Introduction

After US President George W. Bush gave warning about Iran’s endeavours to arm itself with nuclear weapons, an assessment by the US National Intelligence Council (NIC) in November 2007 gave the all-clear: Iran purported to have ceased its nuclear weapons programme in 2003, and as of 2007 there was no indication of any intention to resume it. Additionally, the enrichment of uranium – to date up to a maximum of 5% - is for civilian purposes. NIC attributed this cessation to increasing international pressure and international sanctions.[1] The Iraq war (2003), officially initiated pre-emptively against the possession of weapons of mass destruction[2], as well as the presence of US troops in Iraq and Afghanistan led to the perception of an existential threat by the Iranian government. With the end of the Iranian nuclear weapons programme, Iran appeared to the International Atomic Energy Agency (IAEA) to have temporarily adopted a transparent path.

Four years after the NIC assessment, in November 2011 a report from the IAEA showed a different picture. In this report the discontinuation of the Iranian nuclear weapons programme was indeed confirmed, however it determined that since 2007 Iran had again been attempting to conceal its nuclear activities. Examples of this are the construction of a water pressure reactor in Darkovin[3] and the construction of the underground uranium enrichment plant “Fordow,” near Qom.[4] In September 2009, Iran informed the IAEA about “Fordow” because public exposure by western states was imminent.[5]

By 2008 Iran informed the IAEA about the development of an "exploding bridge-wire detonator" (EBW), which could be used both for civilian as well as military purposes. Its civilian use was restricted to exceptionally rare, highly precise blasting – however, an EBW is an integral component for the construction of an implosion bomb. Iran did not reveal to the IAEA any position on the question of what the intended purpose of the EBW was. Additionally, the IAEA received information that Iranian engineers had studied the behaviour of spherical core of shock compression and neutron behaviour as well as the energy released in an implosion detonation, which occurs in a functioning atomic bomb in accordance with the implosion principle.[6] The IAEA also received indications that Iran had already undertaken preparations for an atomic bomb test.[7] On the basis of these points, the lack of transparency of the Iranian nuclear programme, and the lack of willingness to work together, the IAEA suggests in its report that Iran has either begun its nuclear weapons programme again or never seriously stopped it.[8] Thus, the conflict over Iran’s nuclear programme continued. New economic sanctions were concluded and the option of military intervention is not on the table.[9]

The objective of this paper is to evaluate the necessity of nuclear power for Iran, to determine the reasons for such an ambitious nuclear programme, to evaluate the endeavours of Iran to enrich uranium to 19.75%, and to come to a final conclusion on the upshot of this. The period of the transparency and cooperation phase with the IAEA as well as the current status of Iranian nuclear technology will be
Necessity of Nuclear Power for Iranian Electricity Production

"Finally, there is Iran’s claim that it is building massive and expensive nuclear fuel cycle facilities to meet future electricity needs, while preserving oil and gas for export. All of this strains credulity. Iran’s uranium reserves are miniscule, accounting for less than one percent of its vast oil reserves and even larger gas reserves. Iran’s gas reserves are the second largest in the world, and the industry estimates that Iran flares enough gas annually to generate electricity equivalent to the output of four Bushehr reactors."

--- John R. Bolton, Under Secretary for Arms Control and International Security.

As regards the disclosed oil reserves, Iran is at 4th place worldwide. In his function as US Secretary of State for arms control and international security, John R. Bolton argued that due to its fossil energy reserves, Iran was not dependent on nuclear power for covering its necessary energy requirements. This viewpoint contradicted that of a study commissioned in 1972 by Mohammad Reza Pahlavi, the last Iranian Shah, which came to the conclusion that Iran’s future energy demand can not be met exclusively by fossil fuels. This appears to be confirmed.

The generation of electricity in Iran is currently ensured principally by the combustion of natural gas. Almost the entire amount of natural gas produced is consumed, whereby the annually produced amount increases slightly. In the long-term, the approximately 9% annual increase in natural gas consumption is unlikely to be covered. At the end of 2007 and the beginning of 2008 when Iran was confronted with a harsh winter, its supply of natural gas came from Turkey. The long-term initial energy problem became more clear regarding oil, since Iran’s own consumption of stagnate oil output increased from around one third at the end of the 1990s to almost half currently. The consumption of fuel increases annually by 11-12%. Thus Iran is the second largest oil consumer in the Middle East after Saudi Arabia. Since energy consumption increases by about 7-8% annually, it makes sense to cover the energy requirements long-term with nuclear power because an increase in energy production will mainly be at the expense of oil exports from the exhausted capacity of natural gas.

A massive dismantling of nuclear power would not only reduce the dependency on electricity supply from natural gas and oil production, but would also make more natural gas and oil available for exporting. Even if this alone is a good reason for the construction of nuclear power plants, another reason exists for Iran.

Good and True Reasons

"Legally they have the right to enrich uranium the way Japan, Brazil, Germany, the thirteen, fourteen countries are having the right to enrich."

--- Mohamed ElBaradei, former Director General of the IAEA.

The contention that even for oil exporting states it can make sense to base the production of energy on nuclear power and to avail themselves of the explicit right of a state under the atomic weapon treaty to use
nuclear power for peaceful purposes and to enrich uranium[23] does not justify a concealed atomic weapon programme that is operated simultaneously. However, ever since a cooperation agreement for nuclear research and the peaceful use of nuclear power between the USA and the allied Shah was signed in 1957 there have been such endeavours.[24]

Following the cooperation agreement within the scope of the “Atoms for Peace” programme, the USA delivered a 5 MW research reactor which began operation in 1967 at the University in Tehran. After the oil crisis (from 1973) and the high oil prices resulting from it, Iran had sufficient financial resources available to implement the findings of the study commissioned by the Shah in 1972 – basing future energy production on nuclear power. The Shah signed a declaration of intent to purchase a total of 22 reactors for the production of 23,000 MW of electricity: eight from the US, six from France, and four reactors each from the German Nuclear Plant Union (KWU) and from Siemens.[25] On the Iranian side there was Albolfath Mavi, one of the Shah’s confidants, who was principally responsible for implementing the project.[26] According to Mavi, in 1970 the Shah confided to him that the American 5 MW research reactors would be procured with the long-term intent of the development of atomic weapons.[27] Even when the Shah was seen as an ally, the American public documents described a clear, growing mistrust of the US government, which was triggered by the concealed nuclear weapon programme.[28]

From the perspective of the USA, the Iranian nuclear programme was not only designed to conceal future energy requirements, but also for the development of nuclear weapons. This speculation triggered mistrust for the allied Shah. It is not surprising that the current regime in Iran – which was included in the axis of evil by the USA[29] – became very mistrusted.

Limited Willingness to Cooperate

With the Iranian Revolution in 1979, not only the American-Iranian relationship was put on hold, but also the Iranian nuclear programme. This was in conjunction with the supreme leader Ayatollah Ruhollah Khomeini who did not give high priority to the nuclear programme. In 1987, plans were concealed and components of centrifuges for uranium enrichment were bought by Abdul Qadeer Khan.[30] Not until after the death of Khomeini in 1989 was the nuclear programme revitalised under the supreme leader Sayyed Ali Khamenei and the Iranian President Akbar Hashemi Rafsanjani. Centrifuge testing was carried out up until 1995, and finally in 1999 uranium hexafluoride gas (UF$_6$) was introduced in a centrifuge for the first time.[32] In August 2002, Iranian dissidents overseas uncovered the existence of one of the uranium enrichment plants in Natanz not declared to the IAEA and a heavy-water reactor in Arak.[33] Negotiations with France, Germany and Great Britain (EU-3) and especially the US led invasion of Iraq in March 2003 caused Iran to notify the IAEA of all further nuclear construction plans, to grant UN inspectors more rights for implementing additional IAEA protocols, and to suspend operation of all nuclear enrichment plants. In spite of this, more concealed centrifuges were built and up to June 2004, 40-45 kg UF$_6$ had been produced.[34] When Iran informed the IAEA about the continuation of construction and installation of centrifuges and the resumption of tests for uranium enrichment, the mutual agreements were broken. This was factually confirmed with the beginning of UF$_6$ production of 37 tonnes of Yellowcake[35] in autumn 2004.[36] When the IAEA threatened to report the case to the UN Security Council, more agreements were made between the EU-3 and Iran, but Iran only adhered to the requirements selectively. The newly-elected Iranian President Mahmoud Ahmadinejad rejected a new binding agreement with the IAEA, the goal of which was the long-term suspension of uranium enrichment. Thus the limited cooperation phase between Iran and the IAEA was over and the IAEA reported Iran’s violations of the nuclear weapon ban treaty to the UN Security Council in September 2005.

This showed that Iran was not interested in cooperation with the IAEA. The limited willingness to cooperate was merely a reaction to the existing perception of threat from the invasion in Iraq. There was
never any intention to forego uranium enrichment permanently – rather, the time was used to build an underground plant in order to better protect uranium enrichment plants from aerial attacks. According to Ali Asghar Solatanieh, the Iranian ambassador to the IAEA, “Fordo” was built precisely for this purpose. Iran later argued that its willingness to cooperate with the IAEA and the EU-3 was not reciprocated positively. This viewpoint cannot be confirmed: up until the breach of the agreements, the EU-3 prevented Iran’s earlier violations against the nuclear weapon ban treaty (declarations and reports about research activities were not made) from being passed on to the UN Security Council.

Production with no Civilian Use

In 2004, the USA handed over more than a thousand pages of comprehensive documentation to the IAEA, which demonstrated that Iran was researching the development and implementation of essential technology for nuclear weapons. Even if the authenticity of the documents is not without dispute, there are still several developments in the Iranian nuclear programme which make no sense for a purely civilian purpose: for example, the uranium enrichment at 19.75%. The Bushehr reactor that went on the grid on 3 September, 2011 requires 3.5% enriched uranium to operate. The enriched uranium at 19.75% is intended for the production of fuel elements for the medical research reactor in Tehran (Teheran Research Reactor, TRR), according to the official Iranian justification.

The enrichment up to 19.75% began in February 2010 in a pilot plant in Natanz. In January 2012, the enrichment plant “Fordo” was also put into operation. Approximately 5kg of 19.75% uranium was to be produced monthly at the “Fordo” plant, although the TRR only required about 1.5kg monthly at full capacity. It is estimated that at the end of May 2012 Iran had more than around 120kg of 19.75% uranium. If the objective pursued was to manufacture an atomic bomb as quickly and with as much surprise as possible, then the 90% enrichment of highly-enriched uranium with the supply of 19.75% uranium in the enrichment centrifuge would make sense. If such a scenario occurred then, in the most optimistic case, at least 370kg of 19.75% uranium would be necessary for the production of two atomic bombs, which would be produced by 2016 at the earliest. If Iran only wanted to build one nuclear weapon, which however is highly improbable due to efficiency reasons of reusable waste, required testing and the possibility of failure, as well as due to the deterrent effect of a harsh international reaction, the necessary amount of 19.75% uranium would be produced by the end of 2013 at the earliest. With sufficient raw materials the production of the first atomic bomb would take about 6 months and each subsequent one about 4 months. Because this scenario rests on the most varied, ideal assumptions (constant production rates, optimal production conditions and successful engineering), the degree of uncertainty is high. Even the assumption that Iran really intends to manufacture an atomic bomb is not proven to date.

According to US President Barack Obama, the dimensions and configuration of the uranium enrichment plant “Fordo” is in conflict with a peaceful programme. Furthermore, the plant is situated in Iranian Revolutionary Guard territory, which was formerly used for firing missiles.

In order to equip the TRR with new fuel rods, theoretically no independent production of 19.75% uranium would be necessary because by 1987 Iran had already commissioned the Argentinean “State Society for Applied Research” (Investigaciones Aplicadas Sociedad del Estado, INVAP SE) to manufacture fuel rods for the TRR, which was implemented in 1993. After the Iranian President Mahmoud Ahmadinejad appointed Ahmad Vahidi as Minister of Defence on August 9, 2009, Argentina would hardly still be prepared to produce fuel rods for Iran. Ahmad Vahidi was sought internationally by Interpol – he was allegedly involved in the attack on the "Asociación Mutual Israelita Argentina" (AMIA) in 1994 in Buenos Aires. With 85 mortalities and more than 300 injured, this is the most violent attack to date in Argentina. US President Barack Obama instigated an exchange of nuclear materials in September 2009. The plan was for Iran to hand over 1,200kg of the suspected 1,500kg of 3.5% uranium to Russia,
where it would be enriched to 19.75%. The enriched uranium would finally be processed into fuel elements in France, which then would be returned to Iran. According to an earlier Iranian negotiator, the Iranian President Mahmoud Ahmadinejad supported this plan, however the premature publicising of a possible agreement gave him too little time to win over the conservative Iranian Supreme National Security Council. Mir Hossein Mussawi, the opposition’s presidential candidate, contested any such agreement because – according to Mussawi – it would violate the rights of the Iranian people. The conclusion of the agreement ultimately failed which meant an early end to Barack Obama’s new diplomatic approach.

This again showed that Iran was not prepared to cooperate. The expensive enrichment of 19.75% uranium did not make sense because no such enrichment is necessary for the only power generator nuclear reactor in Iran, Bushehr. The production capacity of the uranium enrichment plant is clearly too high for the TRR and the necessary fuel rods for the TRR could be procured abroad.

**Status of Iranian Nuclear Technology**

There are also several inconsistencies with respect to the nuclear fuel cycle, if Iran were interested exclusively in civilian usage. This begins with uranium mining, which by some way cannot cover the needs of a civilian nuclear programme. Iran has two uranium mines in Gchine and Saghand. In Gchine, about 24 tonnes of Yellowcake are produced annually; in Saghand no production was determined as of 2010. To compare: to keep a reactor operating in Bushehr, 25 tonnes of 3.5% uranium or a concentrated 269 tonnes of Yellowcake is necessary annually. The necessary supply of fuel elements is secured through Russia because Iran neither produces sufficient uranium nor, in the case of Bushehr, do Iranian engineers have the technological expertise and technical resources for fuel element production. Additionally, as regards the TRR, Iran lacks the technology for the production of fuel elements from the enriched uranium. A corresponding fabrication plant is being built in Estahan, however the date of its completion is still open. With the restricted uranium deposit it is astounding that the reprocessing of fuel elements does not present an issue.

Of the around 8,000 centrifuges in Natanz, in November 2011 there were 6,208 centrifuges in operation and supplied with UF6. The initial operation of 48,000 centrifuges is planned, which optimistically would be seen as sufficient to produce approximately 20 tonnes of 3.5% uranium, and thus hardly balance out the annual uranium consumption of the Bushehr reactor.

**Conclusion**

In 2007, the National Intelligence Estimate (NIE) presented the situation regarding the Iranian nuclear programme to the NIC as more positive than it in reality was. The NIE pursued a political goal – that could already be concluded from the publication, which is not typical. For example, in 2010 the completely revised NIE was no longer made public. Since in 2002 the NIE created the justification for the unpopular Iraq war, it can be assumed that at the end of US President George W. Bush’s second term the American intelligence services did not want to once again provide the justification for a war. With the collection of documents that the IAEA had received in 2004 and the end of the cooperation phase between Iran and the IAEA at the end of 2005, the NIC would have had to consider the resumption of the Iranian nuclear weapons programme as a serious possibility.

Because of the increasing perceived threat by the invasion in Iraq, Iran temporarily ceased uranium enrichment in 2003 and was ostensibly prepared to cooperate with the IAEA. However, Iran never intended to permanently forego uranium enrichment. This contention is further underpinned by the contemporaneous transfer of uranium enrichment plants to underground locations, where they (possibly) could not be destroyed from the air by bombs. Accordingly, diplomatic efforts were also unsuccessful.
Negotiations were delayed on the part of Iran and potential or existing negotiated agreements were gradually watered down, with more and more exceptions being defined or contrary suggestions being presented, which in turn subverted the actual aims of the agreement. If an agreement failed, Iran presented itself as the victim, who in contrast to the other states was ready to make concessions and to cooperate. The negotiations of the P5+1 with Iran in Istanbul in the middle of April and in Baghdad at the end of May 2012 also followed this pattern.\[56\]

Military threats proved to be counterproductive, and instead gave rise to a nuclear arms build-up in order to have the option of protection from a military attack through retaliatory measures. Additionally, this external threat prevented Iran from having to have a discussion about the meaning of its nuclear programme in both domestic and foreign politics. As regards energy policy, a massive development of nuclear power would certainly make sense since not only would the dependency of the energy supply on natural gas and oil production be reduced, but there would also be more natural gas and oil available for export.\[57\] However, Iran’s endeavours are concentrated not on essential projects for a civilian nuclear programme, but instead on projects which make little sense for purely civilian usage. For example, uranium enrichment at 19.75% does not make sense. Additionally, Iranian uranium mines do not have sufficient capacity and the production of 3.5% uranium would not even be quantitatively sufficient for the current operation of the reactor in Bushehr. The production of fuel elements is currently (and in the foreseeable future) not possible and there is no interest in resuming it.

How much Iran’s nuclear programme cost the country is unclear. In addition to the annual expenses – which are estimated by the Iranian President Mahmoud Ahmadinejad to be around 270 million US dollars\[58\] – the international insulation and the indirect costs of the economic sanctions must also be taken into consideration.\[59\] Procuring the fuel elements overseas – as is the case for Bushehr – is in all probability not only financially cheaper, but would also put Iran in a better light internationally and not involve any economic sanctions. The question of what these negative consequences of the nuclear programme may offset remains open. Autonomous power supply based on nuclear reactors or regional dominance and military sanctity through the possession of nuclear weapons?

The technical opportunities indicate one last thing – in addition to technical expertise, Iran has the necessary infrastructure for the production of weaponised uranium. Whether Iran is currently producing 19.75% uranium with the intention of concealing sufficient raw materials and possibly producing two or more atomic bombs quickly, and thereby presenting the international community with a fait accompli, remains to be seen. With two atomic bomb this could be the case in 2016, as a rough estimate based on the underlying assumptions (unchanging production capacity, no setbacks, etc.)

However, one atomic bomb alone is not sufficient for regional dominance. For such a scenario, Iran would additionally need to also be able to bring into use the capacity of a nuclear warhead by means of a missile. To comprehensively analyse the intention behind the nuclear programme this aspect can not be neglected, and it would be an interesting follow-up topic for a subsequent paper.

Appendix\[60\]

Table: Iran’s consumption of oil increased from a stagnating oil output of around one third at the end of the 1990s, to currently almost a half. (Annual increase of fuel consumption: 11-12%). Thus Iran is the second largest oil consumer in the Middle East after Saudi Arabia
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Davari, Mohammad. "Enrichment 'Not a Step Towards a Bomb': Ahmadinejad." AFP, 30.05.2012.


Goldberg, Jeffrey. "Obama to Iran and Israel: ‘As President of the United States, I Don't Bluff’." The Atlantic, 02.03.2012.


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[8] "The information indicates that prior to the end of 2003 the above activities took place under a structured programme. There are also indications that some activities relevant to the development of a nuclear explosive device continued after 2003', and that some may still be ongoing." IAEA, "Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran (Restricted Distribution)," 8.

[9] Compare: Jeffrey Goldberg, "Obama to Iran and Israel: 'As President of the United States, I Don't
Bluff," The Atlantic, 02.03.2012.


[12] To a lesser extent oil is also burned, otherwise it is mainly used as fuel oil.


[14] 137.5 billion cubic metres; Stand: 2010.


[18] See appendix.


[23] "Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II of this Treaty." UN, "Treaty on the Non-Proliferation of nuclear weapons," 22.04.1970, Article IV.


[30] Abdul Qadeer Khan was seen as the "Father of the Pakistani nuclear weapons programme"; "In 1987, Iran acquired through a clandestine supply network drawings for a P-1 centrifuge, along with samples of centrifuge components." IAEA, "Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran (derestricted)," ed. Board of Governors (Vienna: 15.11.2004), 6.

[31] UF6 is the basis for uranium enrichment.


[35] Yellow, powdered mixture of uranium compounds.


[37] International Crisis Group, "The P5+1, Iran and the Perils of Nuclear Brinkmanship," Middle East Briefing, No. 34, 15.06.2012, 4.

[38] "When the question of suspension came up in 2003, there were two schools of thought in Iran. One group advocated engagement with the West, while others were proponents of resistance [...]. Supreme Leader Ayatollah Ali Khamenei consented to a temporary suspension [...]. He was, however, suspicious of Western intentions and remained skeptical about the ability of European count ries to fulfil their end of the bargain [...]. After two years of Tehran’s full cooperation and transparency efforts, the Europeans failed to deliver on their promises because of American obstructionism. As a result of this deadlock, the Supreme Leader decided to turn the tables." — Hossein Mousavian, former member of the Iranian
negotiation team; International Crisis Group, "In Heavy Waters: Iran’s Nuclear Program, the Risk of War and Lessons from Turkey, 4, Fussnote 27."


[41] Compare: Mohammad Davari, "Enrichment 'not a step towards a bomb': Ahmadinejad," AFP, 30.05.2012.


[43] International Crisis Group, "In Heavy Waters: Iran’s Nuclear Program, the Risk of War and Lessons from Turkey," 7, footnote 43.


[50] Parsi, A single roll of the dice: Obama's diplomacy with Iran: 147f; Chipman and Fitzpatrick, Iran's nuclear, chemical and biological capabilities: a net assessment: 40. Mussawi knew about the concealed uranium enrichment in Natanz and visited the plant before it was exposed in the beginning of August 2002: NCRI, "New Information on Top Secret Projects of the Iranian Regime's Nuclear Program".

[51] Chipman and Fitzpatrick, Iran's nuclear, chemical and biological capabilities: a net assessment: 52.


It is of course possible that this was in fact the case in the classified version of the NIE.

The permanent members of the UN Security Council and Germany.


Of course there are also other forms of energy, in particular by means of solar panels. This was not considered in 1972 by the Shah commissioned study.


Insuring the enforced oil embargo and ban on Iranian tanker by the USA and Europe in mid 2012 cost Iran 4 billion per month; Paul Richter Ramin Mostaghim, "Iran sanctions are about to get tougher," Los Angeles Times, 28.06.2012.

Data source: US Energy Information Administration.

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