Introduction to Smart Grid
Prof. N. P. Padhy
Department of Electrical Engineering
Indian Institute of Technology, Roorkee

Lecture - 40
Conclusions

Welcome you all to this NPTEL online course on Smart Grid. And after long journey we are shortly reaching to the last lecture on conclusion. All my viewers my personal suggestion is to not limit yourself to the course content which has been addressed during last 39 lectures, though they are the basic materials for smart grid. But, it is a vast research area where you are expected to also look for different opportunities, and scope of learning through other sources of literature and other web media materials.

But is a whole we tried our level best to cover the syllabus in smart grid, the main emphasis was you know just to make sure that you understand both fundamentals and the implementation aspect of smart grid. And our experience is limited to the lab scale test available in this campus. And I hope for the new learners this is a quite enough to understand the basic fundamentals on smart grid and bit of application scope.

We started with introducing smart grid in detail, covering all the architectures the way it has been described in different literatures the different definitions of smart grid at large, and then we move to difference case studies. So, the different control schemes, protection schemes and slowly we entered to different analysis schemes and we understood what is AC smart grid what is DC smart grid what is AC DC smart grid or hybrid smart grid. So, for all 3 AC smart grid, DC smart grid and hybrid smart grid different simulations, modeling and analysis have been discussed.

And at the end I also wish we have to look for opportunity, what currently our country is focusing on smart grid at this stage and what kind of initiatives government has taken to encourage young researchers to work in this field, and what are the other revenues available for you youngsters to go ahead for research opportunity in this particular field.

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Now, you see India's journey in the field of smart grid is quite significant.

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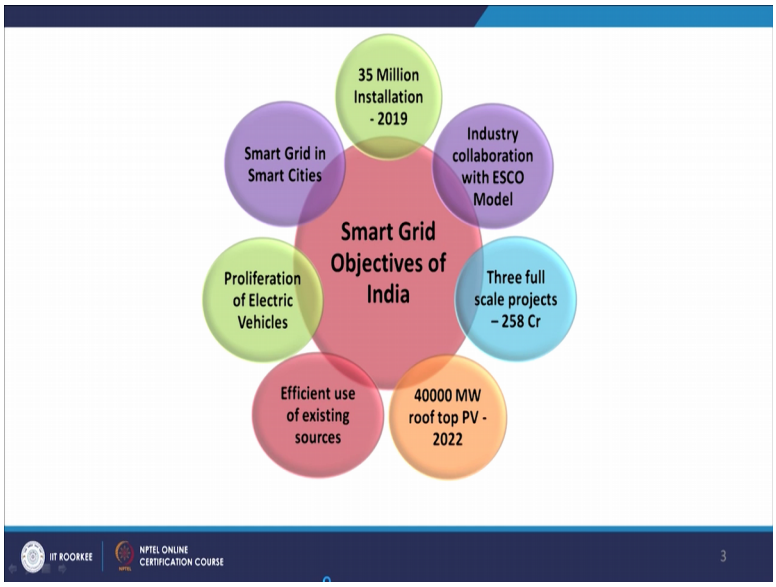

And if you see today the smart grid objectives of India highlights many goals or decide milestones have been fixed: 35 million smart meters installation by 2019 which is a huge target being fixed. Industry collaboration with ESCO model: which is the very new initiative where energy efficiency schemes are adopted by the distribution utilities. Three full scaled projects and smart grid executed with by spelling 258 crores by now. 40000 megawatt rooftop pv expected by 2022. The effective use of existing sources

proliferation of electric vehicles they are coming in a big way, smart grid and smart cities are the hot topics and with this fundamental (Refer Time: 04:01) I do see that you are learning the course on smart grid under this NPTEL online program not limit you just as a course, but you can perhaps extend your understanding and be part of the smart grid initiative taken by Indian government.

Now, the government of India approved smart grid pilot projects their many.

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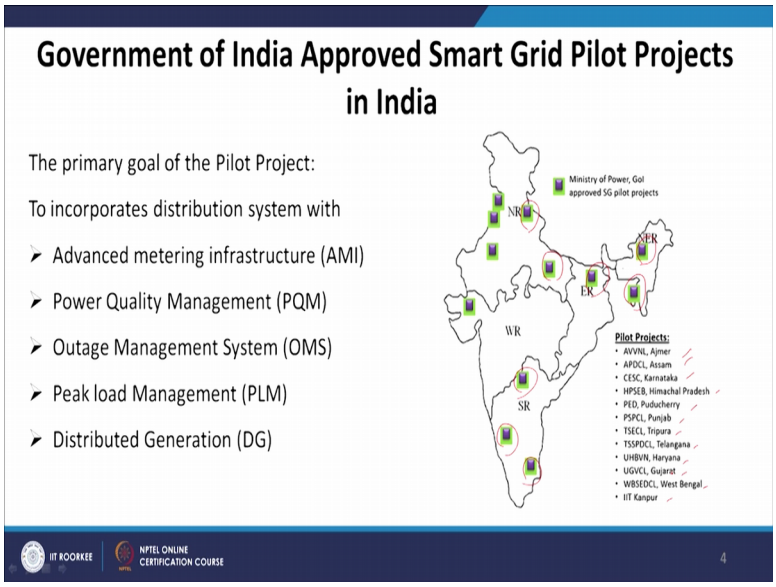

The primary goal of the pilot project is to incorporate distribution system with advanced metering infrastructure AMI schemes. Power quality management PQM, outage management systems, peak load management distributed generators. So, you can see there are so, many pilot projects are in being executed most of them have been over and some of them are still in progress. So, we could see that the different pilot projects in the field of smart grid are on way at this stage.

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Now, the worth is to many the pilot project cost too much like 3816 million, rupees have been spent to achieve smart grid outlook to this pilot projects.

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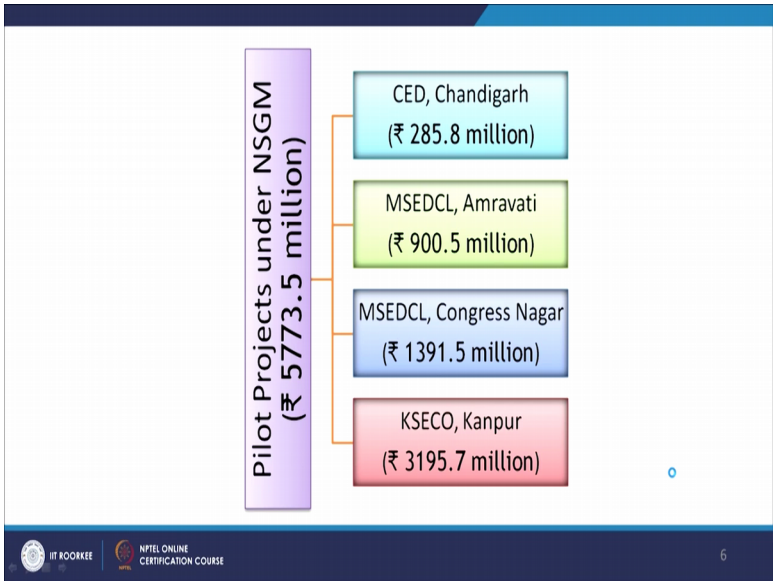

And there are few pilot projects under NSGM national smart grid mission which is also spent 5773 million rupees at both Chandigarh Amaravati Congress Nagar and at Kanpur the projects are in process.

And currently almost all the leading institutions in the country, all the IIT s and most of the central funded institutions today do work rigorously in the field of smart grid.

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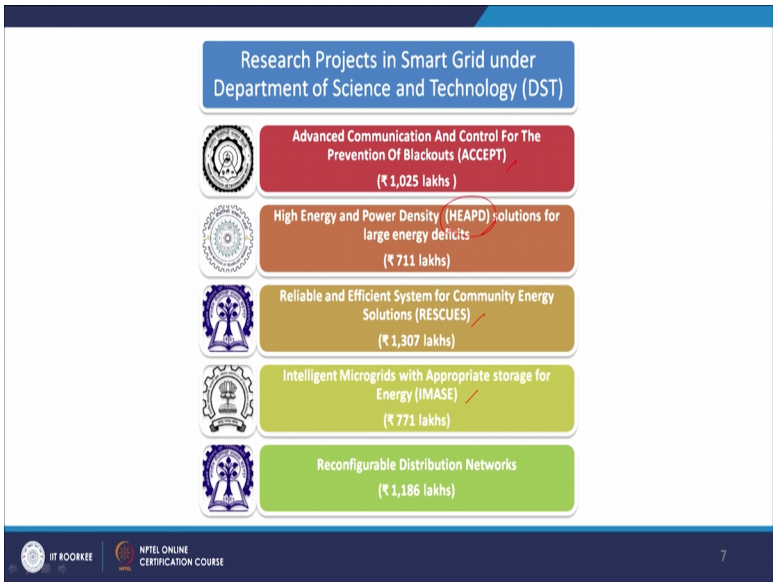

And to mention few the Indian government has sponsored 5 indo UK collaborative project on smart grid the first one is ACCEPT, HEAPD, RESCUE, IMASE and reconfigurable distribution networks let by different IITs and the one of the projects that is HEAPD is being led by Indian Institute of Technology,. Roorkee. And all the analysis the HEAPD said with you is the outcome of the HEAPD project and the support that you have received from the government of India department of science and technology.

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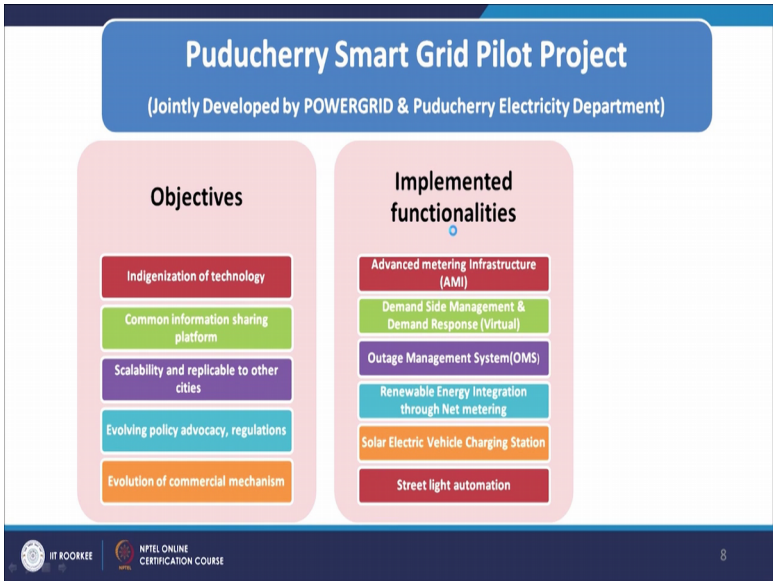

Now, there is one more Puducherry smart grid pilot project, jointly developed by power grid and Puducherry electricity department.

They had very specific objectives and the implemented functionalities do have advanced metering infrastructure, demand side management and demand response out is management system, renewable energy integration through net metering, solar electric vehicle charging stations and street light automation. And this also quite expensive project at present time.

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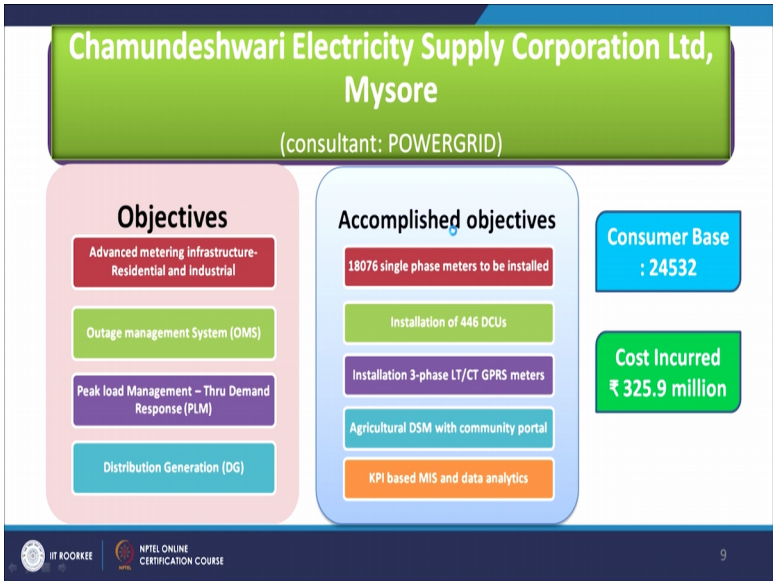

Now, Chamundeshwari electric supply corporation Mysore also achieved a good initiative in the field of smart grid, where the accomplish objectives where 1876 single phase meters to be installed; installation of 446 DCUS installation of 3 phase LTCT GPRS meters, agricultural DSM with community portal KPI based mis and data analytics. And this also a quite successful project at this point of time to highlight the Chamundeshwari a project.

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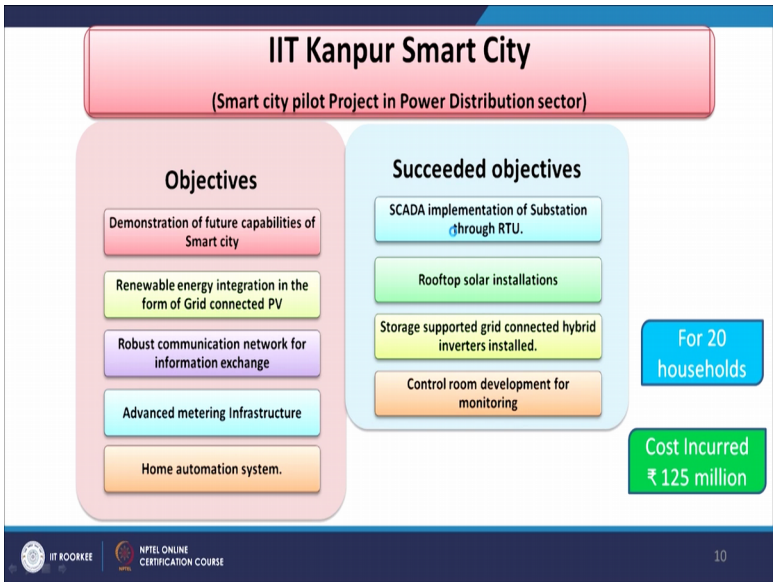

Then perhaps IIT Kanpur also initiated smart grid project under smart city.

So, they have perhaps actually try to SCADA implementation of substation through RTUs. Rooftop solar installations, storage supported grid connected hybrid inverters and control room development for monitoring. So, they have taken a 20 households and try to execute a kind of what kind of smart grid concept can be extended so, that energy efficiency can be achieved. Now key smart grid facts and figures till 2016, the number of smart meter square 5.2 million and number of electric vehicles registers were close to 6000.

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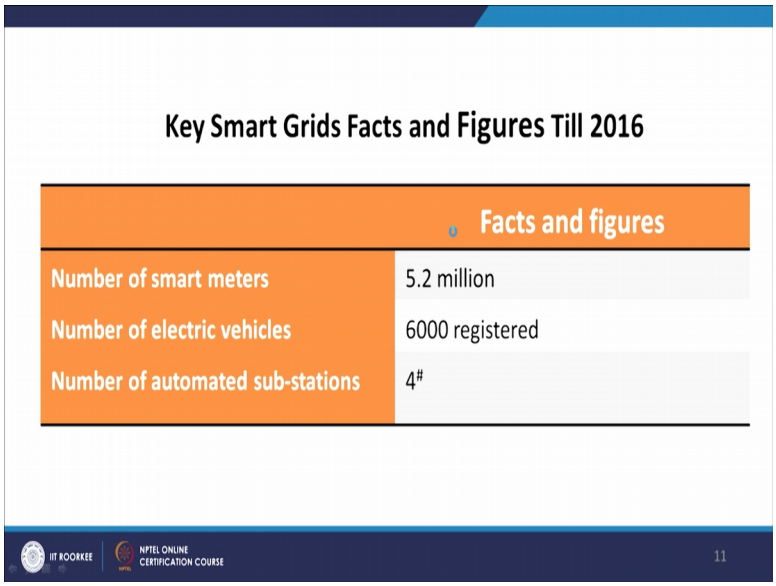

And there are four substations which are completely automated. And now many sub stations are coming up in this direction.

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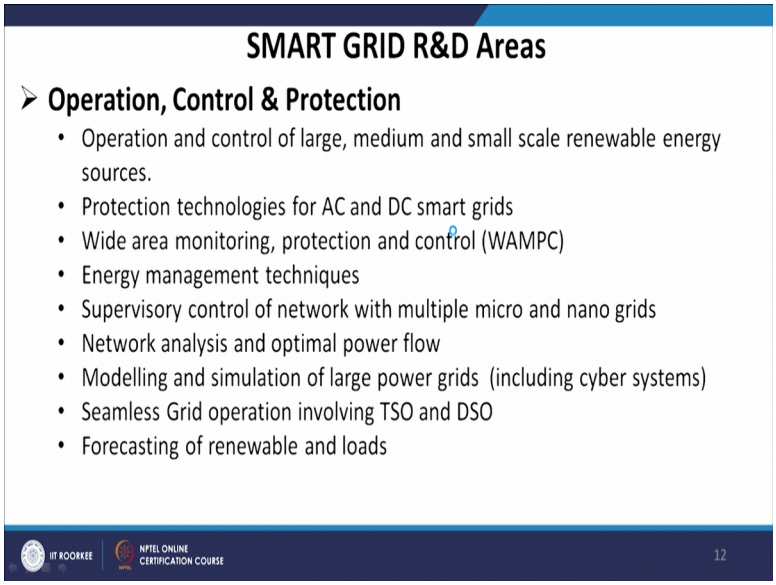

Now, I mean for all the viewers I wish to also highlights after learning this fundamental, this is something I said regarding the kind of opportunities available for you to participate in smart grid activity at different levels from the government side. And also we have identified few research areas, that one can choose to continue this smart grid research further. In the line of operation control and protection we have different

categories which has been highlighted with the support of many experts across the country, operation and control of large medium small scale renewable energy sources, protection technologies for AC and DC smart grids, wide area monitoring protection, and control energy management techniques, supervisory control of network with multiple micro and nano grids, network analysis and optimal power flow modeling and simulation of large power grids, seamless grid operation involving TSO and DSO forecasting of renewable energy and loads.

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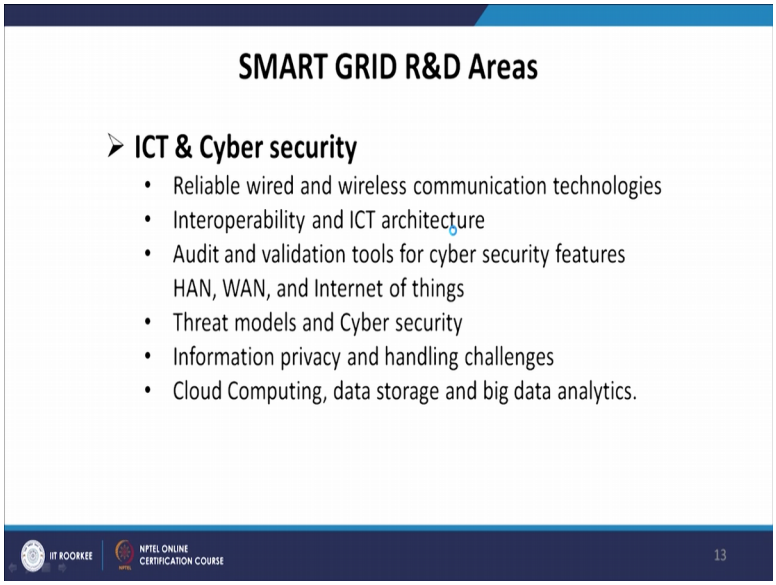

And there is one more important aspect that is cyber security ICT, reliable wired and wireless communication technologies interoperability and ICT architecture, audit. And validation tools for cyber security feature, HAN WAN and internet of things, threat models and cyber security information privacy and handling challenges cloud computing data storage and big data analytics.

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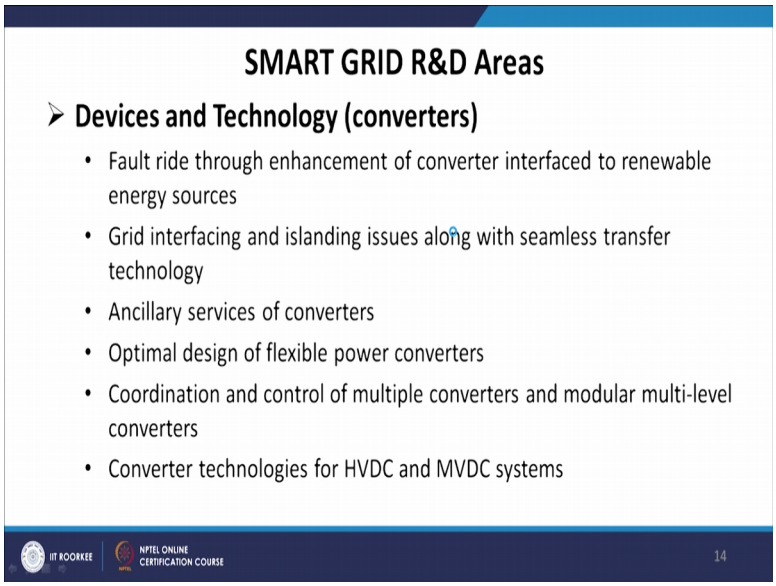

Now, you move to the device what is are the fault area one can choose; fault ride through enhancement of converter interface to renewable energy sources, grid interfacing and islanding issues along with seamless transfer technology, ancillary services of converters, optimal design of flexible power converters, coordination and control of multiple converters and modular multilevel converters, converter technology for HVDC and medium voltage DC systems. Multifunctional hardware smart grid enablers smart and unified control of converters.

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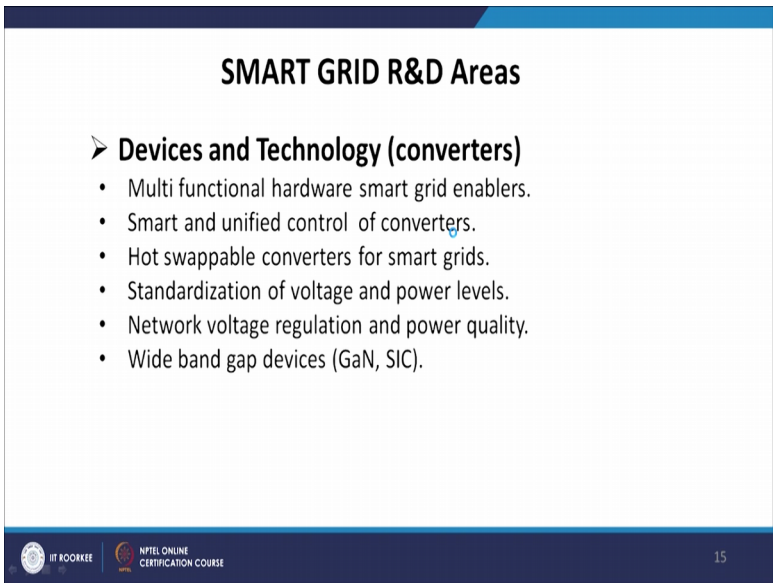

Hot swappable converters for smart grid, standardization of voltage and power levels, network voltage regulation and power quality wide band gap devices. And finally, we come to energy resources storage and deployment issues.

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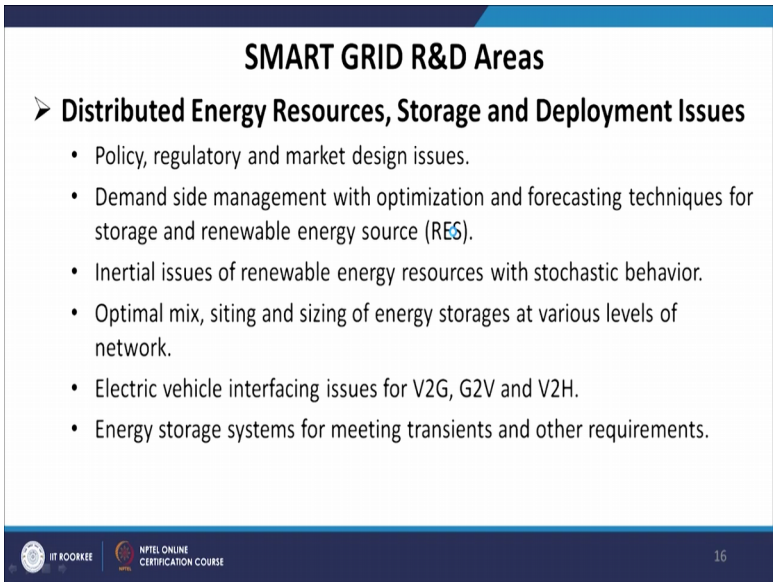

Policy regulatory and market design issues, demand side management with optimize and forecasting techniques for storage and renewable energy sources, industrial issues of renewable energy sources with stochastic behavior, optimal mix sighting and sizing of energy storage at various level of the network, electric vehicle interfacing issues for V to G, G to V and V to H energy storage system for meeting transient and other requirements.

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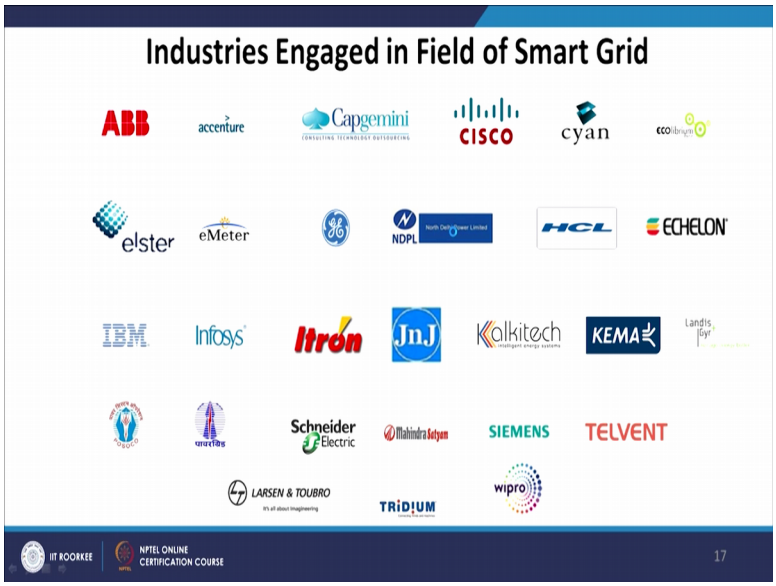

And there are so many industries were currently working on smart grid. So, you can also choose a future with industry and to name few ABB, Accenture, Capgemini, Cisco, Cyan HCL NDPL general electric, e meter, elster IBM, Infosys Kema, Siemens Snyder, Mahindra Power grid Posco I mean there are so many currently focusing on the field of smart grid researchso, I do see a long way for viewers to go ahead if you are taking this course seriously.

To conclude the session I wish to highlight that all the aspects starting from simulation, modeling, theory and understanding and execution of smart grid have been covered in detail. Perhaps we have taken high level attempt to make you understand the real time simulation of smart grid and few cases have been discussed in detail.

To start with we have initiate the architecture of smart grid, definition of smart grid, modeling and simulation of smart grid, analysis of smart grid at all three levels of AC smart grid, DC smart grid and hybrid smart grid. And to end up with their applications we have considered different case studies like demand management, demand side management, demand response load flow analysis coordinate voltage control schemes through both hardware and (Refer Time: 14:22) simulation platform. We have analyzed all the case studies for your benefit and to make better understanding of a theory, we tried our level best to cover the syllabi as maximum as possible.

Hope this course will certainly help you to make you understand the background concept and application on smart grid at large.

Thank you very much.