

Analysis of Nuclear Industry Exports Associated with Nuclear Cooperation Agreements

**Prepared by the Staff of Senator Edward J. Markey (D-Mass.)
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Summary: *The US nuclear industry states that additional nuclear cooperation agreements could lead to 185,000 American jobs worth more than \$125 billion in the next decade¹. These statements, however, are not supported by an analysis of the economic impacts of existing nuclear cooperation agreements. Since 1996, exports of nuclear reactor technology and nuclear fuel have made up less than 4 percent of industry's annual revenue. Moreover, only one of the fourteen newly concluded or renewed agreements since 1996 has led to any nuclear reactor technology exports at all. Exports of nuclear reactor technology alone comprise less than 0.6 percent of the sector's annual revenue.*

By contrast, nuclear fuel is exported to about two-thirds of the 53 countries with which the U.S. has nuclear cooperation agreements and comprises as much as 86 percent of the sector's export-related revenues. Although exports of nuclear fuel make up the vast majority of the sector's exports, they are still worth less than 3.4% of the industry's total annual revenues.

The U.S. nuclear industry has consistently opposed legislative efforts to ensure that nuclear cooperation agreements prohibit countries from developing the technologies needed to make nuclear fuel. Because the vast majority of the small amount of revenue the industry derives from exports comes from the sale of nuclear fuel, nuclear cooperation agreements which allow a country to learn how to make its own nuclear fuel have the potential to significantly erode the primary source of the U.S. nuclear sector's export-related revenues.

Background: Enrichment and reprocessing (ENR) are the two critical steps in the nuclear fuel cycle where it is possible to create both the technologies needed to fabricate nuclear reactor fuel and the fissile material needed for nuclear weapons. Therefore, it has long been U.S. policy to limit the number of enrichment and reprocessing sites around the world. The Atomic Energy Act (AEA) of 1954 requires the establishment of peaceful nuclear agreements with countries seeking to import nuclear technology from the United States. Currently the United States has nuclear cooperation agreements with 53 countries and the IAEA (28 of these are European countries under a single agreement with Euratom).

The Nuclear Energy Institute² estimates that U.S. nuclear industry's revenue from electricity sales and from the procurement of materials, fuel and services from domestic suppliers total \$54-\$64 billion each year, and has also informed Senator Markey's staff that this total does not

¹ <http://www.nei.org/CorporateSite/media/filefolder/IssuesinFocusNuclearExports.pdf?ext=.pdf>

² <http://www.nei.org/Issues-Policy/Policy-Resources/Testimony/Testimony-for-the-Record-for-the-Energy-Tax-Reform> and private communications with Senator Markey's staff

include revenues from vendor-to-vendor services, which makes a very significant contribution to the sector. It also has argued that nuclear cooperation agreements are important to the success of its industry. This analysis is an effort to ascertain whether the industry's arguments are supported by data.

Markey Analysis of NRC Export Licenses: According to Nuclear Regulatory Commission (NRC) export license records provided to Senator Markey's office, since 1996, the United States has implemented new or renewed expiring nuclear cooperation agreements with 14 countries: Argentina, Australia, Brazil, China, India, Kazakhstan, Morocco, Romania, Russia, South Africa, Switzerland, Turkey, United Arab Emirates, and Ukraine. For a complete list of countries with nuclear cooperation agreements in force at any time since 1996 see Table 1.

Only one of these agreements – with China – resulted in new export licenses for nuclear technology (defined as nuclear reactors, components, and equipment). The nuclear cooperation agreement with China allowed Westinghouse to export four reactors for \$2.5 billion and a reactor vessel head for an unspecified amount. In addition, Curtiss-Wright Electro-Mechanical Corp sold China reactor coolant pumps for an unspecified amount.

The only other export licenses issued for nuclear technology during this time were under pre-1996 agreements with South Korea, Taiwan, Colombia, Thailand and Spain. Combustion Engineering sold South Korea four reactors for \$700 million. Westinghouse also obtained export licenses to sell South Korea \$800,000 worth of reactor components. General Electric sold Taiwan two reactors for an unspecified amount³. Colombia and Thailand purchased research reactors from the Department of Energy for \$550,000 and General Atomics for \$50 million, respectively. Finally, FirstEnergy Nuclear Operating Company sold Spain a reactor vessel head for an unspecified amount. In summary, during the past 17 years, the United States has exported nuclear reactor technology or components to only six (eleven percent) of the 53 countries with which it has nuclear cooperation agreements.

The NRC export license records also indicated licenses for the export of nuclear fuel. Licenses have been granted to export nuclear fuel to 34 of the 53 entities (64 percent) with nuclear cooperation agreements (see Table 1). Because the data from the NRC does not report whether nuclear fuel was actually exported, it is not possible definitively to quantify the financial impact of these licenses.

GAO Analysis: A General Accounting Office (GAO) report⁴ released in 2010 also attempted to quantify the value of nuclear exports to the United States by analyzing data from the United Nations Commodity Trade Statistics database for the 15 years from 1994 to 2008. The report found that the U.S. share of nuclear exports had decreased over that time period from one-quarter

³ Total \$7.54 billion, but split between GE and Mitsubishi. (<http://www.world-nuclear.org/info/Country-Profiles/Others/Nuclear-Power-in-Taiwan/>)

⁴ <http://www.gao.gov/assets/320/311924.pdf>

of the world market to less than one-tenth of the world market. In sum, the U.S. has become a net importer of nuclear reactor technology and fuel. Over the time period investigated the US exported, on average, \$1.4 billion / year in nuclear fuel and \$290 million / year in nuclear reactor technology. The report cites the Department of Commerce estimates that \$1 billion in U.S. exports is equivalent to 5,000 – 10,000 jobs. Therefore, exports from the nuclear industry under 123 agreements annually represent 8,500 – 17,000 jobs using GAO’s export data, 17 percent of which come from the export of nuclear technology and 83 percent of which come from the export of nuclear fuel.

CRS Analysis: Congressional Research Service (CRS) attempted to extend GAO’s analysis in a memo⁵ that they distributed “in response to multiple congressional requests.” This memo states that from 2009 to 2012, the U.S. industry exported an average \$1.9 billion/year in nuclear fuel. The memo also says that, from 2009 to 2012, the industry exported \$350 million/year, on average, in nuclear reactor technology. These numbers seem roughly in agreement with the trends from the GAO report and were obtained using the same United Nations database. CRS also utilized additional statistics obtained from the Global Trade Atlas (GTA) database, a private proprietary database. This database shows that during the time period considered in the GAO report (1994 to 2008) the U.S. exported \$1.3 billion/year in nuclear fuel and \$209 million/year in technology. The difference between this and the GAO report may be accounted for by the fact that GAO adjusted their number for inflation and reported results in constant 2010 dollars. For 2009 to 2012, the GTA database reports U.S. nuclear exports were comprised of \$1.6 billion/year (84 percent) in nuclear fuel and \$316 million/year (16 percent) in nuclear reactor technology.

Conclusion: This analysis shows that nuclear cooperation agreements do not lead to substantial exports of nuclear reactor technology. Very few reactors or components thereof have been exported under these agreements and none of the new or renewed agreements since 1996, other than the one with China, have led to nuclear reactor technology exports. Based on various reports the economic value of these exports is anywhere from \$209 to \$350 million per year.

The export of nuclear fuel, however, is much more significant and ranges anywhere from \$1.3 to \$1.9 billion per year. In addition nuclear fuel is exported to 64 percent of the countries with which we have nuclear cooperation agreements. For a full list please see Table 2.

If the value for the exports of nuclear reactor technology and fuel is combined, the total revenue from nuclear exports is \$1.5 to \$2.3 billion/year. This represents 7,500 to 23,000 jobs on a yearly basis. This means the U.S. nuclear energy industry’s annual revenue from electric sales, the procurement of materials, fuel and services from domestic suppliers, and exports is totals \$55.5 - \$66.3 billion/year. This total does not include all revenues to the entire nuclear sector, which are not currently available. Therefore, exports account for less than two – four percent of its annual revenue. Of the revenues from exports, however, the export of nuclear fuel represents 83 – 86

⁵ “United States Exports of Nuclear Reactor Technology and Uranium, Top Foreign Country Consumers: 2009 Through 2012” January 7, 2014

percent of the industry's revenue from exports. This means the export of nuclear technology represents less than 0.6 percent of the industry's annual revenue.

Based on this data, it is clear that nuclear exports are a very small portion of the nuclear energy industry's yearly revenue. However, most of this revenue is generated through the sale of nuclear fuel. Therefore, adding requirements to nuclear cooperation agreements to limit the development of enrichment and reprocessing sites around the world would serve both U.S. nuclear nonproliferation goals and benefit the U.S. nuclear energy industry by limiting the competition to their main source of nuclear export revenue.

Table 1: 123 Agreements In Force At Any Time Since 1996

Country	Most Recent Agreement Signed	Entered into Force	Expiration	Nuclear Technology Exports	Nuclear Fuel Exports
Argentina	February 29, 1996	October 16, 1997	October 16, 2027	NO	YES
Australia	May 4, 2010	December 22, 2010	December 22, 2040	NO	YES
Bangladesh	September 17, 1981	June 24, 1982	June 2012	NO	NO
Brazil	October 14, 1997	September 15, 1999	September 15, 2029	NO	YES
Canada	June 23, 1999	December 13, 1999	January 1, 2030	NO	YES
China	July 23, 1985	December 30, 1985 ⁶	December 30, 2015	Four reactors (\$2.5 billion), one reactor vessel head, and reactor coolant pumps. Export licenses issued in 2005 and 2009.	YES
Colombia	January 8, 1981	September 1983	September 17, 2013 (future coop under IAEA agreement)	One research reactor (\$550,000). Export license issued in 1996.	NO
Egypt	June 29, 1981	December 29, 1981	December 29, 2021	NO	YES
European Atomic Energy Community (Euratom)	November 7, 1995	March 29, 1996	March 29, 2026	Reactor vessel head for an unknown amount.	YES
India	October 10, 2008	December 6, 2008	December 6, 2048	NO	NO
Indonesia	June 30, 1980	December 30, 1981	December 30, 2031	NO	YES
International Atomic Energy Agency (IAEA)	May 11, 1959	August 7, 1959	August 7, 2014	NO	YES

⁶ The US-China agreement entered into force on December 30, 1985. However, it could not be implemented until the President certified China was in compliance with certain conditions. This certification did not occur until 1998. <http://crs.gov/pages/Reports.aspx?PRODCODE=RL33192&Source=search>

Japan	November 4, 1987	July 30, 1988	July 30, 2018	NO	YES
Kazakhstan	November 18, 1997	November 5, 1999	November 5, 2029	NO	YES
Republic of Korea	November 24, 1972	March 19, 1973	March 19, 2014	Four reactors (\$700 million) and components (\$800,000). Export license issued in 1997.	YES
Morocco	May 30, 1980	May 16, 1981	May 16, 2021	NO	YES
Norway	January 12, 1984	July 2, 1984	July 2, 2014	NO	NO
Peru	June 26, 1980	April 1982	April 2012	NO	YES
Russian Federation	May 6, 2008	January 11, 2011	January 11, 2041	NO	YES
South Africa	August 25, 1995	December 4, 1997	December 4, 2022	NO	NO
Switzerland	October 31, 1997	June 23, 1998	June 23, 2028	NO	YES
Taiwan	April 4, 1972	June 22, 1972	June 22, 2014	Two reactors for an unknown amount. Export license issued in 1997.	YES
Thailand	May 14, 1974	June 27, 1974	June 27, 2014	One research reactor (\$50 million). Export license issued in 1998.	NO
Turkey	July 26, 2000	June 2, 2008	June 2, 2023	NO	YES
Ukraine	May 6, 1998	May 28, 1999	May 28, 2029	NO	YES
United Arab Emirates	May 21, 2009	December 17, 2009	December 17, 2039	NO	NO

Table 2- Estimates of Value of US Nuclear Exports Under 123 Agreements

		1994 - 2008		2009 - 2012	
		Fuel	Technology	Fuel	Technology
Totals (\$ billion)	GAO Report (UN Database)	20.70	4.39	N/A	N/A
	CRS Memo (UN Database)	N/A	N/A	7.69	1.42
	CRS Excel Data (GTA Database)	19.01	3.13	6.48	1.26
Yearly Average (\$ billion)	GAO Report (UN Database)	1.38	0.29	N/A	N/A
	CRS Memo (UN Database)	N/A	N/A	1.92	0.35
	CRS Excel Data (GTA Database)	1.27	0.21	1.62	0.32