

Observationer och avslutande kommentarer

Huvudslutsatserna av de två fallstudier som sammanfattas i denna rapport är, i punktform:

Politiska och institutionella

- Kolimport kommer att fortsätta utgöra en mycket stor utgift för den indiska staten under överskådlig framtid. Ren energi och energieffektivitet ses som viktiga pusselbitar för att minska kostnaderna och möjliggöra fortsatt stark ekonomisk tillväxt.
- Privata initiativ och privat kapital utgör en växande drivkraft för utvecklingen av politiken inom dessa områden. Statens roll skiftar från, som i traditionell energi-politik i Indien, från ägande och drift till att rigga ramvillkor och skapa marknads-baserade incitament för privata aktörer. De kommande fem åren ser ut att bli for-mativa för hur denna process ska se ut i framtiden.

Teknologirelaterade

- Det finns i Indien en tydlig förståelse för behovet av internationella partnerskap inom teknikutveckling och innovation.
- Eventuella samarbeten kommer dock att behöva vara starkt förankrade i den indiska miljön, sannolikt rent fysiskt lokaliserade dit.
- Huvudsyftet med den indiska politiken för teknikutveckling och innovation inom energiområdet är att lösa den inhemska energisituationen, inte att öka exporten.

Några lärdomar för fortsatt FoI-samarbete

För Sveriges del finns ett antal observationer att ta fasta på. För det första visar materialet i denna rapport att det finns en vilja på den indiska sidan att inte bara köpa bästa tillgängliga teknik på den internationella marknaden, utan att också vara med och utveckla framtidens teknik samt att anpassa den efter inhemska förutsättningar. För att göra detta söker man efter internationella samarbeten med länder och aktörer som anses ligga långt framme – Sverige tillhör utan tvekan denna grupp.

Viktigt är också att notera att det politiska landskap som nu växer fram i Indien, kanske i synnerhet vad gäller förnybar energi, allt mer karaktäriseras av ett bottom-up-perspektiv. Statens roll förskjuts mot att skapa incitament och ramverk för teknik- och näringslivsutveckling. Aktörer i den regionala och lokala kontexten blir då viktigare för politikens praktiska implementering. I framtida samarbeten bör därför resurser investeras i att förstå denna underliggande dynamik. I Indien sker vidare implementeringen sällan enligt plan och det bör således finnas både flexibilitet och uthållighet i de samarbeten som etableras.

För en mer utförlig diskussion om detta hänvisas till Tillväxtanalys rapport *Building Innovation Partnerships with India* (Svar direkt 2013:01). Här konstateras bland annat att ett framgångsrikt utbyte med Indien sannolikt kommer att kräva relativt omfattande resurser i form av långsiktigt relationsbyggande och även i form av konkreta samarbeten i innovationskedjans alla skeden – inte bara de senare skedena där affärskontrakten sluts. Både produktutveckling och forskning bör därför ske i samarbeten mellan Indiska och Svenska aktörer på olika nivåer – från politisk nivå till myndigheter, universitet och forskningsinstitut. I samtliga samarbeten bör också privata aktörer – företag eller branschorganisationer – från båda sidor vara representerade för att säkerställa kvalitet, relevans och kontinuitet.

1 An Overview of India's Energy Policy Landscape

India has been growing at an average of 6 per cent annually over the past decade. Between 1990 – 2010 the number of Indians living below the poverty line of $1.25 has decreased by 17**%**, and the average annual income has tripled in the last ten years alone.

In order for India to continue on its path of economic development, the Indian government has assumed an 8 – 10% growth rate and stressed the need for inclusive growth to help India achieve its economic potential. India has linked its level of human development to a concurrent increase in the expected growth in the per capita use of energy[6]. It is estimated that India's energy demand will be in excess of 300 GW by 2030, which is an increase of 300% in 15 years, and that the overall cost of India's energy development and urbanisation needs will be $1.2 trillion[7]. With this in mind, two main challenges face India in the coming decades; meeting its growing energy demand and addressing the needs of its urban centres that are considered to be India's engines of growth.

India has continued to assert that the country's growth path is still significantly based on coal as the primary energy source. However, its growth ambitions coincide with the impacts of climate change and finite supplies of fossil fuel, forcing the government to recalibrate its growth plans and move away from 'business as usual' scenarios towards inclusive low carbon growth options.

Renewable energy and energy efficiency measures are central to finding alternatives to the country's fossil fuel based supply options. In 2010, India had an installed capacity of approximately 172,200 MW, with renewable energy making up eleven% of the total energy mix[8]. In order to achieve planned growth, energy access will become a critical component. The role of renewables in this mix will grow as overall energy demand continues to increase. Public finance will not be enough to meet the demands of the maturing renewable energy sector. The challenges of scaling up renewable energy will increasingly fall on the private sector, but will need to be supported by effective institutional frameworks to facilitate sustainable development in the renewable energy sector.

Conventional energy policies have focused on providing consumer subsidies to publicly owned monopolies. Challenges of transparency and financial sustainability have pushed the Indian government to embrace market-based incentive mechanisms for its development of renewable energy and energy efficiency policies.

1.1 Energy Security and National Action Plan on Climate Change

India is a federal state with 28 state governments and 4 union territories. Although the economy has been growing at an average annual rate of 6%, there are up to 400 million people without access to energy and an estimated 700 million who live on less than $2 a day. Poverty reduction and inclusive growth continue to be India's main economic priorities and are linked to increased energy demands.

[6] Ghosh, Prodipto, *Climate Change; Is India a solution to the problem, or a problem to the solution*, Chapter 2 in Climate Change - Perspectives from India, UNDP, 2010
[7] (2010), *India's Urban Awakening*, McKinsey & Company
[8] *MNRE Annual Report 2010-2011*

As a major importer of energy and in view of the increasing domestic energy demand, India considers energy security and energy efficiency to be important issues as regards climate change. In 2011, India imported 85 million tonnes of coal and this figure is set to grow to 185 million tonnes by 2016-17[9]. Concurrently, however, as coal prices increase, so too does the economic value of integrating renewable energy into India's energy mix. India sees the next twenty years as a time for research, development and deployment of feasible energy options[10]. In this context it is important to underline that climate change *per se* is not the primary trigger for India's current measures to promote renewable energy development. Rather, it is the country's perceived need to enhance its energy security by developing a more diverse energy mix that drives its aggressive push towards alternative energy development.

In 2008, and largely in response to the pressure of the international climate community, India committed to reduce its carbon intensity by 25%[11] and released its National Action Plan on Climate Change (NAPCC). The NAPCC consisted of 8 missions directed at moving India towards a low carbon growth pathway. Three of the eight missions are directly linked to issues of energy access and energy security; the Jawaharlal Nehru National Solar Mission (NSM), the National Mission on Enhanced Energy Efficiency and the Sustainable Habitat Mission.

India's ongoing commitment to market-based mechanisms as a means of facilitating renewable energy growth has ushered in a need for strong cooperation between the national government and state and local governments. When unpacking the NSM objectives and delivery in India, it is important to keep in mind the independent but complementary role of the state governments vis-à-vis the national government. This on-going tension is between delivery on international climate change objectives, the domestic imperative of energy security, and the priorities of re-election for local political parties. While the central government has overall regulatory authority on national security issues, states take on decentralised matters such as land tax, agricultural development and urban service delivery[12]. There is a list of concurrent subjects that require the cooperation and coordination of both levels of government. Renewable energy development and the NSM therefore have cross-cutting jurisdictions to navigate. It is not surprising then that many of the concerns from the results of Phase I of the NSM, which will be elaborated on in chapter 3, arise from the tensions of cooperation between the central government and the states.

The role of the climate action plan is to provide overarching direction regarding the Indian government's approach to climate change issues and how this will be balanced with growth. The missions themselves have been done subsequently elucidated though extensive deliberation between stakeholders. Specifically with relation to the missions focused on energy conservation and augmentation, market-based mechanisms has been put forward as the delivery vehicle for objectives.

[9] 2012, Indian Chamber of Commerce, *The Indian Coal Sector: Challenges and future outlook*, presented at November 2012 4th India Coal Summit

[10] Interview with R.K. Gupta, Strategic Director, IL&FS Environmental Services Group, September 28, 2012

[11] Nitin Sethi, Times of India, *India says it will cut carbon intensity by 20-25 per cent*, November 29, 2009 available at http://mobiletoi.timesofindia.com/mobile.aspx?article=yes&pageid=9&sectid=edid=&edlabel=TOIPU&mydateHid=28-11-2009&pubname=Times+of+India+-+Pune&edname=&articleid=Ar00900&publabel=TOI

[12] For a full list of subjects and jurisdiction at the Central, state and concurrent level please refer to www.vakilbabu.com

The mission documents provide clear objective timelines and expected incentives. The resource questions are taken up in the mission documents and are also reflected in the Five-Year-Plan documents and annual budgets. But apart from suggested incentives, much of the implementation of missions, set at the Central level, will come down to enforcement at the state level. The market-based mechanism approach ensures that the public and private sectors will increasingly need to find bases for cooperation. This is a relatively new model of governance for India and much of the early findings in this paper point to early stages of traditional roles being redefined for a new balance.

2 From Government Fiat to Market Facilitation - A Case Study of India's National Solar Mission

The case study will focus on the 2010 Jawaharlal Nehru Solar Mission, which has a stated objective of *adding* 20,000 MW of grid-connected solar capacity to India's energy mix. The study will look at the way that policy has been critical to kick-starting the solar market. A process of consensus building and constant feedback has allowed the solar market to grow by 300% over the last 3 years. The study will conclude by outlining some of the challenges of a national policy that forces domestic market growth based on conditions that are potentially out of sync with international technology development.

The solar market is growing in India. The Phase II guidelines for the mission were released on 4 December 2012. This paper relates the story of solar in India up until 31 December 2012.

2.1 Background and policy landscape

In 2003, India had 6,000 MW of installed capacity in renewable energy, excluding large hydroelectric projects. This was 3% of the total energy mix. In 2012, this number had increased to 26,000 MW. This growth is largely due to the positive influence of government policies and the ecosystems created as a result of predictable policy setting.

The Jawaharlal National Solar Mission (NSM), launched in 2010, aims to add 20,000 MW of grid-connected solar by 2022. This is one of the world's largest development schemes for solar grid connectivity. The potential for solar energy in India is obvious, with natural access to approximately 300 days of sunshine, an average hourly radiation of 200 MW/sq km and vast areas of wasteland available for development[13]. It is a natural first step for the country's implementation of its 2008 National Action Plan on Climate Change. India's desire for growth and the need for energy security have pushed the government to look for ways of reducing fossil fuel dependence[14]. The NSM indicates a mainstreaming of renewable energy into India's future energy roadmap.[15]

In 2010 optimism and expectations of India's solar development were at an all-time high. Progressive policies, attractive tariff-setting and a commitment to pushing local manufacturers, through the NSM's domestic content requirement clause, provided a sufficiently enabling environment to attract actors along the value chain. Two years later, however, confidence in the market has waned. More than half of India's solar manufacturers have gone out of business and capacity in the market has stalled, with a production overhang of 50%[16]. In addition, policy loopholes have allowed international investors to promote technology not originally envisioned in the NSM, which has pushed local manufacturers into further decline.

The NSM framework holds great promise as it is both forcing and incentivising new technology development to meet its stated objectives. An understanding of the way in which

[13] MNRE, Jawaharlal Nehru National Solar Mission, *Mission Document*, 2010
[14] Basu, Sambit, *India's Solar Policy: Elements Casting Shadow on Harnessing the Potential*, IDFC, Sector Note, No. 1, November 2011
[15] (2010), Deshmukh Ranjit, Ashwin Gambhir, Girish Sant, *Need to Realign India's National Solar Mission,* Economic and Political Weekly, Vol XLV, No. 12, March 20, 2012
[16] Rahul Gupta, Chairman, Indosolar, November 10, 2012

sector actors have responded to policy objectives, the strength of existing capacity, and the room for growth and development will become important in helping build market confidence the market and creating longer-term predictability for new entrants. What becomes clear when evaluating the dynamics aroundrenewable energy policies in India is the way in which government and subsequently governance has shifted towards a better understanding of the role of market-based mechanisms as a means to incentivise change.

2.2 NSM Framework

The Ministry of New and Renewable Energy (MNRE) has been given the task of developing and implementing the NSM. The NSM is the product of iterative discussions about developing India's renewable energy potential. In 2010 the Indian government introduced a coal cess of Rs 0.50 (SEK 0.125) for every tonne of coal mined or imported. Ostensibly, the reason for this was to develop capital for incentivising India's renewable energy potential. The National Clean Energy Fund (NCEF)[17], which today stands at Rs 3864 crore (SEK 4.7 billion) put in place a substantial government investment component for new projects, focused on facilitating market-based mechanisms.

The objective of the NSM is to create a market for solar power in India by developing a policy mechanism that internalizes and develops a framework to overcome the technical, financial and institutional barriers that normally exist when developing a new market[18]. Included in this are the explicit objectives of encouraging domestic manufacturing, bolstering local industry, and introducing livelihood benefits and greater energy access.[19]

Table 2-1 India´s NSM targets

	Phase 1 (2010-2013)	**Phase 2 (2013 -2017)**	**Phase 3 (2017-2022)**
Grid-connected	1,100 MW	10,000 MW	20,000 MW
Off-grid	200 MW	1,000	2,000 MW
Solar Thermal Collectors	7 million m^2	15 million m^2	20 million m^2

Source C-STEP, available at http://www.cstep.in/node/217

In the first phase of the solar mission, 2010 – 2013, a two-batch allocation policy was announced. The first phase of the NSM aimed to add 1 GW of solar power to India's grid by 2012. The guidelines put forward by the Ministry of New and Renewable Energy (MNRE) solicited for both Solar Photo Voltaic (PV) technology projects and Solar Thermal Technology (Concentrated Solar Power or CSP).

2.2.1 Market Entry Incentives: Power Purchase Agreements and Feed-in Tariffs

The National Thermal Power Corporation Vidyut Vyapar Nigam Ltd (NVNN), the power-trading arm of the National Thermal Power Corporation (NTPC), was given responsibility

[17] *Proactive steps in Budget 2010-2011 for the Environment via http://pib.nic.in/newsite/erelease.aspx?relid=58419, 26 February 2010, last accessed November 28, 2012*
[18] *For an in-depth discussion about the barriers to innovation, andsustainable innovation in particular, see OECD 2011 Fostering Innovation for Green Growth, OECD Studies, OECD Publishing*
[19] *Ministry of New and Renewable Energy, Government of India, Jawaharlal Nehru National Solar Mission – Building Solar India: Guidelines for Selection of New Grid Connected Solar Power Projects, May 2009*

to finalize advantageous Power Purchase Agreements with preferential tariff-setting with all successful solar developers for the first phase of the NSM. NVNN was also given a mandate by the national government to 'match' each MW of installed capacity under a proposed solar project with unallocated power in a 1:4 ratio[20].

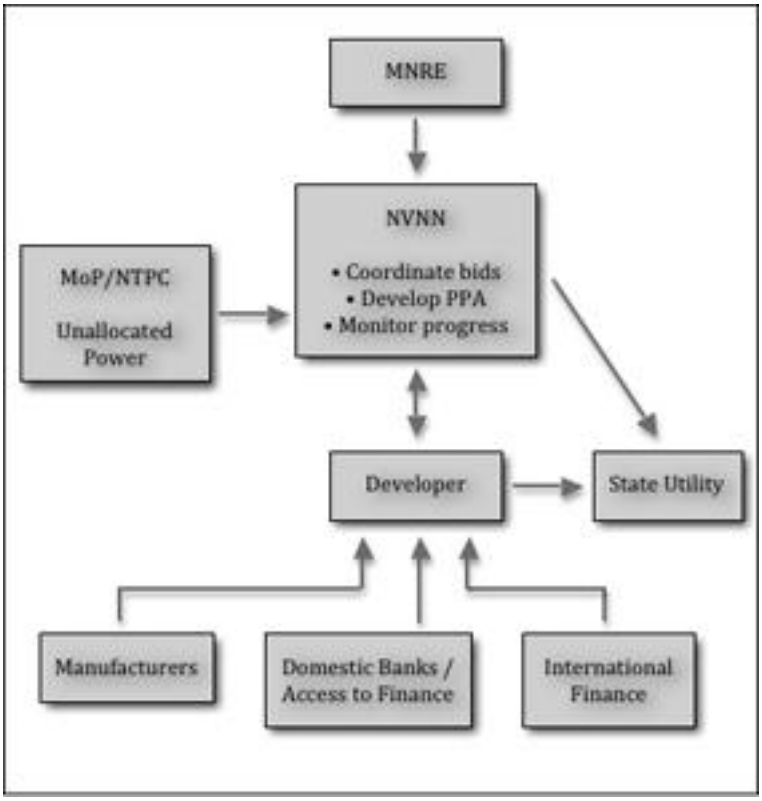

Figure 2-1 Organogram of the main actors in Phase I - NSM

Source: National Solar Mission, 2009

To further the objective of boosting local manufacturing, the Domestic Content Requirement (DCR) was introduced – which required local products and services be used. For the first batch of solar bids, for projects using crystalline silicon technology, all modules were to be manufactured in India[21]. For solar thermal energy, 30% of all content in plants was to be procured locally.

Because of the high number of bids submitted, the government put in place a reverse bidding mechanism that focused on per unit price. This modality remained for the second bids in 2011.

Extensive boundary setting was put in place for the first batch of solar projects, in order to minimize the risk of commissioning projects. Bid bonds were required to be submitted, along with performance guarantees, by all Solar Project Developers (SPD). Should the projects not be executed after selection, or should financial closure extend beyond the permissible limit of 180 days, the guarantees were to be encashed by the NVVN.

[20] *Unallocated power refers to the central government's discretionary quota of 15% of the capacity of central power generating stations that have an installed capacity of 40,000 MW. The government has used this to bridge the supply gap in power-short states.*
[21] *National Solar Mission 2009*

Table 2-2 Falling price of solar PV in NSM

	Batch 1 – November 2010	**Batch 2 – December 2011**
No of bids	300	130
Final selection	30	22
Cut-off price by CERC	Rs 12.66/kWh (1.51 SEK)[22]	Rs 9.44/kWh (1.13 SEK)
Lowest bid price	Rs 10.85/kwH (1.3 SEK)	Rs 7.48/kWh (0.9 SEK)

Source: Facing the Sun, Centre for Science and Environment, New Delhi

The reverse auction process has succeeded in pushing competition between actors and has also led to a reduction in unit pricing. Although all projects approved in Phase I batch 1 have now been commissioned, more time is needed to understand how batch 2 projects will unfold.

2.2.2 Market Entry Incentives: Enabling Framework

State-sponsored market mechanisms were also introduced to pave the way for solar project development. Amendments to the Electricity Act (2003) introduced Renewable Purchase Obligations (RPO) and Renewable Energy Certificates (REC). These are mandatory measures placed on industries and state electricity boards to add sector confidence. RPOs are applicable to distribution companies, open access consumers and captive consumers, who are obliged to purchase from renewable energy sources at a percentage of overall energy consumption.

RECs are generation-based incentives available to entities generating renewable energy, including solar power, hydropower, and wind power. They are awarded in proportion to the amount of renewable energy generated and can be traded, thus providing an additional revenue stream. The RECs can be purchased by entities with RPO obligations to satisfy their requirements. The floor and ceiling prices of RECs are set by the national government. Between 2012 and 2017, the floor and ceiling prices will stand at Rs 9,300 (SEK 1,140) and Rs 13,400 (SEK 1,643)[23]. Specific renewable purchase obligations were set subsequent to the launch of NSM such that 0.25% of all electricity was to be sourced from solar.

By creating a market-based incentive for the creation of renewable energy and stipulating a requirement that certain consumers of power must buy it, the government has created a trading framework that aims to support the development of solar energy in the country. The framework, however, is as strong as the enforcement of its component parts, which will drive market growth and instil long-term sector confidence.

2.2.3 Future Steps for Technology, Project Development, and India's Second Phase for NSM

The NSM has played an important role in increasing India's solar capacity from 18 MW to 500 MW in the space of two years. Reverse bidding has managed to push down prices such that solar is now cheaper than diesel and close to parity with fossil fuel technology. The lowest bid in the second batch auction had a per unit price of Rs 7.49/kWh (0.9 SEK)

[22] *All currency conversions done at http://www.xe.com/ucc/convert/*
[23] *'India's First Solar REC issued to M&B Switchgear', HindubussinessLine, May 24, 2012, available at http://www.thehindubusinessline.com/companies/indias-first-solar-renewable-energy-certificates-issued-to-mb-switchgear/article3451934.ece*

compared to conventional energy costs of Rs 4-5/kWh. Experts forecast that solar could be grid comparable by 2017[24]. Power Purchase Agreements at favourable rates are set for 25 years at a fixed price. The falling price of solar project development and the parallel declining price of solar components, due to the global drop in demand give MNRE cause to reconsider the PPA approach for the second phase of the NSM with regard to cost-effective public spending.

The final guidelines for the second phase of the NSM are due shortly and will revise the financial incentives currently in place for new projects. It will also review the experience of manufacturers, developers and investors with regard to the original conditions of the NSM. Specific focus will be put on the discussion on domestic content requirements and the role of the supporting landscape provided by Renewable Purchase Obligations and Renewable Energy Certificates. Ultimately, however, the best explanation of the way in which India is approaching the rollout of its solar ambition is encapsulated in the words of MNRE Secretary Girish Pradhan '*Policy-making in India is a complex process. It is easy to criticize, but as long as it is moving the sector along from its current position, we should consider it successful*'.[25]

The next section looks at the NSM from the perspective of the Technological Innovation System framework (TIS) and aims to understand and evaluate the triggers and potential bottlenecks in developing India's solar industry.

2.3 Functional Analysis

When looking at NSM and understanding the potential it has for the development of the solar market in India, it is important to keep in mind that the NSM is the result of an iterative process on possible measures that should be taken to catalyse new market actors, incentivise technology development and attract investors. NSM is also the clearest symbol of the changing role of governance in the Indian context, from one of government fiat and extensive regulation to increasingly one of market facilitation. Indications of this prediction will be best tested when the second set of guidelines for the NSM is released. Market actors have lined up on two main issues: domestic content requirement and the nature of the subsidies being provided. Indian solar manufacturers looking for market share and for whom domestic requirements are of benefit stand against developers in search of cost-effective capital deployment. The Indian government has to walk a delicate line between them to ensure the continued strength of the solar sector. All these questions, which are being debated in numerous forums for India's growing solar family, show us that the government has indeed succeeded in its ambition of introducing a market where there had been none previously.

2.3.1 Knowledge Development and Diffusion

A marked change has been seen in India, between the ninth and eleventh five-year-plans (2003 – 2008 and 2008 – 2012 respectively), with regard to the development of energy sources and recognition of the role that renewable energy can play. These changes have come about for a multitude of reasons, which have coalesced around the need for parallel strategies to strengthen India's energy portfolio. Continued currency volatility, increasing prices of coal, an increased focus on energy security and access, and not least the height-

[24] *KPMG, Grid Parity Gets Closer – a point of view on the Solar Energy Sector in India,* September 2012
[25] *Girish Pradhan, Secretary MNRE, November 16, 2012 CSE South Asia Media Workshop on Climate Change and Renewable Energy*

ened discussion on the impacts of climate change and limited availability of fossil fuel over the long term, have been the broad pillars upon which India's renewable energy discussion have taken shape.

The revision of the Electricity Act (2003), the Jawaharlal Nehru National Urban Renewable Mission (2005), the Integrated Energy Policy (2007), and India's draft low carbon growth plan, put forward by the Planning Commission in 2008, sent a clear message that India has understood the market value of developing renewable energy options and investing in energy efficiency measures. Central to these actions was the recognition that the market would have to take a strong role in developing the ambition on a non-fossil fuel based economy. This is in stark contrast to the role the government continues to take within conventional energy and infrastructure.

In 2008, India released its National Action Plan on Climate Change (NAPCC). The NAPCC had eight missions, all of which focus on enabling growth for the Indian economy, with a context of climate change and depleting fossil fuels. In 2009, the Ministry of Finance introduced a climate change department, and in 2010 the National Clean Energy Fund was set up to support initiatives in research and innovation. These signals were relayed through industry member associations such as the Confederation of Indian Industries (CII), and the Association of Chamber of Commerce and Industry (ASSOCHAM), together representing 800 of India's largest industrial energy consumers.

Integrated Energy Policy

India's Integrated Energy Policy (IEP) broke ground in two ways; it advocated the central importance of renewable energy and new technologies as a backbone for India's long term energy mix and the introduction of market based mechanisms to support India's targets for energy security[26]. In keeping with the IEP's blueprint of actions, in 2009 India committed to a 25% reduction in carbon intensity from 2005 levels by 2020 prior to the Copenhagen climate change negotiations.

The IEP is key to understanding the long-term trajectory of the Indian market for energy technologies as it set out a path of market development for the energy sector. Market development will have to include the transfer of technology, at a Government level, but it will also have to allow for easier integration of global best practices if India is to both develop its energy supply and reduce the intensity at which it consumes energy.

2.3.2 Influence on the direction of search

Due to India's geographic position, there is an estimated potential for solar of up to 5,000 trillion kWh per year[27]. This combined with the relatively mature state of solar manufacturers in the country, mostly with international clientele, made solar development a natural first step within India's climate change ambition. The objectives of solar development were to extend India's solar capacity, but were also to ensure that the benefits of NSM-sanctioned spending were felt in-country. Although the second objective is now being tested, as the market matures, the first objective is in line to be achieved before the dates set by the government.

The solar industry had grown worldwide from USD 17 billion in 2003 to USD 93 billion by 2011. This was due to the efforts made by Europe, specifically Germany and Spain, to

[26] *(2006) Planning Commission, Integrated Energy Policy, Report of the Expert Committee*
[27] *MNRE, press release on solar mission, available at http://www.mnre.gov.in/schemes/grid-connected/solar/*

implement solar development. High feed-in tariffs and healthy macroeconomic conditions led to the rise of India's solar manufacturing market.

Table 2-3 Global solar production

Distribution of Solar Production - Worldwide (%)		
	2005	**2010**
Germany	19	8
Japan	47	9
China	7	45
United States	9	5
Taiwan	5	15
Other (incl. India)	13	18

Source: 2012, KPMG, Rising Sun

It was with this background that discussion on the details of India's NSM took place. Although technology choices were said to be neutral, there was an understanding that it would focus on the capacity that India possessed at the time of mission development. For this reason, crystalline silicon PV modules were the focus of the solar project development criteria. Alternatives such as thin film were not considered. International investors, offering low interest loans, have taken advantage of this loophole. Investors have been able to push thin film development without having to worry about complying with the NSM guidelines. This has made the biggest difference with regard to financing solar projects.

Local developers and PV manufacturers have to work with domestic financial institutions offering an average of 14% loans, as compared to 3-4% for international projects focusing mostly on thin film. It is estimated that up to 60% of the projects under the first phase of NSM have utilised thin film panels sourced internationally. This has been in direct contradiction with the NSM objectives of strengthening local production capacity[28].

With the recent economic downturn in Europe, and the collapse of the solar market, capacity additions have taken place mostly in Asia with China leading the market of low cost PV technology. The second phase of the NSM guidelines is due to be released in early 2013 and the discussion on its development has focused on the need to expand the options for solar development projects in India if the market is to be sustainable. This will focus on technology, financing and the direction of government funding. Predictability of policy for longer-term projects to be put in the pipeline and for new actors to be able to stay in the market will be important.

2.3.3 Entrepreneurial Experimentation

The Domestic Content Requirement stipulation set the baseline for technology development within NSM. As a result, the core areas of experimentation have been limited to opportunities to develop the market potential of going beyond grid connections as well as the business models associated with solar development that have served to bring costs down as a response to the ambitious reverse auction system set up by the MNRE.

The reverse bidding system for project selection has forced evolution through competition. The critical parameters that have been influenced by this are financing, technical integra-

[28] *(2012), Chandra Bhushan, Facing the Sun, Policy for sustainable grid connected solar energy, Centre for Science and Environment, New Delhi*

tion and technology choices. Integrated power producers stand to gain substantially from NSM because of their cost-effective approach to development and distribution. In order for innovation to be truly released, the market will need to be more substantially integrated into the revised guidelines for the NSM. All indications suggest that the next phase of the guidelines will still have a component of DCR. MNRE, however, has also stated that subsidies for solar, such as the set rates for Power Purchase Agreements, will be reduced over time to allow the market to be exposed to competitive development.

2.3.4 Market Formation

Although many questions still remain about the future of India's solar ambition, what is very clear with NSM is the way new networks have been successfully created to open up a market that was effectively dormant, despite its potential, five years ago. Between 2010 and 2012, India's installed capacity in solar has more than tripled. This is largely considered to be a result of policy directives that have created a sense of confidence in entering a new market, sufficient for us to see active discussions today between supply chain actors and MNRE about the way in which the second phase of NSM should be developed.

NSM came about after a series of initial preparatory steps to develop an enabling environment for solar development. 80% of conventional energy is controlled by state-owned monopolies, compared to private ownership of 85% of solar development[29]. The Electricity Act (2003) and the National Electricity Policy (2005) mainstreamed the need for development of renewable energy. It also stipulated that incentive schemes, and subsidies, should be introduced to mitigate the higher per unit costs in the initial phase of deployment.

Fast Track Development: Reverse Auctions and falling unit price of Solar

The lowest bid for the second batch of solar projects was made by Solairedirect India, a subsidiary of a French company. The per unit price offered was Rs 7.49/kWh (SEK 0.9) or half the benchmark tariff set by the Central Electricity Regulatory Commission (CERC) for its preferential Power Purchase Agreements.

Scale has been the key driver for the solar market in India. The cost of solar development per megawatt fell by 50% between 2010 and 2012[30]. The global PV market price curve has been falling at an annual rate of 7%.

Table 2-4 Solar PV in 2010

Capacity Addition of Solar PV - 2012 NSM[31]	
Quarter	**Addition - MW**
2012 – 1st quarter	401.74
2012 – 2nd quarter	340.63
2012 – 3rd quarter	67.25

Source: Bridge to India, October 2012

Prior to its formal launch, the National Solar Mission was seen as a huge boost for India's solar manufacturing industry. Most capacity addition took place as a result of the first batch of NSM project development. Following its launch and its support of market sys-

[29] *International Energy Agency, Understanding Energy Challenges in India – policies, players and issues, October, 2012, IDFC, 2011*
[30] *Alan Rosling, Chairman and Executive Director of Kiran Energy, November 10, 2012*
[31] *Bridge to India, October Report 2012*

tems, and in line with international retraction of solar manufacturing, the reverse is currently in place.

The current situation is that more than two thirds of India's solar manufacturing capacity has stalled. Global overproduction of solar PV has resulted in a spiralling reduction of module prices and reduced the competition for manufacturers. This has helped power producers to obtain components at a fraction of the cost. This situation is reflected globally and marks a turning point for solar production[32]. With a continued interest in the Domestic Content Requirement in the second phase of NSM, there is considerable pressure to guarantee the outcome of a robust domestic manufacturing market. The argument has been made that the DCR should be phased out and smaller actors artificially protected from the international market should be forced to exit as a natural result of market action.

The cost of conventional electricity in India is estimated to increase by 3-5% per annum. At the same time, solar power is expected to decrease by 5-7% per annum. Should this prove the case, the cost of solar power has been predicted to reach grid parity as early as 2017, assuming neutral technology applications[33].

The Invisible Hand: Market success is varied along the value chain and at odds with NSM objectives

The NSM specifically outlined requirements for crystalline silicon technology in its DCR. It did not take into account requirements for thin film technology because it was not mature in the Indian market, and more costly. Given the clear potential of solar projects in India, international investors made use of the policy loophole to encourage developers to promote thin film technology with low interest rate loans, averaging 3%. In contrast manufacturers working with crystalline silicon technology, in India, were up against domestic financing requirements of 14% interest[34].

A sign of market formation and the ongoing potential of India's solar market is perhaps best encapsulated in the two trade negotiations currently underway. In September 2012, the USA, Japan and China raised their concern at India's domestic content requirement with the World Trade Organisation. Given that India has not ratified the WTO's Local Content Requirement Agreement it is unlikely to be affected by the complaint. It is not the first case of nation states taking umbrage at the localisation component of renewable technology development[35]. It does, though, raise some flags about the potential future of domestic manufacturing requirements in future iterations of the national guidelines[36].

India has struggled to maintain its objective of domestic production as the key focus for NSM. In November 2012, the Indian Ministry of Commerce and Industry initiated proceedings for anti-dumping investigations against Malaysia, Taiwan, China and the USA. The investigation will cover both crystalline silicon and thin film PV.

[32] *Aanesen, Krister; Stefan Heck; Dickon Pinner (2012), Solar Power; Darkest before Dawn, McKinsey on Sustainability & Productivity*
[33] *International Energy Agency, Understanding Energy Challenges in India – Policies, players and issues, October 2012; IDFC 2011*
[34] *For more on the dumping of solar technology into India see– Kushal Pal Singh Yadav, Jonas Hamberg, Sunshine Sector loses sheen , Down to Earth, August 15, 2012*
[35] *Ontario, Canada was taken*
[36] *Jonas Hamberg, Centre of Science and Environment, New Delhi November 20, 2012*

In 2009, at the height of the climate debate and international positioning on commitments to be made for climate mitigation, a report on clean development in India was released[37]. The study on energy-intensive industries and their options for efficiency illustrated that India's ambition for clean growth would be thwarted by the very basic questions of land, labour and resources. It is these questions that will determine the future growth of the solar market. Responses to the challenges still on the ground with regard to licenses, sanctions and technology deployment have led developers to look at alternative means for solar energy. These include a move to off-grid technology development and alternative installation modalities such as rooftop solar.

2.3.5 Legitimacy

The Indian government has been consistent in its intention, starting as early as 2005, to introduce the market to renewable energy development. With the increasing price of coal, the market potential of renewable energy, and specifically solar, has been made clear. However, the deployment of NSM indicates that work still needs to be done to revise the traditional approach of the Indian government with regard to approval and licenses that are still required when setting up solar plants. Approximately 35 sanctions are required to set up a solar plant. Solar plant developers also rely on the RPO and REC market incentives to provide a financial rationale for their projects, which in turn allow them to scale their services. Stakeholder discussions have made clear the ongoing problems of enforcing RPO obligations on state electricity boards. The NSM guidelines are indicative for the country. It will be state governments and state electricity boards that will ultimately be responsible for enforcing these guidelines. The MNRE has been clear about its lack of resources to investigate and ensure all projects meet with the expected response from state actors[38].

In September 2012, the Rajasthan High Court delivered a judgement on the RPO framework that was seen as ground-breaking and a strong signal of the commitment of the government regarding the future of solar. The High Court dismissed a petition submitted by 17 captive power plants and open access users who claimed that they were not obligated to recognise the government's RPO mandate[39]. This decision has gone some way to boost confidence in the solar market and the potential of developers to benefit from REC system put in place as part of the NSM.

With legal frameworks still very weak in the country, and therefore little short-term recourse in the event of lack of payment, medium sized companies are hesitant about what to realistically expect from the government a few years down the road. The results of the two bidding rounds during the first phase of the NSM led market experts to predict a faster than expected fall for solar to grid parity compared to the original estimate of 2025[40]. Much of India's experimentation with gearing up for domestic growth and energy consumption has been based on the assumption that public finance will incentivise competitive production, capital development and service provision. There is nonetheless some hesitation on the part of private developers about working with public sector financing.

[37] *2009, Centre for Science and Environment, Challenge of the New Balance,*
[38] Girish Pradhan, Secretary, MNRE, November 10, 2012
[39] *See courtnic.nic.in/jodh/dojqry.asp, last accessed on December 5, 2012*
[40] *KPMG, Grid Parity Gets Closer – a point of view on the Solar Energy Sector in India, September 2012*

2.3.6 Resource Mobilisation

The Government of India has budgeted Rs 10 billion (approx. SEK1.2 billion) for the development of NSM up until 2020[41]. This support is not channelled through grant-based financing or soft loans but is the estimated cost of the NTPC bundling scheme and the preferential PPAs that are negotiated with the developers. This is likely to be increased with the release of the Twelfth Five Year Plan, and does not incorporate the investments being made by multiple state governments to support localised development of solar energy.

2.3.7 Development of Positive Externalities

Although India's solar market is at a point of transition and MNRE is navigating difficult waters in putting out its next set of guidelines, the first phase of solar bids has resulted in some interesting secondary effects. The long-term commercial viability of solar development has now been proven. Outside of technical stipulations, the interest of smaller scale players, previously not engaged in the solar bids has become apparent. The potential of off-grid solar, and captive plants has increased and a push is being made by developers for India to consider expanding its modest objective of 2,000 MW by 2022 for off-grid solar projects.

The NSM has set the tone for states to develop their own solar policies. States such as Gujarat, Tamil Nadu and Andhra Pradesh have developed solar policies with ambitious objectives for generation with their own innovative policy prescriptions. Tamil Nadu announced its solar policy in October 2012. Lessons have been taken from the experiences of NSM in its first phase. The state plans to develop 3,000 MW of solar capacity by 2015. It has understood the value of off-grid and decentralised solar application, and has therefore developed a generation based incentive for rooftop solar. It has also specified purchase obligations of solar power for special economic zones and large industry of up to 6% by 2013 through solar purchase obligations (SPOs)[42].

Gujarat launched its solar policy in 2009 and chose not to limit technology specifications in the policy guidelines. Gujarat had stated a modest solar ambition of 500 MW by 2014[43]. This is close to being achieved and it is likely that the state will expand its expected capacity in the coming year. Of the 714 MW approved to 34 national and international developers, the split between solar PV and solar thermal has been about equal. For the Solar PV projects, there is a distinct preference for thin film technology[44].

2.4 Lessons Learned and the Way Forward

With Phase I of the National Solar Mission, the government sought to tap into low hanging fruit and promote confidence in the Indian solar market. India had a well-established network of PV manufacturers and Phase I of the NSM focused on strengthening this existing market. India's manufacturing capacity increased three times during the first phase of the NSM[45]. However, contractions in international procurement in the solar market lead to a reduction of project opportunities for young companies. Allegations of dumping and the

[41] *Solar Ambition, www.planningcommission.nic.in*
[42] *See Here Comes the sun,* Hindu, October 26, 2012 available at http://www.thehindu.com/opinion/op-ed/here-comes-the-sun/article4031764.ece
[43] Gujarat State Electricity Regulatory Commission, www.gercin.org
[44] See Gujarat State Solar Policy at www.powerliners.com
[45] *MNRE Phase II Policy Document*

move by the Indian Government to pursue legal recourse for anti-dumping measures have increased market pessimism[46].

On 3 December 2012, the Ministry for New and Renewable Energy released its draft policy document for the second phase of the National Solar Mission, proposing 9,000 MW of grid-connected solar and 800 MW of off-grid projects[47] by 2017. The policy document outlines the way in which all actors, from technology developers to skilled end of pipe workmen, will be strengthened to ensure the solar market continues to grow. The draft guidelines for Phase II of the National Solar Mission are a good indication of the way in which the Government has institutionalised the understanding that in order to pursue an effective market driven solar policy, it has become clear that there is a need for stronger control of the regulatory provisions required to push the market.

Table 2-5 Phase II NSM Main Points

Lessons – Phase I	Way Forward – Phase II
Domestic Content Requirement has not fulfilled objective of robust local manufacturing	Domestic Content Requirement to stay, but with support given to R&D
Market mechanisms not strongly enforced contributing to loss of market confidence	Market mechanisms of RPO/REC to have stronger enforcement
NVNN not capacitated to effectively monitor project development	Solar Energy Research Council set up with sector experts for monitoring and enforcement
Use of unallocated power useful in bringing down average unit cost of power	Unallocated power to be discontinued, replaced by money from the National Clean Energy Fund to continue market incentive

Central to the growth of the solar market will be to restore confidence in the market mechanisms established, namely the Renewable Purchase Obligations and the Renewable Energy Certificates. At the close of Phase I of the national solar mission, most states were well below the 0.25% of total consumption that should have been met by solar energy. State sanctions and institutional mismanagement have been a major source of frustration for project developers during Phase I[48]. By bringing the states into specific focus in the Phase II document, there is an understanding that steps to ensure market confidence are being taken across the entire ecosystem of management

Although grid-connected solar might be the first step for India, there is sufficient evidence to suggest that off-grid development and rooftop solar could provide new ways of extending the market.

Compared to Phase I of the NSM, which focused on strengthening existing capacity, with the draft policy document for Phase II of the NSM India has set the framework for a situation of directed innovation and indigenous market expansion. This capacity development has been indicated along all parts of the supply chain, including a focused approach to research and development.

[46] *See* Bridge to India, India Solar Compass, October 2012 and January 2013; CSE
[47] Ministry of New and Renewable Energy, Government of India, *Jawaharlal Nehru National Solar Mission – Phase II Policy Document*, first released December 3, 2012 and available at www.mnre.gov.in
[48] *See* National Solar Mission – Phase II, available at www.mnre.gov.in, last accessed on January 15, 2013

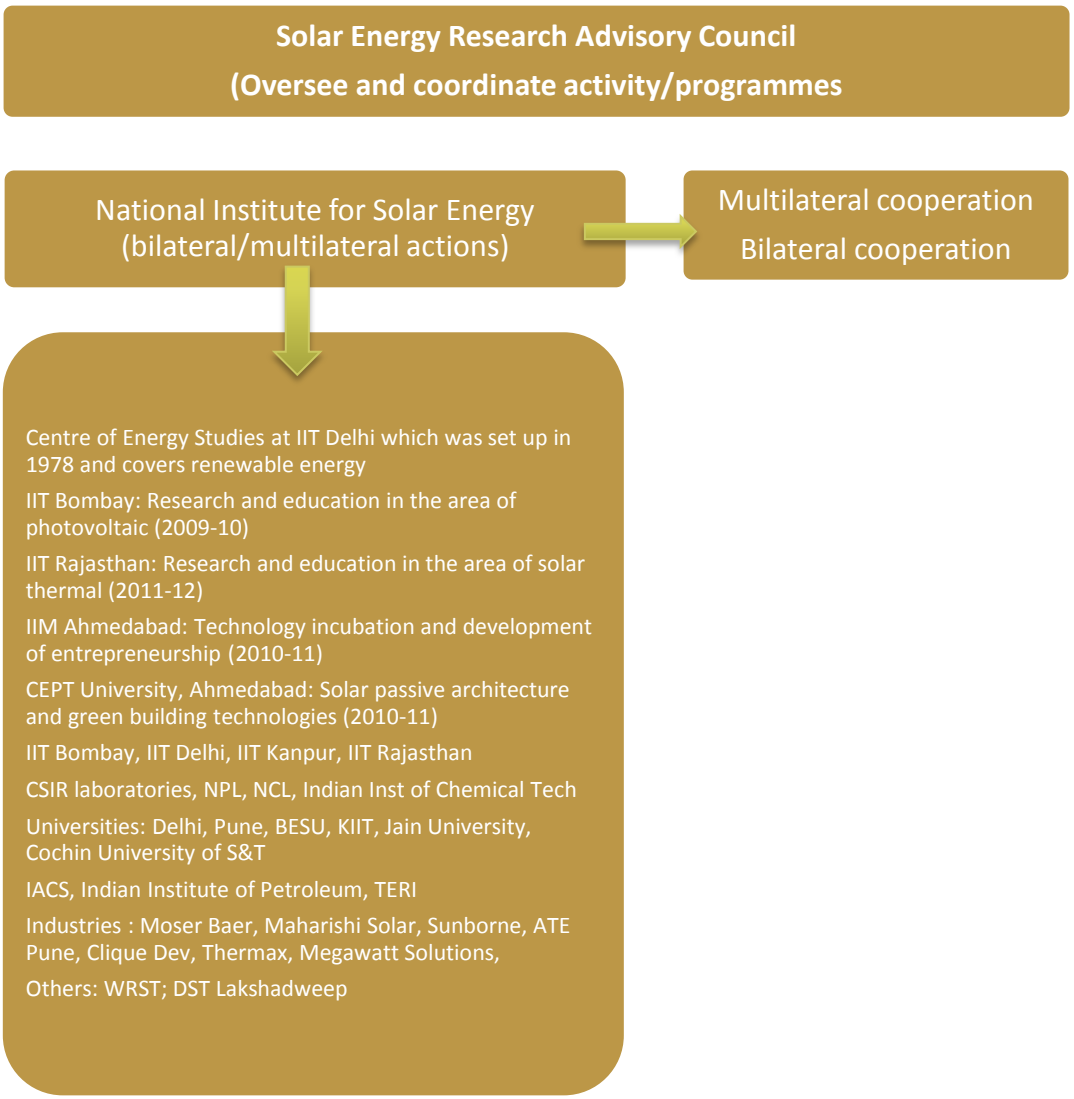

Figure 2-2 Research and Development focus of Phase II NSM

From a technical innovation system framework of analysis we can conclude that the solar sector has moved from its formative phase into one of market expansion, where the drivers for change are greater than the barriers to change in the chosen area[49].

For the solar market in India, the worrying situation of oversupply has not stopped the process of domestic development; it has rather spearheaded a recalibrated change of direction with the same objective of domestic market expansion. This growth phase is being made possible by increasing focus on resource mobilisation, legitimation and knowledge diffusion.

[49] (2007) Foxton, Tom et al., *Energy Technology Innovation; A systems perspective*, ICEPT, Imperial College London

3 National Mission on Enhanced Energy Efficiency –India's experiments with market development for energy efficiency with a focus on pulp and paper

3.1 Summary

India's growth ambition comes at a time when the international community is taking heed of the limits to conventional growth paths. The challenges of climate change increasingly set the boundaries for growth roadmaps. With India's demand for energy set to triple over the next twenty years, the country has undertaken a number of policy measures to both augment its energy supply and secure efficiency. It is India's urgent need to ensure energy security that has been the tipping point to push these policy measures into action.

The Perform, Achieve and Trade Scheme (PAT) is one of the four pillars of India's National Mission on Enhanced Energy Efficiency (NMEEE) and part of India's National Action Plan on Climate Change (NAPCC). The NAPCC was released in 2008 prior to the United Nations' Framework Convention on Climate Change meeting in Copenhagen. The NAPCC aims to pursue a growth directed roadmap within the limitations that climate change has now put on conventional industrial and energy development. NMEEE, in the first five years of implementation (2012-2017) aims to save 23 million tonnes oil equivalent and up to 19,000 MW of additional capacity. In total, NMEEE would reduce CO2 emissions by 98.55 million tonnes annually. The market potential for energy efficiency is pegged at INR 74,000[50] (SEK 87.5 billion[51]) PAT aims to achieve its efficiency targets through an ambitious market-based scheme, which will allow energy trading between selected industries to comply with mandated sector targets. This market-based approach to energy security is a relatively new form of governance for India and is developed with an understanding of the limitations of public sector finance to sustainably support new markets. The role of government in this market-based framework is to act as an overarching facilitator of actions, through enforcement of regulations and limited financial support.

The story of PAT goes well beyond India's integration into the climate change community, and its decision to come forward with a national plan of action. It begins in 2001 against a backdrop of an increasing growth rate and an understanding that, unless changes were made to the national governance framework, this growth would not be sustainable. The challenges with PAT have been similar to those experienced internationally when looking to promote demand-based management measures. These challenges are related to the investments needed, the role of the public sector, and facilitating a market that will effectively bring in new techniques and technologies. How energy-efficient a sector is, or can be is a contested question. In order to indicate efficiency norms, baseline data becomes critical. However, the modalities for measurements of baseline data and the subsequent development of sector norms continue to be at the heart of the challenges with PAT in India.

The pulp and paper sector is one of the eight industrial sectors selected under PAT for first phase implementation. The pulp and paper sector has been taken as a case study in this

[50] 2010, Press Information Bureau, Government of India, available at pib.nic.in/newsite/erelease.aspx?relid=62791
[51] www.xe.com , Feb 21, 2013

report. 759 mills are currently in operation in India, with a total production of 10.1 million tonnes per annum. This is approximately 2.6% of world production[52]. There is a large variation in the size of mills in the country, but all mills currently produce for domestic consumption. Paper demand in India is projected to double by 2020. Paper production is energy intensive. Energy costs account for up to 15-20% of total production costs and combined with the relatively low quality of India's paper mills has much scope for improvement with regard to energy efficiency, cleaner production and technologies. In light of the projected increase in industrial growth, the relatively high current energy consumption of growing industries and the potential efficiencies that can be achieved by improved actions on demand side management, the pulp and paper sector has been selected to be one of the industries in the first phase of PAT.

2% of total PAT energy targets are to be met by measures taken in the pulp and paper sector. Key to fulfilling PAT's objectives is the introduction of new technology and clean energy options for existing actors. For this reason, confidence in a new market and right-sized incentives will be important for the future. The largest mills in India are internationally competitive and financially robust. Technology procurement that is cost-effective and provides immediate results is common. An example of this is the 2011 purchase of the Swedish pulp and pulp and bio-refinery company Domjso Fabriker for $340 million (SEK 2.2 billion) by the Aditya Birla Group, a leading Indian pulp and paper manufacturer[53].

What is clear from this report is that investments to improve processes that might provide only marginal returns will be made only when such investment is made mandatory. With its aim of encouraging selected industries, with its flexible approach to mandatory target setting, PAT highlights the need for clear enforcement guidelines in order to ensure sector confidence and action.

Using a Technology Innovation Systems framework of analysis, this report illustrates that much more work will have to be done to secure the confidence of the market through the enforcement of PAT's regulatory targets. Combined with new models for business development, this will reduce the risk of engagement for actors capable of working with selected industrial sectors to achieve their targets. The role of capacity 'bridge builders' such as Energy Service Companies (ESCos) will be critical to ensure the successful rollout of PAT's first phase.

3.2 Background to the National Mission on Enhanced Energy Efficiency

The National Mission on Enhanced Energy Efficiency (NMEEE), approved by the Indian Government in 2010, sets out to develop policy and regulatory frameworks that push technology innovations and sustained market development for energy efficiency. In the first five years of implementation (2012-2017), the NMEEE aims to save 23 million tonnes oil equivalent and avoid up to 19,000 MW of additional capacity. The NMEEE comprises four main initiatives (table 1), which together would reduce CO2 emissions by 98.55 million tonnes annually, which will go a long way towards contributing to India's international commitment of reducing carbon intensity by 25% from 2005 levels.[54]

[52] 2011, Planning Commission, Government of India, *Report of Working Group on Pulp and Paper Sector for 12th Five Year Plan*

[53] 18, April, 2011, Aditya Birla Group, Press Release, available at http://www.adityabirla.com/media/press_releases/201104apr/aditya_birla_group_acquires_domsjo_Fabriker.html

[54] Sethi, Nitin, *India says it will cut carbon intensity by 20-25 per cent*, Times of India, November 29, 2009

The Perform, Achieve, and Trade scheme is one of the four core pillars of the NMEE, viz Perform, Achieve and Trade (PAT), Market Transformation for Energy Efficiency, the Energy Efficiency Financing Platform, and the Framework for Energy Efficiency Economic Development, put forward by the Bureau of Energy Efficiency (BEE). The NMEEE conceptualised in such a way, has understood the critical importance of supporting private sector action with incentives and clear targets for energy efficiency. The implementation of the NMEEE seeks to create a market for energy efficiency that has an estimated value of INR 74,000 crore (SEK 87.5 billion) by 2017.

Table 3-1 NMEEE initiatives and objectives

Initiative	Objective
Perform Achieve and Trade (PAT)	Marked-based mechanism for improvements in energy efficiency through certificates and trading
Market Transformation for Energy Efficiency	Accelerate the shift to energy-efficient appliances in designated sectors through innovative measures to make the products more affordable with focus on leveraging international financial instruments, including the Clean Development Mechanism (CDM) to make energy-efficient appliances affordable and increase their levels of penetration
Energy Efficiency Financing Platform	Help stimulate necessary funding for Energy Service Company (ESCo) based delivery mechanisms for energy efficiency. The costs will be recovered from the energy savings, which will also reduce the state government's subsidy bill
Framework for Energy Efficient Economic Development	Fiscal instruments to promote energy efficiency including Partial Risk Guarantee Fund, and Venture Capital Fund for Energy Efficiency

Source: Ministry of Power, PAT Scheme Document

PAT draws from, and builds on, the Energy Conservation Act of 2001, which notified energy intensive industries as Designated Consumers (DCs). The eight industries selected for PAT comprise 478 units and consume up to 45% of total industrial energy usage. DCs were given the responsibility of reporting energy use on an annual basis, and were given the option to buy energy saving certificates (ECerts) for compliance upon verification of energy consumption and savings.

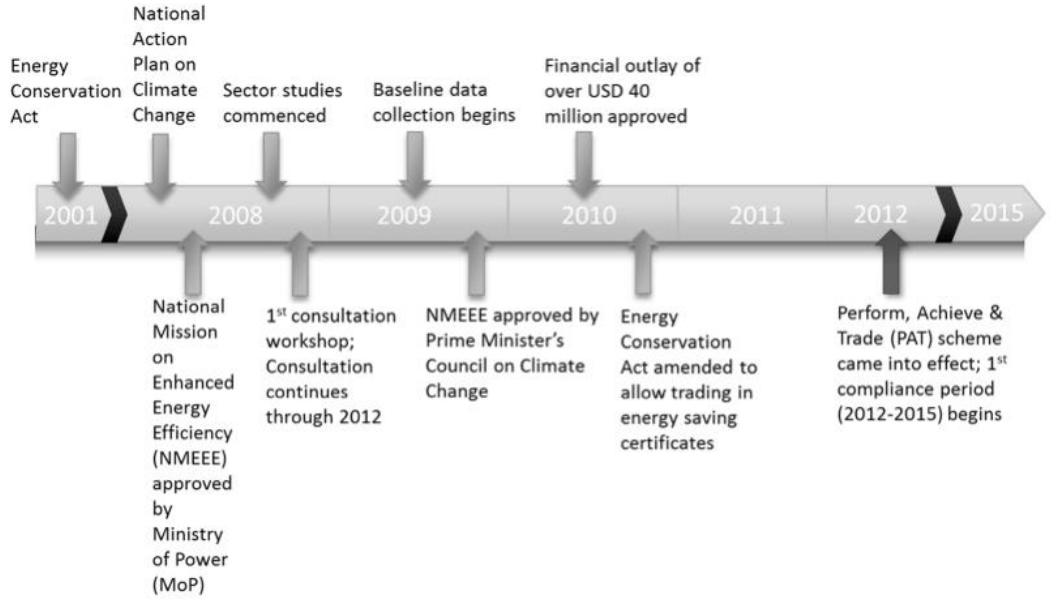

Figure 3-1 Steps for PAT implementation

Source: World Resources Institute

Following extensive baseline data collection and capacity building, on 4 July 2012 the Perform Achieve and Trade Scheme (PAT) was launched by the BEE under the auspices of the Ministry of Power. PAT then moved into its mandatory phase for the selected 8 sectors - Pulp and Paper, Thermal Power Plants, Cement, Iron and Steel, Power, Chlor-Alkali, Aluminium, Textiles, and Fertiliser. PAT targets India's most energy-intensive sectors in its first phase and those who have the most to gain if they are to move towards more efficient processing.

Table 3-2 No of Designated Consumers per sector and targets, million tonnes oil equivalent

Sl no	*Sector*	*No of DCs in PAT Phase I*	*Energy saving Targets PAT Phase I (million toe)*
1	Aluminium	10	0.456
2	Cement	85	0.816
3	Chlor-Alkali	22	0.054
4	Fertiliser	29	0.478
5	Iron and Steel	67	1.486
6	Pulp and Paper	31	0.119
7	Textile	90	0.066
8	Thermal Power Plants	144	3.211
	TOTAL	**478**	**6.686**

Source: Ministry of Power, PAT Scheme Document

With the recognition of the importance of industry buy-in, the process of developing PAT and mandating energy intensity reporting was extensive. Working with member organisations such as the Confederation of Indian Industry and the Federation of Indian Chambers

of Commerce and Industry, the BEE conducted up to 100 stakeholder engagements that sought to a) understand the variation in energy intensity in industry sectors, b) develop potential sector-specific energy targets, and c) work with DCs to understand the ways in which targets set could be met.

With an understanding of the variation between DC sectors, and within the sectors themselves, the BEE developed *Specific Energy Consumption Targets* for all of the 478 plants selected under the first phase of PAT. In the pulp and paper sector, this has been categorised on the basis of raw material input, i.e. wood-based, agro-based or recycled. The total energy consumption of the 31 DCs selected is 2.09 million tonnes of oil equivalent, and the by the end of the first PAT cycle this is expected to decrease by 5.7%.

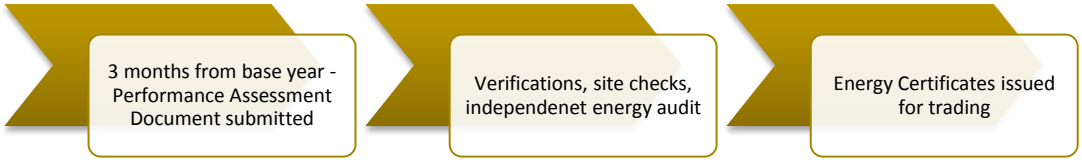

Figure 3-2 Process of obtaining/trading for energy efficiency

Source: Ministry of Power, PAT Scheme Document

The implementation of PAT and the development of the NMEEE pillars should be seen as a product of lessons learned by its implementing organization, the BEE, in demand side management. Previous schemes have all had a component of market consensus building before being put into practice. Similarly, all schemes put forward have focused on the benefits to end-customers and suppliers rather than on highlighting the mandatory nature of meeting compliance targets. In order to have learnt the lessons of its predecessors PAT would have to have reduced regulatory requirements to attract new actors to enter the market, carry out pre-bid consensus building with the private sector, move away from grant-based finance and move towards gap financing to encourage market development but also ensure competitiveness and replication of models.

The next section will focus on understanding PAT from a technological innovation systems (TIS) framework of analysis. TIS allows us to understand the triggers and challenges while implementing PAT into the Indian landscape. What is not perhaps included in the TIS framework is the role of the individuals and leadership in the implementation of innovation. This will be reflected in the closing remarks in section 4.4 below.

3.3 Functional Analysis

The Technical Innovation Systems framework of analysis allows a deeper understanding of the triggers and potential bottlenecks with regard to the policy in question. What we can see when we break up the PAT scheme is extensive market preparedness and pro-active legislative support. This has laid the ground for PAT implementation. The first-phase reporting of selected industries is scheduled for March 2013 but there are early warning signs that targets are not being met by all sectors. Although it is a mandatory scheme, PAT seeks to be a flexible tool with which energy efficiency can be achieved through a market-based mechanism of certificate trading. This flexibility has served to create confusion for stakeholders because of a lack of predictable policy enforcement. This loss of confidence has been compounded by limited market support and the slow growth of actors such as

Energy Service Companies (ESCos) that could bridge the information and delivery divide. While a new market arena is being developed, confidence needs to be built with predictable timelines and an assurance of enforcement. In the case of PAT, this is currently still lacking. It is expected that PAT will continue to unfold and strengthen in its delivery modalities. Legitimation and resource mobilisation will be two key areas for PAT to develop in order to achieve its ambitions targets of energy efficiency.

3.3.1 Knowledge Creation and Diffusion

The BEE Model for Energy Efficiency: Information, Confidence, and Voluntary

The voluntary nature of all the BEE's programmes has played an important role in building market confidence. Transparency of information and the introduction of skilled service providers has put the BEE in a strong position to roll out its first mandatory scheme, PAT, under the NMEE.

Table 3-3 Demand side management actions taken for energy efficiency

Scheme	Launch Date	Objective	Voluntary/ Mandatory
EC Act 2001	2001	Policy leadership for national energy conservation measures.	
ECBC	2007	Energy efficiency guidelines for buildings with connected load of 100 kW or more	Voluntary to be transitioned to mandatory but this has been delayed
Star Labelling Programme55	2006	Labelling of efficiency potential between 1 and 5 stars for select appliances (air conditioners, fridges, etc)	Voluntary with certain appliances to have mandatory standards by 2010
EC 2001 Amendment	2010	Provides a framework within which savings in energy use can be traded between those industries	
PAT	2012	Mandatory phase begins 2012 – first energy sector verification set for 2014	Mandatory, with verifications to be made by 2014

3.3.2 Influence in the Direction of Search

The Indian government has understood the value of energy efficiency as part of its larger strategy to move towards energy security as a required balancing mechanism to achieve economic growth and sustainable development. It is estimated that 70 % of India's infrastructure has yet to be built. Investment for this growth is pegged at $1.2 trillion. The expected growth in energy is forecast to increase by 300 % by 2030. While India is clear about its intention to continue on a coal-supported growth paradigm, the benefits of energy savings have been clearly articulated in its 11th and 12th five year plans (2008/9 – 2011/12 and 2012/2013 – 2017/2018 respectively)[56].

The most energy-intensive sectors were listed as Designated Consumers (DCs) by the Energy Conservation Act, 2001. These DCs currently account for 45% of total energy con-

[55] Sari-energy, Star Labeling, available at http://www.sari-energy.org/PageFiles/What_We_Do/activities/SAWIE/wiser/cap_dev_program_for_afghan_women_march_22-30_2010/PRESENTATIONS/24032010/ENGLISH/Nisha_Jose_Star_labelling.pdf

[56] 2012, *Demand Side Management*, Chapter 5, Working Group on Power for 12th Plan, Planning Commission, Government of India

sumption. The introduction of best available technology is seen to be an easy way of bringing down energy demand and freeing up energy for future growth[57].

Eight industry sectors were selected for the first phase of PAT and 478 DC units. In order to allow transparent and achievable targets, the BEE worked with each sector to develop unit-specific sector energy consumption targets. This was to reduce concerns about the great variability in consumption between industries as a result of size, nature of output and existing technology choices.

Targets were set in close consultation with industry representatives and despite the launch of the PAT scheme, they are still being modified in discussion with the BEE and in response to evidence-based arguments[58]. In addition to setting targets, the BEE has worked with industry to understand potential options for energy optimisation in each sector. These suggestions were released, along with the PAT scheme, for each industry.

The launch of PAT in July 2012 was largely a pre-scripted event. All DCs present knew the details of targets, sector baseline data collected, and mechanisms by which PAT could be achieved. Suggestions put forward by the BEE on possible technology/techniques were those developed in discussion with stakeholders during awareness workshops and focused sector-specific discussions[59].

3.3.3 Market Formation

The fundamental objective of PAT is trading for energy efficiency. This is to be done by obtaining and exchanging Energy Certificates (ECerts). The cost to industry of achieving specific energy consumption targets has been estimated at INR 74,000 crore (SEK 87.5 billion). Trading is set to take place at the end of the first phase of PAT in 2015. In order for trading to take place, Designated Consumers (DCs) are required to submit Performance Assessment forms, outlining savings achieved, measures taken and technology procured to achieve such savings. Upon approval, ECerts are to be issued and trading can begin.

Although the first phase of PAT is still under way, the eventual outcome requires a substantive exercise in market development and incentives for industry to take up the challenge of meeting energy efficiency objectives. In order to encourage market development, the BEE has formed the Energy Efficiency Services Limited (EESL) as the main implementing arm of the NMEEE's resources. EESL plays a role in leveraging bilateral and multilateral funding for projects, enters into joint ventures with ESCos so as to reduce their risk, and acts as consultants on standards for DCs on energy efficiency projects and Clean Development Mechanism benefits.

Challenges in market development, specifically with respect to Pulp and Paper, have been threefold: 1) Lack of confidence in baseline data collection, 2) Risks associated with specific energy consumption targets that involve 'unproven' savings, and 3) The unwillingness of ESCos to enter the energy efficiency market, in a significant enough manner to build confidence on the part of industry regarding possible target viability.

[57] (2012) Dube, Sanjay, Ritesh Awasthi and Vivek Dhariwal, *Can the Learnings from International Examples make the 'Perform Acheive and Trade (PAT) Scheme' Perform better for India,* Emergent Ventures International

[58] Interview with Secretary General, Indian Paper Manufacturers' Association of India (IPMA), December 15, 2012

[59] Interviews with IPMA, December 13, 2012; Mr Neehar Aggarwal, COO, Ballarpur Int. Graphic Paper Holdings B.V., January 07, 2013

Table 3-4 Feedback from Stakeholders on PAT

Energy Service Companies	Pulp and Paper Sector stakeholders
Weak Contracts: More investigation needed into viable contract models that share risk between ESCo and client. Performance based contracts leave ESCos at risk of 'trusting' the client.	Enforcement of a flexible scheme is hard to predict: The flexibility of PAT has also introduced confusion in industry about the actual enforcement of PAT. This has delayed actual uptake of efficiency measures, beyond business as usual action.
Insufficient timeline to break existing vendor/client relation: DCs have existing relationships with service providers/vendors. As the results of efficiency measures cannot be guaranteed ex-ante, DCs are unwilling to break relationships for unknown results.	Process Optimization too expensive to invest in without guarantees: The biggest savings in pulp and paper are from changes in process optimisation. This however requires expensive technology, with no knowledge of in-country returns. Process optimization relies on reporting and there is a large degree of variation between DCs.
Venture Capital Fund and Partial Risk Guarantee Fund are too small to incentivise the selected paper mills and/or ESCos	
Government requested to take on project demo sites, per selected sector, to build confidence in the ability of meeting targets	

Source: Stakeholder Interviews

3.3.4 Legitimation

The Indian government has been clear in its intentions to follow a coal-based development path to achieve its growth ambitions, set out in the twelfth five year plan (2012-2017) at 7% per annum. However, it has also understood the increasing concerns related to carbon-intensive growth and the long-term limitations to such an approach. Policy action in the area of energy efficiency began in 2001 with the Energy Conservation Act (EC Act) of 2011, which set energy conservation as a target for 15 of the most energy-intensive industrial sectors. The Act, alongside the recommendations of the BEE, sets out energy conservation norms for all the selected industries. These industries were notified as Designated Consumers (DCs) and required to file energy consumption information on an annual basis. It further required each plant to appoint an energy auditor to oversee measures at the plant level. Non-compliance is met with financial penalties[60]. At the BEE's request, and after active lobbying, the Act was amended in 2010 after two years of negotiations with policy-makers. The amendment created two main features that would allow PAT to be implemented. The first was the introduction of energy certificates (ECerts) that would be subsequently traded[61]. This is the main pillar by which PAT introduces a market-based mechanism to achieve efficiency targets. The second feature of the amendment was to give the BEE greater autonomy to act as a 'quasi-regulator' in the enforcement of PAT objectives.

Although these are significant steps taken for the policy support of demand side management measures, it is clear that more still needs to be done to build the confidence of both Environment Service Companies (ESCos) that act as critical bridge builders in this new market space, and DCs who are unwilling to make extensive investments without the knowledge that PAT enforcement is likely to be undertaken[62].

PAT deadlines for the first phase have been extended once, and there is reason to believe that it will undergo a second revision. PAT was envisioned as a tool that was flexible and

[60] (2001), *Energy Conservation Act, 2001*, Ministry of Power, available at powermin.nic.in/**acts**_notification/pdf/ec**act2001**.pdf
[61] (2010), *The Energy Conservation Amendment Bill, 2010*, PRS India, available at www.prsindia.org
[62] Interview with Nehar Aggarwal, COO, Ballarpur Int. Graphic Paper Holdings, B.V, Jan 07, 2013

reactive. However, a fine balance has to be struck by policy-makers to achieve flexibility with a robust degree of confidence, especially for those entities that stand to gain from the trading of ECerts and are pushing for formal enforcement at an early stage.

3.3.5 Resource Mobilisation

Previous experiments with energy efficiency and the role of ESCos as service providers, led the BEE to create special features with PAT that allow for a perceived de-risking of efficiency investments. The Venture Capital Fund was developed, with a budget of INR 190 crore (SEK), to be administered by the Energy Efficiency Services Limited (EESL). Additionally a Partial Risk Guarantee Fund for Energy Efficiency (PRGF) has been made available, which aims to lower the risk to the lender by providing government guarantees for loans. The PRGF is considered a way to reduce risk and slow uptake for energy efficiency projects in the short term. In the long term, such support would result in an greater understanding of the market potential of energy efficiency programmes and increase confidence in their financial viability. Between 2011 and 2012, USD 20 million (SEK 128,316,560) was set aside to support the fund's activities and this figure is likely to increase between 2013 and 2014[63].

Although this is seen as a valuable step, in understanding the financial requirements that need to be undertaken when opening up new market space, with the estimated cost of PAT at INR 74,000 crore (SEK 87.5 billion), investors are clear that this is insufficient financial leverage for investment behaviour to move beyond business as usual.

3.4 Lessons learned and the way forward

The National Mission on Enhanced Energy Efficiency, as part of India's National Action Plan on Climate Change looks to create energy efficiency through market based mechanisms. The Perform, Achieve and Trade (PAT) scheme is considered to be the flagship of the NMEEE. The PAT framework has been developed through extensive consultation, consensus, and consent by industry partners. PAT developers have focused on introducing a flexible, industry-friendly approach to policy development and enforcement. This flexibility, compounded by the lack of awareness on the part of the market and the complications for long-term predictability, has been one of the main stumbling blocks to effective implementation.

Despite the BEE's actions on developing an enabling framework for the active participation of Energy Service Companies (ESCos) to ensure market preparedness on the part of the selected industries, the risk of weak contract models has prevented active uptake of ESCos. In the pulp and paper sector, efficiency measures for process optimisation are seen to have the highest returns. ESCos are not able to necessarily ensure that the behaviour of clients is in line with ensuring the highest returns. Current practices of performance guarantee contracts; with all risk being borne by the ESCO for the outcome, gains have not served to ensure confidence in the market.

The purpose of PAT is to introduce incentives for market development of energy efficiency and thereby the uptake of new and innovative technologies to meet sector targets. India has been seen as the first emerging economy to use trading and market-based mechanisms as a means of achieving energy efficiency.[64]

[63] (2012) Nair, Gireesh and Saurabh Diddi, *Partial Risk Guarantee Fund for ESCO Business – an innovative support system for energy efficiency business*, ECEEE 2012 Summer Study on Energy Efficiency in Industry
[64] (2012), Singh, Neelam, *Creating Market Support for Energy Efficiency: India's perform, achieve and trade s*

This ambitious programme was made possible by the active cooperation of cross Ministry committees, and consistent policy support. The BEE's ambitious approach to energy savings, are all actions of an Agency that, with a select team of 25 energy economists, has been able to push through policy decisions in a relatively short time. This ability to sidestep bureaucratic red-tapism and put measures in place with a large degree of cross-ministry support, most significantly from the Ministry of Power, is unusual when combined with the degree of autonomy the BEE enjoys in its quasi-legal mandate. It requires further investigation to understand how the BEE has been to grow and occupy such a fundamental place in the decision-making hierarchy.

The former Director General of BEE was brought in at the inception of the Bureau and headed the organisation from 2002 until December 2012. His role, the networks to which he has access, and the strong political support he enjoys within the domestic and international community cannot be ignored as one of the strong triggers that has taken DSM this far in India. The former DG had led the World Bank Climate Change team in Washington D.C., worked at The Energy Resources Institute (TERI), and had been President of Suzlon Energy Ltd. In his role as government officer, he was part of the Prime Minister's National Council on Climate Change, a member of India's team at the International Energy Association, and was a lead climate negotiator on issues of technology transfer and intellectual property rights. As a mission champion and leader, the BEE's actions were often synonymous with its leader. This has enabled the development of large-scale programmes, pushing industry to innovate and develop. However, this also calls into question the degree to which bureau objectives have been embedded within the institution. With the change in leadership and clear signals from the market about the limitations of PAT, stronger signals will be needed from BEE of its intention to continue with PAT in the way originally envisioned.

Bilaga 1: Beskrivning av tillvägagångssätt

Metod

För att kunna dra lärdom av andra länders erfarenheter på ett mer systematiskt sätt krävs att relevant och trovärdig information samlas in samt att informationen analyseras och presenteras på ett genomtänkt och strukturerat sätt. På grund av att studieobjektet i det här fallet är pågående implementeringsprocesser av teknik- och innovationsdrivande energipolitik i Indien är de huvudsakliga källorna, utöver officiella rapporter från olika offentliga aktörer och publicerade akademiska artiklar (vilka ger viktig men inte tillräcklig information), enskilda personer med unik inblick i de processer de aktuella studierna avser beskriva. Endast i undantagsfall finns formella processer för uppföljning och utvärdering vilka annars i princip skulle kunna ge svar på flertalet av de frågor som ska besvaras (se nedan).

Den huvudsakliga metoden är således att genom djupintervjuer av experter och beslutsfattare komplettera offentliga dokument för att kunna besvara följande övergripande frågor:

1. Vilket är syftet med en genomförd åtgärd, det vill säga hur ser målbilden ut och vilka bakgrundsanalyser har gjorts? Vilken typ av problem är det som åtgärden ska adressera:
    a. Brister i den tekniska infrastrukturen
    b. Stela tekniska system
    c. Bristande entreprenörskap/företagande
    d. Hög risk och höga kapitalkostnader
    e. Socialt motstånd, tröga socio-tekniska system
    f. Bristande koordinering mellan olika aktörer
    g. Annat…
2. Hur sker genomförandet?
    a. Styrningsfilosofi: regler, marknad, kombinationer, pull/push, informationssatsningar etc.
    b. Institutionella former: vilka politiska nivåer är drivande, vilka normer eller regler påverkas eller behöver förändras?
    c. Organisatoriska former: behövs nya universitet, program med mer komplicerade mål och organisationsformer (nya kompetenscentra, nya institut, mer samarbete mellan akademi och näringsliv etc.), förändringar i myndighetsstruktur etc?
3. Effekter? Finns utvärderingar och vad säger dessa i så fall? Om bra utfall – varför? Om dåligt utfall – varför?

Analytiskt ramverk

Givet syftet med detta projekt att försöka förstå implementeringsprocessen för innovationsdrivande[65] politik för förnybar energi och energieffektivitet uppstår behovet att strukturera och kategorisera den information som samlas in i mer avgränsade subgrupper. Ett verktyg som kan användas för detta ändamål är TIS, Teknologiska Innovationssystem, vilket nämnts ovan.

TIS är ett analytiskt ramverk som utgår ifrån att det finns vissa grundläggande funktioner i ett tekniskt innovationssystem och att ökad förståelse om dessa funktioner kan ge ökad insikt i hur innovationsprocesser har sett ut och vilka faktorer som är avgörande för innovation och teknisk utveckling inom olika teknikområden. Ett användningsområde är att genom TIS-analys identifiera svagheter i specifika innovationssystem och utifrån dessa utforma policyförslag för att undanröja hinder för ny teknik och innovation.

I föreliggande rapport används TIS som ett verktyg för att sortera den information som samlas in och för att beskriva den implementeringsprocessen, eller governancestrukturen kring solenergi och energieffektivitet i Indien. Med detta material som underlag kan sedan en analys genomföras av vilka faktorer som varit drivande och vilka som hindrat utveckling i den eftersträvade riktningen.

TIS bygger på sju identifierade funktioner som krävs för att ny teknik och innovation ska växa fram och spridas på en marknad (tabell 0-2). Det finns inte utrymme att här gå in mer i detalj på dessa eller TIS-modellens olika för- och nackdelar. För en sådan diskussion hänvisas till Bergek (2008) och Hillman (2011)[66].

Tabell Sju funktioner i ett TIS

Funktioner	Definition
Kunskapsutveckling	bredden och djupet av kunskapsbasen och hur denna kunskap utvecklas, sprids och kombineras i systemet.
Vägledning av aktörernas sökprocesser	incitament och/eller tryck för organisationer gå med i ett TIS. Dessa kan komma i form av visioner, förväntningar på tillväxtpotentialen, styrmedel, artikulerad efterfrågan från ledande kunder, tekniska flaskhalsar, kriser inom etablerad verksamheter, etc. I en tidig fas, inkluderar det hur de första aktörerna definierar den tekniska möjligheten och gör området intressant för andra aktörer.
Legitimering	sociala acceptans och efterlevnad av relevanta institutioner. Legitimitet är inte given utan skapas genom medvetna åtgärder från organisationer och privatpersoner.
Resursmobilisering	i vilken utsträckning aktörer inom ett TIS kan mobilisera mänskligt och ekonomiskt kapital, samt kompletterande tillgångar såsom kompletterande produkter, tjänster, nätverk infrastruktur etc.

[65] *Det är viktigt att påpeka att innovationsdefinitionen här är bred och även innefattar tjänsteinnovationer och praocessinnovationer – det handlar alltså inte uteslutande om teknikutveckling utan lika mycket om att t.ex. hitta sätt att implementera teknik i nya sammanhang.*

[66] *Bergek et al (2008)* Analyzing the functional dynamics of technological innovation systems: A scheme of analysis, Research Policy, 37 pp. 407-429; *Hillman et al (2011)* Fostering Sustainable Technologies: a framework for analyzing the governance of innovation systems, S*cience and Public Policy, 38(5), Juni 2011, pp. 403-415*

Funktioner	Definition
Entreprenöriellt experimenterande	testandet av ny teknik, applikationer och marknader, i vilka nya möjligheter skapas och en lärandeprocess möjliggörs. Detta omfattar även utveckling av, och investeringar i, produkter, produktionsanläggningar och annan fysisk infrastruktur.
Marknadsformering	faktorer som driver att nya marknader bildas. Dessa inkluderar artikulation av efterfrågan från kunderna, institutionella förändringar, och förändringar i pris/prestanda. Marknadsformering går ofta genom olika stadier i form av demonstrationsprojekt, nischmarknader och så småningom massmarknader.
Utveckling av fria nyttor...	den kollektiva dimensionen av innovations- och diffusionsprocessen. Dvs. hur ett företags investeringar kan utnyttjas ”gratis” av andra företag. Det indikerar också dynamiken i systemet eftersom utvecklingen av fria nyttor förstärker de övriga funktionerna.

Källa: Tillväxtanalys (2012) Miljödriven näringslivsutveckling – Några grundläggande utgångspunkter för en verksam, effektiv och lärande politik*, Rapport 2012:02*

www.tillvaxtanalys.se

Tillväxtanalys, myndigheten för tillväxtpolitiska utvärderingar och analyser, är en gränsöverskridande organisation med 60 anställda. Huvudkontoret ligger i Östersund och vi har verksamhet i Stockholm, Brasilia, New Delhi, Peking, Tokyo och Washington D.C.

Tillväxtanalys ansvarar för tillväxtpolitiska utvärderingar och analyser och därigenom medverkar vi till:

- stärkt svensk konkurrenskraft och skapande av förutsättningar för fler jobb i fler och växande företag
- utvecklingskraft i alla delar av landet med stärkt lokal och regional konkurrenskraft, hållbar tillväxt och hållbar regional utveckling

Utgångspunkten är att forma en politik där tillväxt och hållbar utveckling går hand i hand. Huvuduppdraget preciseras i instruktionen och i regleringsbrevet. Där framgår bland annat att myndigheten ska:

- arbeta med omvärldsbevakning och policyspaning och sprida kunskap om trender och tillväxtpolitik
- genomföra analyser och utvärderingar som bidrar till att riva tillväxthinder
- göra systemutvärderingar som underlättar prioritering och effektivisering av tillväxtpolitikens inriktning och utformning
- svara för produktion, utveckling och spridning av officiell statistik, fakta från databaser och tillgänglighetsanalyser

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Tillväxtanalys Studentplan 3, 831 40 Östersund
Telefon: 010 447 44 00 | info@tillvaxtanalys.se | www.tillvaxtanalys.se