

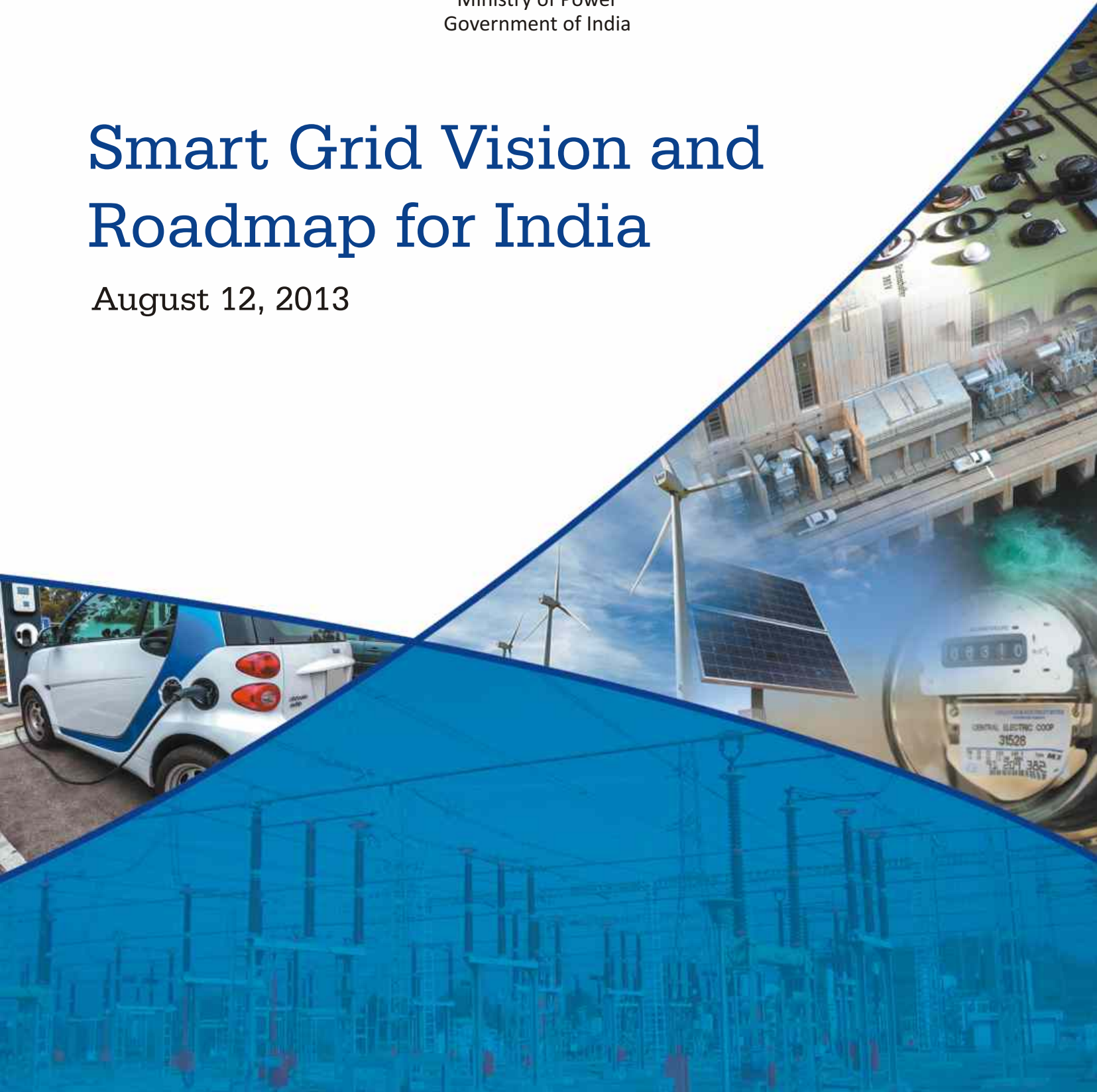


सत्यमेव जयते

Ministry of Power  
Government of India

# Smart Grid Vision and Roadmap for India

August 12, 2013







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**SAM PITRODA**



**ADVISER TO PRIME MINISTER**  
PUBLIC INFORMATION INFRASTRUCTURE  
AND INNOVATIONS  
Government of India  
30<sup>th</sup> August, 2013

### Message

I am delighted at the release of the Ministry of Power's Smart Grid Vision and Roadmap for India.

Smart grid technologies are vital to meeting India's vast and growing electricity needs. We need an Indian smart grid model that can engage our country's particular operating conditions, and address her priority challenges: curbing power losses, and enhancing access to reliable, quality power for the common citizen. In the face of rising citizen aspiration and demand, smart grid technologies offer India the tools needed to engage and overcome these challenges.

The India Smart Grid Task Force was established as an interdisciplinary group to explore how India can develop and deploy smart grid capabilities. Our deliberations and recommendations covered a range of areas, from Wide Area Monitoring Systems for transmission, through renewable and distributed energy systems, automation, and standards, to cybersecurity. The Task Force collaborated closely with Indian industry, through the India Smart Grid Forum, to develop this cross-functional understanding.

The Smart Grid Vision and Roadmap offers a series of time-framed, specific, target-driven measures, across these different areas, with which to enable the development and deployment of an Indian smart grid model. It offers hundreds of millions of Indians the possibility of accessible, reliable power: a fundamental requirement of inclusive growth. I warmly compliment Shri Jyotiraditya Scindia, Minister for Power for his leadership in this important area. I also extend my thanks to the officials of the Ministry of Power, the members of the India Smart Grid Task Force, and the members and leadership of the India Smart Grid Forum for their invaluable input and support to this initiative.

Sam Pitroda



ज्योतिरादित्य मा. सिंधिया  
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भारत सरकार

Minister of State (I/C) for Power  
Government of India

22 AUG 2013

## MESSAGE

I am delighted to release the **Smart Grid Vision and Roadmap for India** formulated by the Ministry of Power with the support of India Smart Grid Task Force and India Smart Grid Forum. I compliment and thank Mr. Sam Pitroda, Chairman of India Smart Grid Task Force, Senior Officers in the Ministry and other experts who have worked towards bringing out a clear vision and roadmap for leveraging the emerging smart grid technologies for transforming the Indian power sector. The roadmap is aligned to Ministry of Power's overarching policy of "Access, Availability and Affordability of Quality Power for All" and it prescribes different technologies that would help achieve these objective in a time bound manner. This roadmap has placed highest importance to providing supply of electricity to all households by 2017 through smart grid technologies. Ministry of Power is committed to working with all State Governments, Regulators and Utilities to implement the programmes and policies envisaged in the smart grid roadmap.

I am also happy to note the deep involvement and support of the industry, academia and research organization in this smart grid journey which will be mutually rewarding to all stakeholders.

JYOTIRADITYA M. SCINDIA



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सचिव  
भारत सरकार  
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29th August, 2013

**MESSAGE**

It has been my pleasure and privilege to work with the talented team at the Ministry of Power and to give final touches to the **Smart Grid Vision and Roadmap for India**, one of the key policy documents from this Ministry after I took over as Secretary in July 2013. World over, advanced countries are promoting smart grid technologies for both modernizing their aging grids as well as for transition towards low carbon economies by integrating renewable generation with the grid. In this smart grid roadmap, we have attempted to leverage the same smart grid technologies for finding solutions to some of the basic challenges in the Indian power sector, such as, enabling better access to electricity, providing lifeline supply to all households, reducing T&D losses, etc.

Ministry of Power is committed to work with all stakeholders in launching a National Smart Grid Mission that will plan and monitor the implementation of the policies and programs envisioned in this smart grid roadmap. I compliment the vision and leadership of Shri Sam Pitroda for leading the team of experts from the India Smart Grid Task Force and the India Smart Grid Forum to prepare this important document that will be a guide for investment planning in the power sector in the country in the coming years.

  
(P. K. Sinha)





**Ashok Lavasa**

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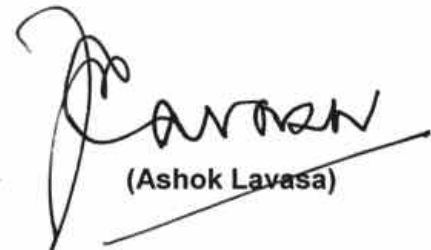
August 29, 2013

### MESSAGE

Smart Grids have emerged as the top infrastructure upgrade program in most developed countries in recent times. It encompasses different technologies that can completely transform the way electricity is generated, transmitted, distributed and consumed. It has the potential to innovate business models that can change the electric utility landscape. The same technologies are highly relevant in the Indian context too with the additional potential of addressing some of the routine management issues that the Indian power sector is grappling with. Hence Ministry of Power had taken an early decision to study and examine the smart grids development around the globe. It is in this context that India Smart Grid Task Force and India Smart Grid Forum were constituted by Ministry of Power way back in 2010 when only 6 other countries in the world had such entities working on smart grid developments.

These institutions have done useful work and the **Smart Grid Vision and Roadmap for India** is one of the significant contributions, which could be converted into a National Smart Grid Mission in future.

I take this opportunity to acknowledge the efforts made by all those who have worked towards preparation of this important policy document under the guidance of Shri Sam Pitroda and other experts.



(Ashok Lavasa)



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NEW DELHI - 110001 August 29, 2013

### FOREWORD

Ministry of Power had taken early actions towards grid modernization and leveraging the smart grid technologies. APDRP-I during Tenth Plan upgraded the basic electricity networks in 56 urban circles across the country whereas RGGVY electrified about 56 million households in 100,000 villages. The ongoing R-APDRP launched in the Eleventh Five Year Plan covers 1401 towns across all the state owned electricity distribution companies and under this program the distribution companies are building their IT networks and a set of basic IT and Automation systems for the first time.

With the completion of these ongoing programs the basic building blocks of smart grids will be in place in all the electricity distribution companies in India and it is the logical next step to upgrade these systems to smarter grids that can monitor and control power flows in real time thereby mitigating demand-supply gaps during peak hours, reducing leakages in the electrical network and smoother integration of renewable generation and electric vehicles.

The **Smart Grid Vision and Roadmap for India** has been drafted keeping the above parameters on top priority - to leverage the R-APDRP and RGGVY infrastructure and systems to upgrade the network to the next levels of smart grids that can address the primary objectives of the Ministry of Power by enabling better access to electricity for the masses, providing lifeline supply to all households by shifting some of the loads during peak hours and promotion of microgrids etc; and reduce the T&D losses substantially. While finalizing the roadmap we have also taken special care to align most of the initiatives with ongoing programs such as R-APDRP, RGGVY, JNNISM etc and attempted to cover it in the 12<sup>th</sup>, 13<sup>th</sup> and 14<sup>th</sup> Five Year Plans by 2027.

While Ministry of Power will work towards launching a National Smart Grid Mission, we need the whole hearted cooperation and support of all state governments, regulatory commissions and utilities in formulating state and utility specific roadmaps, policies and programs as most of the work needs to be done at the utility level.

I take this opportunity to thank Mr. Sam Pitroda, Secretary and Additional Secretary in the Ministry and all experts from India Smart Grid Task Force and India Smart Grid Forum who have contributed towards the preparation of the roadmap.

  
(B.N. Sharma)





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29<sup>th</sup> August 2013

## PREFACE

Smart Grid development is one of the most important technology revolutions currently taking place as electricity grids are the world's largest pieces of infrastructure still to be digitized. In most technology revolutions in the past few centuries, India was a laggard. However thanks to the foresight and early actions taken by Ministry of Power in smart grid development, India is not far behind developed nations in this technology wave of smart grids development. With the formal issuance of this **Smart Grid Vision and Roadmap**, India joins the elite club of few nations having a national smart grid roadmap.

While developed nations with reliable electrical infrastructure and minimal growth rates are concentrating on smart metering, tools for forecasting and dispatch of renewable generation and analytics in their smart grid journeys, countries like India with weak and growing grid need to simultaneously strengthen the electric network as well as build additional layers of IT and automation systems to make the grids smarter. Also we have the challenges of access to electricity for about 80 million households, availability of quality power at least during evening hours and reduction of T&D losses to address. Finding appropriate technological solutions to these challenges have been the guiding principles followed while drawing the smart grid roadmap. As evident from the programs and policies recommended in the roadmap, India can build smart grids with little or marginal costs as we have much better business cases for the same from huge efficiency gains that can accrue through automation and elimination of wastages of all kinds.

The roadmap also envisages research and development and over all capacity building in the industry and leveraging the demographic advantage of India to export smart grid products and services worldwide which could be a trillion dollar market worldwide in the next few decades. In India alone the market size of smart grid projects envisioned in this roadmap is about 30-40 billion dollars in the next 15-20 years at current prices. This is a huge business opportunity for all stakeholders.

India Smart Grid Forum would like to take this opportunity to thank Mr. Sam Pitroda and Senior Officers in the Ministry of Power for their guidance in drawing the **Smart Grid Vision and Roadmap for India** and we wish to dedicate our strong commitment to work with Ministry of Power, India Smart Grid Task Force, State Governments, Regulators and Utilities to make this roadmap a reality on a win-win model. I wish to thank Ministry of New and Renewable Energy and Department of Telecommunications for their support on smart grid initiatives. I also wish to thank all our Members and other experts from India Smart Grid Task Force for their valuable contributions in preparation of this roadmap.



**Reji Kumar Pillai**







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## Acronyms, Definitions and Notes

<b>AMI</b>	Advanced Metering Infrastructure
<b>AT&amp;C</b>	Aggregate Technical and Commercial
<b>B2G</b>	Building to Grid
<b>CTU</b>	Central Transmission Utility
<b>DLMS/COSEM</b>	Device Language Message Specification / Companion Specification for Energy Metering
<b>DMS</b>	Distribution Management Systems
<b>DR</b>	Demand Response
<b>DSM</b>	Demand Side Management
<b>EMS</b>	Energy Management Systems
<b>ERP</b>	Enterprise Resource Planning
<b>EV</b>	Electric Vehicle
<b>GIS</b>	Geographic Information Systems
<b>GW</b>	Gigawatts
<b>HVAC</b>	Heating, Ventilation, and Air Conditioning
<b>IEC</b>	International Electrotechnical Commission
<b>ISGF</b>	India Smart Grid Forum (A PPP body established by MoP)
<b>ISGTF</b>	India Smart Grid Task Force (Inter-ministerial body)
<b>IT</b>	Information Technology
<b>KW</b>	Kilowatts
<b>MDMS</b>	Meter Data Management Systems
<b>MNRE</b>	Ministry of New and Renewable Energy
<b>MoP</b>	Ministry of Power
<b>MW</b>	Megawatts
<b>NBSG</b>	National Board for Smart Grids
<b>NCSG</b>	National Council for Smart Grids
<b>NOFN</b>	National Optical Fiber Network
<b>NSGM</b>	National Smart Grid Mission
<b>OMS</b>	Outage Management Systems
<b>PMU</b>	Phasor Measurement Units
<b>Prosumer</b>	Producer and Consumer
<b>PPP</b>	Public Private Partnership
<b>PV2G</b>	Photovoltaic (Solar) to Grid
<b>R-APDRP</b>	Restructured-Accelerated Power Development and Reforms Program
<b>RE</b>	Renewable Energy
<b>REMC</b>	Renewable Energy Monitoring Centre(s)
<b>RGVY</b>	Rajiv Gandhi Grameen Vidyutikaran Yojana
<b>SCADA</b>	Supervisory Control and Data Acquisition Systems
<b>T&amp;D</b>	Transmission and Distribution
<b>V2G</b>	Vehicle to Grid
<b>VPP</b>	Virtual Power Plant
<b>WAMS</b>	Wide Area Monitoring Systems





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## Background: Smart Grids

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The electrical grid has been cited as the greatest engineering achievement of the 20th century, but it now faces new challenges of sustainability, energy security, reliability, etc. Developed countries have a well-developed grid, and seek to improve it, while developing regions are still expanding their grids.

Over the past decade, the electricity generation, transmission and distribution landscape around the globe has changed drastically – in the traditional grid of the 20th century there were relatively few points of power generation or injection and millions of points of power consumption. With rapid proliferation of distributed and renewable generation, the 21st century grid will have numerous points of power injection as well as millions of points of consumption. Electric Vehicle (EV) roll out has further increased the complexity of the traditional electricity grid. To manage a grid with such increasing number of intermittent energy sources and EVs, smarter automation and IT systems are imperative. Peak load management through control of loads (such as through demand response, which can be considered a dynamic form of Demand Side Management, or DSM) has assumed high priority for electric utilities as there is a growing peak demand, leading to a supply gap during peak hours of consumption in many parts of the world. Beyond such drivers, increased deregulation, consumer choice for green power, which is inherently variable, and many more factors are giving thrust for the transition to smarter grids that can address all these issues.

A smart grid is an electrical grid with automation, communication and IT systems that can monitor power flows from points of generation to points of consumption (even down to the appliances level) and control the power flow or curtail the load to match generation in real time or near realtime. The increased visibility, predictability, and even control of generation and demand bring flexibility to both generation and consumption and enable the utility to better integrate intermittent renewable generation and also reduce costs of peak power. If the traditional grid was made secure only through over-engineering, a smart grid is cost-effective, nimble, responsive, and better engineered for reliability and self-healing operations.

The traditional electric grid will need to build additional layers of automation, communication and IT systems to transform it to a smarter grid. Some of the applications or building blocks of a smart grid (some of which are already being deployed worldwide, including in India), are:

- Supervisory Control and Data Acquisition Systems (SCADA) with Energy Management Systems (EMS) and Distribution Management Systems (DMS)
- Enterprise IT network covering all substations and field offices with reliable communication systems
- Enterprise Resource Planning (ERP)/Asset Management Systems



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- Geographic Information Systems (GIS) – mapping of electrical network assets and consumers on geospatial maps
- Modernization of the substations with modern switchgear and numerical relays
- Advanced Metering Infrastructure (AMI) with two way communication and Meter Data Management Systems (MDMS)
- Electronic Billing Systems and Customer Care Systems
- Distribution Automation (DA) and Substation Automation Systems
- Outage Management Systems (OMS)
- Mobile Crew Management Systems
- Wide Area Measurement and Control Systems
- Forecasting, Dispatch and Settlement Tools
- Enterprise Application Integration
- Analytics (converting data into business intelligence)

The above list is focused on applications and systems, i.e., enablers. From a functionality point of view one might aim for functionalities or uses such as variable or dynamic tariffs, renewable integration, electric vehicle (EV) integration, etc.



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## Relevance of Smart Grid in India

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Every global driver for smart grids applies to India, but India also has additional drivers in the short term. The power system in India has roughly doubled in the last decade and similarly in the previous decade. With 230 GW of installed capacity with utilities (as of July 2013), the Indian power system is now the fourth largest in the world, but per-capita consumption of electricity in India is only about one-fourth of the world average. This underscores the need to grow the power system at a rapid pace for the next several decades. This low consumption is amplified by the lack of access to electricity to a significant proportion of the population. The potential demand by 2032 is estimated to be as high as 900 GW.

India is also pursuing an aggressive renewable generation program. The 12th Five Year Plan target for renewable energy (RE) generation is 36 GW which will increase the current 12% share of RE (excluding hydro) to around 20% by end of this decade. A power system of this size growing at such a pace (8-10% per year) with an increased share of renewable energy requires smarter systems to manage it efficiently and ensure its stability and reliability.

India has also recently launched a National Mission on Electric Mobility with a target of 6 million electric vehicles (4 million two-wheelers and 2 million four-wheelers) by 2020. For efficient rollout of the EV program, electrical distribution infrastructure upgrades and smarter systems are required which will control/limit simultaneous charging of hundreds of EVs from the same feeder. Beyond just timing the consumption of power, immediate policy level support is required to build enabling infrastructure to integrate the EVs in the electrical network so that these millions of EVs connected to the power system can be leveraged as virtual power plants (VPPs) that can store energy when there is surplus generation and support the grid during moments of deficit. Vehicle to Grid (V2G) technologies are evolving rapidly that can achieve these objectives.

The transmission and distribution losses are still very high in the Indian power system and distribution network (aggregate technical & commercial, or AT&C) loss reduction continues to be the top priority of both utilities and government. Smart grid solutions will help monitor, measure and even control power flows in real time that can help identify losses and thereby appropriate technical and managerial actions can be taken to arrest the losses.

Under the ongoing Restructured-Accelerated Power Development and Reforms Program (R-APDRP) some of the basic building blocks of smart grids are being implemented in all urban areas (1401 towns) all across India and this infrastructure can be effectively leveraged to transform these utilities to smarter grids with low incremental costs which would result in better utilization of R-APDRP assets as well as those installed under new smart grid programs.



## Drivers for Smart Grid in India

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The drivers for smart grid for different stakeholders in India are:

### Utilities:

1. Reduction of T&D losses in all utilities as well as improved collection efficiency
2. Peak load management – multiple options from direct load control to consumer pricing incentives
3. Reduction in power purchase cost
4. Better asset management
5. Increased grid visibility
6. Self-healing grid
7. Renewable integration

### Customers:

1. Expand access to electricity – “Power for All”
2. Improve reliability of supply to all customers – no power cuts, no more DG sets and inverters
3. Improve quality of supply – no more voltage stabilizers
4. User friendly and transparent interface with utilities
5. Increased choices for consumers, including green power
6. “Prosumer” (producer and consumer) enablement
7. Options to save money by shifting loads from peak periods to off-peak periods

### Government and Regulators:

1. Satisfied customers
2. Financially sound utilities
3. Tariff neutral system upgrade and modernization
4. Reduction in emission intensity

It is evident that the far-reaching goals of the Indian power system can be enabled by smart grids which can help improve the efficiency and optimize performance within the Indian power sector.



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## Need for a Smart Grid Roadmap

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From the brief description above, it may be observed that smart grid is a transformation or journey from the present state of the grid towards adding a set of smarter systems/applications in a phased manner and according to the business priorities of each utility. In order to manage and achieve this transformation successfully, detailed planning and development of an implementation strategy, methodology and guidelines are required, covering processes, selection of technologies and standards, resource requirements and capacity building programs for utilities, regulators, implementation agencies and technology providers. A transparent and comprehensive plan and roadmap for the implementation of smart grids would help technology development, capacity building and investment planning by all stakeholders and could ensure completion of projects in planned timelines.

Realizing the growing importance of smart grid technologies in the Indian power sector, the Ministry of Power (MoP) had taken early steps in 2010 by constituting the India Smart Grid Task Force (ISGTF), an inter-ministerial task force chaired by Mr. Sam Pitroda, Advisor to Prime Minister of India; and the India Smart Grid Forum (ISGF), a public-private partnership initiative. The mandate of both these agencies is to advise MoP on appropriate policies and programs for accelerated development of smart grids in India. One of the key tasks under taken by ISGTF and ISGF is to formulate a comprehensive smart grid vision and roadmap for India. The draft roadmap prepared by ISGTF and ISGF is in alignment with Ministry of Power's overarching policy objectives of **“access, availability and affordability of power for all”**. The roadmap is also drafted in alignment with the on-going programs such as R-APDRP and RGGVY and builds on the assets being created under these programs and other existing systems in a manner that would complement each other. The draft roadmap has been discussed at different forums and the diverse stakeholders' views have been incorporated in the final version detailed in the following sections.



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# Smart Grid Roadmap for India: Vision, Targets and Outcomes

## Smart Grid Vision for India

“**Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality energy for all with active participation of stakeholders**”

In order to achieve this vision, stakeholders are advised to formulate state/utility specific policies and programs in alignment with following broad policies and targets which are in line with MoP's overarching policy objective of Access, Availability and Affordability of Power for All:

### A) Distribution (Including Distributed Generation)

1. Appropriate policies and programs to provide access to electricity for all with uninterrupted life line supply (8 hours/day minimum, including the evening peak) and electrification of 100% households by 2017 and continuous improvement in quality and quantum of supply.
2. Completion of on-going programs which will lay the building blocks of smart grids such as system strengthening, consumer indexing, asset mapping as part of RAPDRP, and planning for integration of such systems into future smart grid deployments.
3. Enabling programs and projects in distribution utilities to reduce AT&C losses to below 15% by 2017, below 12% by 2022, and below 10% by 2027.
4. Integrated technology trials through a set of smart grid pilot projects by 2015; and based on outcome of the pilots, full rollout of smart grids in pilot project areas by 2017; in major urban areas by 2022 and nationwide by 2027.
5. Availability of an indigenous low cost smart meter by 2014. After successful completion of pilots, AMI roll out for all customers in a phased manner based on size of connection (and geography and utility business case), starting with consumers with load >20 KW by 2017, 3-phase consumers by 2022 and all consumers by 2027 by deploying smart meters and necessary IT and communication infrastructure for the same. Innovative and sustainable financing/business models for smart meter roll outs may be developed.



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6. Working with other stakeholders, building the National Optical Fiber Network (NOFN) by connecting 2,50,000 village Panchayats in the country by Optical Fiber Cable and extending the fiber link to all the 33/11 kV and above substations to build a backbone communications network for the power sector by 2017.
7. Modernisation of distribution sub-stations and conversion of sub-stations in all urban areas (starting with metro cities) to Gas Insulated Substations based on techno-commercial feasibility in a phased manner through innovative financing models.
8. Development of Microgrids, storage options, virtual power plants (VPP), solar photovoltaic to grid (PV2G), and building to grid (B2G) technologies in order to manage peak demand, optimally use installed capacity and eliminate load shedding and black-outs.
9. Policies for mandatory roof top solar power generation for large establishments, i.e., with connected load more than 20kW or otherwise defined threshold.
10. EV charging facilities may be created in all parking lots, institutional buildings, apartment blocks etc; and quick/fast charging facilities to be built in fuel stations and at strategic locations on highways.
11. Microgrids in 1000 villages/industrial parks/commercial hubs by 2017 and 10,000 villages/industrial parks/commercial hubs by 2022, which can island from the main grid during peak hours or grid disturbances.
12. Optimally balancing different sources of generation through efficient scheduling and dispatch of distributed energy resources (including captive plants in the near term) with the goal of long term energy sustainability.

## B) Transmission

1. Development of a reliable, secure and resilient grid supported by a strong communication infrastructure that enables greater visibility and control of efficient power flow between all sources of production and consumption by 2027.
2. Implementation of Wide Area Monitoring Systems (WAMS, using Phasor Measurement Units, or PMUs) for the entire transmission system. Installation of a larger number of PMUs on the transmission network by 2017 or sooner, as guided by the results of initial deployments. Indigenization of WAMS technology and PMU development and development of custom made analytics for synchrophasor data by 2017.



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3. Setting up of Renewable Energy Monitoring Centre's (REMCs) and Energy Storage Systems to facilitate grid integration of renewable generation.
4. 50,000 Kms of optical fiber cables to be installed over transmission lines by the year 2017 to support implementation of smart grid technologies.
5. Enabling programs and projects in transmission utilities to reduce transmission losses to below 4% by 2017 and below 3.5% by 2022.
6. Implement power system enhancements to facilitate evacuation and integration of 30 GW renewable capacity by 2017, 80 GW by 2022, and 130 GW by 2027 – or targets mutually agreed between Ministry of New and Renewable Energy (MNRE) and MoP.

### C) Policies, Standards and Regulations

1. Formulation of effective customer outreach and communication programs for active involvement of consumers in the smart grid implementation.
2. Development of state/utility specific strategic roadmap(s) for implementation of smart grid technologies across the state/utility by 2014. Required business process reengineering, change management and capacity building programs to be initiated by 2014. State Regulators and utilities may take the lead here.
3. Finalization of frameworks for cyber security assessment, audit and certification of power utilities by end of 2013.
4. Policies for grid-interconnection of captive/consumer generation facilities (including renewables) where ever technically feasible; policies for roof-top solar, net-metering/feed-in tariff; and policies for peaking power stations by 2014.
5. Policies supporting improved tariffs such as dynamic tariffs, variable tariffs, etc., including mandatory demand response (DR) programs, starting with bulk consumers by 2014, and extending to all 3-phase (or otherwise defined consumers) by 2017.
6. Policies for energy efficiency in public infrastructure including EV charging facilities by 2015 and for demand response ready appliances by 2017. Relevant policies in this regard to be finalized by 2014.





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7. Development/adoption of appropriate standards for smart grid development in India—first set of standards by 2014; continuous engagement in evolution of applicable standards relevant to the Indian context. Active involvement of Indian experts in international bodies engaged in smart grid standards development.
8. Study the results of the first set of smart grid pilot projects and recommend appropriate changes conducive to smart grid development in the Indian Electricity Act / National Power Policy by end of 2015.
9. Development of business models to create alternate revenue streams by leveraging the smart grid infrastructure to offer other services (security solutions, water metering, traffic solutions etc.) to municipalities, state governments and other agencies.
10. Development of Skill Development Centers for smart grid development in line with the National Skill Development Policy 2009 for Power Sector by 2015.

#### D) Other Initiatives

1. Tariff mechanisms, new energy products, energy options and programs to encourage participation of customers in the energy markets that make them “prosumers” – producers and consumers – by 2017.
2. Create an effective information exchange platform that can be shared by all market participants, including prosumers, in real time which will lead to the development of energy markets.
3. Investment in research and development, training and capacity building programs for creation of adequate resource pools for developing and implementing smart grid technologies in India as well as export of smart grid know-how, products and services.

Highlights of some of the target milestones and activities are summarized in the table below. *More targets and details are provided in Appendix A: Smart Grid Roadmap Plan Details.*



## Highlights of Smart Grid Milestones and Activities

During 12th Plan	During 13th Plan	During 14th Plan
<b>A) Enable Access and Availability of Quality Power for All</b>		
<ul style="list-style-type: none"> <li>• Electrification of all households by 2017</li> <li>• Reduction in power cuts; 24 hrs availability of power at principal cities, 22 hrs for all towns and Life line supply (8 hrs, including evening peak) to all by 2017</li> </ul>	<ul style="list-style-type: none"> <li>• 24 hour supply in all urban areas; Minimum 12 hour supply to all consumers (including evening peak) by 2022</li> </ul>	<ul style="list-style-type: none"> <li>• Stable and quality 24x7 power supply to all categories of consumers across the country</li> </ul>
<b>B) Loss Reduction</b>		
<ul style="list-style-type: none"> <li>• Reduction of AT&amp;C losses in all Distribution Utilities to below 15%</li> <li>• Reduction of transmission losses (66 kV or above) to below 4%</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of AT&amp;C losses in all Distribution Utilities to below 12%</li> <li>• Reduction of transmission losses (66 kV or above) to below 3.5%</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of AT&amp;C losses to below 10% in all Distribution Utilities</li> <li>• Reduction of transmission losses (66 kV or above) to below 3%</li> </ul>
<b>C) Smart Grid Rollouts including Automation, Microgrids and other improvements</b>		
<ul style="list-style-type: none"> <li>• SG Pilots, full SG roll out in pilot project cities</li> <li>• Infrastructure for AMI roll out for all consumers with load &gt;20kW or as per prioritised target areas of Utilities</li> <li>• Deployment of Wide Area Monitoring Systems (WAMS)</li> <li>• Development of micro grids in 1,000 villages/industrial parks/commercial hubs</li> <li>• Enablement of "Prosumers" in select areas</li> </ul>	<ul style="list-style-type: none"> <li>• SG roll out in all urban areas</li> <li>• Nationwide AMI roll out for customers with 3-phase connections</li> <li>• Deployment of WAMS at all substations and grid connected generation units</li> <li>• Development of micro grids in total 10,000 villages/industrial parks/commercial hubs</li> <li>• Enablement of "Prosumers" in metros and major urban areas</li> </ul>	<ul style="list-style-type: none"> <li>• SG rollout nationwide</li> <li>• Nationwide AMI roll out for all customers</li> <li>• Development of micro grids in 20,000 villages/industrial parks/commercial hubs</li> <li>• Active Participation of "Prosumers"</li> </ul>



During 12th Plan	During 13th Plan	During 14th Plan
<b>D) Policies and Tariffs</b>		
<ul style="list-style-type: none"> <li>Implementation of Dynamic Tariffs</li> <li>Mandatory Demand Response programs for select categories of consumers</li> <li>Tariff mechanism for roof top solar PV's – Net Metering/Feed in Tariffs</li> </ul>	<ul style="list-style-type: none"> <li>Choice of electricity supplier (open access) to consumers in metros and select urban areas</li> <li>Mandatory Demand Response programs for larger sections of consumers</li> </ul>	<ul style="list-style-type: none"> <li>Choice of electricity supplier (open access) to all consumers</li> </ul>
<b>E) Green Power and Energy Efficiency</b>		
<ul style="list-style-type: none"> <li>Renewable integration of 30 GW</li> <li>Energy Efficiency Programs for lighting and HVAC in Metros and state capitals; initiation of Dynamic (smart) Energy Efficiency Programs</li> <li>Policies for mandatory roof top PV and Energy efficient building code for all new large public infrastructures by 2014</li> </ul>	<ul style="list-style-type: none"> <li>Renewable integration of 80 GW</li> <li>Energy Efficiency Programs for lighting and HVAC in all urban areas; expansion of Dynamic (smart) Energy Efficiency Programs to all urban areas</li> </ul>	<ul style="list-style-type: none"> <li>Renewable integration of 130 GW</li> <li>Dynamic (smart) Energy Efficiency Programs nationwide</li> </ul>
<b>F) Electric Vehicles and Energy Storage</b>		
<ul style="list-style-type: none"> <li>Development of EV and smart grid synergy plan (in coordination with National Electric Mobility Mission)</li> <li>EV charging stations in urban areas and along selected highways</li> <li>Introduction of Battery Parks and other Energy Storage Systems on trial basis</li> </ul>	<ul style="list-style-type: none"> <li>Large roll outs of Energy Storage Systems</li> <li>EV charging stations in all urban areas and strategic locations on highways</li> </ul>	<ul style="list-style-type: none"> <li>EV charging stations in all urban areas and along all state and national highways</li> </ul>



During 12th Plan	During 13th Plan	During 14th Plan
<b>G) Enablers and Other Initiatives</b>		
<ul style="list-style-type: none"> <li>• First set of technical standards after completion of pilots, including standards for EVs and its charging infrastructure</li> <li>• Cost-Benefit Analysis of smart grid projects with inputs from the pilots and assessment of direct and indirect benefits to consumers and other stakeholders</li> <li>• Development of indigenous low cost smart meter by 2014</li> <li>• Finalization of frameworks for cyber security assessment, audit and certification of power utilities by 2013</li> <li>• Initiation of Customer Outreach and Engagement Programs</li> <li>• Research &amp; Development, Training &amp; Capacity Building - 10% Utility technical personnel to be trained in smart grid technologies</li> </ul>	<ul style="list-style-type: none"> <li>• Standards Development for Smart Infrastructure (SEZ, Buildings, Roads/Bridges, Parking lots, Malls)</li> <li>• Export of SG products, solutions and services</li> <li>• Development of business models to create alternate revenue streams by leveraging the smart grid infrastructure to offer other services (security solutions, water metering, traffic solutions etc) to municipalities, state governments and other agencies; integration of meter data with other databases etc.</li> </ul>	<ul style="list-style-type: none"> <li>• Continuous Research &amp; Development; Training &amp; Capacity Building</li> </ul>



## Next Steps

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### 1. Finalization of Institutional Framework for Smart Grid Development

There is a need for a strong institution that can drive smart grid development in India. One designated entity should be made responsible for the smart grid roadmap including implementation roadmaps, research activities, technology selection guidelines, standards guidelines, capacity building programs etc., in addition to bringing all the stakeholders together.

Existing institutions related to smart grid are the India Smart Grid Task Force (ISGTF) and India Smart Grid Forum (ISGF). Both these bodies currently lack the organizational and financial strength to take up the above responsibilities, and also lack authority. To begin with, ISGTF can be supported by induction of permanent, independent staffs who are experts in their respective areas who will work exclusively for smart grids. ISGTF can assign some tasks on selective basis to ISGF which could leverage the vast knowledge base of its members. ISGTF should have broader powers in taking decisions in matters related to smart grid developments. Independent, strengthened and empowered ISGTF may be accomplished by end 2013.

### 2. Alignment of ongoing activities (including R-APDRP) with Smart Grids

There are a number of ongoing activities that either already are or could feed into smart grids, including R-APDRP and RGGVY. By properly leveraging such efforts utilities can speed up the deployment of smart grids and ensure that investments today do not become prematurely obsolete. For R-APDRP, this includes a technical evaluation of deployments and standards for smart grid extensibility. In addition to technical issues relating to data standards for consumer indexing, GIS, asset mapping, billing, etc., there should also be business model clarity on the ability to re-use and extend functionalities under smart grids. There should also be coordination of state-level and other activities outside R-APDRP, e.g., all new metering deployments henceforth including single phase consumer meters should be based on standards such as DLMS/COSEM (IEC 62056) so that they become smart grid ready, if not smart meters.

Promotion of smart rural microgrids under RGGVY may be accorded priority to address both access and availability concerns of rural electrification. An important activity during 2013-14 is the roll-out of smart grid pilot projects with part funding under R-APDRP. These will help push technology, business case, and regulatory frameworks for smart grids.

Detailed plans for leveraging existing and R-APDRP/RGGVY systems may be drawn in the utility/state specific smart grid roadmaps.



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### 3. Launching a National Smart Grid Mission

During the stakeholder consultation workshops, there was unanimity in launching a National Smart Grid Mission in order to effectively implement the goals conceived in the Smart Grid Vision and Roadmap. Accordingly it is proposed to establish a National Smart Grid Mission (NSGM), with parallels to the National Mission for Electric Mobility launched recently by the Ministry of Heavy Industries.

For the National Smart Grid Mission (NSGM), a new Secretariat shall work to define the short, medium and long-term detailed implementation plans and formulate projects, funding arrangements, resource requirements, timelines and preliminary feasibility reports, identifying key stakeholders that will own such projects, in line with this Smart Grid Vision and Roadmap. The NSGM would be supported by two bodies working in coordination. A National Board for Smart Grids (NBSG) housed under the Ministry of Power (MoP) would advise and oversee the efforts; and a multi-stakeholder body, spanning central and state utilities, academic/non-profit institutes, regulators, standards bodies, and industry representatives, would provide options and inputs for the NSGM Secretariat and NBSG. Given smart grid efforts in India already have an established multi-stakeholder body, the India Smart Grid Forum (ISGF), its charter and mandate could be strengthened to play a more substantive role in the NSGM as the multi-stakeholder body providing inputs to the mission. Similarly, the NBSG could subsume the ISGTF to ensure inter-ministerial coordination.

The chosen implementation plan shall be recognized as a national objective and be included as part of the national planning process and thereby receive adequate resources to carry out the work detailed in the implementation plan. The NSGM Secretariat shall work closely with all industry stakeholders and through a process of consultation shall conclude all transverse issues related to: standards, regulation and policy, engineering design, process methodologies, technology selection etc. The NSGM and NBSG may be given appropriate statutory powers to approve the necessary rules and regulations.

The NSGM is targeted for launch in 2014.



## Appendix A: Smart Grid Roadmap Plan Details

Note: these are generic roadmaps, and (a) not every step would be undertaken sequentially; (b) utilities should prepare their own roadmap steps guided by the below.

During 12th Plan	During 13th Plan	During 14th Plan
<b>A) Enable Access and Availability of Quality Power for All</b>		
<ul style="list-style-type: none"> <li>• Electrification of all households by 2017</li> <li>• Reduction in power cuts; 24 hrs availability of power at principal cities, 22 hrs for all towns and Life line supply (8 hrs, including evening peak) to all by 2017</li> </ul>	<ul style="list-style-type: none"> <li>• 24 hour supply in all urban areas; Minimum 12 hour supply to all consumers (including evening peak) by 2022</li> </ul>	<ul style="list-style-type: none"> <li>• Stable and quality 24x7 power supply to all categories of consumers across the country</li> </ul>
<b>B) Loss Reduction</b>		
<ul style="list-style-type: none"> <li>• Reduction of AT&amp;C losses in all Distribution Utilities to below 15%</li> <li>• Reduction of transmission losses (66 kV or above) to below 4%</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of AT&amp;C losses to below 12% in all Distribution Utilities</li> <li>• Reduction of transmission losses (66 kV or above) to below 3.5%; overall EHV and UHV strengthening</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of AT&amp;C losses to below 10% in all Distribution Utilities</li> <li>• Reduction of transmission losses (66 kV or above) to below 3%</li> </ul>
<b>C) Smart Grid Rollouts including Automation, Microgrids and other improvements</b>		
<ul style="list-style-type: none"> <li>• SG Pilots, full SG roll out in pilot project cities</li> <li>• Infrastructure for AMI roll out for all consumers with load &gt;20kW or as per prioritised target areas of Utilities</li> <li>• Enablement of "Prosumers" in select areas</li> <li>• Development of micro grids in 1,000 villages/industrial parks/commercial hubs</li> </ul>	<ul style="list-style-type: none"> <li>• SG roll out in all urban areas</li> <li>• Nationwide AMI roll out for customers with 3-phase connections</li> <li>• Enablement of "Prosumers" in metros and major urban areas</li> <li>• Development of micro grids in total 10,000 villages/industrial parks/commercial hubs</li> </ul>	<ul style="list-style-type: none"> <li>• SG rollout nationwide</li> <li>• Nationwide AMI roll out for all customers</li> <li>• Active Participation of "Prosumers"</li> <li>• Development of micro grids in 20,000 villages/industrial parks/commercial hubs</li> </ul>



During 12th Plan	During 13th Plan	During 14th Plan
<b>C) Smart Grid Rollouts including Automation, Microgrids and other improvements</b>		
<ul style="list-style-type: none"> <li>• Deployments of WAMS including PMUs by CTU</li> <li>• Gas insulated EHV/HV and automated distribution substations in all metros by 2017</li> <li>• Grid connection of all consumer end generation facilities where feasible</li> <li>• Development of 5 smart cities</li> </ul>	<ul style="list-style-type: none"> <li>• Extended deployments of WAMS at all substations and grid connected generation units</li> <li>• Gas insulated EHV/HV and automated distribution substations in all state capitals and principal cities by 2022</li> <li>• Development of 25 smart cities</li> </ul>	<ul style="list-style-type: none"> <li>• Gas insulated EHV/HV and automated distribution substations in all urban areas by 2027</li> <li>• Development of 100 smart cities</li> </ul>
<b>D) Policies and Tariffs</b>		
<ul style="list-style-type: none"> <li>• Implementation of Dynamic Tariffs</li> <li>• Mandatory Demand Response programs for select categories of consumers</li> <li>• Tariff mechanism for roof top solar PV's – Net Metering/Feed in Tariffs</li> </ul>	<ul style="list-style-type: none"> <li>• Choice of electricity supplier (open access) to consumers in metros and select urban areas</li> <li>• Mandatory Demand Response programs for larger sections of consumers</li> </ul>	<ul style="list-style-type: none"> <li>• Choice of electricity supplier (open access) to all consumers</li> </ul>
<b>E) Green Power and Energy Efficiency</b>		
<ul style="list-style-type: none"> <li>• Renewable integration of 30 GW</li> <li>• Energy Efficiency Programs for lighting and HVAC in Metros and state capitals; initiation of Dynamic (smart) Energy Efficiency Programs</li> <li>• Policies for mandatory roof top PV and Energy efficient building code for all new large public infrastructures by 2014</li> </ul>	<ul style="list-style-type: none"> <li>• Renewable integration of 80 GW</li> <li>• Energy Efficiency Programs for lighting and HVAC in all urban areas; expansion of Dynamic (smart) Energy Efficiency Programs to all urban areas</li> </ul>	<ul style="list-style-type: none"> <li>• Renewable integration of 130 GW</li> <li>• Dynamic (smart) Energy Efficiency Programs nationwide</li> </ul>





During 12th Plan	During 13th Plan	During 14th Plan
<b>E) Green Power and Energy Efficiency</b>		
<ul style="list-style-type: none"> <li>Setting up of Renewable Energy Monitoring Centre's (REMC) at 5 RLDCs for better forecasting, scheduling and dispatching of renewable generation (in coordination with MNRE)</li> </ul>		
<b>F) Electric Vehicles and Energy Storage</b>		
<ul style="list-style-type: none"> <li>Development of EV and smart grid synergy plan (in coordination with National Electric Mobility Mission)</li> <li>EV charging stations in urban areas and along selected highways</li> <li>Introduction of Battery Parks and other Energy Storage Systems on a trial basis</li> </ul>	<ul style="list-style-type: none"> <li>Large roll outs of Energy Storage Systems</li> <li>EV charging stations in all urban areas and strategic locations on highways</li> </ul>	<ul style="list-style-type: none"> <li>EV charging stations in all urban areas and along all state and national highways</li> </ul>
<b>G) Enablers and Other Initiatives</b>		
<ul style="list-style-type: none"> <li>First set of technical standards after completion of pilots</li> <li>Finalization of frameworks for cyber security assessment, audit and certification of power utilities by 2013</li> <li>Standards for EVs and their charging infrastructure</li> <li>Cost-Benefit Analysis of smart grid projects with inputs from the pilots and assessment of direct/indirect impacts on all societal stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>Standards Development for Smart Infrastructure (SEZ, Buildings, Roads/Bridges, Parking lots, Malls)</li> <li>Strengthening of Research &amp; Development as well as Training and Capacity Building. 25% of Utility technical personnel to be trained in smart grid solutions</li> <li>Export of SG products, solutions and services</li> <li>Development of business models to create alternate revenue streams by</li> </ul>	<ul style="list-style-type: none"> <li>Continuous Research &amp; Development; Training &amp; Capacity Building</li> </ul>



During 12th Plan	During 13th Plan	During 14th Plan
<b>G) Enablers and Other Initiatives</b>		
<ul style="list-style-type: none"> <li>• Development/adoption of appropriate performance standards for smart grid development in India by 2014</li> <li>• Development of indigenous low cost smart meter by 2014</li> <li>• Augmentation of Control Centre's and Data Centre's for deployment of smart grids</li> <li>• Strengthening of EHV/Distribution Systems</li> <li>• Strengthening of optical fiber communication systems along and for transmission lines and substations</li> <li>• 1200 kV UHV AC testing and simulation studies</li> <li>• Initiation of Customer Outreach and Engagement Programs</li> <li>• Research &amp; Development, Training &amp; Capacity Building - 10% of Utility technical personnel to be trained in smart grid solutions</li> <li>• Planning for smart grid synergies with other activities such as multi-utility meter, automation, security, and monitoring services, traffic management, etc.</li> <li>• Establishment of Smart Grid Test bed by 2014 and Smart Grid Knowledge Centre by 2015</li> </ul>	<p>leveraging the smart grid infrastructure to offer other services (security solutions, water metering, traffic solutions etc) to municipalities, state governments and other agencies; integration of meter data with other databases etc.</p>	





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India Smart Grid Knowledge Portal  
[www.indiasmartgrid.org](http://www.indiasmartgrid.org)

Ministry of Power  
[www.powermin.nic.in](http://www.powermin.nic.in)