China Three Gorges Project
a Case of Intensive Planning and Preparation
plus
an Innovative and Adaptive approach

Presenting for the China 3G Project Corp.

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Features of the Project
Functions and Features of the Project

- **Flood protection**: no alternatives for flood control to the vast plain areas in the middle and downstream
  - Protecting 15 million people, 1.6 million ha of farm land from flooding under 100-year flood
  - Safety under 1000-year flood together with diversion measures

- **Power generation**:
  - Capacity: 18,200MW, 84.7 TWh/Year
  - Expansion: 4,200MW underground powerhouse

- **Improvement of river transportation conditions**
  - Increase on-way (Chongqing-Wuhan) shipping capacity from 10 million to 100 million tons/year
  - Lower cost of shipping by about 35%
Functions and Features of the Project

- Implementation in 17 years from 1993 to 2009 to complete
  - **Resettlement:** 1.3 million people
  - earth and rock excavation: 134 million m³
  - concrete placement: 27,940 million m³
  - metal structure erection: 25.7 thousand tones
  - Installation of turbine generators: 26 (+6) units, 700 MW each

- Cost Estimation (excluding underground powerhouse)
  - RMB 90.1 billion Yuan ($12.8 billion) at 1993 price level, excluding IDC and price escalation
    - **Dam project:** 50.1 billion Yuan ($7.2 billion), **56%**
    - **Resettlement:** 40.0 billion Yuan ($5.7 billion), **44%**
  - RMB 203.9 billion ($29 billion), including IDC and price escalation
三峡工程枢纽布置图
Intensive Planning and Preparation

Planning and preparation

- Project idea officially proposed in 1919
- Project concept developed in 1944 by the Chief Engineer of the Bureau of Reclamation of USA
- Intensive planning and preparation with dedicated institutions
  - “3G Hydropower Generation Technical Review Committee” set up in 1945
  - Yangtze Water Recourse Commission (YWRC) established in 1950
  - First round research, geological survey, feasibility study and project design completed in three years by 1957, with technical support of Soviet Union
  - Continuous update of planning, survey, research and design, and preparation work by YWRC, universities, research institutes, and the Ministry of Water Resources, and
Intensive Planning and Preparation

- Re-justification on 14 topics from 1985 to 1992
  - Sate Council organized Panel of Experts for Justification of 3G Project: 412 domestic senior experts in 14 discipline groups
  - A Canadian consulting consortium (CIPM): Independent feasibility study and justification in parallel

14 disciplines reviewed for the re-justification
- Flood control
- Navigation
- Hydraulic Structures
- Power System
- Environment
- Dam Safety
- Cost Estimation
- Overall Planning and Reservoir Levels
- Sedimentation
- Mechanical and Electric Equipment
- Construction
- Resettlement
- Economic Assessment
- Geology and Seismic
The Most Difficult Challenges Faced at the Beginning

Resettlement of 1.3 million people, including 40% rural people
- **State Council**: “resettlement is the key to the success of 3G”

**Sedimentation**
- 630 km long reservoir in the upper reaches
- Impacts to dam operation, Chongqing City at the end of reservoir, navigation, and downstream river bed
3G Reservoir – Inundation (in BLUE) and affected 19 Counties/Cities
The Most Difficult Challenges Faced at the Beginning

Technical challenges

- World-record breaking production rate of concreting
  - more than 5 million m³/year at the peak required
- Commissioning 4 sets of 700 MW units a year
  - Design: huge challenges to ensure stable operation of the 700 MW Fancies turbine under the given large water head variation: from 63 to 113 m
  - Supply capacity: difficult for a single international supplier to supply more than one 700 MW unit a year
  - Lack of know-how to design and manufacture 700 MW hydro units in China
- Other technical challenges
  - Rock stability: cutting a channel 175 m deep into the rock for the shiplock
  - Shiplift for passenger boats: 11,800t of lifting capacity with a lift of 113m
  - Preventing cracking of massive concrete placement in summer (35-40°C)
The Most Difficult Challenges Faced at the Beginning

**Project Financing**
- A concern about financial capacity to finance the project
- Undeveloped capital market and limited financing channels for domestic financing
- Seeking international financing might result in delay in project construction
  - The Project was voted at the People’s Congress in April 1992 and construction of preparation works started in early 1993
  - Preparation for international financing: time for appraisal
  - Timing: one year delay would result in direct financial loss of about 30 billion Yuan ($4.3 billion)
Innovative and Adaptive Solutions for Resettlement

Resettlement Preparation

- 8-years of pilot resettlement before 1993
  - Adopted a “development-oriented resettlement”
    - Take resettlement and associated investment program as opportunities for development and poverty alleviation
  - Compensation + re-establishment of livelihood
  - relocation industrial factories and enterprises
  - resettle rural people in the nearby, in the second and tertiary industries, and with own efforts to find jobs
  - Resettlement planning took in a stepped approach & on county-basis
Innovative and Adaptive Solutions for Resettlement

Institutional Set-up

State Council 3G Project Construction Committee (SC3PCC)
- Chair: the Primer
- 5 Vice-Chairs: including a vice-premier
- Members: ministers of 28 line ministries

3G Resettlement Bureau
- Provincial
- Municipal
- County Government

SC3PCC Office

3G Project Corporation
- Design Institute
- Supervision Engineers
- Contractors

Project Construction

Resettlement Implementation

Quality POE
Innovative and Adaptive Solutions for Resettlement

Resettlement Implementation

- Empowered and effective institutional set-up
  - State Council, provincial / municipal / county governments and 3G Corp to creating authorities and synergy to mobilize resources

- Provide adequate budget (44% of total project cost)
  - Breakdown budget to Provinces, prefectures and counties and finally to every planned activities
  - Favorable government policies: e.g. Tax reduction / exemptions

- Support from developed cities throughout the country
  - Encourage provinces to build one-on-one support to the affected counties / cities
Innovative and Adaptive Solutions for Resettlement

Resettlement Implementation

- State Council Document for 3G Resettlement in 1996, with adjustment of principles for resettlement of rural people, in combinations of:
  - resettlement in nearby and moving out of the region, encouraging moving out
  - concentrated and disbursed resettlement
  - Government organized and self-choice resettlement
  - Farming and non-farming, shifted the focus to farming
  - Relocation and rehabilitation / bankruptcy of industrial factories/enterprises
  - Encouraging competitive enterprises to establish business in the reservoir areas
Innovative and Adaptive Solutions for Resettlement

Support from provinces

- Each of the 19 affected counties was linked to one “sister province”
- About 60 central government agencies and offices also provided linked support to the affected counties / cities
- Supports:
  - Financial support to investment in infrastructure projects
  - Provide employment to surplus labors
  - Staff-exchange program
Innovative and Adaptive Solutions for Sedimentation

**Sedimentation Control**

- Extensive experience on sedimentation control form other hydropower projects in China
- Extensive sedimentation modeling to support dam design and reservoir operation procedures
  - One model in a top hydropower engineering university
  - One model in water resource science research institute
- Adaptive reservoir impoundment schedule
  - Gradually increased operation levels: El. 135m, 139m, 156m, and 175m
- Emergency measures prepared
  - Dredging maybe required for navigation at the end of reservoir
- Water and soil loss protection in the upper-reach catchment area
Innovative and Adaptive Solutions for Technical Challenges

High Production Rate required for Concrete Placement

- Extensive Use of Tower-Belt systems for continuous concrete placement
  - Changed from traditional concrete placement method of transport with trucks and pouring with buckets and cranes
  - Achieved **5.4817 million m3/year**, 550,000 m3/month
Innovative and Adaptive Solutions for Technical Challenges

**Supply 4 sets of 700 MW units a year and ensure performance**

- Encouraging JVs in China to expand manufacturing capacity
  - VOITH/SIEMENS/Shanghai and ALSTOM/Tianjin set up in mid 1990s

- International Competitive Bidding (ICB) for turbine runner hydraulic design and all suppliers using the same design for manufacturing
  - To achieve maximum plant efficiency and best stability performance
  - To simply future operational and maintenance management

- First ICB for 14 Units and second ICB for 12 units - economy of scales
  - Competition among international supplier consortia
  - Two consortia selected
  - One consortium awarded 6 units, another 8 units
Supply 4 sets of 700 MW units a year and ensure performance

- Technology transfer to the two major Chinese manufacturers – conditions for bidding
  - Joint design and manufacturing by Chinese manufacturers and foreign consortia, one Chinese manufacturer associated with each of the 2 consortia
  - Share of Chinese manufacturing and supply gradually increase, and each manufactures a whole set of the 14 units within each contract
  - All design documents, computer software including source code and detailed explanations were provided to the two Chinese manufacturers
  - Same technology transfer for turbine governor and generator excitation system in a follow up ICB

Through this process the Chinese manufacturers are able to manufacture 700 MW hydro units now
Innovative and Adaptive Solutions for Project Financing

Project Financing through equity and borrowing

- Established a “3G Project Construction Fund”
  - A levy on electricity consumptions through China, with some exceptions

- Power Revenue during construction (1993-2009)
  - Commissioning 4 sets of 700 MW units a year since 2003
  - Power revenue from the downstream existing Gezhouba Hydropower Plant (2,705 MW)

- Domestic Bank Loans
  - A 30 billion Yuan ($4.3 billion) loan was provided at the beginning of project implementation

- Export credit for imported equipment
  - E.g. US$1.12 billion for supply the 14 power generation units
Innovative and Adaptive Solutions for Project Financing

**Project Financing through Capital Market**

- Set up a 3G Financial Company, to manage the 3G funds and prepare for capital market financing
  - recruiting people from the financing / banking sector
- Issuance of Corporate Bounds
  - First issuance of Corporate Bound of RMB 1.0 billion Yuan (about $1.43 billion) in 1996
- IPO of its power generation assets
  - Set up China Yangtze Power Co., Ltd. in 2002 and IPO in 2003
- Financing advisory from domestic & international consulting firms
In early 2008, the project has achieved or is likely to achieve:

- Resettlement of about 1.3 million people
- Completion of project in 2008, one year earlier than scheduled
- Cost within 180 billion Yuan vs 204 billion at appraisal
- Excellent project quality
- Strong project development and financial capacity of 3G Corp
- Contributions to uplifting the technical capacity of China among the strongest in the world in hydropower planning, design, supervision, construction, project management and major equipment manufacturing
- Provision of a practical reference and experience to the world hydropower communities with a number of technical innovations and breakthroughs
3G Corp: expanding business in hydropower development

- Expanding business with power revenues and financing through the public listed China Yangtze Power Co., Ltd.
  - 4 new sites, 38,000 MW, 174.4 TWh/Yr, on upper reaches of the River

<table>
<thead>
<tr>
<th>Dam</th>
<th>Capacity (MW)</th>
<th>Cost ($bn)</th>
<th>Resettlement</th>
<th>Status</th>
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<tbody>
<tr>
<td>Xiluodu</td>
<td>18 x 700</td>
<td>6.6</td>
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<tr>
<td>Xiangjiaba</td>
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<td>Feasibility</td>
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<tr>
<td>Baihetan</td>
<td>13,050</td>
<td>9.4</td>
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<td>Feasibility</td>
</tr>
</tbody>
</table>

Note: cost excluding IDC and price escalation

- Expanding business beyond hydro: Wind, solar, thermal;
- Expanding business beyond Yangtze River: Guangzhou, Shanghai, Hubei, partnership with China Southern Grid for GMS countries
Thank You!