

Case study of the VVER project at Tianwan, China

PROJECT AND LOGISTICS MANAGEMENT IN NUCLEAR NEW BUILD

Working Party on Nuclear Energy Economics Workshop

11 March 2014

NEA Headquarters, 12 boulevard des Iles, 92130 Issy les Moulineaux,
NEA Conference Room A & B

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Tianwan Nuclear Power Plant

Other Name:	田湾核电站; Lianyungang NPP; Jiangsu Nuclear Power Station
Location:	Lianyungang City, Jiangsu Province, ~ 250 km north of Shanghai
Subordinate To:	Jiangsu Nuclear Power Corporation (JNPC)
Size:	2 operational reactors, with 6 more planned
Facility Status:	Phase I is operational, Phase II is under construction
Reactor type:	Phase I and II – Russian VVER-1000 (AES-91) 1,000 MWe



Project overview

Tianwan NPP is considered to become the largest NPP on mainland China. It is located on the coast of the Yellow Sea ~ 30 kilometers east of Lianyungang city. Currently it consists of 2 VVER-1000 reactor units. It's owned and operated by **Jiangsu Nuclear Power Corporation of China (JNPC)**. In 2010 JNPC signed another contract with ATOMSTROYEXPORT to supply VVER-1000 reactors for units 3 and 4.

Unit	Reactor type	Net capacity	Gross capacity	Construction started	Commercial operation
Tianwan-1	VVER-1000/428 (AES-91)	990 MW	1,060 MW	October 1999	May 2007
Tianwan-2	VVER-1000/428 (AES-91)	990 MW	1,060 MW	October 2000	August 2007
Tianwan-3	VVER-1000/428M (AES-91)	1,050 MW	1,126 MW	December 2012	2018
Tianwan-4	VVER-1000/428M (AES-91)	1,050 MW	1,126 MW	September 2013	2018

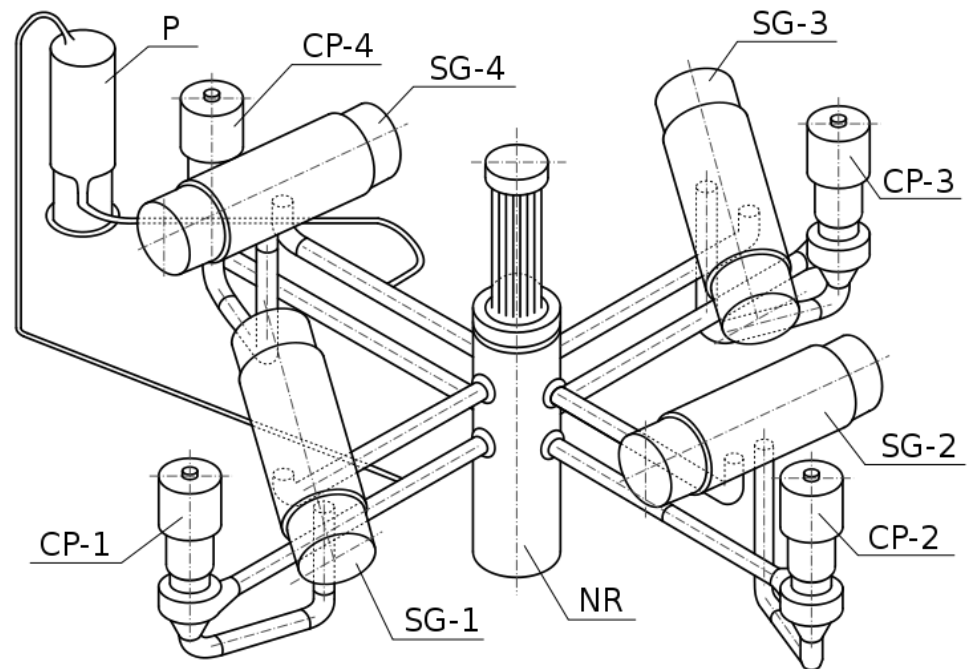
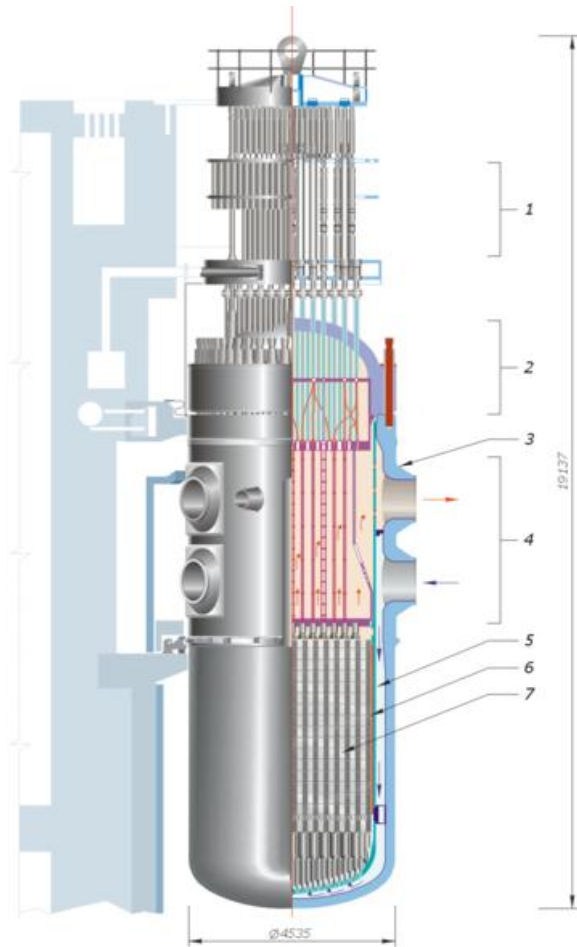
Construction site



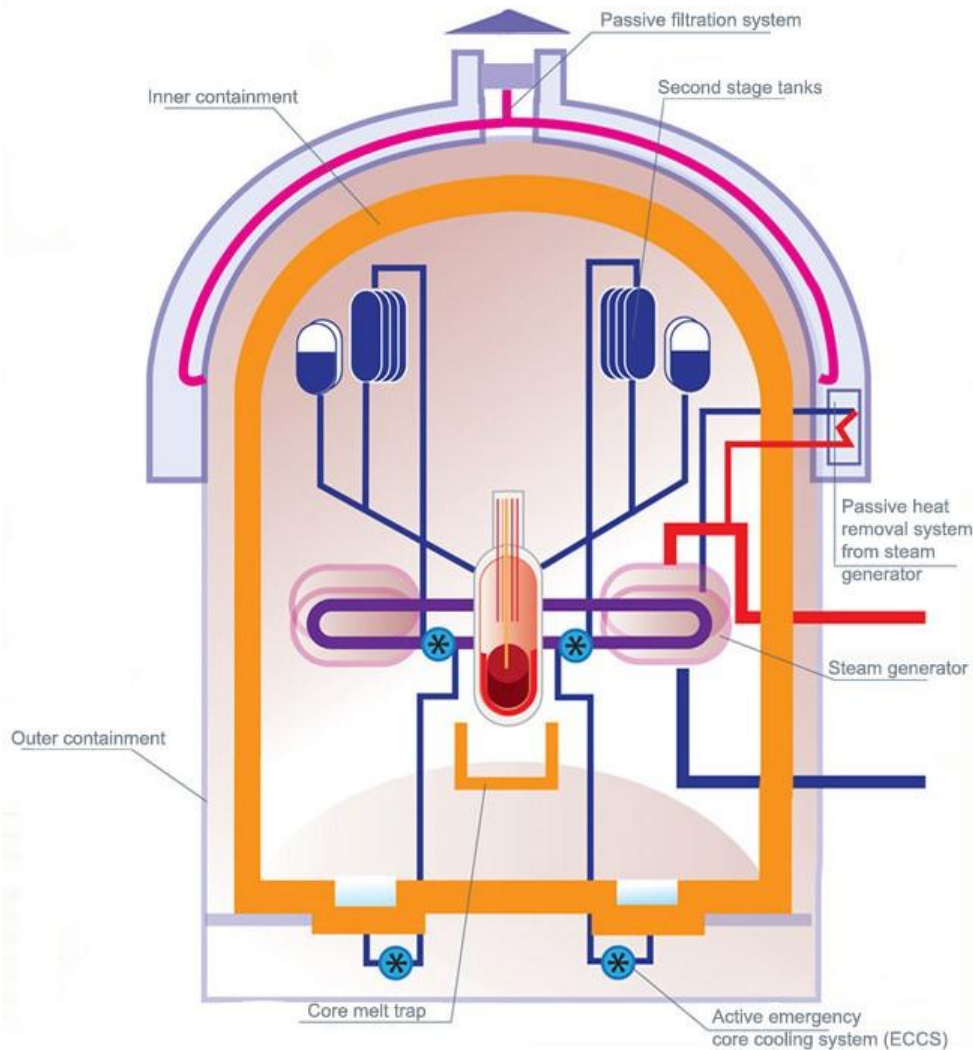
Reactor design

VVER-1000 is a PWR of Russia's OKB GIDROPRESS design with some distinctive features:

- horizontal steam generators;
- hexagonal fuel assemblies;
- no bottom penetrations in the pressure vessel;
- high-capacity pressurisers providing a large reactor coolant inventory.



Plant design



The AES-91 unit is based on the design, building and operating experience of Russian VVER-1000/V320 units.

The unit was improved both in terms of safety and of performance:

- double containment;
- core-catcher;
- pre-stressing tension system of containment vessel with reverse-U model with 50-cable tension;
- wholly independent safety facilities;
- physical separation of smelt filter and a cooling system to relieve the impact of severe accidents;
- uranium-zirconium gadolinium-wide integrated advanced fuel;
- all digital control systems.

Project background

The joint construction contract between China and Russia was signed in December 1997. The contract was signed by AO Atomenergoeksport (AEE) and VPO Zarubezhatomenergostroy (ZAES) of Russia (both later were combined into special overseas project company **ATOMSTROYEXPORT**) and Tianwan Nuclear Power Corporation of China (later was renamed into **Jiangsu Nuclear Power Corporation**).

The Russian side is responsible for providing general technology, project design as well as supplying, installing and calibrating equipment, and personnel training. Major contractor and supplier is ATOMSTROYEXPORT company.

The Chinese side is responsible for project construction management, construction engineering, purchasing equipment from third-party countries, providing auxiliary services and performing most of the installation work on the NPP. Major contractor and operator of the plant is **Jiangsu Nuclear Power Corporation**. **Jiangsu Power Systems** is in charge of the HVDC (high-voltage direct-current transmission) power line engineering and peak modulation facilities.

ATOMSTROYEXPORT profile

Atomstroyexport JSC (ASE JSC) is an engineering company of **State Corporation "Rosatom"** on construction of nuclear power facilities abroad.

At present, Atomstroyexport is the company implementing construction contracts, including **"turn-key"** ones, for five nuclear power units abroad simultaneously.



Bushehr NPP (Iran)



Kudankulam NPP (India)

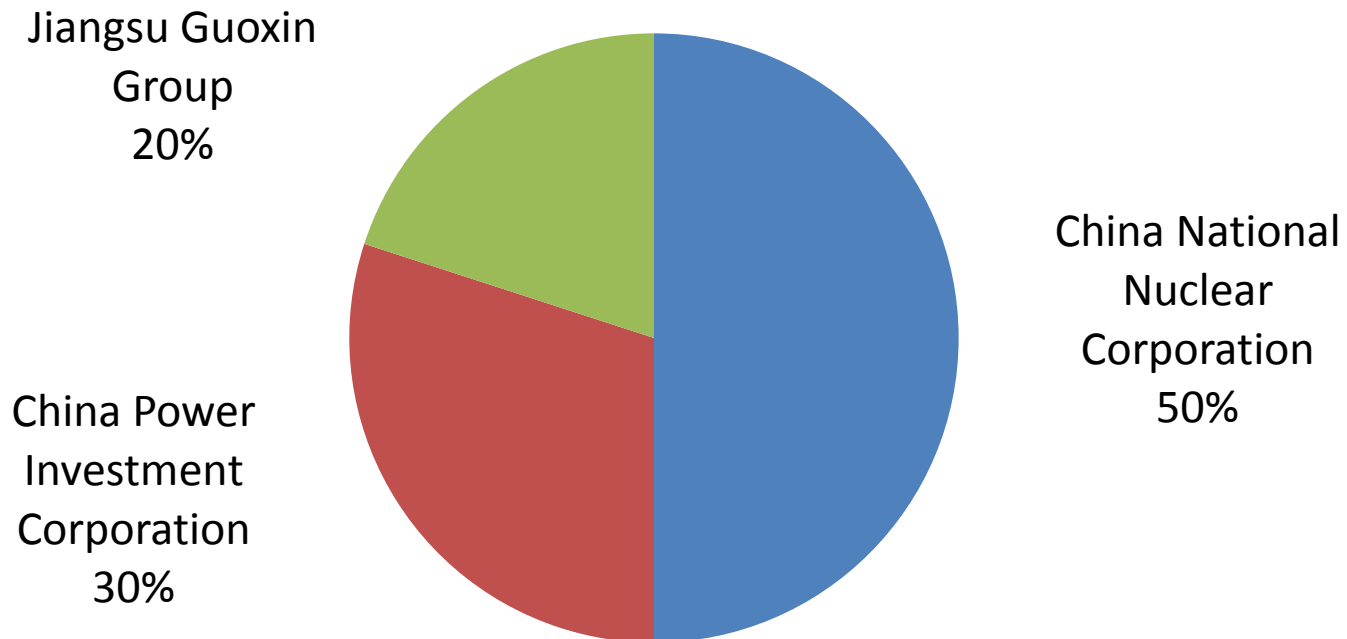


Tianwan NPP (China)

JNPC profile

Jiangsu Nuclear Power Corporation (JNPC) was established in December 1997, and is mainly responsible for the construction and operation of Tianwan NPP. The main stakeholders are state-owned **China National Nuclear Corporation**, **China Power Investment Corporation** and **Jiangsu Guoxin Group**.

Main shareholders



Tianwan project – Phase I (1999 – 2007)

Russia is in charge of:

- technology of the NPP,
- design of nuclear island and conventional island,
- supply of the whole equipment,
- commissioning of NPP

50%

China is in charge of:

- construction management,
- civil work, procurement of certain equipment within walls from a third country,
- auxiliary project of NPP,
- design of supporting project outside,
- auxiliary equipment procurement,
- most of NPP erection works

50%

Tianwan project – Phase II (2012 – 2018)

Russia is in charge of:

- technology of the NPP,
- design of nuclear island,
- supply of the reactor and related equipment,
- commissioning of NPP

30%

China is in charge of:

- construction management,
- civil work, procurement of most part of the equipment, excluding nuclear island,
- auxiliary project of NPP,
- design of balance of plant,
- most of NPP erection works

70%

Project management in progress

Phase I (1999 – 2007):

- 2 x 1060 MW
- The project's cost was originally estimated at US\$2.5bn, but finally has reached over **US\$3.2bn** (US\$1.4bn on Russian side)
- Construction duration – 91 month from first concrete to the connection to grid
- Construction involved ~400 Russian workers

Phase II (2012 – 2018):

- 2 x 1126 MW
- The project cost is estimated at **US\$6.0bn** (US\$1.8bn on Russian side)
- Construction duration – 62 month from first concrete to the connection to grid

Timeframe for Tianwan NPP – Phase II

- In November 2010 a general contract between ATOMSTROYEXPORT and Jiangsu Nuclear Power Corporation has been signed for the construction of units 3 and 4 of the Tianwan nuclear power plant.
- After the Fukushima-1 nuclear accident in Japan in March 2011, China introduced a moratorium on new NPP projects. The ban lasted for nearly two years, until the Russian project to build a second stage of the Tianwan NPP was finally cleared after strict checks for compliance with the post-Fukushima safety requirements.
- In late 2012, China's National Nuclear Safety Administration approved the construction of the third and fourth units.
- In December 2012 the first concrete was poured for the foundations of the third unit. Construction of fourth unit has been started in September 2013.

Electricity market

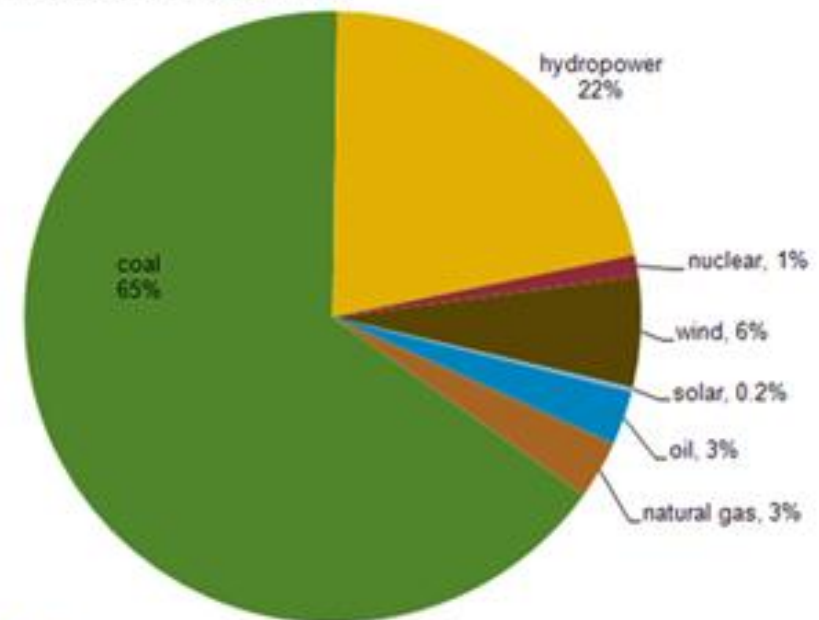
The main grid systems are operated by the **State Grid Corporation of China (SGCC)** and **China Southern Power Grid Co (CSG)**. It is sophisticated and rapidly growing, utilising ultra high voltage (1000 kV AC and 800 kV DC) transmission.

In July 2013 the NDRC set a wholesale power price of CNY 0.43 per kWh (**7 US cents/kWh**) for all new nuclear power projects.

The price is actually less than power from coal plants with flue gas desulfurization.

China's installed electricity capacity by fuel, 2011

installed capacity: 1,073 gigawatts



Source: FACTS Global Energy

Image Credit: Energy Information Administration

Concluding remarks

Tianwan NPP is a joint project of Russia and China with significant localization value.

The project to build Tianwan units 3 and 4 is similar to the first phase of the power plant, comprising two Russian-designed VVER-1000 pressurized water reactors, with JNPC taking responsibility for the design and supply of non-nuclear components and equipment.

The Chinese side gaining experience in construction, procurement and overall management was able to increase its share of construction works up to 70%, with Russian side being responsible for the nuclear island and technology supervision.

Russian experience in reactor design and procurement, economy of serial VVER manufacturing as well as Chinese experience in construction works and third-party equipment procurement allowed to keep the project cost under **US\$3,000 per kW** and reasonable construction time.