In The Name Of God

Foreword

Climate change is one of the most important and complex environmental issues facing the world that demands a coordinated global response. The constitution of the Islamic Republic of Iran, the Twenty Year Vision Document, the set of "Major Environmental Policies" drafted by the Infrastructure Commission of the Expediency Council in January 2015 which was endorsed by the Supreme Leader of the I.R. Iran in November 2015, and the various Five Year Development Plans of Iran, have addressed various dimensions of this extreme challenge at various levels of policy and decision making at the national levels. At the international level the Sustainable Development Goals (SDGs) as adopted in 2015, especially SDG number 13 calls for global action towards adaptation to and mitigation of climate change impacts.

The United Nations Framework Convention on Climate Change (UNFCCC) documents and its conferences and relevant meetings are the primary base for negotiating the global response to climate change and at its decision "Lima call for action" urged the contracting parties to submit their Intended Nationally Determined Contribution (INDC) to reduce Green House Gases Emission (GHGs) by the year 2030. At the UN Climate Change Conference in December 2015 in Paris over 140 countries including I.R. Iran, submitted pledges to reduce greenhouse gas emissions. Although, international cooperation helped to reach the Paris Agreement in 2016 emphasizing on carbon reduction, however the policy measures to meet the obligations and objectives have to be approved by a parliament implemented at national level.

Reduction of GHGs by any country calls for a strong political will, legal and technological reform, human resources development, huge investments in infrastructure, and most importantly change of social attitudes towards sustainable production and consumption patterns.

Acquiring adequate technology for addressing the issue of climate change and its terrible impacts require careful and in depth evaluation and analysis. Identification and prioritization of technologies needed for reduction of greenhouse gases emissions and adaptation to climate change are important steps towards low carbon strategies and sustainable development.

Article 50 of the Constitution of the Islamic Republic of Iran is a declaration on the importance of the environmental laws. It emphasizes that environmental issues are multi-sectoral and all sectors of the society, particularly organizations and agencies, must be diligent in protecting the environment to the best of their abilities.

Technology Needs Assessment (TNA) is a powerful tool for the assessment of the technology options and resources, institutional mechanisms, interaction with stakeholders, and for identification of priority sectors and technologies required to achieve maximum mitigation and adaptation.

Technology Needs Assessment Project Coordinator
Majid Abbaspour

Acknowledgment

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List of Abbreviation

A

AMI
Advanced Metering Infrastructure 39

B

BEMS
Building Energy Management System 40
BRT
Bus Rapid Transit 41

C

CCHP
Combined Cooling, Heating and Power 38,39
CCS
Carbon Capture and Storage 40
CCT
Clean Coal Technologies 40
CDM
Clean Development Mechanism 30, 31, 59
CHP
Combined Heat and Power 30,38,39,43
CITC
The Center for Innovation and Technology Cooperation 9
CFL
Compact Fluorescent Lamp 39
CNG
Compressed Natural Gas 41
COP
Conference of Parties 59
CSP
Concentrating Solar Power 40

D

DHC
District Heating and Cooling 39
DOE
Department of Environment 3, 9, 10,75,66

E

ED
Electro Dialysis 47
EDLCs
Electrochemical Double Layer Capacitors 41
ERVs
Energy Recover Ventilators 39
ESSs
Energy Storage Systems 41

F

FO
Forward Osmosis 47

G

GCF
Green Climate Fund 31
GEF
Global Environment Facility 31
GHGs
Green House Gases 5,16,17,22,29,37,51,52,64

I

IGCC
Integrated Gasification Combined Cycle 40
IPCC
Intergovernmental Panel on Climate Change 3,4,63
IRSEN
Iranian Society of Environmentalists

M

MED
Multi-Effect 47
MSF
Multi-Stage Flash 47

N

NCG
Non-Condensable Gas 41
NGOs
Non-Governmental Organizations 11

R

RO
Reverse Osmosis 47

List of Abbreviation

T

TNA
Technology Needs Assessment 9,10, 11, 15, 16, 17, 59,60,64

TOC
Total Organic Carbon 48

U

UNFCCC
United Nations Framework Convention on Climate Change 3, 4, 5, 25, 30, 31,64,65

UNIDO
United Nations Industrial Development Organization 17

USC
Ultra Super Critical (steam turbine) 40

V

VMEP
Vision and the Major Environmental Policies 64

VAV Systems
Variable Air Volume Systems 39

VOCs
Volatile Organic Compounds 48

W

WMA
Weighted Multivariable Analysis 35

Section 1

The impacts of the Climate Change in the Islamic Republic of Iran

1 The Impacts of the Climate Change in the Islamic Republic of Iran

1-1 Introduction

Drastic changes in human life-style have occurred from the inception of industrial revolution at the beginning of the 19th century and the ensuing economic development. The population growth has altered the traditional land use, deteriorated forests, amplified livestock products and agricultural crops and has created voluminous amounts of solid and liquid wastes. The consequences of trends have been diverse and profound at the global scale including the phenomenon of climate change.

The technological advances in recent decades have intensified the demand for energy. The increasing energy consumption has resulted in excessive emission of greenhouse gases, thus disturbing the natural equilibrium of the Earth's atmosphere. The meteorological models predict the upsurge of the Earth temperature from 1 to 3.5ºC by 2100. This would exceed the temperature changes experienced during the past 10,000 years (Soltanieh and Ahadi, 2004).

Iran is situated in Southwest Asia. It has shorelines along the Caspian Sea and is neighbouring Azerbaijan and Turkmenistan to the north. Iran has also borders with Turkey and Iraq to the west and with Pakistan and Afghanistan to the east. The vast shorelines of Persian Gulf and Sea of Oman are at the southern borders of the country.

Iran enjoys a diverse climate. However, it is dominantly located in an arid zone (over 85.5% of the total land area). Approximately, 35.5% of Iran is hyper-arid, 29.9% is arid and 20.1% is semi-arid. Only 5% of the country has a Mediterranean climate and 10% of it is categorized as a mountainous/humid zone. Iran’s location and geographical features have resulted in average annual precipitation of only 250 mm which is less than a third of the world’s average annual precipitation (860 millimetres). Another significant characteristic of its climatic condition is the wide range of temperature fluctuation from -20 to +50ºC (DOE.ir/Portal, 2015). In accordance with the plan of Action for Climate Empowerment developed under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC), and the scenarios developed by the Intergovernmental Panel on Climate Change (IPCC), doubling of carbon dioxide concentrations by 2100 would increase the temperature from 1.5 to 4.5ºC in Iran. This would greatly affect the water resources, energy demand, agricultural products and the Iranian coastlines. Thus, alteration of temperature patterns, reduction of water resources, upsurge of sea level, destruction of coastal areas, deterioration of agricultural and food products, deforestation, observation of more frequent and severe droughts, and threat to human health would be amongst the adverse impacts of climate change in Iran.

1-2 Predictions of the climate change in Iran

The IPCC prediction on the impacts of climate change for various biological components in the Asian continent are presumed to occur in Iran, being located in an arid and semi-arid region.

Table 1-1 IPCC Prediction of Climate Change Impacts in Asian Continent [1]

Region	Food & Forest	Biodiversity	Water Resources	Coastal Ecosystem	Human Health	Settlement
Northern Asia	(H) -1	(M)-2	(M)-1	(L)-1	(L)-1	(M)-0
Arid & Semi-arid (Including Iran)	(H)-2	(L)-1	(H)-1	(L)-1	(M)-1	(M)-1
Asian Mild Climate Zone	(H)-2	(M)-1	(H)-2	(H)-2	(M)-2	(H)-2
Asian Tropical Zone	2- (H)	2- (M)	2- (H)	2- (H)	1- (M)	2- (M)

Abbreviations in the table indicate the followings:

(-2) = High Susceptibility

(-1) = Moderate Susceptibility

(0) = Very Low Susceptibility

(H) = High Reliability of the Results

(M) = Moderate Reliability of the Results

(L) = Low Reliability of the Results

In general, impacts of climate change in Iran could be categorized as:

- Quality of water resources, especially the surface waters, would be seriously threatened and availability of sanitary water would be reduced (Ministry of Energy, 2014).
- The precipitation regime would be altered so that the amount, duration and intensity of rainfall in various regions might deviate from the traditional patterns (Ministry of Energy, 2008), (Iran 2nd Communication to UNFCCC, 2009c).
- The deterioration of vegetation coverage and forests as well as the upsurge in wildlife mortality, fauna population decline and intensified desertification are to be observed as direct consequences of changes in the amount of runoffs, rain infiltration rate of soils and increase in the amount of sedimentation at watersheds (Jalali, 2014).

1- IPCC, 2001, "Climate Change 2001: The Scientific Basis"

- The ratio of evaporation/permeability would change the level of groundwater and the amount of runoffs in various regions (Iran 2nd Communication to UNFCCC, 2009c).
- The snow reserves would be reduced and premature melting of snow could result in inadequate water resources to feed the dam reservoirs in the country throughout the year (Farasat, 2009).
- Alteration in spatial and temporal distribution of precipitation would change the traditional water regimes in different parts of the country. Thus, the hydrometric forecasting, which is the primary instrument in designing and construction of hydro structures such as dams, would become more and more difficult(Iran 2nd Communication to UNFCCC, 2009c).
- Climate change causes inconsistencies in historical and data series obtained from the meteorological and hydrometric monitoring stations, resulting in greater inaccuracies in estimating water return period for designing and construction of hydro structures (Mirzaei, 2011).
- Greater fluctuations in water levels and water reserves at seas, lakes, wetlands and dams would be experienced which in turn will reduce the fisheries resources (Oufi, 2010)
- The amount of agricultural products would decline, therefore, dependence on import of such products is to amplify, and eventually migration from rural areas to major metropolitans would have a domino effect on the socio-economic predicaments in the country (Iran 2nd Communication to UNFCCC, 2009a).
- The drying up of the lakes and wetlands will result in dust and sand storms, a phenomenon whose growing scale has been quite evident during the last few years (Iran 2nd Communication to UNFCCC, 2009c).
- The adverse consequences of climate change would reduce the potential energy resources in the country (Moshtaghian, 2006), (IEEO-SABA, 2006).
- Increase in the number of diseases due to higher temperatures and lack of adequate sanitary waters (Iran 2nd Communication to UNFCCC, 2009b).

Results of a study on the GHGs emitting sectors and sectors vulnerable to GHGs emission revealed that the impacts of climate change includes temperature fluctuations, evaporation, transpiration, salinity of soil, changes in precipitation type, and increase in sea water levels. It was also noted that the most vulnerable sectors are agriculture, water resources, forests and rangelands as illustrated in the figure 1.1.

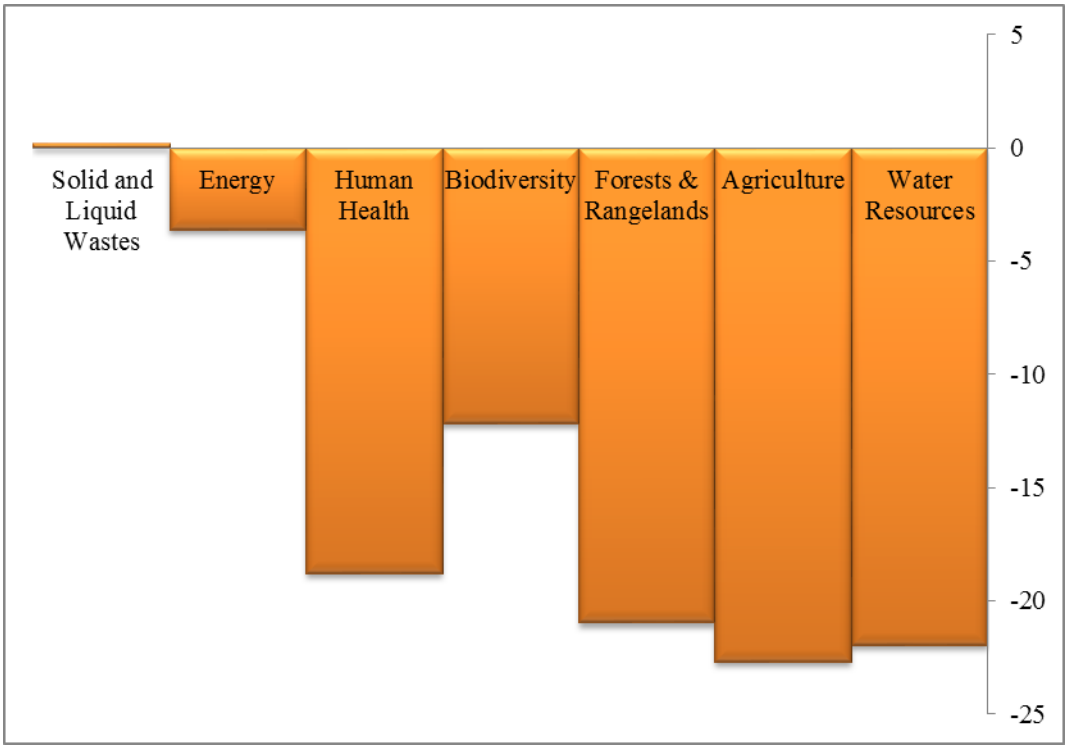


Figure 1-1 Sectors vulnerable to climate changes in Iran, relative expert-weighted scores

Section 2

Establishment of the Technology Needs Assessment Team and Stakeholders Involvement

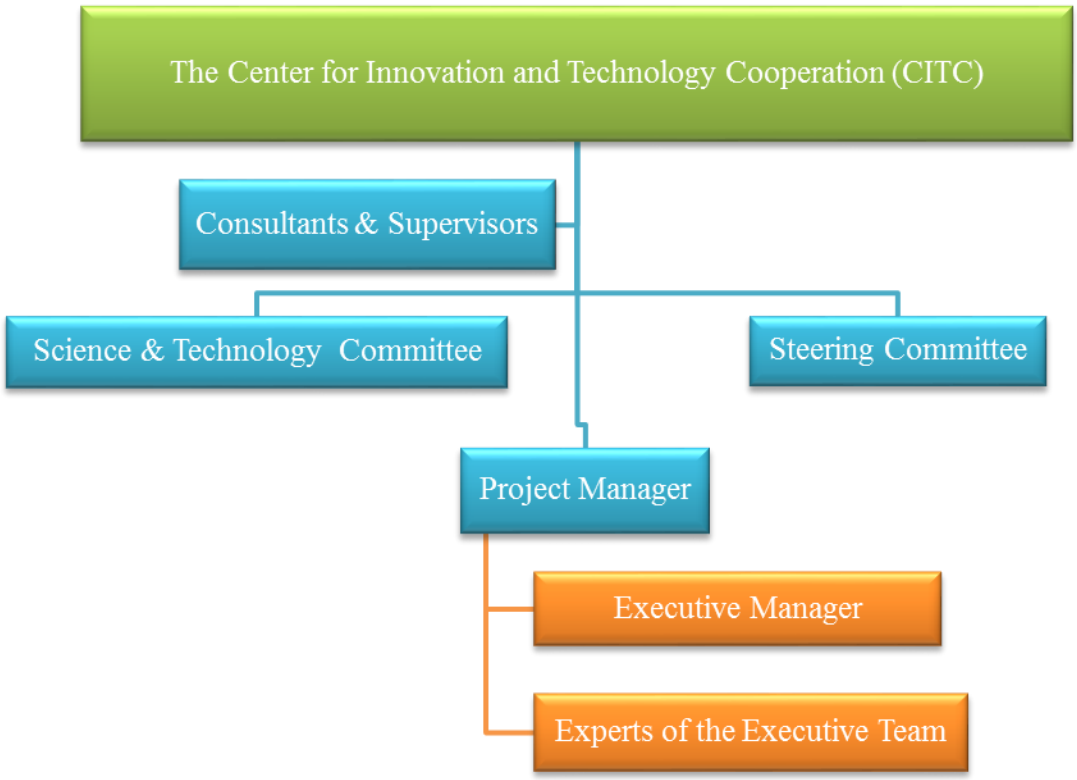
2 Establishment of the Technology Needs Assessment Team and Stakeholders Involvement

2-1 Technology Needs Assessment Team

Climate change is considered as one of the most significant challenges to human development in the 21st century. Acquirement of new technologies is one of the principal solutions to reducing mitigation and the impacts of climate change and concurrently, ameliorate socio-economic development.

The goal of the present study is to identify and prioritize the technological needs to address climate change. To this end, a TNA working group was established. The organizational chart of the TNA working group is illustrated in which the activities and responsibilities of the pertinent authorities reflect their current mandates.It should be noted that this mission was given to The Center for Innovation and Technology Cooperation for Presidency (CITC) by the special working group of climate change of the Department of Environment (DOE) of Islamic Republic of Iran.

Figure 2-1 Organizational Chart of the TNA Team



2-2 Stakeholders Involvement

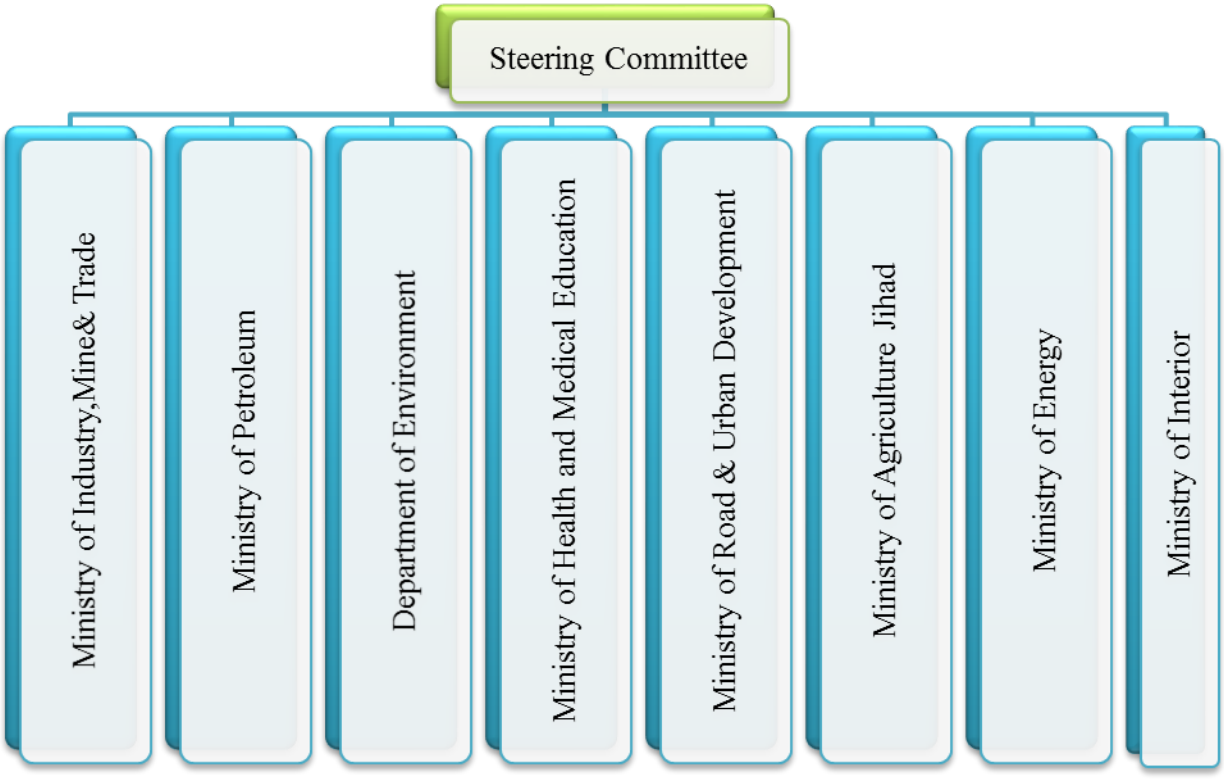
Involvement of pertinent ministries was identified to be as one of the most important activities in this study. Sectoral and inter-sectoral priorities and policies were assessed and inter-sectoral cooperation and collaboration were enhanced through series of stakeholders meetings. The most relevant ministries are as follows:

- Ministry of Industry, Mine and Trade
- Ministry of Power (Energy)
- Ministry of Agriculture Jihad
- Ministry of Road and Urban Development
- Ministry of Health and Medical Education
- Ministry of Petroleum
- Department of Environment (DOE)
- Ministry of Interior

2-3 Establishment of the TNA Steering Committee

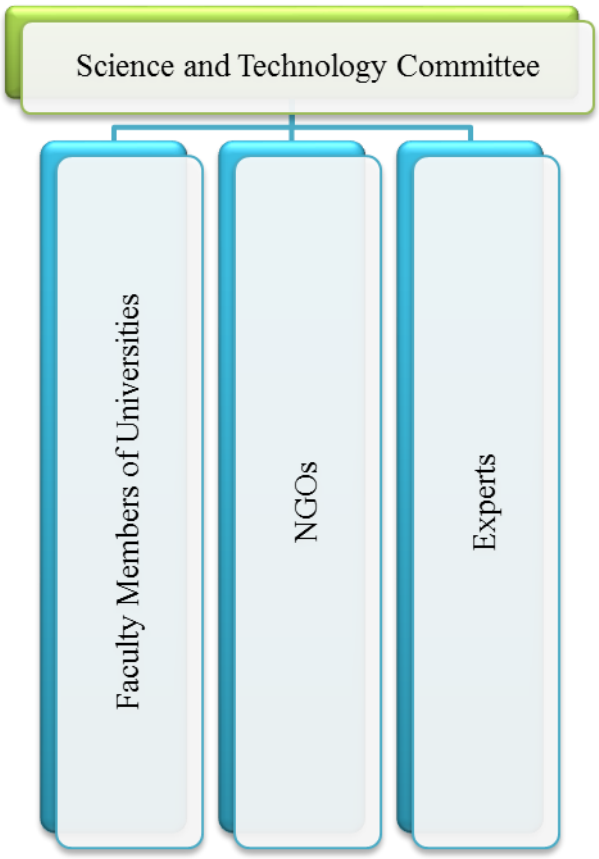
A Steering Committee was established to coordinate the decision-making process comprising of relevant stakeholders including governmental, non-governmental, public and private entities as well as the economic institutions and international organizations.

Figure 2-2 Members of the Steering Committee



The liaison between the national implementing agencies and knowledge based institutions were established to harmonize the scientific and technological aspect of this study as shown in Figure 2-3

Figure 2-3 Members of the Science & Technology Committee



The execution of the TNA Project was assigned to a professional team comprising of a Project Manager, an Executive Manager and a group of experts from academia and professional NGOs.

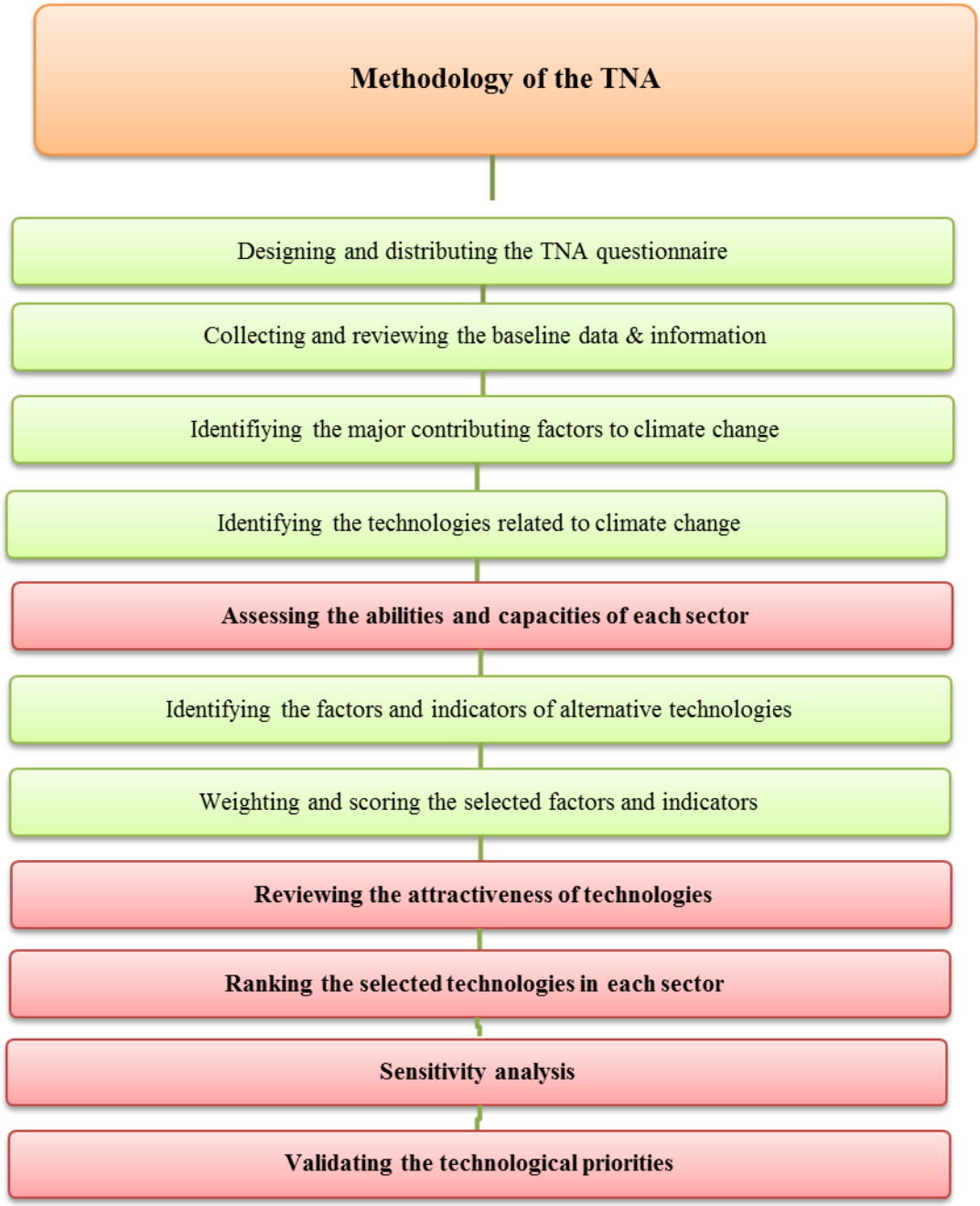
Section 3

Methodology of the Technology Needs Assessment

3 Methodology of the Technology Needs Assessment

In preparation of the TNA following steps were undertaken as shown in figure 3-1.

Figure 3-1 Methodology of the TNA



As a prerequisite to preparation of TNA, influencing factors such as constitutionally and legally binding instruments, national regulations and legislations, and National Development Plans were taken into consideration. Meanwhile, the estimated amount of Green House Gases (GHG) emissions and the required information about the technological capabilities were collected through the distribution of TNA questionnaire amongst the relevant sectors (namely oil and gas, industries, power plants, residential and commercial, agricultural, water resources and human health sectors).

After basic data collection, major factors contributing to climate change adaptation and mitigation were identified. Then, completed questionnaires were analysed and most appropriate technologies were identified. The identified technologies were categorized by high suitability and acceptable capability. Subsequently, according to expert views and comments, listed technologies of each sector were weighted and scored based on 6 major indicators and 20 sub-indicators. Then, results were validated through sensitivity analysis of the prioritized technologies. Eventually, top priority technologies were finalized in conjunction with the validated results.

3-1 Brief Description of the Methodology

For the successful development and transfer of the prioritized technologies through the policy making process, the developing countries require to improve certain capabilities. In this study, the Technological Needs Assessment Methodology is utilized to assess the technological capabilities. Furthermore, TNA is recommended as an instrumental framework for the Iranian policy-makers for addressing environmental issues. The technological capabilities are assessed, the opportunities and challenges are determined, and eventually the capacity building in the relevant areas with certain deficiencies are undertaken. This study is descriptive-analytical in nature, which reviews the past practices and shortcomings to measure the technological capabilities regarding environmental issues at various sectors, including energy, industry, agriculture, human health and the environment, via questionnaires. TNA standard method was coupled with the views of experts of the Technical Committee and the pertinent sectors. Consequently, all the relevant factors mentioned above are integrated to produce a common framework accepted by all stakeholders.

The Technology Need Assessment is designed for the identification of the required capabilities and the prioritized technologies. TNA methodology provides three types of technological needs assessment at the national, sectoral and institutional levels. It is believed that the three assessment levels would complement each other.

The Technology Needs Assessment at the national level concentrates on the development and implementation of policies at the policy-making level. Meanwhile, the TNA at the sectoral level influences the general technological policies at a lower level for example at a specific industry. However, the technological needs at the institutional level are assessed to satisfy the specific requirements of a business establishment or corporation.

At each level, the major stakeholders take part in a consultative process to determine the main challenges for the transfer of technology. According to the United Nations Industrial

Development Organization (UNIDO) guidelines, TNA is a framework to facilitate the identification of needs and prioritization of technologies in the developing countries to ensure the successful execution of the anticipated transfer of technology. TNA is also a participatory process encompassing a wide range of stakeholders. As a general rule, UNIDO emphasizes on national and sectoral levels of TNA. Thus, technology needs assessment uses different working groups comprised of representatives from all stakeholders and experts in a scientific environment to draft and finalize the TNA report. Table 3-1 illustrates a ranking matrix used in this study.

According to the TNA methodology presented in this report, the technological needs assessment incorporates the following steps:

- Organizing the assessment structure: Determining the structure of the national team, organizing the pertinent stakeholders, and developing the work plan,
- Identifying the priorities: Identifying the national development priorities, considering the potential consequences of new technologies on development, and preparing a package of development priorities,
- Identifying the sectors (sub-sectors): Identifying the priority of sectors, studying the status of sectors based on the envisioned development plan, and preparing a short list of prioritized technologies for each sector

Table 3-1 The Ranking Matrix

	Ranking of contribution to climate change and other policy goal, economic viability							
Technology	GHG	Adaptation benefits	Other environmental impacts	Contribution to competitiveness & economic efficiency	Development benefits	Cost effectiveness	Market potential	Social acceptability

- Prioritization of technologies: Identifying the technologies through categorization, analysis, multi-criteria decision-making and final assessment.
- Establishment of a national strategy and development of an action plan: Determining the objectives and the key turning points, identifying the measures required for capacity building and supporting innovations, establishing a national strategy and drawing up an action plan to accelerate the development and transfer of technology.

To collect the required data and information, a questionnaire was prepared and submitted to the related ministries that are members of the Steering Committee in line with the predetermined environmental objectives and the required technologies.

Section 4

Identification of Development Priorities in the light of a Changing Climate

4 Identification of Development Priorities in the Light of a Changing Climate

4-1 An Overview of the National Laws and Legislations

Over the last decades, rapid urbanization, population growth, climate change and long-term droughts have led to the emergence of serious environmental challenges in Iran. To address these issues a number of legislations have been enacted and certain strategies, policies, guidelines and regulations have been introduced which form the 'legal and institutional context' for environmental related activities. To assess the efficiency and adequacy of these laws and legislations an analysis of existing laws and regulations was undertaken by the group of experts.

In order to identify most relevant laws and regulations pertinent to Green House Gases and Climate Change, an overview of the national laws and regulations with emphases on the 20 Years Environment Outlook and National Social, Economic and Cultural Five Years Development Plans was developed.

4-2 Constitution of the I.R. Iran

4-2-1 Article 50

Concurrent with the development of international environmental law, the environmental issues were accentuated in Iran by the establishment of the Department of the Environment in 1971 (one year prior to the Stockholm Conference). Pursuant to the victory of the Islamic Revolution and drafting of a new Constitution, these important issues were taken into account in Article 50 which states:

> *"It shall be considered a public duty in the Islamic Republic to protect the natural environment in which the present as well as future generations shall have a developing social life. Therefore, economic activities or otherwise which cause pollution or an irreparable damage to environment shall be prohibited"*

The Article 50 is a strong legal declaration on the importance of the environment. It emphasizes that environmental issues are comprehensively multi-sectoral in nature and that all sectors of the society, both the state and private sectors, must be diligent in protecting the environment to the best of their ability.

The Article 50 is considered as one of the world most progressive constitutional provisions which, underlines the need for sustainable development prohibiting any economic and /or activities incompatible with the conservation of environmental resources.

This Article conveys three major messages:

a) Environment is the foundation of economic development, which can only be achieved through the preservation of environmental quality.
b) Environment is the common heritage of mankind and governments have a responsibility towards its protection.
c) Protection of environment is a public duty and requires "common but differentiated responsibilities" of the governments and societies towards the environment.

The Article 50 prohibits any contamination or alteration beyond the carrying capacity of ecosystems. Climate change is seen as an essentially anthropogenic contamination and alteration of the environment in form of drought, global warming, sea level rise, flood, earthquake, reduction of runoff, drying up of rivers and lagoons, etc. As such one can clearly interpret the Article as alluding to the phenomenon calling for an end to or control of economic and other activities that lead to climate change including increasing GHG emissions and destruction of GHG sinks.

4-2-2 Article 45

The Article 45 of the Constitution places most of the natural resources under the jurisdiction of the government to be managed based on national interests. According to this Article "Anfal (Spoils) and public wealth, such as Mavat(ownerless barren lands) or abandoned lands, mines, seas, rivers, lakes and other public waters ,mountains , passes, woods, reed beds, natural groves unbounded pastures, legacy without heirs, unclaimed property and public property taken from usurpers, are at the disposal of the Islamic Government to be dispensed with according to public interests. Details and the manner of utilization of each one of them will be determined by law."

This Article implicitly refers to the environment and the need for its protection equating 'environment' with 'common public benefit' associated with the national natural resources, the safeguarding of which as a common heritage from misuse and destruction are the responsibility entrusted to the government.

4-2-3 The 20-Year Vision (2000-2020)

The Vision Document was developed as the guiding framework for the formulation of the general policies of the National Five-year Development Plans from 2000 to 2020. It was endorsed by the Supreme Leader on 9th Nov. 1998, addressing the heads of Judiciary, Executive and Legislature Powers as well as the Head of the Expediency Council. The Vision is considered as the most important leading national document that sets the stage and needs to be closely followed as a guideline in all legislative, judicial, administrative and executive affairs during the envisioned period. It is a comprehensive document that depicts a realistic, desirable and anticipated ideal future of the country in a 20 year horizon. Creation of the ideal society perceived by this document requires a precise road map elaborating a comprehensive

action plan reflecting the mutual expectations of the government and of the general public with regards to the country's global status in the fields of economy, science, technology, environment and culture (Managing and Planning Organization, 2008). As regards to the environment by 2020, the Iranian society is expected to be able to protect the human environment, prevent pollution, and especially put an end to activities that result in climate change. The society should enjoy public health, well-being, food security, social welfare, equal job opportunities, equitable distribution of income, strong family ties, and access to a clean environment. Also it has to be free of poverty, corruption and discrimination.

The Vision Document assumes a clean and healthy environment as a fundamental "right" for the present and future generations. The "right to environmental services" as stated in this document is a set of privileges that every individual should enjoy in order to grow and prosper in a healthy environment. The notion of the "right on the environment" is equivalent of the "Environmental Rights", this being a major component of Human Rights. The right to the environment is inclusive of the right to health and well-being and is recognized by all international treaties and documents. Also, it encompasses the right of protection against the long-term environmental risks that could threaten human health, the right to have physical and psychological integrity, freedom and security, the right to have an adequate standard of living, the right to have reasonable working conditions, the right to have proper housing and the right of access to healthy food, all of which depend on the environment that can support human life on Earth.

The Vision calls for efforts by the Iranian legal system to identify and support such "environmental rights". Since the inception of the Vision Documents several legislations have been enacted towards this end. One of the earliest regulations was the legislation dealing with the establishment of the Supreme Council for Urban Planning and Architecture, which emphasizes the need for a healthy environment as one of its legal objectives.

4-3 Major Environmental Policies

In the present world, there are hardly any political and/or economic activities that do not have some impact on the environment. Equally there are not many environmental decisions that do not impact politics and economy. The complex relationships and interactions between the environment and other areas of activities call for paying special attention to environmental issues in major national legal documents and high level decision-makings. A major example of such attention could be seen in the set of "Major Environmental Policies" drafted by the Infrastructure Commission of the Expediency Council in January 2015 which was endorsed by the Supreme Leader of the I.R.Iran in November 2015.

The Major Environmental Policies as listed below call for:

1- Integrating and coordinating the systematic resource management (such as air, water, soil and biodiversity) based on the strength and resilience of ecosystems, especially by increased capacity and legal and institutional capabilities associated with public participation.
2- Creating an integrated national environmental system.
3- Improvement of the environmental conditions in order to enjoy a healthy

environment with respect to intergenerational fairness and rights.

4- Prevention of any unauthorized release of pollutants, criminalization of environmental degradation and determination of effective and deterrent penalties like compensation for polluters and those harming the environment.
5- Monitoring the sources of contamination of air, water, soil, noise pollution, destructive electromagnetic waves and rays unfavourable changes in climate; and taking environmental measures through enforced compliance with standards and regulations, development plans and the national comprehensive plan.
6- Compiling a National Ecological Atlas for the purpose of protection, restoration, improvement and development of renewable natural resources (e.g. seas, lakes, rivers, reservoirs, wetlands, groundwater aquifers, forests, soil, rangelands, biodiversity, and especially wildlife); setting legal restrictions on the use of these resources in line with the ecological, restoration and sustainable capacities based on sustainability criteria and indicators; management of sensitive and valuable ecosystems (such as national parks and national natural monuments); and protection of the genetic resources and upgrading them to the international standards.
7- Identifying the emerging environmental phenomena and challenges such as desertification, drought, sand and dust storms and the spread of biological and radioactive agents; and mainstreaming environmental considerations in future national development plans.
8- Development of green economy; protection of groundwater resources through watershed management practices, decreasing the exploitation and evaporation of aquifers; and controlling various types of pollution.
9- Establishment of an environmental auditing mechanism in terms of values and environmental costs (destruction, pollution and reclamation) in the national accounting systems.
10- Encouraging investment on eco-friendly technologies using economic tools such as green taxes and subsidies.
11- Developing the Code of Ethics and promoting the environmental ethics based on Islamic values and Iranian culture.
12- Promoting studies and scientific research; utilizing the environmental innovative technologies and experiences gained by the domestic manufacturers for sustaining ecological equilibrium; and preventing pollution and environmental degradation.
13- Enhancing the awareness, knowledge and understanding of environmental and social responsibility; strengthening the cultural and religious education regarding public participation; and promoting the virtues of environmental protection at all levels and sectors of the society.
14- Strengthening the environmental diplomacy.

The current status of the environment necessitates the rigorous pursuit of environmental issues stated by the above major policies. Implementation of these policies could considerably contribute towards the protection and preservation of the country's environment. The environment could be preserved as a common heritage for all generations.

4-4 Other Major Legal Provisions

In addition to the Constitution, Vision Document and Major Environmental Policies, there are other legislations and legal provisions that have an important bearing for the environment. A

few are listed below:

1. Legal provisions incorporated in the National Five Years Development Plans. These provisions play an important role in implementing environmental policies and rules (Secretariat of the Expediency Council, 2008).The requirement to subject all development projects to EIA (Environmental Impact Assessment), setting up of a National Environment Fund, Green National Accounting and Environmental Economic Evaluation of Natural Resources are but a few examples of such provisions. After culmination of the Islamic Revolution in Iran in 1979, five National Development Plans have been executed and the sixth Development Plan is under implementation.

2. The need to assure sustainable development has implicitly been enshrined in a number of legislations, as well as in strategies, that define and guide the activities of the Ministry of Industry, Mine and Trade; the Ministry of Roads and Urban Development; the Ministry of Health and Medical Education; the Ministry of Energy and the Department of Environment. Infer that climate change is an issue of concern in sustainable development long term planning.

3. I.R. Iran has endorsed and ratified a number of important global treaties that deal with climate change namely, the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, and the Vienna Convention on the Protection of the Ozone Layer and the associated Montreal Protocol on Substances Depleting the Ozone Layer.

The national requirements for the implementation of and compliance with these instruments were reviewed in this report. Results indicate that the Islamic Republic of Iran was able to take advantage of these treaties and accordingly two relatively independent structures, in the form of two Coordinating Bureaus were created in the Department of Environment to investigate climate change and ozone layer and also act as liaison between national and international organizations.

Section 5

GHGs Emission by Sectors

5 GHGs Emissions by Sectors

Precise data on the volume and sources of GHG emission plays an important role in identifying and prioritizing strategies for controlling and reducing emissions by different sectors. In this chapter, five sectors including energy, industry, agriculture, waste, forests and rangelands are investigated. GHGs emissions by the users including residential-commercial-public, industry, transportation, agriculture, power sectors and oil and gas refining units in the energy sector have been noted to account for about 88% of total greenhouse gases emission. Statistics used in this report includes data from the Iran's National Climate Change Office updated in 2010 and also the statistics of the Energy Balance Sheet in 2013.

5-1 Greenhouse Gas Emissions by Various Sectors from 2008 to 2013

During the years 2008 to 2013, the growth of greenhouse gases emissions in all sectors, except the residential-commercial and refining, has been tending upward. Changing consumption pattern of residential sector and replacement of old equipment with higher efficiency appliancesas well as the fuel switching from oil by-products to natural gas are the reasons for the negative growth of greenhouse gases emission in the above mentioned sector sector. However, the amount of carbon dioxide produced by the residential sector is still about 1.5 times higher than the global average. To modify this difference, applying standard equipment and introducing modern and environmentally sound technologies can be of great importance. Figure 5-1 illustrate the trend of Carbon Dioxide Emission in the energy sub-sector.[1]

Figure 5-1 Trend of Carbon Dioxide Emissions from 2008 to 2013

[1] Energy Balance Sheet Report ,Ministry of Energy,2013

Socio-economic impacts caused by increasing greenhouse gases at the local and global levels calls for the mitigation of greenhouse gases emissions, particularly in the energy sector. While the growth of the energy demand can be considered as one of the factors resulting from economic development; but it can also be result of unjustified increase in energy consumption in some areas such as residential sector. Therefore, the amount of energy consumption, mainly fossil fuels (oil and gas), has increased and led to the upward trend of greenhouse gases emission.

Multiple energy models were applied by national authorities to study energy balance, supply and demand in order to identify options to reduce greenhouse gases emissions through the development of multiple scenarios.

The 2010 Iran Second National Communication to UNFCCC forecasted that energy saving potential could be as high as 34% by 2025, if international technical/financial assistance under UNFCCC becomes available. This could have a significant impact on reducing carbon dioxide emissions.

Iran is one of the largest energy consumers per capita in the region and many steps can be taken in order to reduce its diverse environmental impacts. Optimization of energy consumption and use of alternative fuels in the cement, iron and steel industries are the main options to reduce emissions. Another option that could be considered is the emissions reduction in transportation sector. Programs proposed in this sector are concentrated on vehicle improvements, public transport, fuel quality and use of rail transport services.

Long-term development policies of the country emphasize the economic diversification, non-oil revenues and reduction of oil dependency .This would help social welfare and job creation. Effective management of the environment, better energy efficiency and economic innovations are the essential elements for the stated development policies (Iran Second National Communication to UNFCCC, 2010).

Currently, the use of renewable energy for electricity generation is still not comparable with other sources of energy. Hence, in addition to the main mitigation options which are the use of alternative fuels, hydropower, combined heat and power (CHP) cycle and nuclear energy, appropriate actions should be taken into consideration in the field of renewable energies in order to improve related technologies and to reduce costs.

Unfortunately, international cooperation in the field of energy sector such as Clean Development Mechanism (CDM) projects in Iran has not been much successful due to various reasons including unjust sanctions. Only few projects have been studied in Iran. These projects are as follows:

- Norouz and Soroush oil field gas collection project
- Roudshour gas power plant development project
- The project on collecting methane gas from Mashhad landfill to generate electricity
- The project on replacing natural gas instead of fuel oil in the companies affiliated with the sugarcane industry in Khuzestan (6 production companies of sugarcane)
- Piran and Aras hydropower plants projects, etc.

- Switching from single cycle to combined cycle power plants (5 projects)
- N_2O decomposition in Nitric Acid Plant of Shiraz Petrochemical Company
- Flare Gas recovery in Sarkhoon and Qeshm gas treating facility.

Currently, 18 projects are registered by the UNFCCC and 10 projects are at the stage of registration. Three projects have obtained the necessary certificates from the United Nations.

Associated gas gathering project in Soroush and Norouz oil fields was registered as the first project by the executive board and its implementation could reduce 463,000 tons of carbon dioxide emissions per annum (Iran's Climate Change Office, 2015).

It should be pointed out that the following measures could have a substantive impact on promoting transfer of technology and associated know-how, as well as technology development at the national level. These measures include full termination of all unjust sanctions; removing obstacles for the peaceful use of nuclear energy in Iran; facilitating the transfer of new and clean technologies. Strengthening regional technical cooperation and establishing local committees; providing financial assistance through international institutions such as the GEF, GCF, World Bank, etc; identifying investment projects for the use of Clean Development Mechanism (CDM) which could assist in providing facilities or alternative mechanisms in the future.

It should be pointed out that taking some steps can result in positive potential impacts including:

1- Facilitating the transfer of new and clean technologies.
2- Strengthening regional technical cooperation and establishing local committees.
3- Providing financial assistance through international institutions such as the GEF, GCF, World Bank, etc.
4- Identifying projects for the use of Clean Development Mechanism (CDM) which could result in providing financial assistance and alternative clean technologies in the future.

Section 6

Priority Setting for Sound Technologies

6 Priority Setting for Sound Technologies

6-1 Mitigation

6-1-1 Identification of Priority Indices for Mitigation

From an environmental point of view, technology needs of the country were identified in the previous section with respect to their high suitability bearing in mind the capacities at the national level. The following criteria were used for this purpose:

- The main indicators of empowerment
- The main indicators of attraction
- The main indicators of emission reduction
- The main indicators of adaptation
- The international indicators and benchmarks

In order to prioritize the mitigation and adaptation technologies, a number of criteria and sub-criteria were defined and weighted at four desirability levels: low (1), medium (2), high (3), and very high (4) by the experts. Moreover, Weighted Multivariable Analysis (WMA) was adopted in this study. In these criteria, following 7 indices and twenty sub-indices were introduced to prioritize the needed technologies:

- Cost Index
  - Sub-indices:
  1. Attractiveness based on capital costs
  2. Ability to access financial viability(financial viability potential)
- Greenhouse gases Index
  - Sub-indices
  3. Attractiveness for the reduction of greenhouse gases emissions
- Policy making Index
  - Sub-indices
  4. Attractiveness based on the relevance to the existing energy policies and targets
  5. Utilization of local energy resources
  6. Energy resources
  7. Incentive for participation
- Technology Index:
  - Sub-indices
  8. Advanced and proven technology

Note: The more general is the technology, it is easier to access it and thus attain higher score.

  9. Possibilities for local manufacturing
  10. Reliability of technology

Note: The ability to repair, carry out maintenance and support the systems locally.

11. Applicability and development of technology

Note: The possibility of using transferred technology in Iran.

- Environment Index
  - Sub-indices

12. Attractiveness based on the positive environmental effectiveness

- Economy index
  - Sub-indices

13. Attractiveness based on economic growth

Note: The higher is the induced economic growth, the higher is the score.

14. Commercial availability
15. Access to markets is commercially available (market access)
16. Support of sustainability
17. Energy efficiency improvement

- Social criteria
  - Sub-criteria

18. Attractiveness for cultural and social sustainability
19. Capacity building

Note: The presence of the necessary infrastructure

20. Attractiveness based on social acceptance

Based on the expert's opinions, all of the 7 criteria were weighted as shown in Table 6-1:

Table 6-1 Weight Factor of Each Index

Indices	Weight factor
Cost	14
Greenhouse Gases	25
Policy making	15
Technology	16
Environment	12
Economy	10
Social	8

Each of the main indices was divided into sub-indices, and weighting factor for each sub-criterion was determined based on the choice of experts as shown in Table 6-2.

Table 6-2 Weight of Each Sub-index

Indices	Sub-indices	Weight factor
Cost	Capital Cost	8
	Financial Viability	6
Reduction of GHGs Emission	Reduction of GHGs Emission	25
Policy Making	Relevant to Existing Energy Policies and Targets	3
	Utilization of Local Energy Resources	3
	Energy Resources	3
	Incentive for Participation	6
Technology	Advanced and Proven Technology	3
	Possibilities for Local Manufacturing	5
	Reliability of Technology	3
	Applicability and Development of Technology	5
Environment	Positive Environmental Effectiveness	12
Economy	Economic Growth	3
	Commercial Availability	4
	Support of Sustainability	3
	Energy Efficiency Improvement	2
Social	Cultural and Social Sustainability	2
	Capacity Building	3
	Social Acceptance	3

6-1-2 Oil & Gas Industry Sector

Prioritization of the Technology Needs in Oil & Gas Sector:

1) Improvement of Fuel gas systems, Heaters, Boilers
   - Recuperative and Regenerative Burners
   - Flameless (Mild, HICOT, HITAC, FLOX) Combustion Technology
   - Advanced data acquisition and analysis system
   - Efficient Technologies for Improving steam systems Performance
2) CHP & CCHP
   - Exhaust Gas Heat Exchangers
   - Advanced Prime Movers (Gas Engines, Stirling Engines, Micro Turbines and etc.)
   - Automatic System Controller
   - Heat Recover Steam Generator(HRSG)
3) Oil and Gas Refinery Improvement
   - Advanced dehydration/desalting Technologies
   - Improvement of fired heater efficiency
   - Fuel upgrading
   - Total site heat integration
   - Conversion of condensing turbine drive to electric motor drive catalytic cracking unit
   - Improvement of pre-heater efficiency hydro treating process
   - Utilisation of advanced separation technology
   - Gasification of Oil Refinery Waste for Power and Hydrogen Production
   - Waste oil and Tail Gas Incinerators
4) Carbon Capture and Storage
5) Flare Gas Recovery
6) Reduction of Oil and Gas Leakage
   - Advanced Leak Detection System for Oil and Gas pipelines and storage tanks
   - VOC Vapour Recovery Technologies
7) Energy Conservation in Transmission and Distribution
   - Turbo Expander Technology
   - High efficient Turbo machinery
   - Mini LNG production units
   - Robotics Inspection System
8) Process Integration
   - Process Integration Software
   - Energy, water and process technologies integration

6-1-3 Residential Commercial Sector

Prioritization of the Technology Needs in Residential Commercial Sector:

1) Solar Water Heater for Residential and Commercial
   - Thermoelectric Materials
   - Durable Collectors
   - Vacuum Tub
   - Heat Pipe Technology
2) Heating and Ventilation System Efficiency
   - High Quality Reusable Filters
   - Energy Recover Ventilators (ERVs)
   - Variable Air Volume (VAV) systems
   - Low Leakage Damper
3) Building Design and Lighting
   - LED Lighting
   - Dimmable Compact Fluorescent Lamps (CFL)
   - Advanced Materials in Buildings
   - Passive Houses and Net Zero Energy Building
4) CHP & CCHP
   - Micro CHP Units for Buildings
   - Low Sound Level Systems
5) Photo Voltaic
   - High Efficient Panels (more than 20%)
   - Durable Panels (Between 20 to 25 years, with a production rate of more than 85% of the initial nominal power)
6) Technologies to Produce “A “level Energy Label Home Appliances
7) District Heating & Cooling (DHC)
   - Efficient Heat Pumps (Gas & Electric- GHP&EHP)
   - Shut-off valves (solenoid valves)
8) Direct Geothermal Energy for Building
   - Advanced Heat Pumps
   - Advanced Well Drilling Systems
9) Building Energy Management System (BEMS)
   - Energy Analytics for Buildings
   - Hardware System Components and Related Sensors
10) Smart Grid
   - Advanced Metering Infrastructure (AMI): Smart Meter
   - Grid Management and Analytics Platform Software
11) Biomass and Biogas Technology Systems
   - Gas Engine with smaller carbon footprint
   - The Second and 3rd generation of bio-fuels and biomass gasification
12) Solar Cooling System
   - Advanced Desiccant Evaporative Cooling Cycle

6-1-4 Power Industry Sector

Prioritization of the Technology Needs in Power Industry Sector:

1) Combined Cycle Thermal Power Plant

- High Efficient Solid-State Engine
- Integrated Gasification Combined Cycle (IGCC)

2) Wind Turbine Technology (2.5 MW and Over)

- Gear Less Turbine

3) Thermal Power Plant

- Ultra-super Critical (USC) steam turbine
- Energy Conservation Technologies in Transmission and Distribution
- Improved steel prototype rotor
- Corrosion and vibration monitoring technology to improve reliability of low-pressure blades
- Carbon Capture and Storage (CCS)
- Clean Coal Technologies (CCT)
- Turbo Machinery Efficiency

4) Waste to Electric technologies

- Waste Gasification
- Biomass Gasification
- Plasma Gasification
- Pyrolysis Technology
- Biomass to Biofuel

5)Micro Hydroelectric Power Production Units

6) Photo Voltaic Power Plant

- New silicone gel PV panel lamination
- Solar tracking system
- MPPT controller

7) Concentrating Solar Power (CSP)

- Parabolic Trough Power Plant
- Solar Tower
- Low-impact design air cooled compressor
- Heliostat software, control systems, and structures
- Small size solar heat power to mechanical/electrical energy transform (Stirling

engine)

8) Geothermal Power Plant

- Using Surface Condensers
- Steam Jet Ejectors
- Double Flash Condensers
- NCG & H_2S removal

9) Nuclear Power Plant

- Fabrication of fuel rod
- Design and fabrication of light water reactors

6-1-5 Transportation Sector

Prioritization of the Technology Needs in Transportation Sector:

1) Urban Rail Road
   - Timetable optimization to maximize energy interchange between rail vehicles
   - Regenerative braking technologies

   i) Energy Storage Systems (ESSs): (On-board and trackside)
   - Electrochemical Double Layer Capacitors (EDLCs)
   - Composite Flywheels
   - Li-ion and NiMH batteries

   ii) Reversible substations: Include inverters that enable a bidirectional power flow in DC networks

2) Related E-Commerce Technology in Transportation
3) Traditional Internal Combustion Engine Improvement
4) CNG Vehicles
   - Improving storage tanks for excellence in efficiency, safety and durability
5) Traffic Management
   - Real Time Traffic and Travel Information System
   - Traffic and Travel Data Base System
   - Automatic Toll Pay(Electronic Road Tolling)
   - Road Data Digital Map System
6) Bus Rapid Transit(BRT)
7) Intelligent Transportation Systems(ITS)
   - Intelligent Transportation Systems Services
   - Advance Driver Assistance System
   - Establishment of e-call System
8) Plug-in Hybrid Vehicles

9) Technologies for Manufacturing Electrical and Fuel Cell Vehicles
10) Aerodynamic Improvement of Vehicle Manufacturing
11) Technology for Development of New Materials and Reduction of Vehicle's Weigh

6-1-6 Industry Sector

Prioritization of the Technology Needs in Industry Sector:

1) Recovery of Gases and Heat Integration of the Shaft Furnaces and Basic Oxygen Furnaces
2) Recuperative and Regenerative Burners for Iron & Steel Industry
3) Fuel Switching Systems
4) Optimization Coking Unit
    - Coker Advance Process Control
    - Optimization of Delayed Cooker Operation System
    - Energy efficient drives in the rolling mill
    - Process control in hot strip mill
    - Recuperative and regenerative burners
    - Controlling oxygen levels and/or variable speed drives on combustion air fans
5) Adoption of Efficient Technologies and Methods for Finishing the Final Crude Steel Product
6) Substituting Rotary Kilns to Preheaters and Pre-Calciners
7) Pre Heating Systems for Combustion Unit
8) Improved Process Control: Oxygen Monitor and Intake Air Flow Monitor Systems
9) Catalytic Reduction Unit for N2O Removal
10) Electric motor system efficiency
    - Adjustable speed drives
11) Heat Integration Systems
12) Improvement of catalyst efficiency hydro treating process
13) CHP
    - Frame 6C Gas Turbine under 100MW for Industry
14) Introduce Efficient Milling and Grinding Equipment
15) Adoption of Best Practice Reactor Designs and Processes with Best Practice Heat Integration and Energy Recovery
16) Adding Recycling Systems Technology in Production Line
17) Feed Management in Aluminium Industries
18) Carbon Capture and Storage
19) Design and Development of Novel Membrane Separation Technologies

6-1-7 Agriculture Sector

Prioritization of the Technology Needs in Agriculture Sector:

1) Farming Management System
2) Biomass and Biogas Technology Systems
    - 8-10 MW Gas Engines up to 49% Electrical Efficiency
3) Organic Agriculture
4) Renewable Energy for Farming
    - Wind power to pump water and generate electricity
    - Solar Pump
    - Smart Greenhouse
5) Conservation Agriculture Technology
6) Agriculture Mechanization
7) Genetic Engineering
8) Combating Desertification Bio & Nano Technology
9) Rice Crop Breeding for CH4 Reduction
10) Improved Livestock Feed for CHGs Reduction

6-2 Adaptation

6-2-1 Identification of Priority Indices for Adaptation

Priority indices for adaptation were identified six indices and twenty sub- indices as follows:

- Cost index

Sub-indices:

1. Attractiveness based on capital costs
2. Ability to access financial viability(financial viability potential)

- Adaptation index

Sub-index:

3. Attractiveness for adaptation capacity

- Policy making index

Sub-indices:

4. Attractiveness based on relevance to the existing energy policies and targets
5. Utilization of local energy resources
6. Incentive for participation

- Technology index:

Sub-indices:

7. Advanced and proven technology

Note: The more general technology, the easier is access and higher scores.

8. Possibilities for local manufacturing
9. Reliability of technology

Note: The ability to repair, maintain and support the systems.

10. Applicability and development of technology
11. Attractiveness based on positive environmental effectiveness

- Economy index

Sub-indices

12. Attractiveness for economic growth for co-benefit

Note: The higher is the economic growth, the higher is the score.

13. Commercial availability
14. Attractiveness for support of sustainability

- Social Index

Sub-indices

15. Attractiveness for cultural and social sustainability
16. Capacity building

Note: The presence of the necessary infrastructure

17. Attractiveness based on social acceptance

Based on the experts' opinions, each of the 7 indices was weighted as illustrated in Table 6-3.

Table 6-3 Weight of Each Criteria

Index	Weight Factor
Cost	14
Adaptation	25
Policy making	15
Technology	16
Environment	12
Economy	10
Social	8

Each of the main indices was divided into sub-indices, and weighting factor for each sub-index was determined based on the experts choice as presented in Table 6-4.

Table 6-4 Weight of Each Sub-index

Index	Sub-index	Weight factor
Cost	Capital cost	8
	Financial Viability	6
Adaptation	Adaptation Capacity	25
Policy Making	Relevant to Existing Energy Policies and Targets	5
	Utilization of Local Energy Resources	4
	Incentive for Participation	6
Technology	Advanced and Proven Technology	3
	Possibilities for Local Manufacturing	5
	Reliability of Technology	3
	Applicability and Development of Technology	5
Environment	Positive Environmental Effectiveness	12
Economy	Economic Growth for Co-Benefit	3
	Commercial Availability	4
	Support of Sustainability	3
Social	Cultural and Social Sustainability	2
	Capacity Building	3
	Social Acceptance	3

6-2-2 Water Resources Sector

Prioritization of the Technology Needs in Water Resources Sector:

1) Wastewater Treatment
   - Grinder pumps
   - Septic tank effluent filters
   - Chlorination devices
   - UV disinfection devices
2) Desalination
   - Desalination device powered by renewable energy
   - Membrane technologies
     a) Reverse osmosis (RO)
     b) Forward osmosis (FO)
     c) Electro dialysis (ED)
   - Thermal Technologies
     a) Solar distillation
     b) Multistage flash (MSF)
     c) Multi-effect distillations (MED, sometimes called multi-effect evaporation or MEE)
   - Seawater Packaged Desalination
3) Interbasin Water Transfer
4) Point Of Use Water Treatment
5) Water Loss Reduction
   - Accurate sonic leak-detection equipment
     a) Pinpoint listening devices
     b) Geophones
   - Correlator devices
   - Pipe intrusive acoustics
6) Artificial Aquifer Recharge
7) Water Demand Reduction
   - Drought Tolerant Plants and Trees
   - High Efficient Dish Washers
   - High Quality Toilet Flush Valves
8) Rainwater Harvesting
9) Surface-Water Storage
10) Storm-water Management and Bioswales
11) Non-structural Barriers to Flooding
12) Structural Barriers to Flooding
13) Accommodation of Flooding

6-2-3 Human Health Sector

Prioritization of the Technology Needs in Human Health Sector:

1) Technology to Monitor Water Quality (Organic and Mineral)
   - Drinking Water total organic carbon (TOC) Analysers
2) Technology to Detect and Monitor Food Quality
   - Metal Oxide Sensors to Detect Freshness of Food
   - Optical biosensors for food quality
3) Personal Protective Mask for Using in Ambient Air pollutions
4) Indoor Air Pollution Purification Instruments, Specially for Particulates Maters and VOC's
   - Particulate Matter Air Filter
   - Volatile Organic Compounds (VOCs)
5) Technology to Monitor Pollen and Biological Particles at Air Monitoring Stations
   - Wet Walled Cyclonic Instrument (Coriolis µ)
6) Provision of Drinking Water Supply and Sanitation
   - Infrastructural provisions (e.g. borehole)
   a) New Drilling Technologies

7) New Born Diseases Vaccine Production
8) Technology to detect/prevent/contain and control of occupational health diseases, cooling health facilities and supportive shield
   - Advanced Technology solar cooler and heat pump for providing healthy and good work condition, facilities and supportive shield of health workers
9) Flood Proof Drinking Water Wells
10) Nano Technology
   - Quantum dots, Nano sized semiconductors that can be used as biosensors to find disease
   - Nano-drug delivery systems
   a) Nano-capsules
   b) Liposomes
   c) Nano-biomagnets
   d) Fullerene 'buckyball' cages

6-2-4 Agriculture Sector

Prioritization of the Technology Needs in Agriculture Sector:

1) Integrated Crop Management System
2) Pressurized Irrigation Technologies
3) Greenhouse Production
4) Plant and Animal Breeding (Classic & Genetic)
5) Integrated Watershed Management System
6) Floating Agriculture
7) Conservation Agriculture Technology
8) Improved livestock Feed
   - Using feed additives
   - condensed tannins, saponins, essential oils
   - Rumen Modifier
   - commercial active dried yeast products including a new product selected on its ability to improve fibre digestion in the rumen
9) Nano and Biotechnologies
   - Nano-Enabled Membranes
   - Production of hydrophobic Sand
10) Laser land leveling
11) Fungal Symbionts
12) Smart Temperature sensor for Livestock

6-2-5 Forestry & Rangeland Sector:

According to the latest statistics(FRWO, 2016), the forest and rangeland area in Iran is estimated to be around 14.3 and 84 million hectares respectively, scattered in five ecological zones.Iran is home to over 8000 plant species of which 2000 species are endemic that shows a very rich biological and genetic diversity especially in Hyrcanian and Arasbara eco-regions. Within the past half a century, the area of forests and rangelands has been reduced due to a number of causes, namely: illegal logging, forest fires, recurrent and prolonged droughts, soil erosion, pest and diseases outbreaks, and over-grazing, population explosion and land-use change.

Implementation of sustainable forest management (SFM), enhances the capacity of carbon sequestration as well as resilience against climate change impacts. This process requires the use of appropriate technology to reduce the ecosystem vulnerability, promote local communities' livelihoods and thrive economic diversity, through efficient management of raw materials and reduction of wastes.

The technology priorities needed to achieve forestry goals as follows:

1. Non Wood Production
    - Medicinal and industrial plant processing technology
2. Reforestation, Rehabilitation, Afforestation
    - Forest monitoring and inventory system including RS/GIS/RADAR
    - Soil and water conservation technology
    - Flood and drought early warning system
    - Land tenure and cadastre technology
3. Forest Fire Management
4. Pest and Disease Management
5. Seed and Seedling production
6. Carbon Sequestration
7. Forest Genetical Conservation
    - In-situ and Ex-situ germplasm technology
8. Forest Resource Assessment

6-3 Prioritization of Technology Needs at National Level

Based on the selected target sectors, the priorities of technology needs are determined for the following categories:

1. **Oil and Gas Industry**
2. **Residential commercial sector**
3. **Power Industry**
4. **Transportation**
5. **Industry**
6. **Agriculture**

In order to determine the inter-sectoral priorities, main criteria and sub-criteria of all sectors are defined and weighted concurrently. This would ensure inclusive assessment and prioritization of all sectors. Thus, not only the prioritization of technology needs in each sector was performed, but also the inter-sectoral comparison and ranking became possible (Table 6-5).

Table 6-5 Inter-sectoral prioritization for Mitigation of GHGs emissions

Sector	GHGs%	Sector average weighted score	Total ~~sector~~ weighted score	Normalized weighted score
Oil & Gas Industry	23	271	62	23
Residential- commercial	20	288	58	21
Power Industry	22	258	57	21
Transportation	19	273	52	19
Industry	14	297	42	15
Agriculture	02	223	4	2

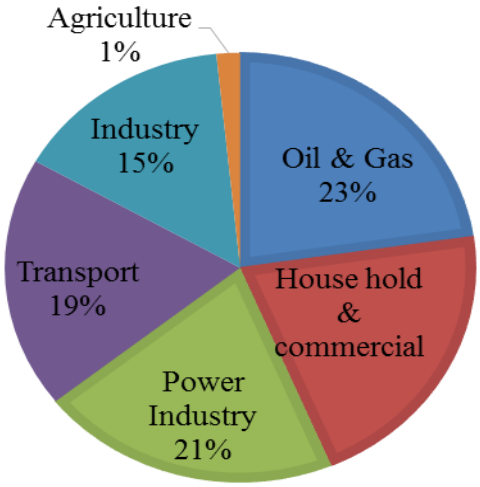


Figure 6-1 Inter-sectoral responsibilities in mitigation of GHGs emissions

Table 6-6 Inter-sectoral Prioritization for Adaptation to Climate Change

Sectors	Vulnerability %	Sector average weighted score	Total sector weighted score	Normalized weighted score
Water Resources	30	282	85	39.11
Forest and Rangeland	25	268	67	30.94
Human Health	21	309	65	29.94
Agriculture	24	255	61	28.31

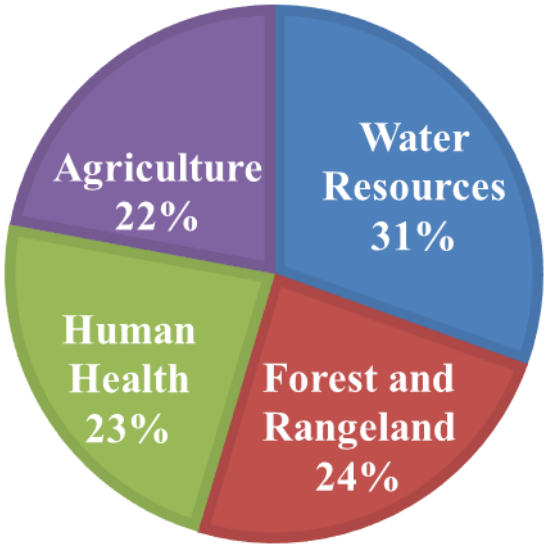


Figure 6-2 Inter-sectoral responsibilities in adaptation to climate change

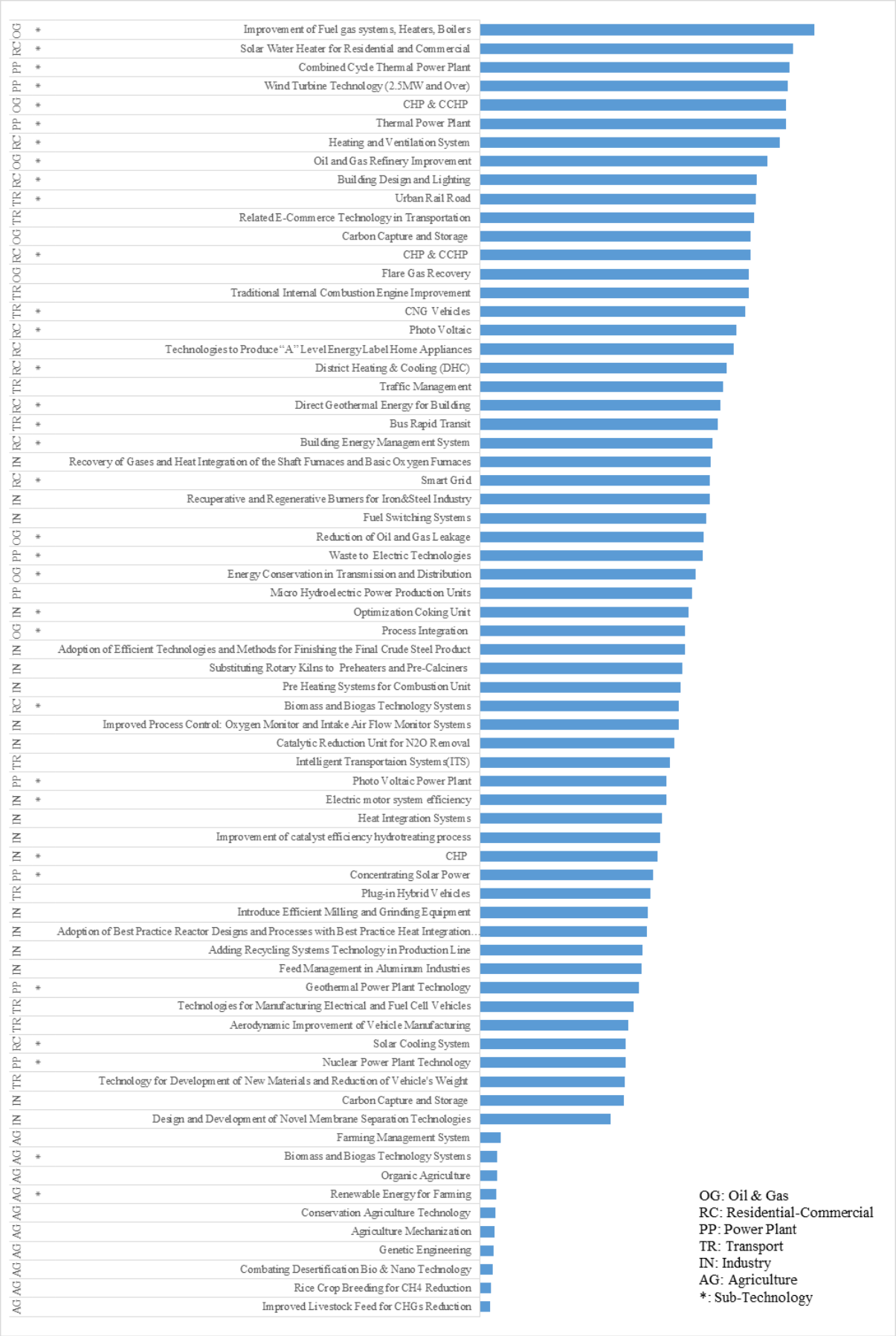


Figure 6-3 The Priorities of Mitigation Technologies

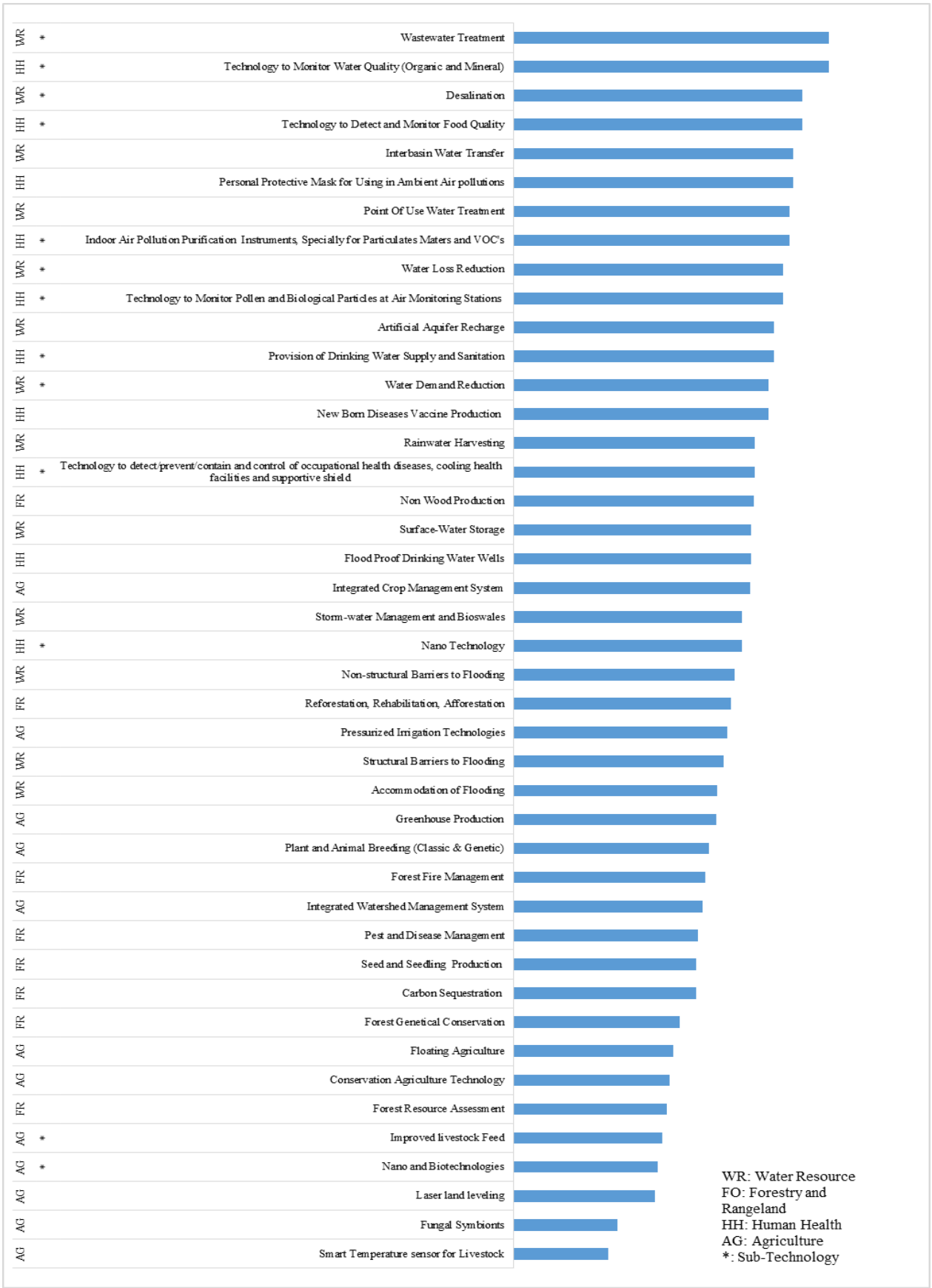


Figure 6-4 The Priorities of Adaptation Technologies

6-4 Validation of the Assessment Results

The assessment results obtained from weighting of the selected criteria and sub-criteria were validated by the experts through a separate scoring of the technologies based on their working experience.

Section 7

Challenges and Barriers Preventing the Transfer of Sound Technologies

7 Challenges and Barriers Preventing the Transfer of Sound Technologies

During the implementation of the TNA, numerous meetings were conducted, questionnaires were distributed and analysed, and brain-storming sessions with experts from various sectors such as oil and gas, electrical power plants etc., were held. As the outcome of this process, it became evident that there were many challenges to be addressed by the pertinent authorities in order to facilitate appropriate transfer of the environmental friendly technologies. Lists of such barriers are provided below, knowing that they could not be resolved without proper planning and specific action plans.

1- Political barriers

Since the Rio Summit in 1992, whose primary objective was to reduce the GHG emissions, the unsuccessful application of its decisions and recommendation resulted in the Conference of Parties (COP) in Kyoto, Japan and the inception of Kyoto Protocol as an enforceable agreement to tackle greenhouse gases. The Clean Development Mechanism (CDM) was a solution for enhancing international cooperation to mitigate GHG emissions through transfer of technology and provision of financial resources from the developed to the developing countries However, the unjust sanctions against the Islamic Republic of Iran was among the major elements hampering Iran's efforts to access financial resources and transfer of technology. Therefore, it is strongly believed that termination of all sanctions could play an important role in facilitating the successful implementation of the policies and measures identified in this TNA report.

2- Inadequate financial resources

It is evident that unjust economic sanctions during the last three decades against the Islamic Republic of Iran have complicated the transfer of financial resources to accomplish the projects, especially those requiring foreign currency.

The fluctuation in the price of energy, which are influential on allocating adequate financial resources for the transfer of technology, was another factor that could hinder the implementation of TNA projects and diminish the potential incentives for foreign investment in any given project. Other factors obstructing the normal flow of financial resources are as follows:

- Over Cautious attitude of the domestic investors towards the risks involved in environmental projects
- Inadequate knowledge of the parties involved and/or poor information-sharing on the financial resources apportioned to the projects by the clients and the project proponents
- Absence of climate finance instrumentations in the national banking system
- Low economic growth rate, in recent years
- Unjust banking and economic sanctions

3- Inadequate infrastructure

Some challenges on this issue include:

- The need for more proper legally binding agreements between the clients and the project's implementing entities
- Implementation of more incentive policies for attracting private investment on environmental projects;
- The need for more transparent regulations for the domestic and international participation and investment;

4- Lack of a competitive national market

The economic shortcomings after the victory of the Islamic Revolution due to the major events like the imposed 8-year Iraq War, the prolonged economic sanctions obstructed the successful implementation of Article 44 of the Iranian Constitution, which emphasizes a greater integration of the private sector into the national economy. Consequently, financially constrained private sector could not compete for lucrative contracts. However, encouraging the participation of private sector in a truly competitive market can help to execute TNA projects, more effectively.

Regardless of the prioritization of the technologies, other aspects of this endeavour should be taken into account. The following is a list of such impediments:

- Taking the advantage of other countries experiences lessons learned.
- Closer link between the activities of the academic and research centres can speed up the TAP projects.
- Encouraging domestic companies to participate in the international transfer of technology projects

5- Cultural and Educational Deficiencies

Public participation, which is a crucial component of a meaningful environmental management can help the process of TNA. Followings are few examples of such deficiencies that have to be dealt with:

- Lack of team work sprit and coordination in multi-disciplinary aspects of the environmental problems
- Absence of parental guidance and education to the youth about the environmental concerns

Undoubtedly, a well-organized campaign to tackle the above-mentioned challenges would highly facilitate the successful and timely implementation of the TNA.

Section 8

Conclusion

8 Conclusion

The national legal settings for the transfer of climate friendly technologies are fairly adequate but in need of improvement. The Constitution, the Vision and the Major Environmental Policies (VMEP) set an adequate platform for introduction of environmental friendly technologies including transfer of technologies and associated know-how as well as national technology development to deal with climate change challenges.

The interface with the international legal setting is equally mixed in terms of effectiveness. The UNFCCC is an important international environmental treaty which has been formed by the efforts of thousands of people over the past two decades in order to control and stabilize greenhouse gases emissions and provide a framework for international cooperation. The full implementation of the Convention at the national level can play a major role in future developments in the field of energy technology, energy conversion, industrial processes, reduction in GHGs emission etc. all of which are in line with the objectives of the sustainable development.

The full implementation of the UNFCCC requires increased energy efficiency in the production and consumption cycle, energy loss reduction in energy transmission lines, development of public transport, use of renewable sources of energy, phase out of the fuel subsidies, use of appropriate energy policies in household equipment, alignment of domestic legislation and the Convention and the pertinent rules, climate change comprehensive program setting priority for preventive and corrective actions, promoting the technologies related to climate change and their expansion through the development of research and educational programs, and finally implementation of programs to promote public awareness are the practical plans to achieve the mentioned goal. UNFCCC full implementation also calls for active participation of Iran in the Convention events including seminars and programs on Climate Change in order to raise fund and transfer new technologies under the Clean Development Mechanism and Joint Initiative.

However, there were many challenges to be addressed for example unjust sanctions, in order to properly transfer environmental friendly technologies.

In this respect, in addition to the removal of all categories of unjust sanctions, it is viewed that the successful implementation of Article 44 of the Iranian Constitution, which emphasizes greater integration of the private sector into the national economy through participation of private sector in a truly competitive market is a key to effective implementation of Iran's TNA.

In conclusion, Iran has fulfilled most of its obligations under the United Nations Framework Convention on Climate Change, but more effective international cooperation would require termination of all unjust sanctions in the fields of economy, banking and financial activities and technology, adopting more stringent law enforcement activities and improved inter-sectoral coordination amongst pertinent national authorities. Overcoming the existing challenges would trigger national activities to address various aspects of climate change, in line with the UNFCCC objectives.

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