

Islamic Republic of IRAN

Country Nuclear Power Profile

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ISLAMIC REPUBLIC OF IRAN

1. GENERAL INFORMATION

1.1. Country overview

The Islamic Republic of Iran is situated in the Middle East and has an area of 1,648,195 square kilometres.

1.1.1. Governmental System

Islamic Republic & presidential democracy

1.1.2. Geography and Climate

Geographically, Iran is bordered by Armenia, Azerbaijan and Turkmenistan Republics and Caspian Sea in the north, Afghanistan and Pakistan in the east, Turkey and Iraq in the west and Kuwait, Persian Gulf and Sea of Oman in the south. Mountain chains like Alborz, Zagros make Iran's feature as a mountainous country. Vast deserts in the centre and south east half of the country makes the major natural geographical profile of it.

Iran has a variable climate. From north to the south of the country, climate and temperature change abruptly (-20°C, +50°C). Central and Southern Iran is dry and hot with low precipitation. On the whole, it has four distinct seasons. The southern part, nearby Persian Gulf, where Bushehr Nuclear Power Plant is situated has long, hot and humid summers and moderate winters. The country has a fairly high seismic activity.

1.1.3. Population

According to the 2011 population census the population of Iran was more than 74 million, which has been doubled over the last three decades (Table 1).

TABLE 1. POPULATION INFORMATION

Year	1970	1980	1990	2000	2005	2013	Average annual growth rate (%)
							2000 to 2013
Population (millions)	28.4	39.3	56.3	63.7	69.39	76.04	1.4
Population density (inhabitants/km ²)	17.3	23.8	34.2	38.6	42.1	46.13	1.4
Urban Population as % of total	-	-	-	-	68	71	-
Area (1000 km ²)	1648.2						

Source: IRAN Statistical Year Books

1.1.4. Economic Data

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

Year							Average annual growth rate (%)
	1970	1980	1990	2000	2005	2013	2000 to 2013
GDP (milliard of current Rial)	780	6607.8	37177	624090	1993665	7091389	20.6
GDP per capita (milliard of current Rial /capita)	27	168	660	9797	28731	93259	18.9

Source: IRAN Statistical Year Books

1.2. Energy Information

1.2.1. Estimated available energy

TABLE 3. ESTIMATED AVAILABLE ENERGY SOURCES

	Estimated available energy sources					
	Fossil Fuels			Nuclear	Renewables	
	Solid	Liquid	Gas	Uranium	Hydro	Other
Total amount in specific units*	1121.8	156.53	33.79	1390**	0.01	0.001

* Solid, Liquid: Million tons; Gas: Billion m3; Uranium: tons; Hydro, Renewable: TW

** Reasonably Assured Conventional Resources (RAR)

Source: Energy Balance 2013, Power Ministry of IRAN & Questionnaire's of Redbook 2015

1.2.2. Energy Statistics

In 2011, the total primary energy consumption had been around 1601.2 million barrels equivalent of crude oil which compared to the 2010 shows growth rate of around 3.5%.and comparing to the past 10 years (2001-2011), it shows an average annual growth rate around 4.6%. This comparison shows an increase in consumption trend during the recent years.

In 2011, fossil resources provided for 99.3% of primary energy of the country. Despite efforts and activities made, utilization of other energy resources has negligible share of primary energy production.

At the end of 2011, Iran's yield of crude oil and gas condensates was comprises estimated at around 156.53 billion of barrels. This amount comprises around 9% of the world's total reserves of crude oil. In 2011, in the crude oil and oil by-product sector the total production showed an equivalent amount of 1595.7, imports around 33.8, export around 1029.5 and final consumption around an equivalent amount of 421.3 million barrel of crude oil which as compared to the previous years and past 10 years

shows growth rates of -9.8% and 0.7%, respectively. Considering the rising trend of consumption, import and almost constant production rate of energy careers in the recent years, one might expect that in the future, Iran's situation as one of the major oil exporter will be jeopardized, unless mix-energy policy is effectively implemented.

After crude oil, natural gas is the second source of primary energy production in Iran.

In 2011, more than 37% of total primary energy production was provided by natural gas. Iran's natural gas reservoir is estimated at 33.2 trillion cubic meters which is around 16.2% of world natural gas reservoir. In 2011, the total production of natural gas was an equivalent amount of 947.8 and final consumption showed an equivalent amount of 652.1 million barrel of crude oil. Comparing to the past 10 years, production and consumption of gas have had an average annual growth rate of 9% and 11% respectively. Considering government's vast program for the expansion of the gas network to the cities and villages, injection of this product to oil repository in order to increase the coefficient of recovering oil wells and covering the need for petrochemical industries would be a major task. The possibility of using of this type of energy as the only source, or exclusive source, for providing fuel for the development in the country's electricity programs, at least in the next few years, would surely decrease [Iran's natural gas reservoir]. Cutting off the gas needed for many of the industrial unites, transportation and even country power plants and the use of other alternative sources and fuels and oil by-products to compensate for the lack of gas in cold seasons of the years, will add to the concerns.

In 2011, among the energy careers, after crude oil and oil by-product and natural gas, electricity with 9.3% received the highest share in the final energy consumption. Nominal capacity of the country's power plants has reached to 65222 MW which as compared to the previous year shows an increase of around 6.1%. The share of various kinds of power plants functions includes: steam (around 22.9%), gaseous and combinatorial cycle (around 42%), hydroelectric (around 13.4%), diesel, reproducible and nuclear energies (around 2.3%). The country power plant gross production was 240063 million kilowatt, which compared to the previous year shows a growth rate of 3.1% and as compared to the past year's electricity export shows a significant change and depicts a growth rate of 29.2%. The import of electricity has increased by 21.2% and has been limited to 3656.1 million KWh. Regarding the variety of consumed fuel in power plants, one could say that in 2011 around 38901 million cubic meter of natural gas (around 79% of total consumed energy in the country and more than 25% of country's total consumed natural gas), 9406.3 million liter of gas oil (around 25.8% of total country's gasoil consumption), 12018.9 million liter of kiln petroleum (around 74% of country's total consumption of fuel oil) with the total heat value of 445970 billion Kcal were reported.

In 2010, Iran's energy consumption intensity per GDP was 619.50 ton oil equivalent. It is indicating that Iran is one of the most energy intensive countries in the world with energy intensity index of 10 times more than that of Japan and of 8.4 times more than that of EU. In 2011, per-capita energy consumption for Iran reached to 14.22 barrel equivalent of crude oil which is more than the previous year. It should be explained that annual growth rate and average annual growth rate of energy consumption during the past 10 years has been 6.7% and 5.25%, respectively.

On the other hand, fossil resources are also the main source of country's foreign revenue and their export is the main economical provider of the country's projects. The above statistics and factual information show that the Islamic Republic of Iran has a large and complex challenges to deal with in the field of energy due to its speedy development. Disproportionally of technical, economic and social factors of primary energy source, requirements for sustainable development, providing fuel for the power plants, providing feeding raw materials for refineries and petrochemical industries using the main source of country revenue), are other various aspects of the energy challenge.

TABLE 4. ENERGY STATISTICS

						Average annual growth rate (%)
Year	1980	1990	2000	2005	2013	2000 to 2013
Energy consumption**						
- Total	185	359.82	621.65	1196.7	1181.1	5.1
- Solids***	0.1	0.12	0.15	4.8	2.1	22.5
- Liquids	161.9	270.7	362.7	756.3	422.2	1.2
- Gases	8.7	55.9	200.6	344.1	631.3	9.2
- Nuclear	-	-	-	-	-	-
- Hydro	11.3	29.6	55.6	79.7	117.2	5.9
- Other Renewables	3	3.5	2.6	11.8	8.3	9.3
Energy production						-
- Total	585.2	1366.1	1812.02	2226.68	2215.57	1.6
- Solids***	2.9	4.4	5.6	7.6	5.12	-0.7
- Liquids	541.2	1192.2	1429.4	1582.9	1209.7	-1.3
- Gases	29.3	153.1	372.2	614.8	985.24	7.8
- Nuclear	-	-	-	-	3.29	-
- Hydro	8.8	9.5	2.22	9.54	7.3	9.6
- Other Renewables	3	6.9	2.6	11.84	4.92	5.0
Net import (Import - Export)						-
- Total	-324.7	-872.7	-948	-979.5	-604.4	-3.4

** Energy consumption = Primary energy consumption + Net import (Import - Export) of secondary energy.

*** Solid fuels include coal, lignite

Source: Energy Balance 2013, Power Ministry of IRAN

1.2.3. Energy policy

Iran's government has given priority to hydropower projects in the first and second 5-year development plans. This policy will continue in future development programs. But due to the limitations of hydro potentials and the rapid growth of electricity demand, other options are also needed to be considered for diversification purposes. The other policy of the government is to use different energy potentials for conservation measures at present time. Moreover, some conservation and energy consumption control and management measures have been implemented to control growth of the demand in recent years. In supply side, the government has launched a serious program for substitution of oil by gas as well as more exploitation of hydroelectricity in the country. Completion of Bushehr nuclear power project and implementation of a project to install 100 MW (e) from wind turbine is regarded to be a part of this diversification program.

1.3. The electricity system

1.3.1. Electricity policy and decision making process

The Ministry of Power is responsible for the development of power sector based on the energy programme, and concepts, which are approved by the Government of the Islamic Republic of Iran in its 5-year development programme.

1.3.2. Structure of electric power sector

The main producer of electricity in Iran is the Ministry of Power. The electricity system of Iran (production, transmission and distribution) is centralized and owned by the government. Recently, the government has started to study the option of privatization in small-scale to assess its benefits and outcomes for future programs.

1.3.3. Main indicators

In 2011, the maximum exploitable power was 65,222.2 MW (e) with 22.9% share of steam power plants, 42% share of gas and combined cycle power plants, 13.4% share of hydro power plants, 2.3% share of diesel, Solar & Wind, Atomic & biogas power plants. Table 4 shows the historical electricity production and installed capacity and Table 5 shows the energy related ratios.

TABLE 5. ELECTRICITY PRODUCTION, CONSUMPTION AND CAPACITY

Year	1980	1990	2000	2005	2014	Average annual growth rate (%)
						2000 to 2014
Capacity of electrical plants (GWe)						
- Thermal	9.85	12.85	24.81	32.15	61.17	6.7
- Hydro	1.8	1.95	2	6.04	10.79	12.8
- Nuclear	-	-	-	-	1.02	-
- Wind	-	-	-	0.05	0.17	-
- Total	11.65	14.8	26.81	38.24	73.15	7.4
Electricity production (TWh)						
- Thermal	1	1.25	112.06	155	255.87	6.1
- Hydro	5.62	6.08	3.65	16.1	13.86	10.0
- Nuclear	-	-	-	0.07	4.14	-
- Renewable	-	-	-	-	0.61	-
- Total (1)	6.62	7.33	115.71	171.17	274.48	6.4
Total Electricity consumption (TW.h)	-	-	-	132.9	219.7	-

(1) Electricity transmission losses are not deducted.

* Latest available data

Source: Energy Balance 2013, Power Ministry of IRAN

TABLE 6. ENERGY RELATED RATIOS

Year	1980	1990	2000	2005	2013
Energy consumption per capita (Equivalent Barrel/capita)	4.71	6.72	9.68	12.23	13.92
Electricity consumption per capita (kW.h/capita)	596.59	1084.78	1890.14	2566.48	3344.05
Electricity production/Energy production (%)	5.2	6.6	7.7	8.2	8.1
Nuclear/Total electricity (%)	-	-	-	-	0.15
Ratio of external dependency (%) (1)	54.7	66.1	64	66.1	64.9

(1) Net import / Total energy consumption.

Source: Energy Balance 2013, Power Ministry of IRAN

2. NUCLEAR POWER SITUATION

2.1. Historical development and current organizational structure

2.1.1. Overview

In the mid-1970s, a major nuclear power program was planned, and construction of two nuclear power plants, 2×1294MW (e) PWR units construction started at Bushehr. Bushehr Nuclear Power Plant (BNPP) is situated on the northern part of the Persian Gulf, near the city of Bushehr. In 1979, construction program of this nuclear power plant, first started with the KWU as the vendor, and was suspended and halted, at a fairly advanced stage of the civil work performed for the two units.

The Islamic Republic of Iran resumed the nuclear power program in 1991 with a bilateral agreement with China for the supply of two 300 MW (e) PWR units of Chinese design, similar to the Qinshan power plant. The agreement was confirmed in 1993 (but never been implemented).

In 1992, the government of the Islamic Republic of Iran and the government of the Russian Federation signed a bilateral agreement on the peaceful uses of atomic energy. As a follow-up, the Atomic Energy Organization of Iran (AEOI) and the Ministry of Atomic Energy (MINATOM) of the Russian Federation reached an agreement for the completion of the Bushehr NPP Unit 1 with a VVER-1000 type reactor. The decision to resume the Bushehr project with a new design has placed a heavy responsibility on the Atomic Energy Organization of Iran (AEOI), which serves as the owner organization, and the National Regulatory Authority of Iran (INRA) for performing the national program of nuclear power and nuclear applications in particular on its Nuclear Power handled by the (NPPD). In 1998, the AEOI and MINATOM agreed to change the supply term of agreement for the BNPP Unit 1 to a turnkey contract, Based on this the Atom Story Export ASE from the Russian side was assigned for completion of the construction of the BNPP-1 considering necessary changes in design.

Until 2009, civil modifications, supply of equipment and complementary activities were completed. Initiation of Bushehr NPP Unit 1 has been done in 8 May 2011. In addition first connection to grid and commercial use of Bushehr NPP Unit 1 has been done in 3 and 23 of September 2011.

2.1.2. Current organizational chart(s)

Nuclear Power Production and Development Co. of Iran is responsible for design, construction, commissioning, maintenance and decommissioning of nuclear power plants and research reactors in Iran, and subsidiary of Atomic Energy Organization of Iran. Furthermore, the regulatory body in Iran and Nuclear Power Production and Development Co. of Iran, are separate from each other and generally regulatory body is an independent organization.

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2.2. Nuclear power plants: Overview

2.2.1. Status and performance of nuclear power plants

TABLE 7. STATUS AND PERFORMANCE OF NUCLEAR POWER PLANTS

Station	Type	Net Capacity	Operator	Status	Reactor Supplier	Construction Date	Grid Date	Commercial Date	Shutdown Date
BUSHEHR 1	PWR	915	Operational	NPPDCO	ASE	1975-05-01	2011-09-03	2011-09-23	-

2.2.2. Plant upgrading, plant life management and license renewals

The accident at Fukushima NPP became the most important event in the nuclear energy field over the last 25 years. The NPPD has decided to perform Stress Tests at BNPP-1 as the response measure to this event.

Stress Test was conducted at BNPP-1 with participation of all relevant organizations using deterministic approach. The result of safety assessment recommended to prepare the mobile Diesel generators (2 & 0.2) and Mobil Diesel pump for BNPP-1 doing severe Accident Conditions. The A.M. Equipment's are under manufacturing process and Test.

In addition NPPD/BNPP-1 has participated as a member of WANO-MC in Regional Crisis Centre(RCC) for VVER reactors.

The main tasks of RCC for VVER reactors specified are as follows:

1. To provide advice and Technical Assistance in the event of a Site/General Emergency at WANOMCVVER plants;
2. Distribution of information on safety relevant events at NPPs among its members;
3. A common pool of information and expertise to ensure the response of Emergency team in the event.

2.3. Future Development of Nuclear Power Sector

2.3.1. Nuclear power development strategy

The on-going and planned activities for development of the NPPD in compliance with the country's 5th FYP (Five-Year Program up to 2016) are:

1. Safe and Reliable Operation of Bushehr Nuclear Power Plant – Unit1,

2. Design and construction of Darkhowin Medium sized nuclear power plant with PWR type reactor using capacities of Iranian companies,
3. Implementation of detailed studies, taking possession of and preparing the sites for construction of new nuclear power plants,
4. Starting the activities for the construction of 5000 MW of nuclear power plants including 2 new large size (VVER) at Bushehr site.
5. Training of qualified personnel in the field of nuclear science and technology in line with national plan for the NPP development.

Furthermore, based on the legislation in mid-2005 by the Parliament, the prospect of nuclear power development in country and share of nuclear energy in the total electricity generation capacity of the country has been set at 20000 MW. To obtain this goal, different activities were identified in the Atomic Energy Organization of Iran. One of the key decisions undertakes the development of the conceptual, basic and detail design and eventually construction of a medium size Pressurized Light Water Reactor with an electric output of about 360 MWe (IR-360).

It is expected that the IAEA provides technical support in terms of reviewing and commenting on the various aspects of the IR-360 engineering design. It is also expected that technical support are provided for establishing a strong R&D program in support of the reactor design and its verification.

The Bushehr Nuclear Power Plant unit one, the only NPP under operation in the country, has been connected to the grid in Sep.2011 and started its commercial operation since Sep.2013. Figures for the FYP (Five-Year Program) envisage the addition of 2000 MWe to the power generation capacity. In this respect the contract for units 2&3 has been signed and the works related to the obtaining site engineering data is underway.

TABLE 8. PLANNED NUCLEAR POWER PLANTS

Station/Project Name	Type	Capacity	Expected Construction Start Year	Expected Commercial Year
BUSHEHR-2	VVER	1000	30 months after site report	78 months after construction date
BUSHEHR-3	VVER	1000	48 months after site report	96 months after construction date

In addition, in order to prevent water crisis in the near future, the Atomic Energy Organization of Iran and Nuclear Power Production and Development Co. (NPPD) of Iran have decided to undertake development of the desalination facility with the production capacity of about 200,000 m³/day beside

BNPP to meet the demand of Bushehr province for desalinated drinking water, bearing in mind all safety and environmental aspects.

2.3.2. Project management

The Nuclear Power Production and Development Co. of Iran which is the responsible body for development of nuclear power plants in Iran identifies and approves different projects. For any project, project manager are assigned by NPPD Co. and have adequate authorities to complete the project effectively.

2.3.3. Project funding

Presently, the government is responsible for funding the nuclear power plant development in Iran and the required budget, with regard to long and medium term plans, is estimated and approved in accordance with the development programs and projects. Institutions involved in this process include Islamic Parliament of Iran, Vice Presidency for Strategic Planning and Supervision, and Atomic Energy Organization of Iran.

2.3.4. Electric grid development

There is no need for further development of the existing grid for additional NPPs.

2.3.5. Sitting

In line with government policy and planning for sustainable development, the site surveying and selection project for selecting suitable site/sites for construction of new nuclear power plants was defined & implemented. The study, investigation and evaluation of the proposed sites are carried out based on INRA regulation which considers the Agency relevant safety standards, last documented international experiences and some other relevant regulations including NRC. The project accomplished in three phases are as follows:

1. Phase zero: preparing the necessary documents related to process of selection of consulting engineers for studying different regions and also determining the preparation format of periodical reports.
2. Phase one: study of regions by designated consultant engineers, leading and orienting consultant engineers, developing the methodology for different stages, coordinating the studies of regions, supervising measures for studying, reviewing and approval of case & providing periodical reports until the final phase of the project and presenting the selected sites.
3. Phase two: summing up the results and characteristics of the selected sites and ranking them for determining the chosen ones in coastal and inland regions

Finally 16 proposed sites are under consideration in coastal and inland regions.

2.3.6. Public Acceptance

As we know one of the most important challenges against nuclear energy in the world is obtaining public acceptance. Lack of public acceptance causes the rise of other challenges and risks against nuclear energy. Therefore, lack of consideration for public acceptance in order to take necessary measures for obtaining it, means to face many other great challenges. Public acceptance in nuclear energy field is one of the most important factors that governments must consider it as a high priority issue.

Government should establish and maintain a system or mechanism to convince people and get public acceptance for the development of NPPs in the country.

To achieve this goal some activities will be considered such as:

1. Providing information to the public with regard to advantages of the production of nuclear power. Taking into consideration the objective(s) and strategies of nuclear power development stipulated in national nuclear documents.
2. Presenting overall public acceptance concept and comprehensive understanding of nuclear energy advantages and benefits in all over for the different parts of the Country.
3. Establishing an appropriate nuclear culture in society, and improving it based on proper feedbacks.

2.4. Organizations involved in construction of NPPs

The projects of Nuclear Power Plant construction are being accomplished by the project manager that provides its reports directly to the vice president of the Islamic Republic of Iran. Supervisory Commission is responsible for over sighting regulatory activities which are performed by the operating organization and its contractors.

2.5. Organizations involved in operation of NPPs

The competent authorities of the Islamic Republic of Iran have assigned a high priority to the establishment of certain nuclear power generation capacity within the energy sector of the country as reflected in the Country Program Framework (CPF). The Government provides the required financial and organizational support and technical staff for this National Nuclear Power Program and has established the totally state owned Nuclear Power Production and Development Co. of Iran (NPPD),

, as the owner / operating organization of NPPs in the Islamic Republic of Iran. The scope of NPPD objectives states:

NPPD Company is a symbol of the peaceful use of nuclear power technology in a reliable and safe regime of power production to satisfy demands of next generation in consideration of sustainable development in Iran. It is a dynamic organization that have qualified and skilled human resources in active technical and scientific sections of nuclear power plants.

In addition to this scope, the NPPD missions include:

1. Study and propose appropriate policies and strategies to converges take holders activities for effective and peaceful use of nuclear power technology, providing feeding row materials,
2. Development of technology and human resources and expansion of safety culture,
3. Effective relations with international and regional institutions to exploit technical and scientific opportunities and exchange experiments,
4. Construction and operation of nuclear power plants and acting in power market,
5. Supply of fuel and equipment of nuclear power plants, and
6. Effective relation with domestic scientific institutions and universities in order to promote Iran's potentials in nuclear power plant technology.

Iran follows self-reliance in energy sector and so has a wide program for providing the necessary infrastructures in this sector for its on-going and future long term development programs, with due respect and considerations to its international obligations & involvement in international instruments. In nuclear fuel sector of the energy plan our activities, which are conducted & proceeds based on plan & programmes of the country & by considering & in accordance with international obligations & JCPOA includes: uranium exploration, mining, {U3O8 production, uranium conversion, uranium enrichment and fuel fabrication in complete accordance with JCPOA agreements}. In addition, to respond the requirements of the radioactive waste management, a great project was defined for site selection and it is in the stage of designing. The international practice is envisaged for supply of such services. Relevant measures for storage of wastes will be considered in the unit design.

2.6. Organizations involved in decommissioning of NPPs

Although Iran's first NPP has recently been put into commercial operation, only the overall plan of decommissioning was considered in safety documents of national nuclear safety regulation. This has been done by the operator based on the national regulatory bodies' regulation. Therefore, for the time

being there is no need to any further practical action. However the operator, the Iranian nuclear waste management company and any technical supporting company as well as Supervisory Commission will be involved in planning of NPP'S decommissioning when necessary.

2.7. Fuel cycle including waste management

Iran Nuclear fuel cycle includes uranium exploration, mining, U_3O_8 production, uranium conversion, uranium enrichment and fuel fabrication, which began from several years ago, and achieved different physical progresses. Also, a company known as Iran Nuclear Waste Management (INWM) is designated by the AEOI as the central waste management organization.

2.7.1. Uranium mining and milling

Iran's uranium mines are as follow:

- Saghand, Underground uranium mine.
- Gachin, Open-pit uranium mine.
- Narigan mine that is under planning & designing.

Iran's plants for producing yellowcake are as follow:

- Bandar Abbas Uranium Plant (BUP) that is operating with nominal capacity of 21 tonU/a.
- Ardakan yellowcake plant (YCP) that is under pre-commissioning and has nominal capacity of 50 tonU/a.

2.7.2. Uranium conversion & fuel fabrication

The Uranium Conversion Facility (UCF) at Isfahan contains process lines to convert yellowcake into natural uranium oxide (UO_2) and natural uranium hexafluoride (UF_6) which began in June 2004.

The UCF consists of several conversion lines, mainly the line for the conversion of yellowcake to natural UF_6 . The nominal capacity of the UCF is 296 tons natural UF_6 and 16 ton natural UO_2 per year. The natural UF_6 is made for the uranium enrichment facility (Natanz). The UCF is also able to reconvert LEU into uranium oxide (UO_2) and depleted uranium hexafluoride (UF_6) into depleted uranium tetra fluoride (UF_4).

Iran has achieved to the technologies for producing fuel assembly at the fuel manufacturing plant (FMP) and fuel plate fabrication plant (FPFP) which is used for its Research Reactors.

Enriched UO_2 Powder Plant (EUPP) is producing enriched UO_2 (up to 3.67%) used in manufacturing fuel element of IRB1 in FMP. The nominal capacity of producing enriched UO_2 is 34 tons/a.

FMP is responsible for producing kinds of fuel elements of IRB1.

(FPMP is responsible for producing fuel assemblies of IRA (with nominal capacity of 40 assemblies/a).

The Zirconium Production Plant (ZPP) is able to produce zirconium sponge with nuclear grade that finally it was changed to Zirconium-Niobium alloys (with nominal capacity of 12ton Zr Alloys/a).

Several projects for recycling of radioactive wastes have been defined and also waste volume decreasing is under planning and operation (in Isfahan).

2.7.3. Enrichment process

The first uranium enrichment plant built in Iran is located in Natanz which contains two primary facilities, namely: the Pilot Fuel Enrichment Plant (PFEP) and the Fuel Enrichment Plant (FEP). It also houses a centrifuge assembly area.

Fordow, near the city of Qom, is the second site which is of an underground type enrichment facility in Iran. Fordow facility, according to Joint Comprehensive Plan of Action (JCPOA) is going to be converted into a nuclear physics and technology centre with international cooperation.

2.7.4. Reprocessing

Spent fuel reprocessing is not considered or planned in any stage of the nuclear fuel cycle processing in Iran.

2.7.5. Waste management

Iran Nuclear Waste Management Co. (INWM) is responsible for consulting on all aspects of radioactive waste management activities in Iran, as well as for transportation, processing and storage of institutional radioactive waste derived from the minor waste generators. It is also responsible for disposal of all radioactive wastes in Iran including operational and performing decommissioning waste (with disposal capacity of 165000m³ low & intermediate level wastes) estimated in the future.

The national near surface repository is currently at the construction stage. Based on the current planning, Iran's near Surface Repository (INSuRe) is expected to be operational by 2018 for disposal, but it will be ready for receiving waste packages for long term storage in the near future. The waste to be generated by that time at the relevant institutions can be collected for storage in existing storage facilities of INWM.

In addition to responding to the requirement of the radioactive waste management a great related project is defined, its site selected, and is in the stage of designing. An internationally observed

practice is envisaged for the supply of such services. Relevant measures for the storage of wastes are to be considered in the unit design.

2.8. Research and development

2.8.1. R&D organizations

- Physics and Accelerators Research School
- Nuclear Agriculture Research School
- Reactor Research School
- Laser and Optic Research School
- Radiation Application Research School
- Nuclear Fuel Cycle Research School
- Material Research School
- Instrumentation Research Group
- Safety and Radiation Protection Research Group
- Nuclear law Research Group

2.8.2. Development of advanced nuclear technologies

There is no partnership being considered currently.

2.8.3. International co-operation and initiatives

Iran has been participating in conferences, technical committee meetings, general meetings, advisory group meetings, and training and fellowship programs under the sponsorship of the IAEA or in the framework of its Technical Co-operation projects.

The International Atomic Energy Agency supports the peaceful applications of nuclear science and technology in Iran by means of the following Technical Co-operation projects; for the time period (2014-2015):

- 1- Strengthening and upgrading capabilities for safe and reliable operation and maintenance of a Pressurized Light Water Reactor (IRA2011)
- 2- Increasing Nuclear Power Production Development Co. of Iran (NPPD's) Capability in planning and implementing activities related to the design and construction of Two New Pressurized Light Water NPP Units in Bushehr with Emphasis on Safety (IRA2012)

- 3- Developing Therapeutic Radiopharmaceuticals and Brachytherapy Products for cancer treatment and production of Radioimmunoassay (RIA) Diagnostic Kits (IRA6009)
- 4- Assessing seawater intrusion into the coastal Aquifer of Neka, Mazandaran province (IRA7002)
- 5- Enhancing the regulation of nuclear facilities and radiation Activities (IRA9020)
- 6- Ensuring the safe construction of the TALMESI Radioactive Waste Disposal Facility (IRA9021)
- 7- Enhancing the safety of Tehran Research Reactor (TRR) (IRA9022)

Regional Project

- 1-Supporting nuclear education and training through e-Learning and other means of advanced information communication technology (ICT) (RAS0064)
- 2- Supporting the sustainability and networking of National Nuclear Institutions in Asia and the Pacific Region (RAS0065)
- 3- Providing legislative assistance on establishing and upgrading the Legal Framework designed for the safe, Secure and Peaceful Use of Nuclear Energy (RAS0071)
- 4- Supporting human resource development activities and Nuclear Technology (RAS0073)
- 5- Enhancing the Safety and utilization of Research Reactors (RAS1019)
- 6- Supporting early warning, response systems and Control of Trans boundary animal diseases (RAS5060)
- 7- Supporting food irradiation technology process to ensure the safety and quality of meals provided for Immunocompromised Patients and Other Target Groups (RAS5061)
- 8- Building technological capacity for food traceability and Safety Control Systems through the Use of Nuclear Analytical Techniques (RAS5062)
- 9- Enhancing the productivity of locally-underused crops through dissemination of mutated germplasm and evaluation of soil, nutrient and water management practices (RAS5064)
- 10- Supporting Climate-Proofing Rice Production Systems (CRiPS) Based on Nuclear Applications (RAS5065)

- 11- Promoting the sharing of expertise and infrastructure designed for Dengue Vector Surveillance intended for the integration of the sterile insect technique cooperation with conventional control methods among South and South East Asian Countries (RAS5066)
- 12- Integrating sterile insect technique for better cost-effectiveness cooperation of Area-Wide fruit fly pest management Programmes in Southeast Asia (RAS5067)
- 13- Complementing conventional approaches with nuclear techniques towards achieving Flood Risk Mitigation and Post-Flood Rehabilitation Efforts in Asia (RAS5069)
- 14- Using Stable Isotope Techniques to monitor situations and interventions for promoting infant and young Children Nutrition (RAS6073)
- 15-Improving the quality life of Cancer Patients through Streamlined and emerging Therapeutic Nuclear Medicine Techniques (RAS6074)
- 16- Optimizing the role of Nuclear Medicine Techniques in the diagnosis and clinical management of childhood cancer cases and Inborn Diseases (RAS6075)
- 17- Strengthening Hybrid Imaging in Nuclear Medicine in Asia
- 18- Preventing the spread of Overweight and Obesity cases, and Promoting physical activity among children and adolescents (RAS6080)
- 19- Supporting the Use of Receptor Binding Assay (RBA) to reduce the adverse impacts of harmful Algal toxins on seafood safety (RAS7026)
- 20- Ure (RAS/9/061)
- 21- Strengthening education and training infrastructure and building competence for improved Radiation Safety (RAS9066)
- 22- Strengthening an effective Compliance Assurance Regime for the orderly transport of Radioactive Material (RAS9067)
- 23- Establishing a competent Radioactive Waste Management Infrastructure (RAS9071)
- 24- Supporting Human Resource Development Process for Promoting Nuclear Security (RAS9072)
- 25- Strengthening the Regulatory Infrastructure for Radiation, Control Transport and Waste Management Safety (RAS9073)

- 26- Enhancing and strengthening National Regulatory Infrastructure for Safety purposes through Self-Assessment (RAS9074)
- 27- Strengthening radiation protection infrastructure and technical capabilities achieving the Safety of Workers, Patients and the general Public (RAS9075)
- 28- Strengthening of national capabilities for responding to nuclear and radiological emergencies (RAS9076)

Interregional Project

- 1- Developing human resources and supporting nuclear technology processes (INT0089)
- 2- Enhancing safety management and safety documentation for Research Reactors in extended shutdown cases and during the Transition Periods between Operation and Decommissioning Phases (INT1057)
- 3- Sharing knowledge on the use of sterile insect techniques and Related Techniques for Integrated Area-Wide Management of Insect Pests (INT5151)
- 4- Assessing the impact of climate change and its Effects on Soil and Water Resources in Polar and Mountainous Regions (INT5153)
- 5- Supporting distance assisted training for Nuclear Medicine Technologists-experts (INT6055)
- 6- Supporting quality management Audits in Nuclear Medicine Practices (QUANUM) (INT6056)
- 7- Establishing a Joint IAEA/ICTP International Post-Graduate Medical Physics Education Programme (INT6057)
- 8- Connecting networks for enhanced communication and training (INT9174)
- 9- Promoting safe and efficient Clean-Up of radioactively contaminated facilities and Sites (INT9175)
- 10- Characterization and disposal of low and intermediate level radioactive Waste (INT9177)
- 11- Mart Card/Smart Rad Track - Long term recording of patient doses in diagnostic and interventional procedures (INT9178)
- 12- Regulatory Cooperation Forum (RCF)(INT9179)

- 13- Sustaining the Safe transport of radioactive material by promoting the harmonization of transport regulations and building regulatory Capacity and Outreach to the Transport Community to address global related Issues Including denial of shipment (INT9180)
- 14- Building capacity and supporting self-evaluation of capacity building activities on safety matters. A among possessing Member States Nuclear Power Plants and those contemplating of embarking on Nuclear Power Programmes (INT9181)

2.9. Human Resources Development

The national strategy of human resources development intended for improving the necessary capabilities of nuclear activities in all life cycle of national nuclear facilities.

The importance of HRD in sitting, designing, construction, commissioning, operation and decommissioning of nuclear fuel cycle facilities and activities is prioritised.

The HRD planning and extensive education is done in universities and the complementary professional training courses & on the job training are held as well by AEOI& enterprises.

2.10. Stakeholder Communication

Communication with stakeholders is accomplished through the website, public affairs division, reports submitted in seminars, specific conferences, public briefings offered by the Atomic Energy Organization of Iran (AEOI) spokesman and disseminated information sheets and brochures.

2.11. Emergency Preparedness

According to the set national laws the management of the national crisis will be done by Iranian Crisis Management Organization (ICMO) and any action regarding the management of nuclear or radiological crisis should be done under the supervision of national passive defence organization of IRAN and in collaboration with the ICMO.

3. NATIONAL LAWS AND REGULATIONS

3.1. Regulatory framework

The Supervisory Commission established by Nuclear Energy Commission in 2012, according to Atomic Energy Organization of Iran (AEOI) Act (1974), has been entrusted the regulatory functions governing nuclear and radiation facilities and activities in Iran. The Supervisory Commission encompasses regulatory activities relating to Safety, Security and Safeguards (3S). In this line, the operating organization has the sole responsibility for implementation of safety, security and safeguards measures.

3.1.1. Safety Regulatory Authority

Iran Nuclear Regulatory Authority (INRA) is the only nuclear and radiation regulatory body active in the field of nuclear safety in the Islamic Republic of Iran. The legislative, legal basis for the INRA is primarily provided by the Atomic Energy Organization of Iran (AEOI) Act dated (1974) and Radiation Protection (RP) Act (1989). The AEOI Act covers the activities for which the AEOI was established upon. These activities include application of nuclear energy and radiation in areas including industry, agriculture, medicine and research. The RP Act covers all the affairs related to the radiation protection aspects in the country including radiation related workers, public and future generations to be safeguarded against radiation hazards. The Act also encompasses the construction, commissioning, operation and decommissioning of radiation facilities. Furthermore, it covers the importing, exporting and the proper use of radiation sources. These acts and their corresponding lower tier legislations comprise the basis of the INRA activities. The promulgated legislations authorizes the INRA, as entrusted by AEOI, to exert effective national regulatory supervision control over the nuclear radiation, waste management and safe transport. To accomplish its goals, INRA has established a functional structure comprising of three specific departments: National Nuclear Safety Department (NNSD), National Radiation Protection Department (NRPD) and Nuclear & Radiation Service Department (NRSD). The National Nuclear Safety Department (NNSD) is responsible for regulatory supervision and control of all national nuclear installations. Regulatory control of radiation (sources) activities and facilities is done by NRPD. The regulatory support activities are covered by NRSD.

3.1.2. Nuclear Safeguards and Security Regulatory Authority

National Nuclear Safeguards Department (NNSG) is the Regulatory Authority in the fields of Nuclear Safeguards and Security in the I.R. of Iran. Legislative basis for NNSG regulatory framework include the Non-Proliferation Treaty Act (1970), the Comprehensive Safeguards Agreement with the IAEA (INFCIRC/214, 1974), the Additional Protocol to Iran's Safeguards Agreement (INFCIRC/214/Add.1), The Agreement on the Privileges and Immunities of the International Atomic Energy Agency, (INFCIRC/9/Rev.2, 1974) and Atomic Energy Organization of Iran Act (1974). In addition, a number of Iran's parliamentary/ministerial Acts, regulations and decrees have provided for regulatory framework on Nuclear Safeguards as well as Physical Protection.

3.1.3. Licensing Process

Utilization of all nuclear and radiation facilities and activities in IRAN is subject to obtaining appropriate authorization (license/permit) from the Supervisory Commission. Supervisory Commission is responsible for overseeing regulatory activities including developing regulations, assessment, issuing license/permit/ conduction inspections and taking enforcement actions for nuclear and radiation facilities and activities in Iran.

3.2. National laws and regulations regarding nuclear power generation

National regulations including laws, requirements, guides and codes of practice are presented in the portal website of INRA (www.aeoi.org.ir/INRA). These regulations are open-access documents for the public acknowledgement and also stakeholders' hearings (of the drafts) before approval. All requirements and guide lines are subject to changes according to the latest international safety standards developments.

Main National Laws:

- Atomic Energy Organization of Iran Act, 1974
- Radiation Protection Act, 1989
- Environment Protection Law, 1976
- Main (INRA) Regulations in Nuclear Power (latest versions):
- Administrative Regulation for National Nuclear Safety Department, 2007
- Regulations for Siting of Nuclear Installation, 2012
- Regulations for Radiation Protection during Operation of BNPP-1, 2008
- Regulations for Licensing of IR-360 Nuclear Power Plant, 2007

- Regulations for Supervision over Fire Safety Assurance at IR-360, 2011
- Requirements for Obtaining License by Shift Personnel of IR-360, 2011
- Regulations for Radiation Protection during Operation of Uranium Fuel Cycle Facilities, 2008
- Regulations for Licensing of Uranium Mining and Milling Facilities, 2007
- Regulations on Radioactive Waste Management, 2010
- Safety Regulations for Nuclear Fuel Transportation by Vehicle, 2005
- Safety Regulations for Storage, Transportation & handling of Fresh Nuclear Fuel at a Nuclear Power Plant, 1999
- Licensing Procedure for the BNPP-1 Construction and Operation, Mod. 2, 2006
- Procedure of Granting Permits During Construction and Commissioning of BNPP-1, Mod3, 2007
- Instructions for Supervision over Safety Assurance in BNPP-1, Commissioning, 2009
- Instruction for Supervision over Safety Assurance in BNPP-1, Construction, 2004
- Procedure of Granting Permits for Design, Manufacturing & Transportation of the BNPP-1 Fresh Nuclear Fuel & Associated Core Components, 2004
- Quality Assurance Criteria for Nuclear Facilities, 2006
- Requirements on the BNPP-1 Reactor Plant Passport, 2006
- Requirements for Obtaining License by Shift Personnel of the BNPP-1, Mod. 2, 2009
- Supervisory Procedure for Assurance of Safety of Nuclear Power Plants in Iran, 2004
- Guidelines for Supervision over Observance of Safety Assurance Requirements during Carrying out Electrical Equipment Installation in BNPP-1 Construction, 2004
- Guidelines for Supervision over Observance of Safety Assurance Requirements during installation of Mechanical Equipment in the BNPP-1 Construction, 2004
- Guidelines for Supervision over Observance of Safety Assurance Requirements in Implementation of Civil Construction and Installation Activities in BNPP-1 Construction, 2004

- Guidelines for Supervision over Observance of Safety Assurance Requirements in Installation of I&C Equipment, Engineering means and Subsystems in BNPP-1 Construction, 2004
- Procedure for Registration of the Bushehr Nuclear Power Plant Vessels and Pipelines Operating Under Pressure, Mod. 2, 2007
- Procedure for Regulatory Supervision over Nuclear and Radiation Safety During Fresh and Spent Fuel Handling at the BNPP-1, 2007
- Procedure for Supervision and Control of Technical Examination of the BNPP-1, Equipment and Pipelines Operating under Pressure, 2007
- The Procedure of Flow and Review of Documents for BNPP-1 Completion and Reconstruction, 2000
- The Procedure of Performance of QA Audits at the Organizations Engaged in the BNPP-1 Completion Project, 2001
- The Procedure of Granting Permits for IR-40 Construction and Commissioning, 2010
- Quality Audits Procedure for the Organizations Engaged in NPPs Installation And Operation, 2011
- Procedure of Investigation and Registration of Safety-related Events at BNPP-1, 2009
- The Procedure of Flow of Review of Licensing Documents for IR-360 Nuclear Power Plant Administrative Document, 2011
- General Plan of Inspection in Stage of the BNPP-1 Construction, Commissioning, Operation and Decommissioning, 2009
- Provisions for Procedure of Investigation and Account of Violation in Fresh Fuel Handling During Storage, Transportation and Utilizations, 2003
- Regulation for Granting Permits during Operation of BNPP-1, 2013
- Procedure of Investigation and Registration of Safety Related Events at BNPP-1, 2013
- Guidelines for Inspection of Civil Construction and Installation Activities at NPP, 2013
- Radioactive Waste and Spent Fuel Management, including Storage and Disposal, 2010
- Transport of Radioactive Material, 2007

- Guidelines and Format for establishing a System of Accounting for and Control of Nuclear Material at Nuclear Facilities (2010)
- Nuclear Material Accounting Instruction for Yellow Cake Produced at Bandar Abbas Uranium Ore Processing Plant (BUP) (2009)
- Working Instruction for Termination of Safeguards on Measures Discard of Nuclear Material; Temporary Redemption of Nuclear Material Wastes from Safeguards (2010)
- Working Instruction to Provide Declaration for Nuclear Fuel Cycle-Related Research and Development Activities (2013)
- Working Instruction to Provide Declaration for General Description of Each Building on Each Nuclear Site (2013)
- Working Instruction to Provide Declaration for Description of the Scale of Operations for Each Locations Engaged in Specified Activities (2013)
- Working Instruction to Provide Declaration for Information of Uranium Mines and Concentration Plants and Thorium Concentration Plants (2013)
- The Regulations on the Physical Protection of Nuclear Material and Nuclear Facilities (2013)
- The Regulations on the Physical Protection of Nuclear Material during Transport. (2012)
- Inspection Procedure for Physical Protection System and Security of Nuclear Material (2013).
- Nuclear Security Inspection Program (2013)
- Nuclear Security Inspection Report (2013)
- Working Instruction for completion of the Illicit Trafficking Incident Notification Form (2013)
- Procedure for Completion and Submission of the Illicit Trafficking Incident Notification Form (INF) (2013)
- Guidelines and Format for Preparation of Security Plan for Nuclear Facilities (2012)
- Guidelines and Format for Preparation of Security Plan during Transport of Nuclear Material (2012)
- Advance Notification Form for Transport of Nuclear Material (2012)
- Application Form for Permit to Transport Nuclear Material (2012)

- Incident Notification Form during Transport of Nuclear Material (2012)
- Application Form for Receipt and Hand-Over of Nuclear Material (2012)
- Application Form for Notification of Illicit Trafficking Incident (2012)

**APPENDIX 1: MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES
INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES**

Name	Iran Nuclear Regulatory Authority	Nuclear Power Production & Development Company of Iran
Address	End of north Kargar St. Tehran Iran	No.8 Tandis Alley Africa St. Tehran Iran
Telephone No.	+982188221073	+982124882222
Fax No.	+982188221072	+982122058480
Email Address	inra@aeoi.org.ir	nppd@nppd.co.ir
Web Site Address	www.aeoi.org.ir	www.nppd.co.ir
Main Activities	<p>Regulating nuclear installation and radiation application activities:</p> <ul style="list-style-type: none"> –Preparing and releasing circulars, provisions, directives, regulations guides and so on in the field of nuclear and radiation safety - Assessment of safety analysis, reports, prepared by operating organization and licenses - Over sitting on nuclear installation and radiation - Issuing licenses and permits - Revocation of licenses or permits - Enforcement - Auditing - Monitoring the radiation situation in the country and around nuclear installation - Conducting necessary R&D activities 	<ul style="list-style-type: none"> • Study and recommend appropriate strategies and policies, establishing consensus among stakeholders in the direction of effective use of nuclear technology for the production of electricity. • Construction and operation of NPPs, and sale of their produced electricity. • To cooperate constructively and effectively with international and regional organizations for an efficient utilization of scientific and technological opportunities and exchange of experiences. • Conducting activities in the field of Technical support of NPPs. • Development of technology and human resources and expanding nuclear safety culture. • Energy planning • Defining necessary R&D activities in the field of different sectors of NPPs. • Effective communication with universities, research centers and local sources, in order to enhance the country's capacities in various aspects of nuclear electricity technology.

		<ul style="list-style-type: none"> • Reliable supply of required fuel, parts, and equipment of NPPs.
Capability	<ul style="list-style-type: none"> • Environmental and public dose assessment. • Qualified expert. • Training capacity for new comers. • Equipped labs. • - Regional office in nuclear facilities. 	<ul style="list-style-type: none"> • More than 3 years' experience on safe and reliable operation of BNPP-1. • Experience on commissioning, maintenance and repair as well as refueling of NPP. • Qualified and competence manpower on operation, maintenance and repair, technical support and human resource. • - Comprehensive training system including BNPP training center, full scope simulator (FSS) BNPP and computer based training competence instructors.

Name of report coordinator:

Naimeddin Mataji Kojouri

Institution:

Atomic Energy Organization of Iran– Department of Nuclear Planning and Strategic Supervision–
Office of Codification and strategic planning

Contacts:

nkojouri@aeoi.org.ir

ATTACHMENT 1: PREFIXES AND CONVERSION FACTORS

TABLE 1. PREFIXES

Symbol	Name	Factor
E	exa	10^{18}
P	peta	10^{15}
T	tera	10^{12}
G	giga	10^9
M	mega	10^6
K	kilo	10^3
H	hecto	10^2
da	deca	10^1
D	deci	10^{-1}
C	centi	10^{-2}
M	mili	10^{-3}
μ	micro	10^{-6}
η	nano	10^{-9}
P	pico	10^{-12}
F	femto	10^{-15}
A	atto	10^{-18}

TABLE 2. CONVERSION FACTORS FOR ENERGY

To:	TJ	Gcal	Mtoe	MBtu	GWh
From:	Multiply by:				
TJ	1	238.8	2.388×10^{-5}	947.8	0.2778
Gcal	4.1868×10^{-3}	1	10^{-7}	3.968	1.163×10^{-3}
Mtoe	4.1868×10^4	107	1	3.968×10^7	11630
Mbtu	1.0551×10^{-3}	0.252	2.52×10^{-8}	1	2.931×10^{-4}
GWh	3.6	860	8.6×10^{-5}	3412	1

TABLE 3. CONVERSION FACTORS FOR MASS

To:	kg	T	lt	st	lb
From:	Multiply by:				
kg (kilogram)	1	0.001	9.84×10^{-4}	1.102×10^{-3}	2.2046
T (tonne)	1000	1	0.984	1.1023	2204.6
Lt (long tonne)	1016	1.016	1	1.12	2240.0
st (short tonne)	907.2	0.9072	0.893	1	2000.0
lb (pound)	0.454	4.54×10^{-4}	4.46×10^{-4}	5.0×10^{-4}	1

TABLE 4. CONVERSION FACTORS FOR VOLUME

To:	US gal	UK gal	bbl	ft ³	L	m ³
From:	Multiply by:					
US gal (US gallon)	1	0.8327	0.02381	0.1337	3.785	0.0038
UK gal (UK gallon)	1.201	1	0.02859	0.1605	4.546	0.0045
bbl (barrel)	42.0	34.97	1	5.615	159.0	0.159
ft ³ (cubic foot)	7.48	6.229	0.1781	1	28.3	0.0283
l (litre)	0.2642	0.22	0.0063	0.0353	1	0.001
m ³ (cubic metre)	264.2	220.0	6.289	35.3147	1000	1