গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
বাংলাদেশ জ্বালানি ও বিদ্যুৎ গবেষণা কাউন্সিল (বিইপিআরসি)
বিদ্যুৎ বিভাগ
বিদ্যুৎ, জ্বালানি ও খনিজসম্পদ মন্ত্রণালয়
আইইবি ভবন (১২তম তলা), রমনা, ঢাকা।
www.eprc.gov.bd

নং-২৭.০৩.০০০০.০০১.৪৩.০০১.১৭.১৯২ (২)

তারিখঃ ২৪/০৩/২০২৪ খ্রিঃ

স্মার্ট বাংলাদেশ বিনির্মাণ বিষয়ক কর্মপরিকল্পনা

বিইপিআরসি'র ২০২৩-২৪ অর্থবছরের ই গভর্ন্যান্স ও উদ্ভাবন কর্মপরিকল্পনার কর্মসম্পাদন সূচক [৬.১.২] এ বর্ণিত লক্ষ্যমাত্রা- "স্মার্ট বাংলাদেশ বিনির্মাণ বিষয়ক কর্মপরিকল্পনা প্রণয়নকৃত" পূরণের জন্য প্রণীত কর্মপরিকল্পনাটি এতদসঙ্গে সংযুক্ত রয়েছে।

২৪.৩.২৪
আজফার ইনতেহা
উপ-পরিচালক (ইনোভেশন)
বাংলাদেশ জ্বালানি ও বিদ্যুৎ গবেষণা কাউন্সিল
বিদ্যুৎ, জ্বালানি ও খনিজসম্পদ মন্ত্রণালয়

Hasan Mahmud
২৪/৩/২৪
ড. হাছান মাহমুদ
পরিচালক (ইনোভেশন)
বাংলাদেশ জ্বালানি ও বিদ্যুৎ গবেষণা কাউন্সিল
বিদ্যুৎ, জ্বালানি ও খনিজসম্পদ মন্ত্রণালয়

Broader Research Areas for Short, Medium and Long Term

1. Short Term: 2 years

1.1 Energy demand projection with respect to time

Energy demand projection is imperative for the smooth operation and planning of energy sector of Bangladesh. It can be performed in sectoral, sub-sectoral and national level at a time horizon of short, medium and long term. Research should be focused on energy demand prediction using statistical and Computer intelligence-based tools.

1.2 Energy Economy Modelling to simulate energy economy interaction and identify future pathways for Bangladesh energy system

Energy system models are critical for planning energy transition pathways, understanding their impacts, and identifying which paths our energy system can take and which perspectives we have. The research should concentrate on developing national or sub-national level energy-economic model to simulate energy-economy interactions and analyze energy policy issues for Bangladesh while taking into account national economic goals and environmental commitments. The model could include sub-models of energy demand and supply for coal, oil, gas and electricity that are linked to a macroeconomic model. Forecasting, backcasting, and scenario analysis could all be the general purposes of modeling. The energy models' methodological approach could be optimization/simulation/multi-criteria/accounting. It could be an energy demand model, an energy supply model, an impact model, or an appraisal model.

1.3 Exploration of potential resources (oil and gas) in the vast offshore area of Bangladesh

With the newly acquired sea area by recent maritime victory, sea resources of Bangladesh have increased and the sea resources potential has to be exploited. Oil and gas reserve potential of the vast offshore area in Bangladesh left unexplored. Research should focus on identifying the challenges, their interaction and possible solutions for accelerating exploration and drilling in both swallow and deep sea; limitation of current production sharing contract to attract foreign investment; geological mapping, seismic data acquisition and processing; reserve estimation etc.

1.4 Impact analysis of Electric Vehicle in grid integration

Electric vehicle runs on battery instead of an IC engine. In Bangladesh more than one million three wheeler EV also known as easy-bike run throughout the country. Moreover in future, most of the vehicles will be electric as they do not emit any carbon. These vehicles are charged directly from the utility grid which has impacts on the voltage, frequency and other power quality parameters. Proper research needs to be done on how these electric vehicle affects the power quality and what measures needs to be taken to mitigate those effects in the context of

Bangladesh. Also proper charging station location and how these charging affects our demand is to be investigated through research.

1.5 Making the power grid smart, reliable and resilient

A smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two-way digital communication. Unlike conventional grid consumers can participate in the operation of a smart grid. A smart grid has many features like demand response, distributed generation, renewable energy integration with storage, smart metering, protection, automation and control , resiliency against any cyber-attack, integration of IoT devices, real time data capturing and monitoring etc. The national grid of Bangladesh is not that much smart with these features yet. Research projects can be taken targeting these areas to make Bangladesh's power grid smart, efficient, reliable and resilient.

1.6 Ensuring Cyber-security of smart grid

Cyber-security emerges to be a critical issue for Bangladesh because millions of electronic devices are inter-connected via communication networks throughout critical power facilities, which has an immediate impact on reliability of such a widespread infrastructure. A comprehensive research of cyber security issues for the Smart Grid is required. Specifically, a research focus on reviewing and discussing security requirements, network vulnerabilities, attack countermeasures, secure communication protocols and architectures in the Smart Grid.

1.7 Development of Low-Cost Energy Storage

In near future Bangladesh will have a deeply decarbonized energy systems utilizing high penetrations of variable renewable energy (VRE). At that time, energy storage is needed to keep the electricity flowing when the sun isn't shining and the wind isn't blowing — when generation from these VRE resources is low or demand is high. Hence technology advancement is needed on ensuring affordable and reliable energy storage for the deployment of utility-scale storage and the adoption of distributed storage.

1.8 Energy Demand Management

Efficient demand management is a part of smart grid. There are numerous options for demand management i.e. AGC, demand management from consumer side, change in operation of power/energy system as well as deployment of energy system. Research can be done for the technologies to best fit the Bangladeshi power/energy system to ensure optimized energy demand management.

1.9 Explore the future potential of E-Cooking in Bangladesh

Electric cooking (e-cooking) technology is a complement and viable alternative to biomass based traditional cooking. In light of the substantial cost savings, high-efficiency electric cooking appliances has a great potential. The primary technology driving this new generation of e-cooking is the electric pressure cooker (EPC). EPCs represent a step change in technology: by combining pressure, insulation, and sensors. EPCs cook food quickly, more conveniently, and with a fraction of the energy required to power other types of e-cooking products such as induction stoves. The process by which EPCs apply heat to food also makes them an ideal alternative for preparation of many dishes traditionally consumed by households. The future potential of e-cooking can be explored in depth to see what chances exist as well as the obstacles that need to be overcome.

Three broad areas can be explored in detail:

- Market analysis: There exists a broad market with a variety of different e-cooking appliances from numerous suppliers that customers can choose from. A current market analysis is necessary to understand the various appliances as well as their prices. Additionally, a comparison with other cooking alternatives will determine where e-cooking stands. The analysis may look at e-cooking appliances, prices, suppliers, alternatives, financing etc. to provide an accurate assessment of the e-cooking market in Bangladesh.

- Technical aspects: A reliable access to energy is an on-going challenge. The use of e-cooking appliances would have significant impacts on the grid in terms of power demand, voltage and overall stability. In this regard, the peak demand in the morning and evening seems especially challenging for the grid. Optimization of the energy use in e-cooking appliances needs to be investigated.

- User behaviour analysis: Traditionally, biomass fuel is the primarily used energy source for cooking in households. And even though more people have used alternatives like LPG over the last decades, biomass remains the primary cooking fuel for the majority of households. The shift to a new cooking fuel depends on many factors, including availability, type of food and costs. Understanding the use behaviour towards e-cooking in more detail is crucial if e-cooking is supposed to play a vital role in future.

1.10 Development of Climate resilience of energy infrastructure for Bangladesh

Climate change results in an increase in the frequency and severity of heatwaves, storms, warming, flooding, cyclones, droughts, and sea-level rise, among other things, which has an impact on energy production, supply, transmission and distribution networks, total energy demand, and so on. Bangladesh is one of the most climate change vulnerable countries. As a result, R&D should focus on developing a climate resilience energy system for Bangladesh that can anticipate, absorb, accommodate, and recover from these effects.

1.11 Increasing the efficiency of the existing power plants

Increasing the efficiency of existing is very crucial for supply side energy efficiency improvement. R&D should focus on heat rate improvement, Life cycle management, Multi energy output, Maintenance and inspection methods etc. that can increase the overall efficiency of the existing power plant in Bangladesh.

1.12 Demand side energy efficiency improvement

Demand-side energy efficiency refers to an extensive array of technologies, practices and measures that are applied throughout all sectors of the economy to reduce energy demand while providing the same, or better, level and quality of service. It has the potential to significantly reduce energy consumption and associated CO2 emissions in fast-growing economies such as Bangladesh, where sectoral transformation is taking place. Therefore, necessary R&D should be carried out the Bangladesh perspective in mind to evaluate the opportunities and impacts of various demand-side energy efficiency programs, scenarios, and policies across various demand-side sectors, such as analyzing the technical potential of various energy efficiency measures; estimating the EE improvement potential and impacts for selected measures; and evaluating the opportunities and impacts of financial incentives such as rebates and loans, as well as technical services such as audits and retrofits..

1.13 Reduction of system loss including theft, leakage in gas transmission and distribution system

Factors causing system loss of Natural Gas in the transmission & Distribution line in Bangladesh are inaccurate billing, leakage for pipe defects and illegal connection. The technical causes of pipe defects are corrosion, leaks, or mechanical stress (i.e. cracks). To address these issues, R&D should concentrate on both technical and policy solutions, such as the development of gas flow meters at the consumer end, the improvement of transmission and distribution networks, and the legalization of illegal connections.

1.14 Development and deployment of Offshore wind technology to capture coastal and offshore wind resources in Bangladesh:

To enable the development and deployment of offshore wind technologies that can capture wind resources off the coasts of Bangladesh and convert that wind into electricity. This robust portfolio of research and development will help overcome key barriers to offshore wind development, including the relatively high cost of energy, the mitigation of environmental impacts, the technical challenges of project installation, and grid interconnection.

1.15 Analysis of the energy pricing mechanism, market and its impact on economy

Energy pricing mechanism is one of the most effective techniques for promoting energy efficiency and low-carbon development of the energy system. Proper research on energy prices, taxes, and subsidies, as well as their impact on economic sectors, sub-sectors, and households,

is critical in order to design an appropriate price mechanism of primary and secondary energy to ensure energy support for Bangladesh's rapid economic growth. R&D should concentrate on price elasticities in energy demand and supply; energy pricing impacts on economic sectors and sub-sectors ; effects of the carbon tax and other government taxes, subsidies, and price control mechanisms; energy consumer and producer surplus, and dead weight loss from a tax; marker power, monopoly and oligopoly effects in the energy market; regulated vs competitive market, and so on. R&D in the electricity market and pricing can focus on deregulation of the electricity supply industry, electricity trading principles; load and price forecasting principles and their application; transmission price scheme in open access transmission system; competitive market price of electricity and its impacts; wheeling charges, pricing, and arbitrage in the electricity market; Independent system operator (ISO) functions in competitive and controlled markets.

1.16 Vertical Arrangement of Solar Panel for land area optimization

Bangladesh is a densely populated fertile agricultural land and non-agricultural unused land is not easily available. Utility-scale solar projects require considerable land. Based on the solar irradiance of Bangladesh, about 3.5 – 4.0 acres of land are required for about 1 MW of solar energy. Acquiring land is a major problem for the rapid expansion of on-grid solar in Bangladesh. Normally solar parks are established by arranging horizontal solar arrays which require a huge area of land. Arranging solar panel vertically may reduce the land requirement. Vertical solar array can be optimized through research without compromising the output. Furthermore, it is expected that the efficiency of the solar panel will increase in future through new technological advancement thus requiring lesser area for generating per unit of power.

1.17 Increasing the operational flexibility (from higher to lower capacity) of existing large power plants:

Power plant operational flexibility will be critical in the coming days to accommodate variable renewable energy supply. It is characterized by three main features: the overall bandwidth of the operation (turndown ratio, ranging between minimum and maximum load); the speed at which the net power feed-in can be adjusted (ramp rate); and the time required to attain a stable operation when starting from a standstill (start-up time). R&D should include the necessary technical and operational upgrades, as well as targeted retrofit measures for existing coal, gas, and oil-fired power plants in order to provide relatively flexible output and, if necessary, run well below the optimum design rate.

1.18 Utilization of primary and secondary recovery improvement techniques in Bangladesh's existing gas fields:

Primary and secondary recovery improvement techniques should be utilized in Bangladesh's existing gas fields to maximize production. Based on reservoir structure, drive mechanism and geology, R&D should focus on the applicability of recovery improvement techniques such as

compression, accelerated production rate, recompletion of existing wells, drilling up-dip wells, coproduction of water, waterflooding, and so on in existing reservoir, as well as enhance gas recovery and production enhancement of depleted gas reservoir, shale and tight sand reservoir by techniques such as hydraulic fracturing, CO2 sequestration, magnetic nano-particle technology for optimum fracture propagation, fracturing with dynamic loading or pneumatic fracturing, thermal (cryogenic) fracturing, acidizing etc.

2. Mid Term: 3-6 years

2.1 Energy demand projection with respect to time

Energy demand projection is imperative for the smooth operation and planning of energy sector of Bangladesh. It can be performed in sectoral, sub-sectoral and national level at a time horizon of short, medium and long term. Research should be focused on energy demand prediction using statistical and Computer intelligence-based tools.

2.2 Energy Economy Modelling to simulate energy economy interaction and identify future pathways for Bangladesh energy system

Energy system models are critical for planning energy transition pathways, understanding their impacts, and identifying which paths our energy system can take and which perspectives we have. The research should concentrate on developing national or sub-national level energy-economic model to simulate energy-economy interactions and analyze energy policy issues for Bangladesh while taking into account national economic goals and environmental commitments. The model could include sub-models of energy demand and supply for coal, oil, gas and electricity that are linked to a macroeconomic model. Forecasting, backcasting, and scenario analysis could all be the general purposes of modeling. The energy models' methodological approach could be optimization/simulation/multi-criteria/accounting. It could be an energy demand model, an energy supply model, an impact model, or an appraisal model.

2.3 Exploration of potential resources (oil and gas) in the vast offshore area of Bangladesh

With the newly acquired sea area by recent maritime victory, sea resources of Bangladesh have increased and the sea resources potential has to be exploited. Oil and gas reserve potential of the vast offshore area in Bangladesh left unexplored. Research should focus on identifying the challenges, their interaction and possible solutions for accelerating exploration and drilling in both swallow and deep sea; limitation of current production sharing contract to attract foreign investment; geological mapping, seismic data acquisition and processing; reserve estimation etc.

2.4 Impact analysis of Electric Vehicle grid integration

Electric vehicle runs on battery instead of an IC engine. In Bangladesh more than one million three wheeler EV also known as easy-bike run throughout the country. Moreover in future, most of the vehicles will be electric as they do not emit any carbon. These vehicles are charged

directly from the utility grid which has impacts on the voltage, frequency and other power quality parameters. Proper research needs to be done on how these electric vehicle affects the power quality and what measures needs to be taken to mitigate those effects in the context of Bangladesh. Also proper charging station location and how these charging affects our demand is to be investigated through research.

2.5 Making the power grid smart, reliable and resilient

A smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two-way digital communication. Unlike conventional grid consumers can participate in the operation of a smart grid. A smart grid has many features like demand response, distributed generation, renewable energy integration with storage, smart metering, protection, automation and control , resiliency against any cyber-attack, integration of IoT devices, real time data capturing and monitoring etc. The national grid of Bangladesh is not that much smart with these features yet. Research projects can be taken targeting these areas to make Bangladesh's power grid smart, efficient, reliable and resilient.

2.6 Ensuring Cyber-security of smart grid

Cyber-security emerges to be a critical issue for Bangladesh because millions of electronic devices are inter-connected via communication networks throughout critical power facilities, which has an immediate impact on reliability of such a widespread infrastructure. A comprehensive research of cyber security issues for the Smart Grid is required. Specifically, a research focus on reviewing and discussing security requirements, network vulnerabilities, attack countermeasures, secure communication protocols and architectures in the Smart Grid.

2.7 Development of low-Cost Energy Storage

In near future Bangladesh will have a deeply decarbonized energy systems utilizing high penetrations of variable renewable energy (VRE). At that time, energy storage is needed to keep the electricity flowing when the sun isn't shining and the wind isn't blowing — when generation from these VRE resources is low or demand is high. Hence technology advancement is needed on ensuring affordable and reliable energy storage for the deployment of utility-scale storage and the adoption of distributed storage.

2.8 Development of Hydrogen Energy Production, Transportation and Storage

It is imperative to do research that will advance cutting-edge clean hydrogen technology solutions. Come up with ways to support clean hydrogen uses for a more available and affordable fuel for electricity generation, industrial decarbonization, and transportation fuel. Areas of research interest for Bangladesh in this field are:

• Development of technologies to produce hydrogen from natural gas, to advance clean hydrogen production from sustainable biomass, solar energy, wind power, municipal solid wastes, coal wastes and waste plastics.

• Derive promising technologies for the transport of hydrogen fuel cells.

• Looking for Options for safe, long-term hydrogen storage.

2.9 Energy efficient building materials (Brick, Glass)

The research should draw attention to developing inventory of materials and technologies for energy efficiency by reducing cooling loads of buildings for new as well as existing ones.

2.10 Generation of net-zero carbon fuel (Waste to Energy, Bio fuel, Bio Crude etc.)

Carbon-neutral fuels could serve as mid-to long-term alternatives to replace fossil fuels. The research should focus on developing the technology to produce net-zero fuels like bio-diesel, bio-ethanol, biocrude, bio-coal, ethanol from CO2, green ammonia, green hydrogen, coal, oil & gas from waste , renewable hydrogen based methanol, and so on.

2.11 Minimizing the carbon intensity of the energy and power system

Carbon footprint generated from the power and energy system is a talking point as of now. Bangladesh has also decided to reduce the carbon emission over times. So, to innovate new idea, technology and/or implement it in the context of Bangladesh can be a research focus in upcoming years.

3. Long Term: More than 7 years

3.1 Energy demand projection with respect to time

Energy demand projection is imperative for the smooth operation and planning of energy sector of Bangladesh. It can be performed in sectoral, sub-sectoral and national level at a time horizon of short, medium and long term. Research should be focused on energy demand prediction using statistical and Computer intelligence-based tools.

3.2 Energy Economy Modelling to simulate energy economy interaction and identify future pathways for Bangladesh energy system

Energy system models are critical for planning energy transition pathways, understanding their impacts, and identifying which paths our energy system can take and which perspectives we have. The research should concentrate on developing national or sub-national level energy-economic model to simulate energy-economy interactions and analyze energy policy issues for

Bangladesh while taking into account national economic goals and environmental commitments. The model could include sub-models of energy demand and supply for coal, oil, gas and electricity that are linked to a macroeconomic model. Forecasting, backcasting, and scenario analysis could all be the general purposes of modeling. The energy models' methodological approach could be optimization/simulation/multi-criteria/accounting. It could be an energy demand model, an energy supply model, an impact model, or an appraisal model.

3.3 Making the power grid smart, reliable and resilient

A smart grid is an electricity network based on digital technology that is used to supply electricity to consumers via two-way digital communication. Unlike conventional grid consumers can participate in the operation of a smart grid. A smart grid has many features like demand response, distributed generation, renewable energy integration with storage, smart metering, protection, automation and control , resiliency against any cyber-attack, integration of IoT devices, real time data capturing and monitoring etc. The national grid of Bangladesh is not that much smart with these features yet. Research projects can be taken targeting these areas to make Bangladesh's power grid smart, efficient, reliable and resilient.

3.4 Ensuring Cyber-security of smart grid

Cyber-security emerges to be a critical issue for Bangladesh because millions of electronic devices are inter-connected via communication networks throughout critical power facilities, which has an immediate impact on reliability of such a widespread infrastructure. A comprehensive research of cyber security issues for the Smart Grid is required. Specifically, a research focus on reviewing and discussing security requirements, network vulnerabilities, attack countermeasures, secure communication protocols and architectures in the Smart Grid.

3.5 Deployment of Carbon Capture, Utilization and Storage (CCUS) technology in Bangladesh

Bangladesh, one of the countries that are most vulnerable to the effects of global warming. Average global temperature to 1.5 degrees Celsius above pre-industrial levels and to achieve net-zero carbon emissions by 2050. United Nations climate change conference, COP26, Bangladesh accounts for 0.47 percent of global greenhouse emissions, and it needs more renewable energy to cut the rate further. The future of the oil and gas industry relies on the success of the current energy transition initiatives to net-zero carbon production through sustainability, digitalization, artificial intelligence/machine learning, and circular carbon (CO2) economy. CCUS technologies will play an important role in meeting net zero targets, including as one of few solutions to tackle emissions from heavy industry and to remove carbon from the atmosphere.

3.6 Development of Hydrogen Energy Production, Transportation and Storage

It is imperative to do research that will advance cutting-edge clean hydrogen technology solutions. Come up with ways to support clean hydrogen uses for a more available and affordable fuel for electricity generation, industrial decarbonization, and transportation fuel. Areas of research interest for Bangladesh in this field are:

- Development of technologies to produce hydrogen from natural gas, to advance clean hydrogen production from sustainable biomass, solar energy, wind power, municipal solid wastes, coal wastes and waste plastics.
- Derive promising technologies for the transport of hydrogen fuel cells.
- Looking for Options for safe, long-term hydrogen storage.

3.7 Utilization of Ammonia as an Energy Carrier

Ammonia is regarded as an ideal carbon-free energy carrier. R&D should cover energy efficiency as well as the associated cost of gray, blue and green ammonia from different synthesis process, innovative approach of ammonia synthesis like Photocatalysis, plasmacatalysis and electrocatalysis etc., NH3 fuel use in internal combustion engine of transport vehicles and gas turbine for power generation, volumetric hydrogen density of NH3 storage tank, NH3 fuel cell, superiority in long distance transportation and storage, suitability of NH3 over H2 as energy carrier and so on.

3.8 Development and utilization of Wireless power transfer technology

As like wireless communication, wireless power transfer is a buzzword. Some works have been done over the years for transferring power wirelessly. But the main problem is distance coverage for the transfer. Also, underwater wireless power transfer can be a future technology for battery charging as well as transmitting power to islands. So, as a long term plan, Bangladesh can focus on wireless power transfer innovation according to the need of the country.

3.9 Development and utilization of Tidal energy in Bangladesh

Tidal energy is a renewable energy powered by the natural rise and fall of ocean tides and currents. Although not yet widely used, tidal energy has the potential for future electricity generation. Tidal power plants have a high initial cost. The methods of generating electricity from tidal energy are relatively new technology. Tidal energy is however still very early in the research process and it may be possible to reduce costs in future. Bangladesh can look forward to seeking any possibility of tidal power plants utilizing the tidal energy of the Bay of Bengal in future. Research projects can be taken in future to discover the opportunity of tidal power in Bangladesh.

3.10 Generation of net-zero carbon fuel (Waste to Energy, Bio fuel, Bio Crude etc.)

Carbon-neutral fuels could serve as mid-to long-term alternatives to replace fossil fuels. The research should focus on developing the technology to produce net-zero fuels like bio-diesel, bio-ethanol, biocrude, bio-coal, ethanol from CO2, green ammonia, green hydrogen, coal, oil & gas from waste , renewable hydrogen based methanol, and so on.

3.11 Small Modular Reactor (SMR)

3.12 Development and utilization of Hydrogen Powered Vehicle in Bangladesh:

Hydrogen fuel cell vehicles have the potential to address both the environmental and oil dependency problems in transportation of Bangladesh. To make the vehicles viable it is important through R&D to find an effective catalyst in the fuel cell that can "burn" the hydrogen with oxygen under controlled conditions needed for safe travel, develop a cost effective hydrogen powertrain and analyze the main obstacles posed by the establishment of network of fueling stations.

২৪.০১.২৪

আজফার ইনতেহা
উপ-পরিচালক (ইনোভেশন)
বাংলাদেশ জ্বালানি ও বিদ্যুৎ গবেষণা কাউন্সিল
বিদ্যুৎ, জ্বালানি ও খনিজসম্পদ মন্ত্রণালয়

28/01/24

ড. হাছান মাহমুদ
পরিচালক (ইনোভেশন)
বাংলাদেশ জ্বালানি ও বিদ্যুৎ গবেষনা কাউন্সিল
বিদ্যুৎ, জ্বালানি ও খনিজসম্পদ মন্ত্রণালয়