Submission

No 31

INQUIRY INTO THE ECONOMICS OF ENERGY GENERATION

Organisation:

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Date Received: 27/03/2012

Theme:

Summary

NSW INQUIRY INTO THE ECONOMICS OF ENERGY GENERATION

SUBMISSION COVER PAGE

B Hill March 2009

Summary

Electrical Energy Supply

a) Security of Supply

The current New South Wales electrical energy generation system is operating with insufficient security margin and is at long term risk of reliable supply failure due to deteriorating infrastructure. Additional investment is therefore required immediately given the long lead times for any base load power station construction. Additional investment is difficult to justify on economic grounds in the current market situation and therefore cannot be left to any market-driven solution.. Investment in base load power generation is a complex engineering risk proposition which dictates a major role for overall government leadership, direction, and direct investment or contractual support.

b) Economic Development

Consideration of the fundamentally important economic, security, and greenhouse gas emission reduction imperatives leads to an overwhelming preference to immediately implement a program of nuclear power plant construction.

c) Competitive Energy Markets or Government Intervention

The recent decision on the provision of broadband communication infrastructure provides an excellent model for the power generation industry with many parallel arguments for government leadership to boost national prosperity. Similar levels of investment in nuclear power would completely eliminate Australia's looming power crisis, meet Australia's greenhouse gas emission reduction commitments, and lead to massive flow on economic investment. The current laissez-faire situation is leading to an acceleration of energy intensive industries moving offshore.

Additional Information. I would be happy to expand on any aspect of this submission should the Inquiry committee require this. I have attached a short resume covering my qualifications and experience at the end of this submission for your consideration.

New South Wales Inquiry into the Economics of Energy Generation

Submission

B Hill March 2012

Electrical Energy Supply

There is little doubt that the per capita supply of electrical energy is now one of the major factors if not the major factor currently defining community welfare. Whether that supply is for purely internal consumption or as in the case of Australia also underpins a diverse export trade through value-added commodities is relatively unimportant. The extent of per capita consumption broadly defines overall community prosperity. Many countries are rapidly extending their electrical energy generation and supply networks in an attempt to raise community welfare. India is a case in point with plans to install an additional 100,000 MWe over the next decade.

All predictions are that electrical energy supply needs in Australia will increase, particularly as there will most likely be a move towards an extensive use of electrical energy for transport in the future. A major factor that also needs to be considered for Australia's future electrical energy supply is the need to replace aging and deteriorating base load power stations.

a) Security of Supply

The most fundamental energy requirement for Australia at the moment is that the electrical energy supply system can be relied upon for continuity of supply.

The general consensus is that Australia must have a secure energy supply particularly electrical energy supply with adequate operating margin to cover all eventualities. Discussions in a number of forums leading up to submissions for the Federal government Energy White Paper noted that the Australian electricity supply system operating margin is currently low and very close to unacceptably low.

Recent issues with supply failure in Sydney have highlighted community attitudes and rhetoric around the need for secure supply. Another similar example was seen with the power failures in Auckland which were unfortunately more extensive than the Sydney problem. Whether the failure was caused by an overloaded cable or insufficient system capacity is clearly irrelevant in the public mind. There is a fundamental perception that the disruptive and adverse economic outcome of such failures on a modern society is totally unacceptable and no level of excuse or responsibility diversion cuts ice. The expectation is that supply is available 100% of the time without exception. Meeting that expectation is a considerable technical and logistical challenge but not impossible from an economic or engineering perspective.

My reading of the situation we are currently experiencing is that few people understood and were able to argue for the operating margins and levels of systematic maintenance that were built into the electrical supply systems over 20 to 30 years ago. Conservative management practices of that time have been subsequently eroded in the name of market rationalism or commercial expediency up to the present. Without extensive experience it is very difficult to argue for excess capacity or appropriate levels of capital replacement and maintenance for any business to cover agreed levels of operational security margin. The final decisions are based on matters of expert experience with only minor influence from science or economics.

In summary the current Australian electrical energy supply system including New South Wales is operating with insufficient security margin and is at long term risk of low-cost generation shortfall. Additional base load generating investment is therefore required. Additional investment is difficult to justify on purely economic grounds and cannot be left to any market-driven solution as it is a complex engineering risk proposition which dictates a major role for long-term Federal and State government leadership and direction. Given current power pricing realities it is inevitable that either direct investment or private sector contractual support will be required.

b) Economic Development

The supply of electrical energy at any cost does not enhance industrial competitiveness or the overall welfare of Australians. Expansion and replacement of base load power station capacity must be carried out in an economically responsible manner which does not impose unsustainable costs on industry or community. Current investments in electricity sources utilising wind or solar radiation are technological fun but will never meet any economic or secure base load criteria

Up until the present time Australia has enjoyed low cost of electrical energy supply through a combination of low-cost coal and excellent power station construction and operations management. A change of community attitude to the burning of coal (rightly or wrongly is relatively immaterial) has changed that situation for future investment. Under these circumstances the only way cost will move is higher but this needs to be very carefully managed by government to ensure we do not lose those factors which currently underpin Australia's economic prosperity and general welfare. We are already seeing many of our major energy intensive industries reading the current signals from Federal and State governments and planning to move operations offshore. As an example the concept of value adding to our mineral wealth now appears to be a lost cause. This is a fundamental change of policy (albeit by default) to the detriment of Australia's long-term economic prosperity.

Table 1 Levelised Cost of Electricity consolidates information gathered over the past six years from sources currently seen as reliable. The table details information for base load size power stations but wind and solar options have been added for comparative purposes

Table 1 LCOE Cost, Including Carbon Tax For Various Electrical Power Generation Options

Operating Plant 600 MW Range	Output MWe Gross	Net	Spec Emiss CO_2/MWh	LCOE A$/MWh	+$25/t CO_2tax	Availability %
Integrated Gasification Combined Cycle						
GEE	770	640	0.795	78	98	90
GEE with carbon capture	744	555	0.093	102	104	80
CoP	742	623	0.784	75	95	90
CoP with carbon capture	693	518	0.114	105	108	80
Shell	748	635	0.751	80	99	90
Shell with carbon capture	693	517	0.090	110	112	80
Pulverised Coal Boiler						
Subcritical	583	550	0.855	64	85	95
Subcritical with carbon capture	679	549	0.126	118	121	85
Supercritical	580	550	0.804	63	83	95
Supercritical with carbon capture	663	545	0.115	114	117	85
Natural Gas Combined Cycle						
Natural Gas	570	560	0.361	68	77	95
Natural Gas with carbon capture	520	481	0.042	97	98	85
Atomised Refined Coal (ARC) Combined Cycle						
Atomised Refined Coal (ARC)	650	630	0.6	65	80	90
ARC with carbon capture	590	537	0.068	105	107	80
Wind	500	500	0.001	90	90	20
Solar						
Solar thermal collection	100	100	0.002	200	200	20
Solar photovoltaic	50	50	0.002	160	160	20
Nuclear	1710	1600	0.005	72	72	90

Notes

Reference	US DoE NETL. -- Cost and Performance Baseline for Fossil Energy Plants
LCOE	Levelised Cost of Electricity (present value capital and operating costs)
Energy Costs	Coal (10% ash) $45/t ($1.71GJ) Gas $6.4GJ
ARC	No credits have been allowed for alumina or silica production
Nuclear	US Congressional Budget Office
Wind	Californian Energy Commission
Solar	USDOE Solar America Initiative Fact Sheets

Specific CO_2 emissions (tonnes per megawatt hour) and present value generation costs were obtained from US Department of Energy studies for existing and proposed new (2010) electrical generation plant types and calculated for the Atomised Refined Coal cases using the plant operational data provided in the DoE studies (refer to section General Comment). All carbon capture cases assume CO_2 liquid ex plant and sequested within 80 kilometers. Distribution costs beyond 80 kilometers must be added. In all cases specific emissions and costs are based on net electrical power output

If a simplistic equal weighting is given to the currently identified important factors, security (operational availability), costs (levelised cost of electricity) and minimal greenhouse gas emissions (tonnes CO_2 per megawatt hour) scoring the best base load power station option at 100%, the following preferences are indicated.

Nuclear	92%
Coal	65%
Gas combined cycle (CC)	63%
Atomized refined coal CC	62%
Gas CC CO_2 capture sequest	54%
Coal with CCS	47%

On the same weighting basis other non base load options score as follows

Wind	64%
Solar thermal	50%

All considerations point to the need to accelerate the development of nuclear power if any serious attempt is to be made to limit CO_2 emissions at reasonable cost while maintaining a secure electrical system supply. More general comments beyond the weighting considerations emphasised above are covered under General Comment in this submission.

In summary consideration of the fundamentally important imperatives of cost, security, and greenhouse gas emission reduction targets leads to an overwhelming recommendation to immediately implement a program of nuclear power plant construction

c) Competitive Energy Markets or Government Intervention

Governments across Australia now seem to accept the basic concept that given appropriate government encouragement the marketplace will take care of Australia's energy future.

I believe that this concept is fatally flawed as it is based, on academic economic theory proven to be unsustainable in practice. The economic/financial community has proven on a regular basis and beyond any reasonable doubt that it is unable to provide any real

economic level of public utility service without government intervention in some form, (regulation or subsidy) let alone manage any type of external market activity in the field of public utility in the Australian national interest

The electricity supply utilities in a low population country like Australia are too closely linked to overall economic stability, security, cost effectiveness and general community welfare to be handed over to the market to control (and thereby exploit for financial gain). The free market is never directly concerned with national interest only ever commercial or personal interest - at the extreme, demonstrated by organisations such as Babcock and Brown, Macquarie Bank and in the US, Enron. Is it any wonder that the general public ranks the "marketised" Sydney airport as the worst airport in the country? Monopoly control has bought out the worst of business ethics.

The argument that the private sector has some more innate capacity to manage business activities compared with government is simply not true. My direct personal experience is that management succeeds or fails for exactly the same reasons in the public sector as in the private sector. It is true that private sector business objectives will always be different and in some cases diametrically opposed to public or government interest.

In the current New South Wales market-driven situation the only power generation proposals under consideration are low capital, high operating cost, (inefficient) peaking operations. As the operational availability of the existing base load generators deteriorates and shortfalls are taken up by peaking capacity the cost to consumers will rise dramatically. A total reliance on gas for new investments is also potentially risky as gas prices are progressively becoming linked to international markets with large price rises inevitable

The private sector continues to be very vocal in lobbying governments to sell-off public utilities as these are seen as secure cash cows. In New South Wales the public has come to rely on the union movement to bring some rationality to the power system sell of debate for all the wrong reasons. It may be a great democratic process, but it really does reflect the total lack of informed government management with proposed outcomes swinging in all directions. Lack of any discernible direction has turned the New South Wales power industry into a moribund entity surviving on a day-to-day basis. This is a totally unacceptable situation from any perspective with higher cost and deterioration of secure supply an inevitable outcome.

In the current market-driven situation we are now seeing the New South Wales generators predicting losses in future years. In Victoria the privatised Loy Yang power station is technically bankrupt but has been permitted to keep trading for obvious reasons

Similar lack of leadership in the public interest beyond Australia has seen some countries/states unable to reach any ongoing outcomes or conclusion on power system extension or development of associated infrastructure. One of the worst examples is the Californian power system which has reached a state of total fragility with aging infrastructure constructed in more rational times, not being replaced, upgraded or

extended. The Californian situation is a clear warning for anyone with the wit to investigate.

Government leadership ensuring appropriate public utility infrastructure for the ongoing development of Australia as a whole, and not just the current population centers, is vital if we are to encourage and capitalise on the huge mineral wealth of the nation in any value-added fashion. The construction of the Gladstone power station, which would never have happened under any market-driven philosophy, triggered massive private sector investment which now underpins the economic prosperity of Queensland. A number of similar large-scale electrical generation investment opportunities (imperatives) currently lie dormant particularly in the north of Queensland. Lack of investment is currently seriously disadvantaging existing value adding industries and preventing investment by others. My personal experience is that government intervention is again required, as no private sector solution will ever emerge given the current market structure and current electricity sales models.

Partial government control trying to regulate or prop up the existing electrical energy marketplace in the face of emerging poor outcomes is a total waste of intelligent resources that could be better spent planning and facilitating excellent outcomes. There is little point persisting with a philosophical economic proposition which has been proven flawed, and is now causing considerable financial distress in the Australian and New South Wales community.

I recommend that the New South Wales Inquiry outcome reflects a much broader element of government control over the New South Wales electrical power industry with a commitment to direct investment in minimum LCOE base load power stations and management of the whole generation system in a logically planned manner. There is also a possibility of providing for private investment under agreed long term contract arrangements. As an example the Indian government is now underpinning a massive expansion of base load electrical generation capacity by providing 80% take or pay guarantees to private investors in that country. The recent decision on the provision of broadband communication infrastructure provides an excellent model for the power industry, with many parallel arguments for government leadership to boost national prosperity. Similar levels of investment in nuclear power would completely eliminate Australia's looming power crisis and lead to massive flow on economic investment.

General Comment

Nuclear Power Generation

This submission has only reviewed existing information to ascertain an appropriate way forward for the New South Wales electrical energy generation system based on security, cost, and environmental factors. The fact that the introduction of nuclear power emerges as the most viable option does need further comment.

As more factual information is provided, worldwide public perception and comment on the benefits and issues with nuclear power generation has moved on from the old cold war rhetoric to a more informed debate. This has become most evident in the Middle East, Asia and the Pacific basin where a more educated attitude is now being widely expressed. Ongoing expressions of disinterest in the introduction of nuclear power by the Australian Federal government are now seen as outdated and faintly ludicrous, given the importance of the issues at the gate. Most of the arguments used to support any expression of disinterest may be popularist, but bear little rational scrutiny, particularly arguments around weapons proliferation and waste disposal.

The introduction of a nuclear power plant installation program does not of necessity have to concentrate on very large base load units. Over the past few years there has been considerable development of small modular reactors for power generation. These units range in size from 45 to 300 MWe and would be ideally suited to installation in country New South Wales near the ends of the existing grid. The recent CSIRO led study of the Australian grid characteristics (I Grid) indicates a real opportunity for distributed power generation at multiples of the above capacity levels. An extension of that study is expected to indicate a financial incentive for installations of this type which would lower the extent of line losses in the grid and provide enhanced security of supply for country areas. The emerging designs of small modular reactors mitigate many of the perceived safety concerns associated with larger nuclear power plants. A number of power utilities in the USA are studying the option of progressively replacing older coal-fired power stations with multiple small modular reactors. Reliable costing data is not yet available but it would be my expectation that initial installations would have up to 30% higher LCOE figures than larger nuclear power stations. The installation of small modular reactors in country New South Wales would be an ideal way of introducing nuclear power to Australia in an acceptable fashion.

The first nuclear power plant installation would most likely be sixty percent imported. Australian engineering and construction groups experienced only minor problems with local input requirements for the Opal research reactor recently commissioned by ANSTO. Opal has a similar level of fundamental engineering complexity to a power reactor island albeit on a physically much smaller scale.

The owner's management/engineering team for a new nuclear power station construction project could be assembled in New South Wales within four months as there is already a sufficient pool of appropriately experienced personnel available.

There are no science issues to be resolved for the types of commercially available nuclear power stations that Australia would most likely purchase, only the normal engineering issues of quality management and contract control. There are many science/ engineering issues to be resolved with the construction and early operation of the ITER fusion reactor which Jacobs Engineering is supporting in France, but these will have no impact on any commercial power program for many years.

Atomised Refined Coal Power Generation

If the New South Wales government finds itself incapable of moving to a nuclear power programme, the next best option for base load and distributed power generation is to move to the use of chemically refined coal in combined cycle and diesel power stations.

By chemically removing all ash from coal using fluorine acid technology the resulting refined coal when micronized and mixed with air can be used to fire gas turbines. When mixed with water the micronized refined coal can be used directly in large diesel engines. The application of this technology has been fully researched by the US Department of Energy. Some additional development and demonstration of the refining process is required but this technology does provide an electric power generation option with acceptable LCOE and low specific carbon dioxide emissions compared with firing raw coal. Table 1 refers. By achieving lower specific coal consumption the technology also extends the life of coal reserves.

Jacobs Australia has been supporting the evaluation and development of this locally invented technology for the past six years. It has been disappointing to find that the technology will most likely be taken up in India and Indonesia before any interest is shown or traction gained in Australia. The cost of a modest demonstration coal refinery and diesel generation installation appears to be beyond any local private investment capability and will require support at government level.

Carbon Capture and Sequestration

There may eventually be one or two technically viable opportunities to either a retrofit or build new base load coal or gas-fired power stations with carbon capture and sequestration, but this option is not economically viable, as the capital costs of extra plant and pipelines are high and the operation is very energy intensive. Table 1 refers.

The safety perception issues for any wide spread use in Australia will be such, as to make the gaining of construction approval more difficult than a similar exercise for a nuclear power station. A safety issue not usually mentioned is the serious corrosion experienced in pipelines handling carbon dioxide now found in the oil recovery industry. Given the huge economic incentives to enhance oil recovery from existing reservoirs expensive solutions to these problems are viable but this would not be the case for the power generation option.

Pursuing this option is a futile exercise given that no suitable storage opportunities exist within any reasonable distance of the east coast of Australia where the majority of the new power generation facilities will be required. It is unrealistic for Federal or State government to provide significant research money for this area of work given that any form of implementation to base load power generation within the next 20 years is highly unlikely.

Most other countries have come to similar conclusions although low levels of continuing investigation are seen as useful albeit limited public relations exercises clearly not in the public interest from any economics perspective. The money likely to be wasted would be better spent ensuring appropriate infrastructure and regulatory frameworks are established for a move to nuclear power generation.

Wind and Solar Power Generation

Low operational availability, high cost and an essentially disruptive impact on electrical power grids has precluded these options from any consideration for base load power generation. Ongoing government subsidies (incentives?) are really only another limited life public relations exercise which is again fundamentally not in the public interest from an economics perspective. From an engineering perspective these options have many interesting technical issues to solve but engineering effort cannot resolve the fundamental issue of low energy density which inevitably leads to high capital cost.

A potential byproduct from the atomised refined coal process is ultrapure silicon which can be produced in bulk at very low cost. The option of utilising this material for solar photovoltaic cells is being investigated as it does provide some opportunity to lower solar power costs.

South Korean Case Study

An interesting nuclear generation case study from South Korea is included with the submission. Additional information provided when the paper was presented indicates a high level of planful support by the government of South Korea for low cost electrical energy generation using nuclear power. Low-cost electricity provision is one of the key factors supporting the rapid expansion of the South Korean economy.

The South Korean example provides an excellent case study on government support for the introduction of nuclear power generation facilities.

Barrie Hill March 2009

Present and Future of Nuclear Power in Korea

Oct. 27, 2009

Jong-Shin Kim
President & CEO
Korea Hydro & Nuclear Power Co.

KHNP

Contents

Chap. I

Current status of nuclear power program

The beginning of nuclear power

Research reactor TRIGA MARK II('59.7)

Commercial reactor Kori #1

- Capacity : 587MW
- Construction period : 7 years ('71.3~'78.4)
- Project type : Turn-Key (Westinghouse/USA)
- Construction cost : 320 million $
  (foreign capital : 170 million $)

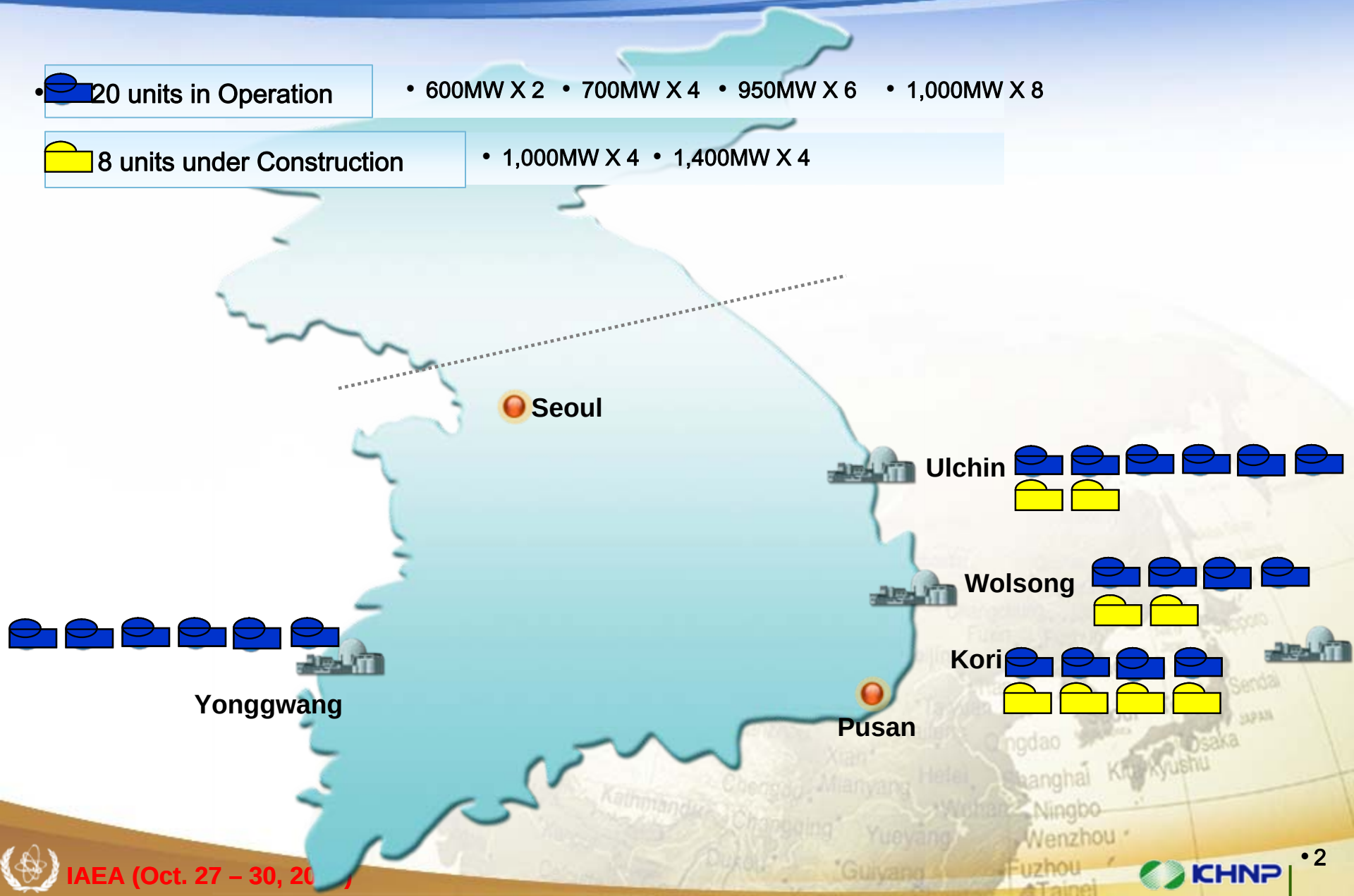
※ Life-extended after 30 years operation ('07.12)

<1971 vs. 2008, Korea>

	1971	2008
GNP per capita	290 $	19,230 $
Export	1 billion $	419 billion $
Power capacity	2,628 MW	72,491MW
Number of Cars	0.14 million	16.8 million

Nuclear power plants in Korea

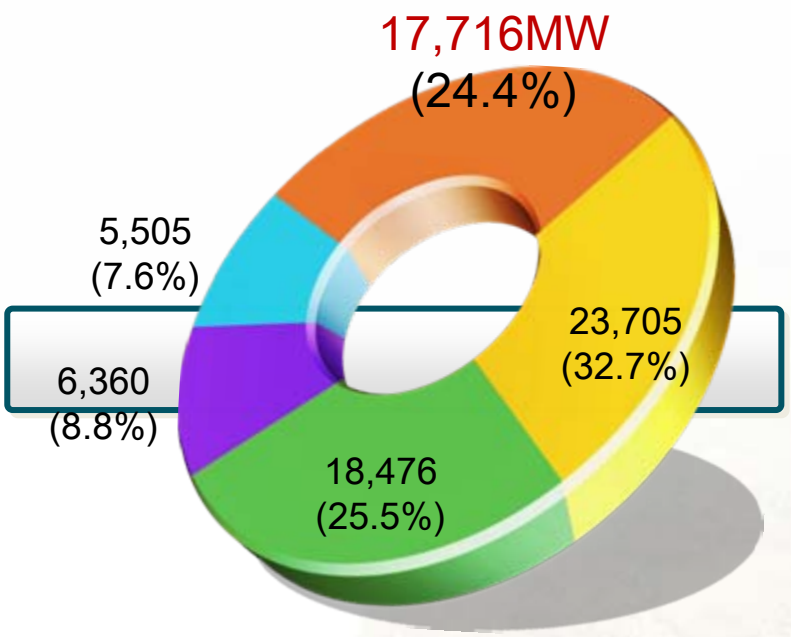
- 20 units in Operation • 600MW X 2 • 700MW X 4 • 950MW X 6 • 1,000MW X 8
- 8 units under Construction • 1,000MW X 4 • 1,400MW X 4



Status of electric power

Nuclear Coal Gas Oil Hydro (As of the end of 2008)

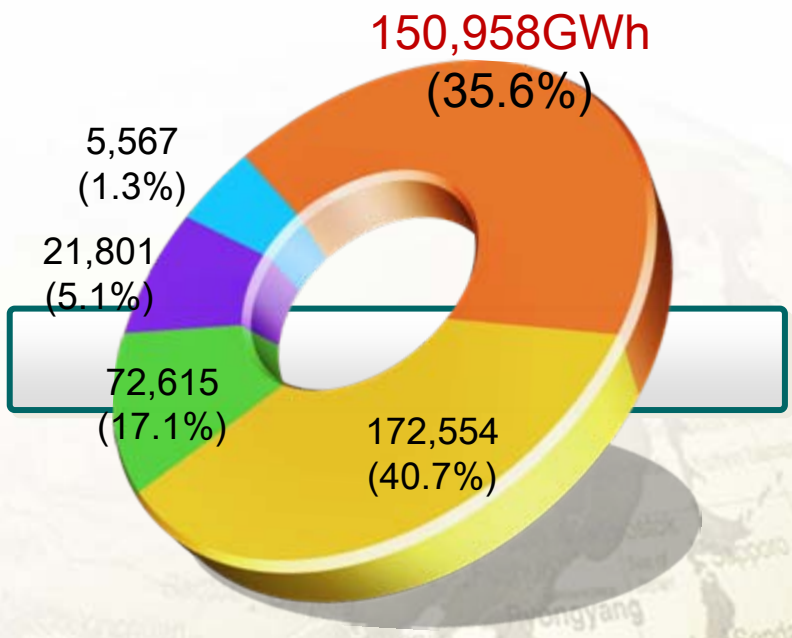
Installed Capacity



*The others : 728 MW(1.0%)

Total : 72,490 MW

Electricity Generation



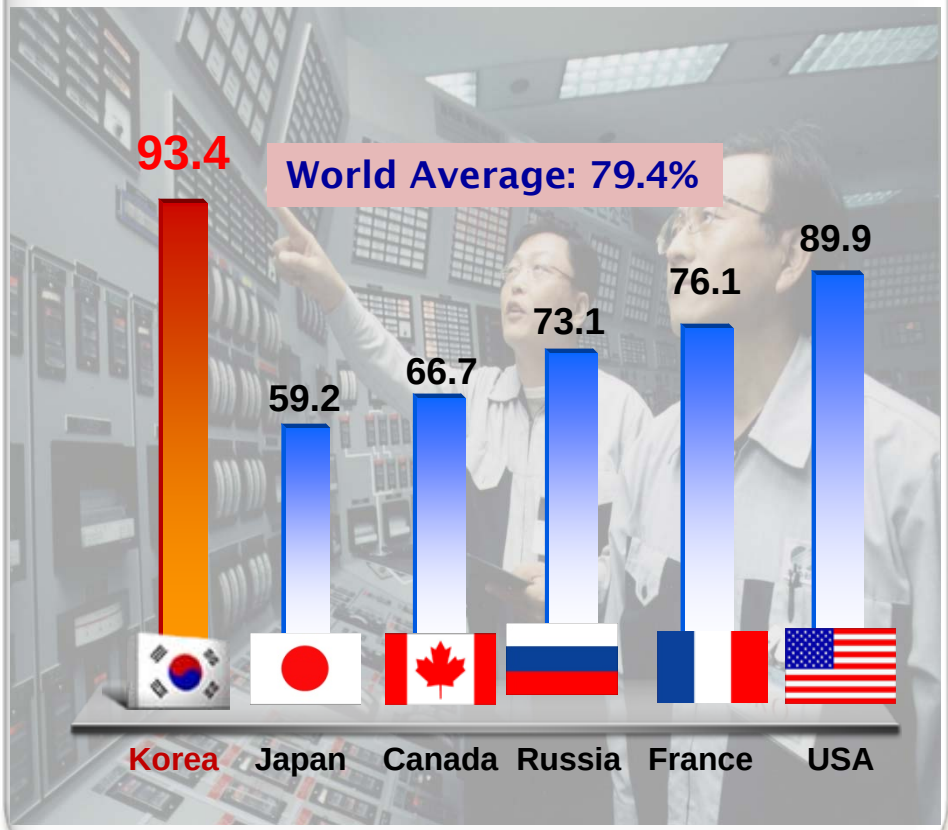
*The others : 928 GWh(0.2%)

Total : 424,423 GWh

Operational performance

Capacity Factor

(Year 2008, %)



※ Source: *Nucleonics Week* (2009. 3)

Unplanned Capability Loss

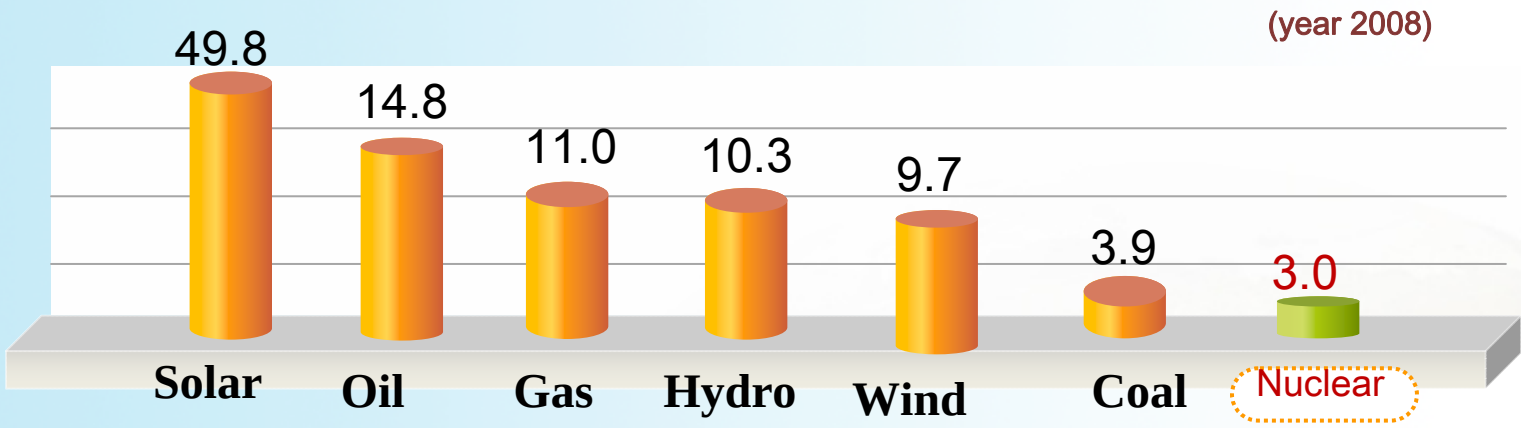
(Year 2008, %)

※ Source : IAEA

Low price of electricity with nuclear power

Economical efficiency

- Sales price (¢/kWh) : Nuclear is the cheapest



Contribution to national economy

Strength of Korea's nuclear power

Well-organized nuclear infrastructure

Strong & consistent government nuclear policy

Well-qualified workforce to maintain nuclear power program

Close cooperation with international organization

Chap. Ⅱ

Construction of advanced nuclear power plants

Construction of nuclear power plants

Project		Reactor Type	Capacity (MW)	Model	Commercial Operation	Remark
Shin-Kori	#1	PWR	1,000	OPR1000	Dec. 2010	Under Construction
	#2	PWR	1,000	OPR1000	Dec. 2011	
	#3	PWR	1,400	APR1400	Sep. 2013	Under Construction
	#4	PWR	1,400	APR1400	Sep. 2014	
	#5	PWR	1,400	APR1400	Dec. 2018	In planning
	#6	PWR	1,400	APR1400	Dec. 2019	
Shin-Wolsong	#1	PWR	1,000	OPR1000	Mar. 2012	Under Construction
	#2	PWR	1,000	OPR1000	Jan. 2013	
Shin-Ulchin	#1	PWR	1,400	APR1400	Dec. 2015	Under Construction
	#2	PWR	1,400	APR1400	Dec. 2016	
	#3	PWR	1,400	APR1400	Jun. 2020	In planning
	#4	PWR	1,400	APR1400	Jun. 2021	

Status of nuclear power construction

Shin-Kori #1,2

Rx. type	Advanced OPR1000
Capacity	1000MW x 2units
Duration	’06.6/’07.6~’10.12/’11.12

Shin-wolsong #1,2

Rx. type	Advanced OPR1000
Capacity	1000MW x 2units
Duration	’07.11/’08.9~’12.3/’13.1

* OPR1000 : Optimazed Power Reactor 1000

Status of nuclear power construction

Shin-Kori #3,4

Rx. type	APR1400
Capacity	1400MW x 2units
Duration	’08.10/’09.8~’13.9/’14.9

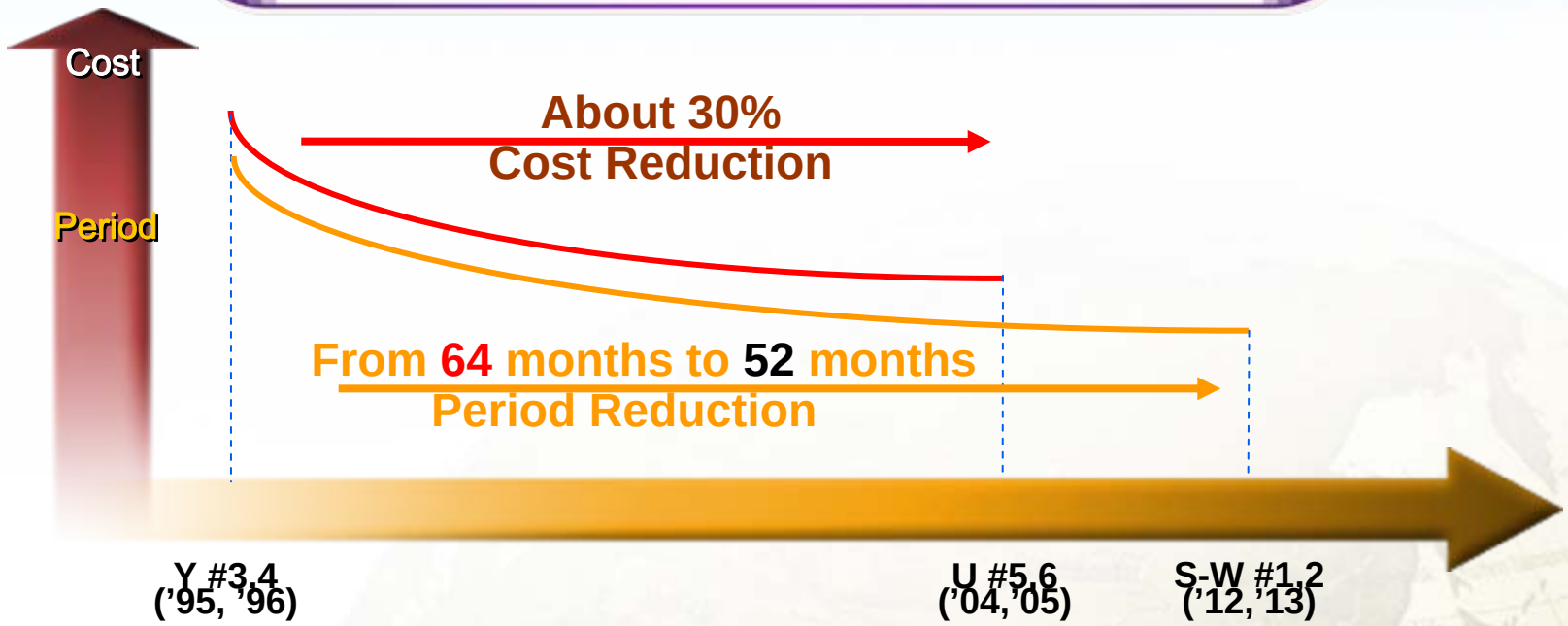
Shin-Ulchin #1,2

Rx. type	APR1400
Capacity	1400MW x 2units
Duration	’11.3/’12.3~’15.12/’16.12

* APR1400 : Advanced Power Reactor 1400

Economic efficiency in construction

Project Cost & Period Reduction



Korea has completed 20 NPP projects within the planned schedule & costs.

Key players of Korea's nuclear industry

- Korea is one of a few countries in the world that have continuously and aggressively implemented NPP projects up to now since 1970s.

Chap. III

Advance in reactor technology

History of reactor technology development

1970s

Completion of Kori Unit1 ('78)

Introduction of Nuclear Power

The first unit

1980s

Technology Accumulation

Units complete: 8 units

1990s

Completion of First OPR1000 ('95)

Development of OPR1000

Units complete : 7 units

2000s

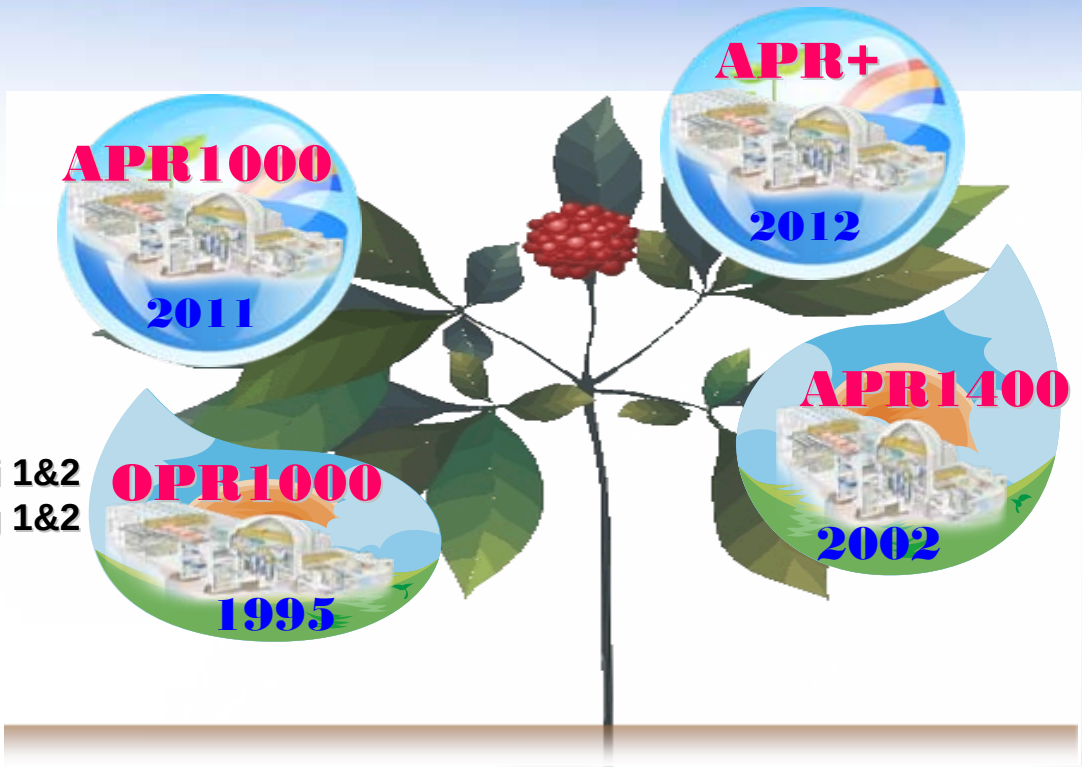
Completion of First APR1400 ('13)

Development of APR1400

Units complete : 4 units

Units under construction: 8 units

Development of Korean reactors



Shin-Kori 1&2
Shin-Wolsong 1&2

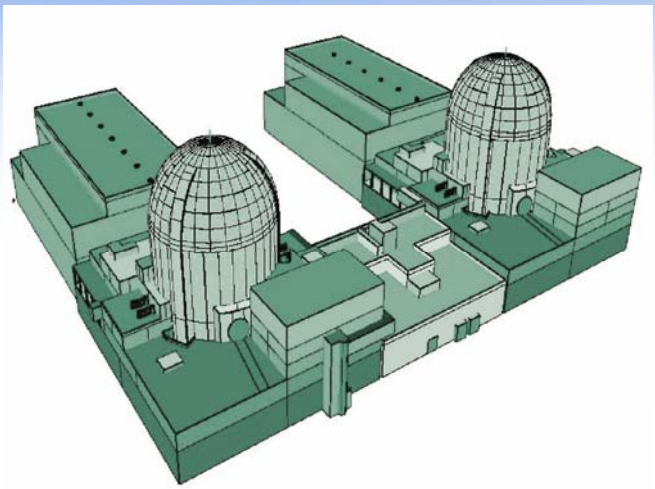
Shin-Kori 3&4
Shin-Ulchin 1&2

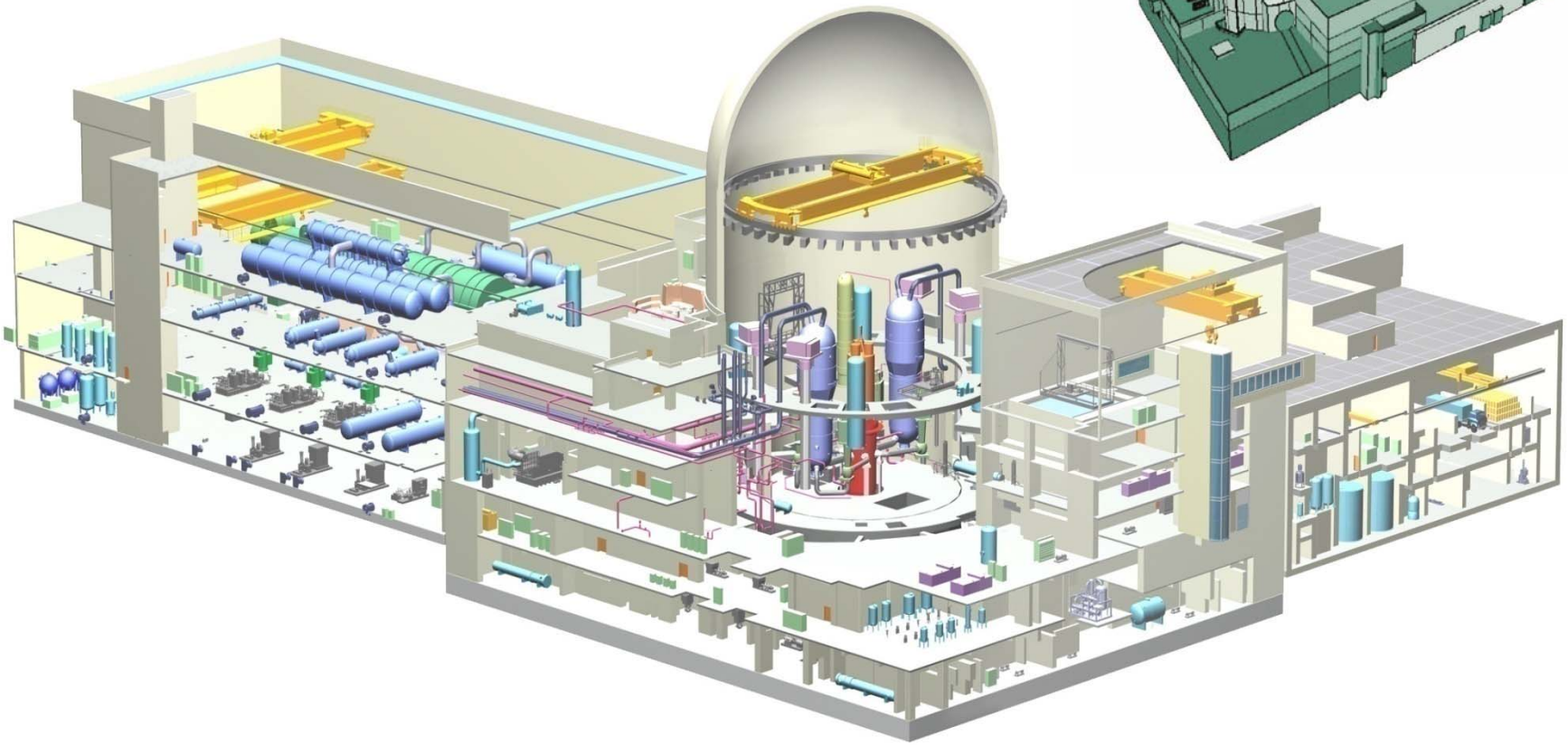
Experienced Engineers

Advanced Technology

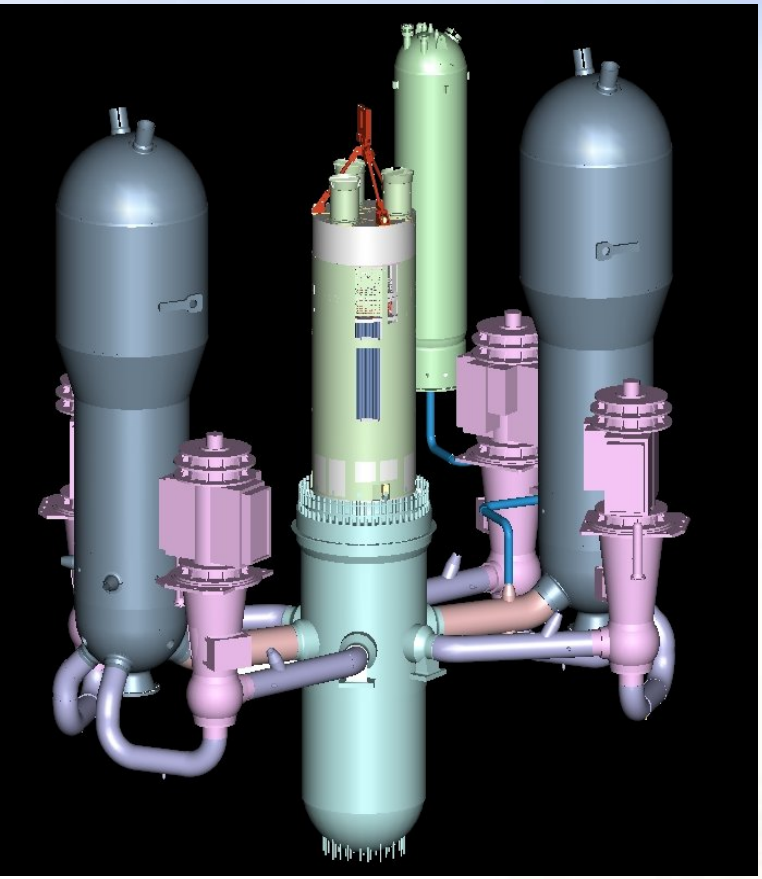
Good Infrastructure

APR1400





Major design features of APR1400



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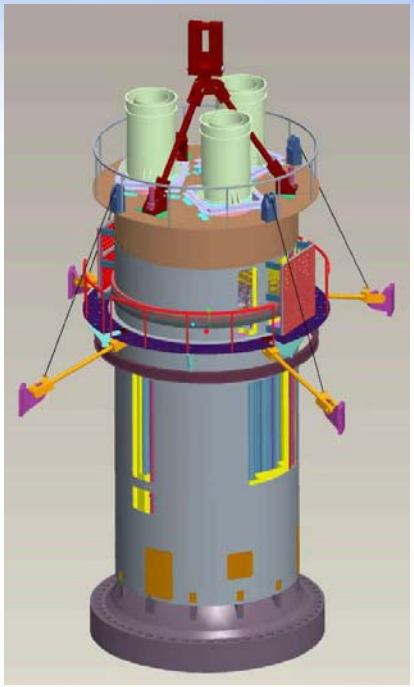
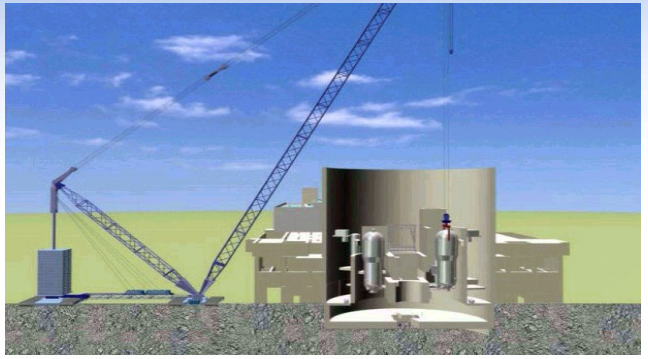


Integrated Head Ass'y

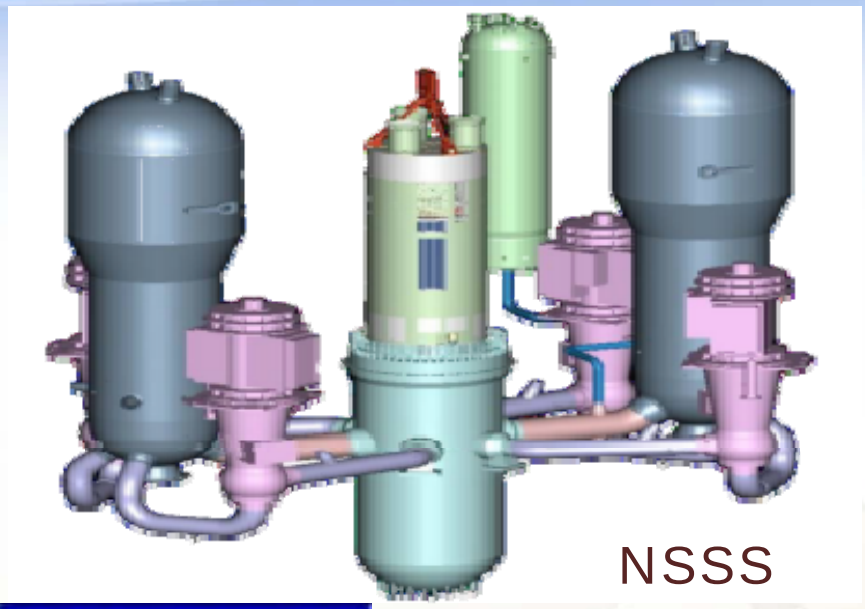


Over the top method

Digital I&C

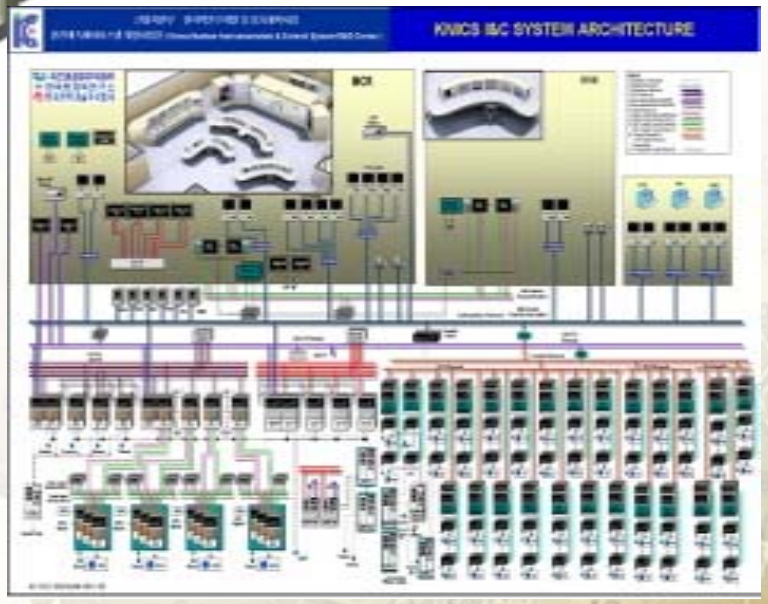
APR+ “to the Future, to the World”

General Arrangement

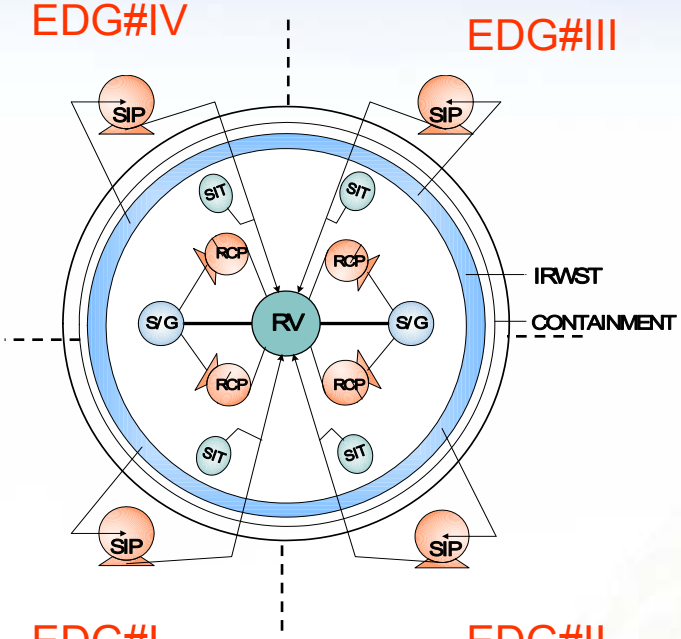


NSSS

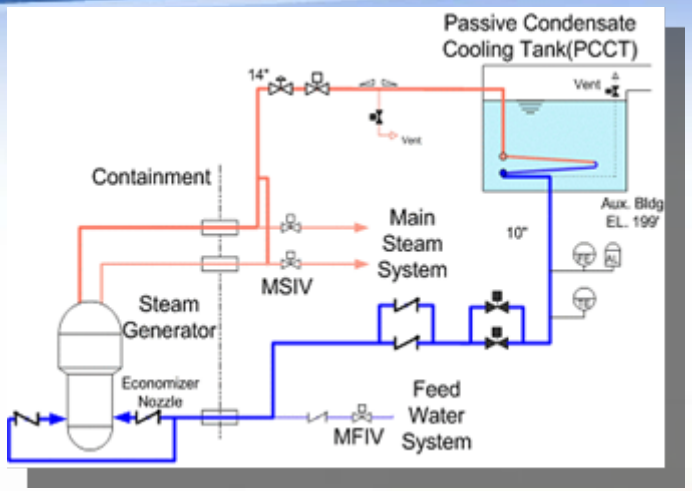
Digital I&C



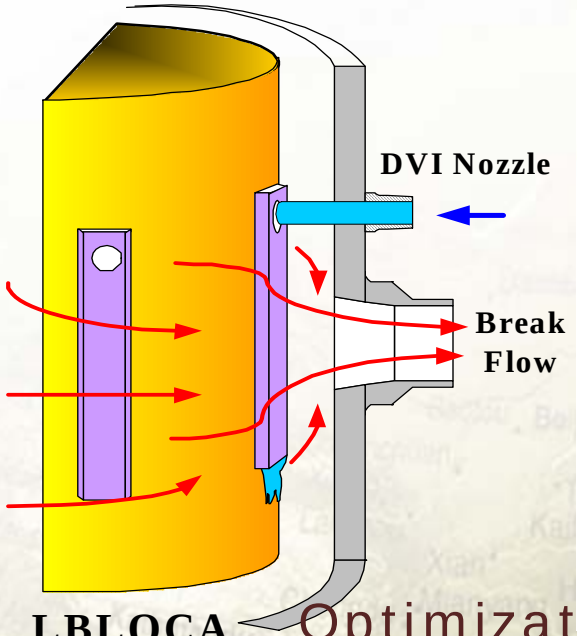
Major design features of APR+

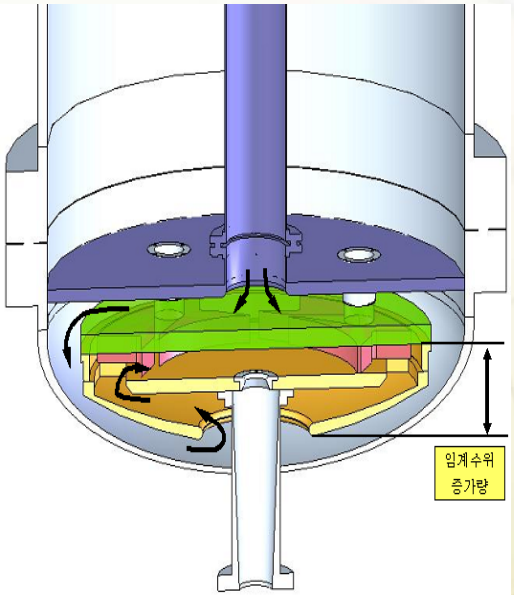


4 train Safety Injection Sys. (4 EDGs)



Passive AFWS





Optimization of Safety Injection Flow

Chap. 

Vision and challenges

Long-term National Energy Plan

Low-carbon, green growth is mapped out as Korea's new national vision for a post-oil era

< 4 Strategies>

- Low energy consumption
- Increasing clean energy
- Boosting green energy industry
- Affordable Supply of energy

Increasing the share of nuclear power generation

36% ('08) → 59% ('30)

Some 40 nuclear power plants will be in operation in 2030

Vision and challenges of nuclear power

Vision

Nuclear is Driving force of Green Growth

- **Core energy source for energy security**
- **Measures against climate change**
- **Contribution to national economy development and enhancement of citizen's life standards**

Challenges

- **Securing new plant sites**
- **Sustainable nuclear fuel supply system**
- **Promoting Public acceptance**
- **Advancing the nuclear technology**

Global green future with nuclear power

Ensuring the safety of operating NPPs

Closer International Collaboration

Helping infrastructure for new comers

Global Green future

Thank you !