Iranian nuclear energy: history and advancements

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ABSTRACT

As Iran rapidly gains toward the establishment of its nuclear arsenal, discomfort and apprehension are escalating in the world. A proof of Iran's cutting-edge technology is its latest milestone on the nuclear front. Iran has begun testing its uranium-enriching centrifuges, which has allowed Iran to extract, separate and then enrich uranium at a faster pace. Despite renewed attempts to reinstate the Joint Comprehensive Plan of Action (JCPOA), commonly known as the Iran Nuclear Deal, Iran continues to make headway in the field. This paper aims to objectively report and illustrate the recent advancements in Iran's nuclear energy. All the while, assessing the political and economic dimension of the nuclear dispute which has brought forth powers from around the world. On one end, nations push for Iran's nuclearisation for their core economic interests, while others, in attempts to further ostracise the pariah, impose economic sanctions. This push and pull of power have materialised into a 'tug-of-war', making Iran's nuclearisation an issue that transcends not only its immediate region but also in the international arena as well. The paper begins by touching upon the historical background of Iran's nuclear programme that was first pursued in the 1950s, however, it was marked with negligible progress. It was only in the 70s that Iran made progress on this front, along with its ambitious efforts toward the revolution in 1979. This section concludes by discussing the advancements in the 90s and 2000s, with the aim of setting the pace as a prelude to the section that analyses Iran's nuclear programme today and its implications. The proceeding sections analyse the groundwork that set the pace for the Iran Nuclear Deal. Lastly, the paper discusses Iran's nuclear technological advancements and the political-economic factors that influence Iran's Nuclear Crisis.

Keywords: Iran, Nuclear Power, Iran Nuclear Crisis

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Background

Iran’s development of its nuclear programme dates back to the 1950s². After an agreement between the Shah of Iran and the United States, the programme was established under the US Atoms for Peace programme³. While there weren’t any major technological advancements under this programme, it led to the initial journey of Iran with respect to the nuclear sphere. In 1967, Iran was the recipient of America’s 5 MW research reactor, which was powered by highly enriched uranium (HEU)⁴, this came to be known as the Tehran Research Reactor (TRR). This served as a starting point for future projects and contracts with nations like South Africa, Germany, France etc. and other foreign companies⁵. While the Shah of Iran was a firm believer in home-grown technological advancements, this applied to its nuclear programme as well, as a result of which the Atomic Energy Organisation of Iran (AEOI) was established in 1974. At the same time, he did not want to rule out receiving help from other countries. It was in the 1970s that Iran broadened the horizon of its nuclear arsenal by signing several agreements and contracts with foreign companies and suppliers. In 1974, the Shah of Iran announced the signings of preliminary agreements with Siemens KWU and Framatome for the establishment of four nuclear power plants⁶. The construction of two major nuclear plant projects, near Bushehr and Darkovin, began in 1975 and 1979 respectively. However, the projects failed as they were eventually dissolved or recalled⁷. This trend continued even in the 80s when despite Iran’s agreement with Germany’s Siemens KWU for the Biblis B reactor; the agreement stagnated quite early into 1979 after which it was damaged by Iraqi air strikes in 1984-88⁸. It was in 1979 when the Islamic Revolution forever changed Iran, which temporarily halted the nuclear programme. This was set off after the Shah’s regime was toppled, closely followed by the imprisonment of AEOI’s head. Many of Iran’s nuclear scientists also fled the nation in wake of the revolution⁹. This led to an inevitable vacuum in Iran, that left it without leadership in the quest for nuclearisation. The fallout of Iran’s nuclear programme was further facilitated by Ayatollah Ruhollah Khomeini, who stood staunchly against

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³ Ibid.
⁴ Katherine Malus “From ‘Atoms for Peace’ to ‘JCPOA’: History of Iranian Nuclear Development.”
⁵ Columbia K=1 Project. Center for Nuclear Studies. 9 September, 2018 https://kproject.columbia.edu/content/atoms-peace-jcpoa-history-iranian-nuclear-development
⁷ Ibid.
⁸ Ibid.
developing a nuclear arsenal\textsuperscript{10}, as he considered it to be ‘un-Islamic’ and called for the programme’s termination\textsuperscript{11}. Eventually, in 1984, the nuclear programme was revived with Khomeini seeking out international assistance to complete the construction of the unfinished Bushehr plant\textsuperscript{12}.

Undoubtedly, ever since the revolution, US-Iran relations took a bitter turn. While the 50s-70s was a time of robust partnership between the two. 1979 was a marked detour in their long history of partnership. The Revolution was against the Shah who now exercised his dictatorial whip over Iran, coupled with an increasingly corrupt system and an overheated economy. Even in the face of ‘anti-Shah’ sentiments, the United States continued to back the Shah. This worsened, during the hostage crisis that began towards the end of 1979 when Americans were captured by radical Iranian students and were held hostage outside the US Embassy in Tehran\textsuperscript{13}. They claimed that the Americans would be set free once the US repatriates the Shah, as Iran believed that Washington was granting refuge to the Shah. 1979 was by far one of the most dramatic years in US-Iran relations. In many ways, it has been a point of no return, as the two severed their relations the following year. Thus far, relations have always been clouded by a looming suspicion and oddity towards one another, which is also part and parcel of the failed JCPOA, that will be discussed in due course of the paper.

Following this, Iran no longer received any assistance from not only Washington but its allies as well. Iran then solidified its ties with China and Pakistan to develop its nuclear arsenal. After several tries, in 1987, Iran was reported to have acquired centrifuges, nuclear plans etc, from A.Q Khan a Pakistani nuclear scientist, who had earlier assisted Pakistan, Libya and North Korea with their nuclear programmes\textsuperscript{14}. Iran’s renewed eagerness to develop its nuclear programme came with the hostilities it experienced with Iraq throughout the 80s which eventually escalated into the Iran-Iraq War which went on for eight years. Iraq was placed at a strategic advantage as it received aid from the United States in the form of training, military equipment, and economic aid. As per reports by the CIA, Iraq was also found to have used chemical weapons against the

\textsuperscript{10} Mohammad Homayounvash, “History and Evolutionary Trajectory of the Iranian Nuclear Programme” Florida International University Electronic Theses and Dissertations. 2012. https://digitalcommons.fiu.edu/cgi/viewcontent.cgi?article=1731&context=etd
\textsuperscript{12} Ibid.
\textsuperscript{14} Katherine Malus “From ‘Atoms for Peace’ to ‘JCPOA’: History of Iranian Nuclear Development.” Columbia K-1 Project. Center for Nuclear Studies. 9 September, 2018 https://kproject.columbia.edu/content/atoms-peace-jcpoa-history-iranian-nuclear-development
Iranian army\textsuperscript{15}. This could also be a contributing factor to the arms race\textsuperscript{16} that began in West Asia, as this would stimulate a ‘domino effect’ in Turkey, Saudi Arabia\textsuperscript{17} and other nations in the region, pronouncing the effects on Iraq’s existing far-reaching abilities. The ‘arms race’ can be said to have manifested in the form of the Persian Gulf War, as Iraq was viewed to have annexed Kuwait with the prime objective of exercising its ‘arms muscle’ over issues of oil pricing and production.

A period of building and developing the foundations of their nuclear structure, slow economic recovery and a chaotic political system along with the costs of various military operations found Iran grappling with domestic and international isolation. Despite this, Iran made commendable progress in the 90s and early 2000s. The 80s concluded with Tehran signing deals with Pakistan and China to train the Iranian army. China also provided Iran with 27KW miniature neutron source reactors (MNSRs) and two 300MW Qinshan power reactors\textsuperscript{18}. In 1995, as part of the Bushehr-I deal, Russia agreed to aid Iran in building the Bushehr power plant as well as three reactors\textsuperscript{19}. Iran’s efforts were continually blocked by America, as it tried to put a stop to its agreements with Argentina and China for nuclear development as well as trying to stall the Russian deal\textsuperscript{20}.

In 2002, when the National Council of Resistance of Iran (NCRI) investigated Iran’s nuclear development programme, it discovered that the various technologies being developed were undeclared and unregulated. For example, the Natanz Enrichment Complex included the construction of a heavy-water production plant in Arak\textsuperscript{21}. These findings were followed by the International Atomic Energy Agency (IAEA) carrying out investigations and inspections. After a few years of back and forth with the IAEA regarding Iran’s suspension of the nuclear enrichment programme, in 2005, Iran announced that it would resume its enrichment programmes, rejecting a negotiatory proposal put forth by France, Germany and the United Kingdom. This then led to a diplomatic fallout, undoing all the progress made through negotiations. In tandem with

\textsuperscript{15} “Impact and Implications of Chemical Weapons Use in the Iran-Iraq War” Interagency Intelligence Memorandum. Central Intelligence Agency. 10 August, 2010
https://www.cia.gov/readingroom/docs/DOC_0001030207.pdf


\textsuperscript{17} Mohammad Homayounvash, “History and Evolutionary Trajectory of the Iranian Nuclear Programme” Florida International University Electronic Theses and Dissertations. 2012. p.91
https://digitalcommons.fiu.edu/cgi/viewcontent.cgi?article=1738&context=etd


https://www.nti.org/learn/countries/iran/

\textsuperscript{21} Ibid.
this, the traumas of the 9/11 attacks, shook people globally. The most apparent manifestation of this isolation by America was through its ‘Bush Doctrine’ which, along with the Middle East, pushed Iran’s nuclear programme further into an impasse. It led the rest of the world to brand Iran as an ‘axis of evil’\textsuperscript{22}. It was in 2009 when relations with the international community were no longer at a stalemate and had escalated that Iranian President, Ahmadinejad announced the construction of uranium enrichment facilities. This was despite Iran having hit a wall with the IAEA and the UNSC over this issue in the past. The decade concluded with Washington imposing sanctions for the first time that would prevent foreign companies from supplying gasoline to Iran. An incident that doesn’t seem too far from the current reality, as Iran was found in a similar situation, not many months ago, over the JCPOA.

Analysis

The onset of the decade was not astray of issues that plagued the preceding years. In September 2009, Iran revealed to the IAEA that its nuclear enrichment facility project was almost complete. Analysts have said that this emerged due to Tehran’s attempts to deter plausible attacks from Israel on its nuclear projects\textsuperscript{23}. A plethora of difficult and cold diplomatic followed which was mostly expressed in the form of sanctions. At the same time, a newfound spirit of solidarity emerged between Iran, Brazil and Turkey, in the form of the Tehran Declaration- which emphasised Iran’s right to uranium enrichment and other nuclear activity. Following a series of on and off impositions of sanctions, the Joint Comprehensive Plan of Action (JCPOA) or the Iran Nuclear Agreement was eventually put into action in 2015, between the UK, US, Russia, France, China and additionally Germany. This deal was struck to prevent Iran’s forward movement on its nuclear programme. Advocates of the deal argued that it would leash Iran and prevent it from expanding its nuclear programme\textsuperscript{24}. Provided the other signatories fulfilled their end of the agreement, which was to lift sanctions and the weapons embargo that dealt with its transfer of weapons and ballistic missiles\textsuperscript{25}. The deal, however, failed as a result of US withdrawal in 2018. The possible reasons and implications of the Iran nuclear crisis will be illustrated in the paragraphs that are to come.


\textsuperscript{23} Mohammad Homayounvash, “History and Evolutionary Trajectory of the Iranian Nuclear Programme” Florida International University Electronic Theses and Dissertations. 2012. p.91
https://digitalcommons.fiu.edu/cgi/viewcontent.cgi?article=1731&context=etd

\textsuperscript{24} Kali Robinson. “What Is the Iran Nuclear Deal” Council on Foreign Relations. 18 August 2021
https://www.cfr.org/backgrounder/what-iran-nuclear-deal

\textsuperscript{25} Ibid.
It is interesting to note that Iran’s economic distress set the stage for the signing of the deal. The crisis was further exacerbated due to years of sanctions that were imposed by the US and EU. Iran was, therefore, more than willing to sign the deal, to revive its economy even at the cost of its progressing nuclear prowess. As per an IMF report\(^{26}\), Iran’s GDP grew by 12.5\(^{\%}\)\(^{27}\) post the nuclear deal.

The impacts of the imposition of sanctions were felt on Iran’s oil exports as well, which contributed to the economic miseries it faced. The lifting of sanctions and the signing of the deal did well to increase Iran’s oil exports and production. Unfortunately, before Tehran could even reorient its policy measures that accommodate a revival of the economy post the sanctions, the United States withdrew, reinstating the sanctions. This set off pressure on the Iranian economy once again since the sanctions were primarily on oil exports, that account for 80\% of its GDP. By 2020, oil exports dropped to an all-time low. This has caused damage to not only Iran’s economy but also its relations with Washington and the revival of the deal. Despite on and off talks on the revival of the deal, it has failed to come through to this date. A large part of this stalemate can be attributed to the inability or rather, the unwillingness of Iran and the US to come to a mutual agreement. Primarily because this requires compromises on the unrealistic demands from both sides. Iran has demanded the US lift its sanctions and bring about a restoration of economic benefits. Second, it asked for compensation for all the


financial damage incurred as a result of the sanctions especially in the face of the pandemic, when it faced difficulties in acquiring medical supplies\textsuperscript{28}. Washington on the other hand, seeks more transparency on its nuclear programme’s developments. A more ambitious demand than the preceding one is also more ‘important’ for the success of the agreement. It deals with Iran’s support for the proxy wars in Iraq, Syria, Yemen and Lebanon\textsuperscript{29}. A prolonged impasse can be expected as the two sides struggle to come to a consensus. Seemingly, Iran however has made full use of the years after 2018 by expanding its nuclear enrichment programmes ever since the dissolution of the deal. It has tested and deployed over a thousand advanced centrifuges that make the uranium enrichment process easier\textsuperscript{30}. This has been very convenient for Iran so to develop its latest addition of the Arak water reactors, missiles and other advancements.

Iranian Advancements in Nuclear Technology

As per reports released by the IAEA, in the early months of 2019- Iran was transparent and cooperative with the IAEA over verification and monitoring of its nuclear developments, specifically its enrichment activities, heavy water processing, development and research for fuel centrifuges\textsuperscript{31}. Iran’s new developments in this field work in tandem with its noncompliance with the JCPOA- and have led to Iran being more uncooperative than before. After the US imposed its sanctions again, Iran exceeded the 300 kilograms limit imposed on it regarding uranium hexafluoride\textsuperscript{32}. Its uranium enrichment process has increased to 4.5\%, later announcing that its commitment to follow the directives and regulations set by the JCPOA, would be disbanded. After the first report published by the IAEA, Iran has gone ahead and defied the restrictions that have been set. It then informed the IAEA that the stock of heavy water reactor material has exceeded 130 metric tons, beyond the permitted limit\textsuperscript{33}. However, it has not gone beyond the 5\% U-235 limit set by the IAEA for uranium enrichment and it continues to cooperate with it over monitoring and verification of its activities\textsuperscript{34}.

\textsuperscript{29} “New US Secretary of State stands by demand Iran return to nuclear deal before US does.” Reuters. 28 January, 2021 https://www.reuters.com/article/us-usa-iran-blinken-idUSKBN29W2XF
Iran’s development of its nuclear programme has undoubtedly stirred suspicion and fear amongst its neighbours and in the world. Israel for instance is fearful of this and is reported to have carried out attacks on Iran’s nuclear facilities, like the explosion at Iran’s Natanz uranium enrichment plant. Israel has always vehemently protested the JCPOA, primarily because it believes that it will be unable to contain Iran’s development of its nuclear weapons and bombs. President Hassan Rouhani, under whom Iran’s nuclear capabilities have progressed most, announced that Iran is inaugurating 30 IR-5, and 30 IR-6 devices at Iran’s Natanz uranium enrichment plant and three cascading centrifuges. This quickly caught the world’s attention because the heavy water used can produce plutonium, a fuel used in nuclear warheads. What concerns the world and the IAEA, even more, is China coming to the aid of Iran in developing its nuclear arsenal, since it is already equipped with developing heavy water reactors. The Arak reactor had earlier been shut down in 2015 after the signing of the JCPOA, however, the Chinese are said to have continued their work on the reactor. Other than this, as per the IAEA, Iran’s nuclear development projects and materials are present in locations that are undisclosed to the organisation.

Recently, Iran has accumulated more than 120 kilograms of 20% enriched uranium. As per the JCPOA agreement, Iran was forbidden from going above the 3.67% threshold of uranium enrichment. In addition to this, Iran has also been engaging in the production of uranium- this is again, prohibited under the JCPOA. Iran informed the IAEA about its production of uranium in 2019 and the process has been underway ever since. This worked in tandem with a nuclear law that was enacted in December 2020. This law was a game-changer for Iran, as it was after this that its projects gained momentum and force. It was passed in order to increase its leverage over Washington and to restart talks for the JCPOA, with the intention that all parties that had imposed

39 “Iran says more than 120kg of uranium enriched to 20%” The Guardian. 10 October, 2021. https://www.theguardian.com/world/2021/oct/10/iran-says-more-than-120kg-of-uranium-enriched-to-20
40 Ibid.
sanctions on Iran, would be lifted\textsuperscript{42}. As per this law, Iran is expected to begin operating its centrifuges and resume the uranium enrichment process. It was under this law that Iran produced 120 kilograms of enriched uranium and restarted its Arak heavy water reactor project.

According to the Arms Control Association, if it weren’t for the Arak water reactors being redesigned, then Iran would have been able to produce plutonium that could fuel up to two nuclear weapons per year. Though the newly designed reactors and the construction of the heavy water reactors pose a higher risk of proliferation. Since the 20\% uranium enrichment process began, Iran has been able to gather 17.6 kilograms of it at the Fordow enrichment facility. Its enriched uranium stocks are now a total of 2,968 kilograms at 2\% enrichment. 1890 kilograms have been enriched between 2-5\% and 17.6 kilograms have been enriched to 20\%. Iran has also produced 13.3 kilograms of uranium in the form of uranium oxides, 10.5 kilograms of uranium in fuel assemblies and rods, and 10.9 kilograms of uranium in liquid and solid scrap. Under the JCPOA, Iran’s stockpile is supposed to be limited to 300 kilograms of uranium hexafluoride enriched to 3.67 per cent U\textsubscript{235}, or about 202 kilograms of uranium by weight.\textsuperscript{43}

\textbf{Political Economic Factors of the Iran Nuclear Crisis}

Analysts that take into consideration the political-economic factors have long argued that what we know of Iran’s nuclear crisis exists as a consequence of the economic order\textsuperscript{44}. This claim is supported and further argued for, through the World-Systems Theory. Proponents of this theory argue that the world is arranged in a hierarchal order that is based on the economic division of labour\textsuperscript{45}. Since the very beginning, Iran’s revolution was seen as a threat to the west, this resonates even today as Iran is miles apart from the capitalist system, while the US attempts to integrate it through the JCPOA.

According to the theory, nations are divided into core countries and peripheral countries. The former refers to wealthy countries, while the latter refers to poorer countries. The peripheral countries are also responsible for the production and exporting of goods. Very often, the core countries rely on the peripheral countries for natural resources. In that regard, the Middle East has always been relied upon by the West (core countries) for its oil and natural gas resources. Consequently, Iran’s role has thus always been considered an important one in shaping the world economy’s

\textsuperscript{42} Ibid.
\textsuperscript{43} Ibid.
\textsuperscript{45} Ibid p.106
trajectory\textsuperscript{46}. Proponents of this theory give an example of the level at which the US exercised its monopoly over influencing decisions. That was especially evident in the coup of 1953, as a post-revolution Iran seemed to support the goal of setting up an export-oriented economy. However, to Washington’s dismay, the revolution failed to bear the fruit that it was so eagerly expecting to reap the benefits of. It was in this political and economic climate that Iran was pushed away even further from the US and viewed from a lens of suspicion due to its non-dependence on the global capitalist system.

The core supporters of the JCPOA primarily wanted it enforced for three main reasons. One is to reduce their dependence on Russia’s natural gas. Two, to ensure that other European companies are able to extract oil and natural gas from Iran and lastly, to capitalise on Iran’s petrodollars through the sale of goods to it\textsuperscript{47}. This is supplemented by those who oppose the JCPOA essentially because the revenue generated by the core countries would reduce due to the development of Iran’s nuclear programmes. Secondly, the increase in oil supply would mean a decrease in its prices and finally, counter Russia’s monopoly over the region and the pipeline it backs in Iran\textsuperscript{48}. Simply put, Iran’s nuclear ‘crisis’ is being made into a crisis in the first place because it fails to align with the interests of the core countries. The implications of this have manifested in the form of these countries punishing Iran and isolating it even further as world powers struggle to gain economic control over it.

**Conclusion**

Today, as Iran’s nuclear crisis worsens, it stands this way as a result of the ups and downs in its nuclear development programmes. A programme that had initially gained momentum in the 50s after an agreement was signed between the Shah of Iran and the United States; was lost under Ayatollah Ruhollah Khomeini following the Iranian Revolution. This also opened a new set of implications like complicated US-Iranian relations and economic sanctions. It was amid this bitterness with Washington that Iran turned to solidify its relations with China and Pakistan; thereby worsening its ties with the US. After a series of sanctions, the JCPOA had just been put to the works when Iran and Washington experienced a falling out. While the deal was considered to be a success on the front of restricting Iran’s nuclear activities; this only lasted for a while, up until Iran recently developed its ARAK heavy water reactors and its centrifuges that focus on uranium enrichment. The allies it has created over the years with nations other than the US and the JCPOA signatories have also aided Iran in attaining the high position that it has on the nuclear front. Another reason why Iran agreed to sign the nuclear deal was

\textsuperscript{46}Ibid p.124
\textsuperscript{47}Ibid. p.140
\textsuperscript{48}Ibid. p.141
to smoothen out its diplomatic ties with the West and its allies. The deal has however failed terribly on that front due to disagreements on other fronts like regional power play. The increasing need to exercise a ‘whip’ over Iran and its nuclear advancements, has not only isolated Iran further into the abyss, but it has also widened the diplomatic gulf between the West and Iran, creating an environment for a seemingly bleak future for Washington’s ambitions for the Nuclear Deal.

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