

# Journey to the West



Paul Grant goes to  
China seeking  
wisdom...

# Epiphanies Undergone...

**“I have seen the future...and it works!”**

*Lincoln Steffens, 1920*

**“A wise Communist will not be afraid  
of learning from a capitalist.”**

*V. I. Lenin, 1922*

**[www.w2agz.com](http://www.w2agz.com)**

# China-USA Electricity Statistics (2001)

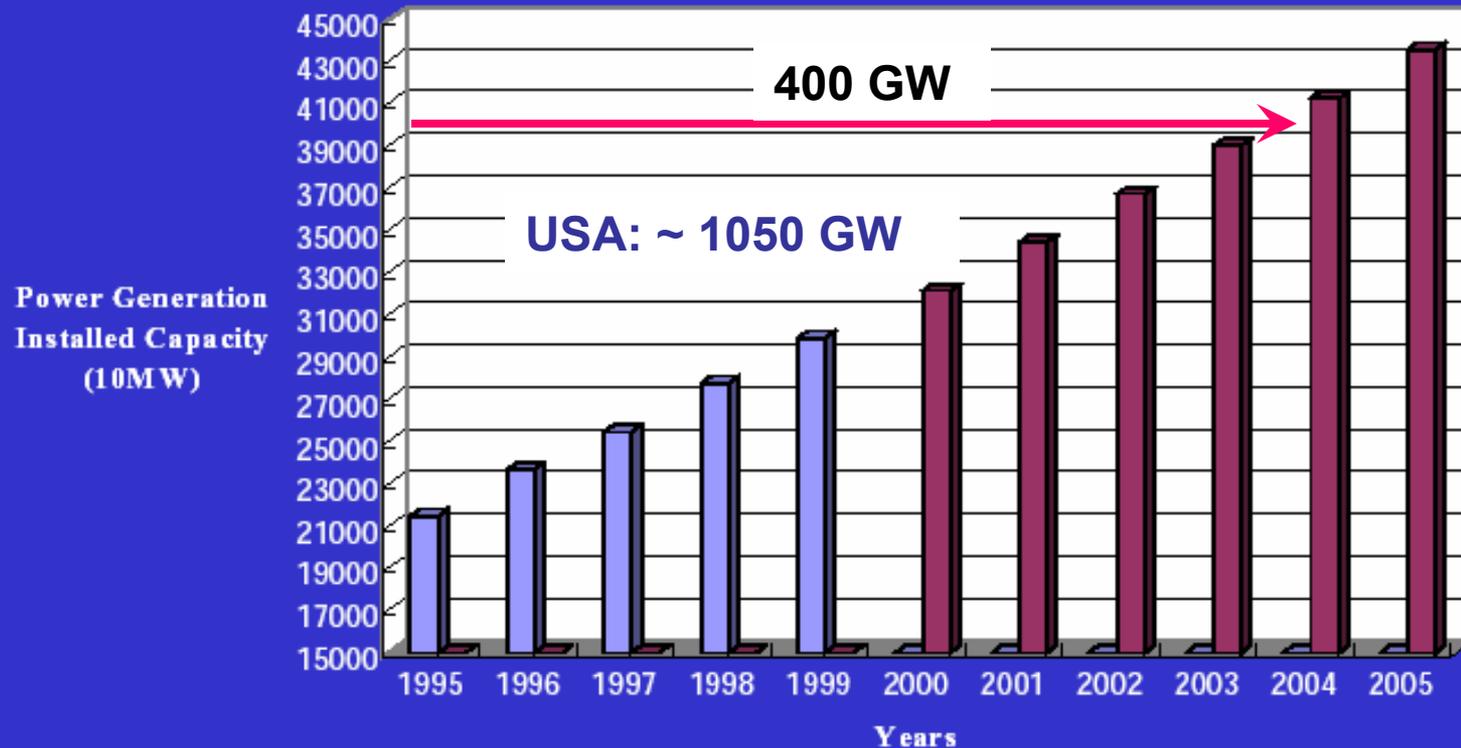
Source (CIA & EIA)

<b><i>Production Source (%)</i></b>	China	USA (NA)
Fossil	80.2	71.4 (15% NG)
Hydro	18.5	5.6
Other	0.1	2.3
Nuclear	1.2	20.0
<b><i>Annual Producton (TkWh)</i></b>	<b>1.42</b>	<b>3.72</b>

# China – Installed Generation Capacity

7%/year increasing (now > 380 GW)

根据预测，2010年将达到6.5亿千瓦左右，2020年达到9.5亿千瓦左右。



# Present & Prospect

- **Total installed capacity, China ranks second only after U.S.A.**
- **In 2000, capacity/population in China < 1/3 of world,.**
- **Capacity / population will be 1kW in 2050, the middle level of current developed country.**
- **Power consumption increased 15% past half year; 8 GW in Beijing and 15GW in Shanghai this summer.**

电荒, 2004年中国仲夏夜之恶梦  
Electrical power shortage (30GW),  
the **midsummer nightmare** of 2004 .



2月全国发电量1581.77亿千瓦时（日均发电量54.54亿千瓦时），比上年同期增长31.36%。

全国发电装机容量已达3.85亿千瓦，在建电力项目1.3亿千瓦。

Capacity 385GW,

Shortage 30GW,

线损率 line losses 7% (Three Gorges Project: 18 GW)

130GW under construction

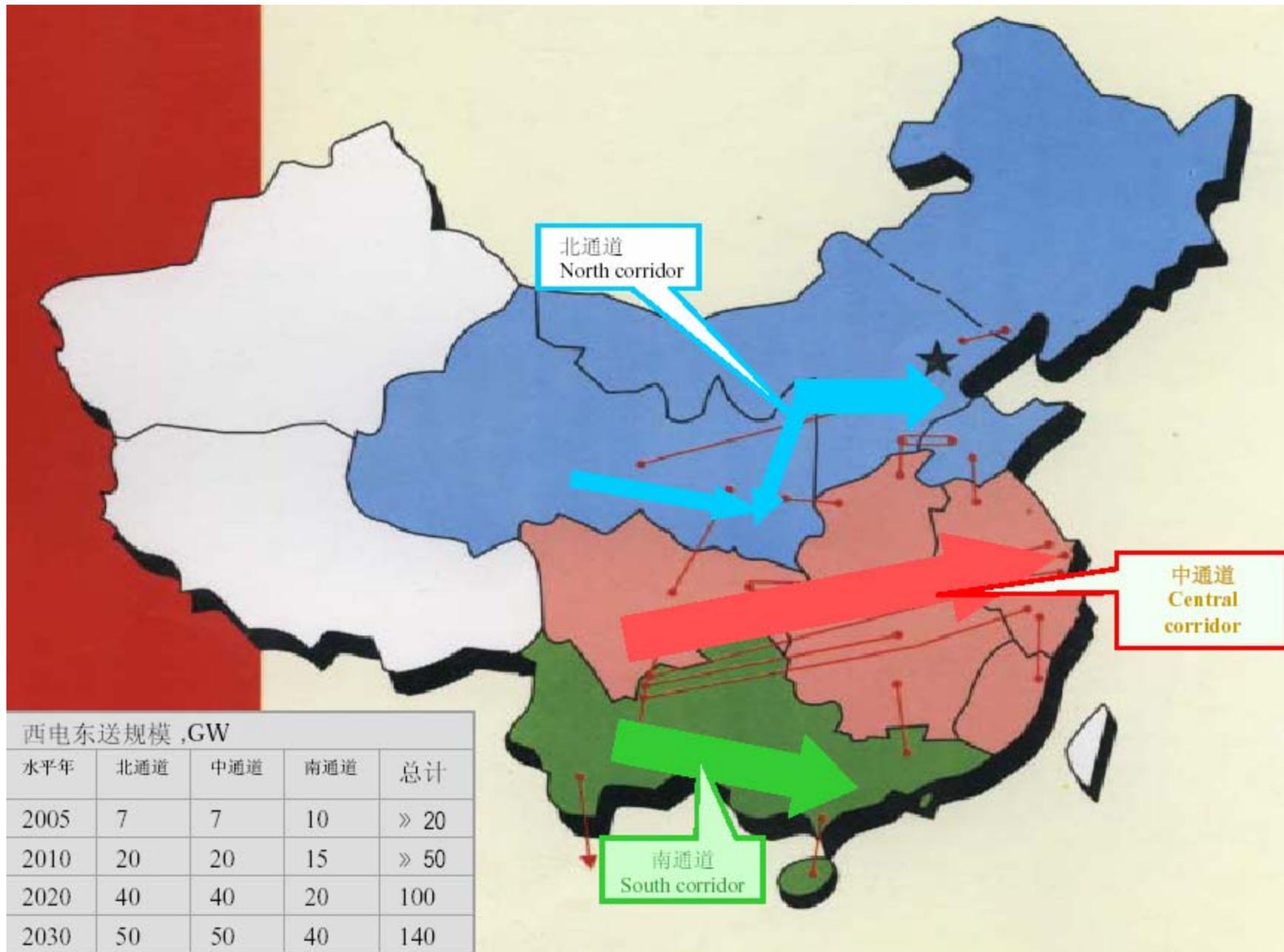
It is said that 2006 could be better

Could be worse

# China “Factoid”

- Current Population: 1.3 Billion Souls
- All want to live like Americans
- Chinese Family Priorities:
  - (1) TV, (2) Washer, (3) Fridge...
  - Next an Air Conditioner (200 USD, 1 kW)
- Assume an average family size of three, then...

*An extra 500 GW of generation capacity must be added just to keep them cool!*



北通道  
North corridor

中通道  
Central  
corridor

南通道  
South corridor

# China-USA Recoverable Coal Reserves (2002)

	Million Short Tons	Years Left*
China	126,215	273
USA (NA)	280,464	309

- One Short Ton = 6150 kWh  
Efficiency Conversion – 40%



# Applied Superconductivity Research Center (ASRC), Tsinghua University

**Established in 2000,**

**A multidisciplinary research center ,**

**11 full-time staff (4 Postdoc) and 14 graduate students.**

- PIT BSCCO wires,
- Coated Conductors,
- Characterization,
- New methods, new applications



Prof. Zhenghe Han

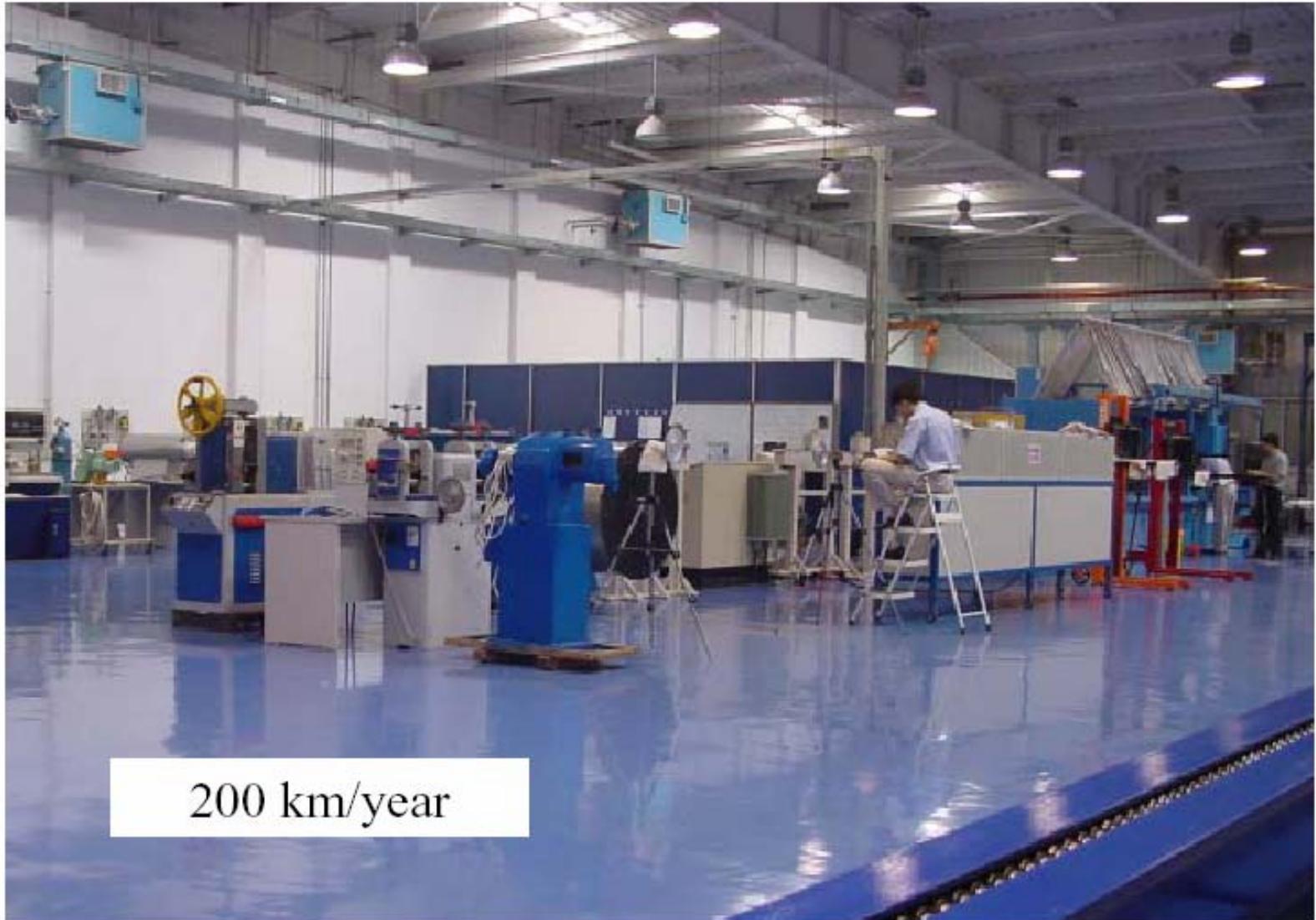
# Close relation with InnoST and Innopower



# Innova Superconductor Technology Co., Ltd. (InnoST) 英纳超导公司

- **THE FIRST SUPERCONDUCTOR COMPANY IN CHINA**
- **Founded in September, 2000**
- **Located in Beijing Economy and Technology Development Area, China**
- **>30 employees,**

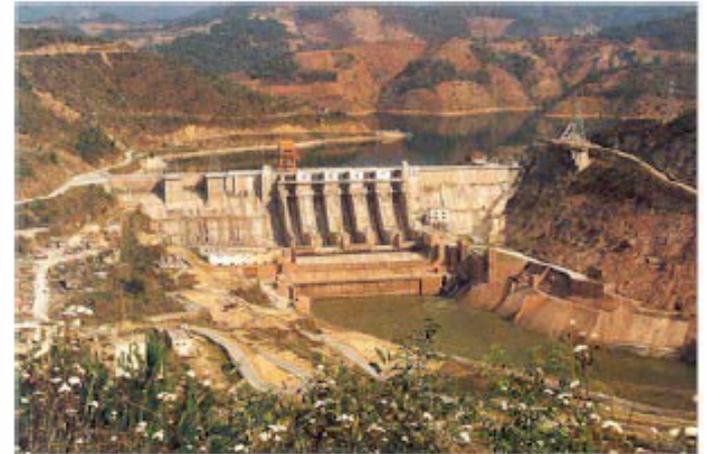
# InnoST Production Unit



200 km/year

# Innopower Superconductor Cable Co., Ltd. 云电英纳超导电缆公司

- **Invested by YEPG and InnoST.**
- **Short term objective**  
**to develop the first HST power**  
**cable in China.**
- **The cable will be installed in**  
**YUNNAN power network in**  
**the beginning of year 2004.**



# Government Sponsorship

## Applied Superconductivity Program

2002-2005, (863 超导专项)

**Department of High and New Technology and Industrialization,  
THE MINISTRY OF SCIENCE AND TECHNOLOGY OF CHINA (MOST)**  
Open to European 6<sup>th</sup> Frame Programme

Executive group members: 专家组成员

Dr. Z. Han, group leader, Tsinghua University,

Dr. H. Wen, vice group leader, CAS Institute of Physics,

Dr. P. Zhang, vice group leader, Northwest Institute for Non-ferrous Metal  
Research

Dr. H. Gu, General Research Institute for Nonferrous Metals

Dr. L. Xiao, CAS Institute of Electrical Engineering

Dr. Y. Tang, Huazhong University of Science and Technology

Dr. F. Wang, Peking University

# Funding

## Three areas:

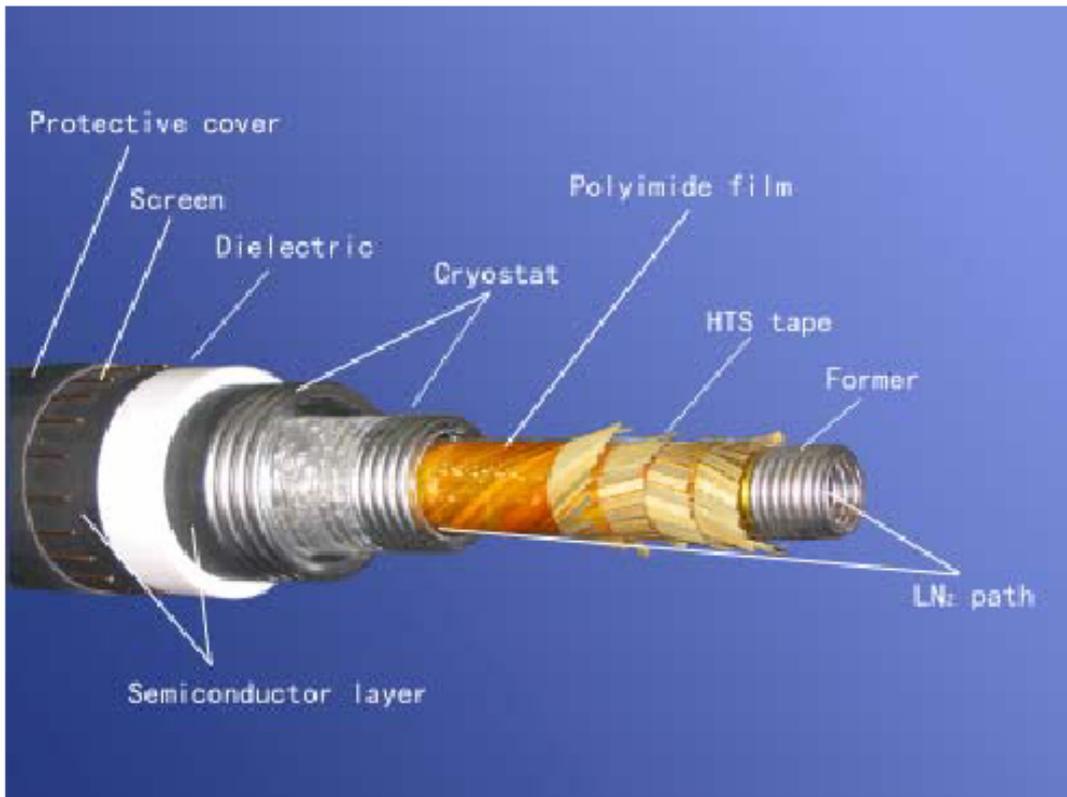
- Superconducting materials.
- Power applications.
- Electronic applications.
  
- **31 projects, 31个项目**
- **RMB 100 millions for 3 years supported by MOST.**
- **> RMB 300 millions supported by local governments and Industries.**

# Superconducting Materials Projects

- Long BSCCO tape,
- $\text{MgB}_2$  wires,
- Low  $T_c$  wires,
- Large Area YBCO Thin Film,
- Coated Conductor.

# Puji Cable

## **33.5 m Cable**



Former ID/OD(with Braiding):  
**30/35 mm**

Layers of HTS tape:  
**4**

Number of HTS tape:  
**90(21,24,24,21)**

Ic of HTS tape:  
**60-80 A (77K, self field)**

ID/OD of cryostat:  
**43/70 mm**

Dielectric material:  
**XLPE**

Thickness of dielectric:  
**11.9mm**

Overall linear specific weight:  
**9.2kg/m**

# Puji Substation



# Puji Cable Specs

<b>Subject</b>	<b>Specification</b>	<b>Subject</b>	<b>Specification</b>
<b>Mode of Cable</b>	Three single phase, Outdoor	<b>Operation Altitude</b>	1,900m
<b>Length</b>	33.5m (flange to flange)	<b>Outer Diameter of Cable</b>	112mm
<b>Rated Voltage</b>	35kV	<b>Cooling Fluid</b>	LN <sub>2</sub>
<b>Rated Current</b>	2kA(rms)	<b>Cooling Capacity</b>	2,000W at 75K
<b>Shortcut Current</b>	20kA/2S	<b>Inlet Temperature</b>	70~72K
<b>Dielectric Type</b>	Warm	<b>Outlet Temperature</b>	74~76K
<b>Installation Bending Angle</b>	90°	<b>Reliability Requirement</b>	>20000 hours

# Accessories

## *Terminations*



Resistance at 300K:

***47  $\mu\Omega$***

Resistance at working:

***40  $\mu\Omega$***

# Cryogenics

## *Cooling System*



Purge (dry N<sub>2</sub> gas):  
***20-24 hours***

Pre-cooling:  
***15-20 hours***

Number of  
Cryorefrigerators  
working at normal  
load(800-1500A:  
***4-5***

LN<sub>2</sub> flow rate:  
***600-900 L/h***

# Power Station

## *Monitoring & Control*



### **Parameters monitored**

#### **Temperatures:**

*In/out of each phase;  
out of pump tank;  
In/out of subcooling tank;  
Coldhead of each cooler;  
Cooling water*

#### **Pressure:**

*In/out of Pump tank;  
In/out of each phase;  
Subcooling tank  
LN2 tank*

#### **LN2 flow rate:**

*Each phase;  
Water*

#### **LN2 level:**

*Pump tank  
Subcooling tank  
LN2 tank*

#### **Current:**

*Each phase*

#### **Voltage:**

*Each phase*

# Future Directions

## *Near Future Applications of HTS Cable*



**Replacing old cables in existing tunnels and trenches to increase capacity**

**From substation to large capacity refineries and plants**



# Future Cable Applications

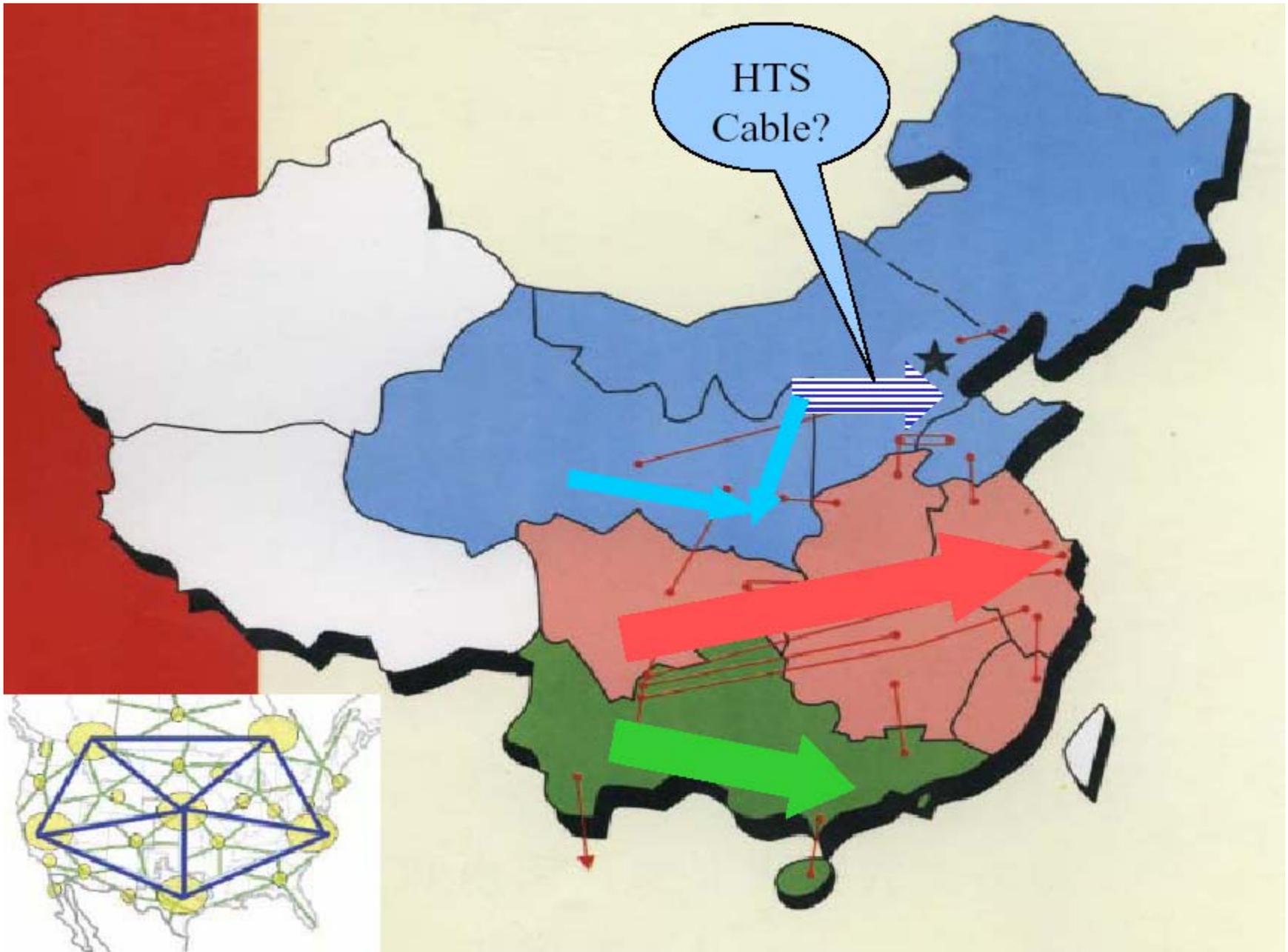
## *Near Future Applications of HTS Cable*



**From generator to transformer,  
typically, 24kV/20-30kA, 20-200m**

**Metropolitan constant voltage network**





**Postcard from China**

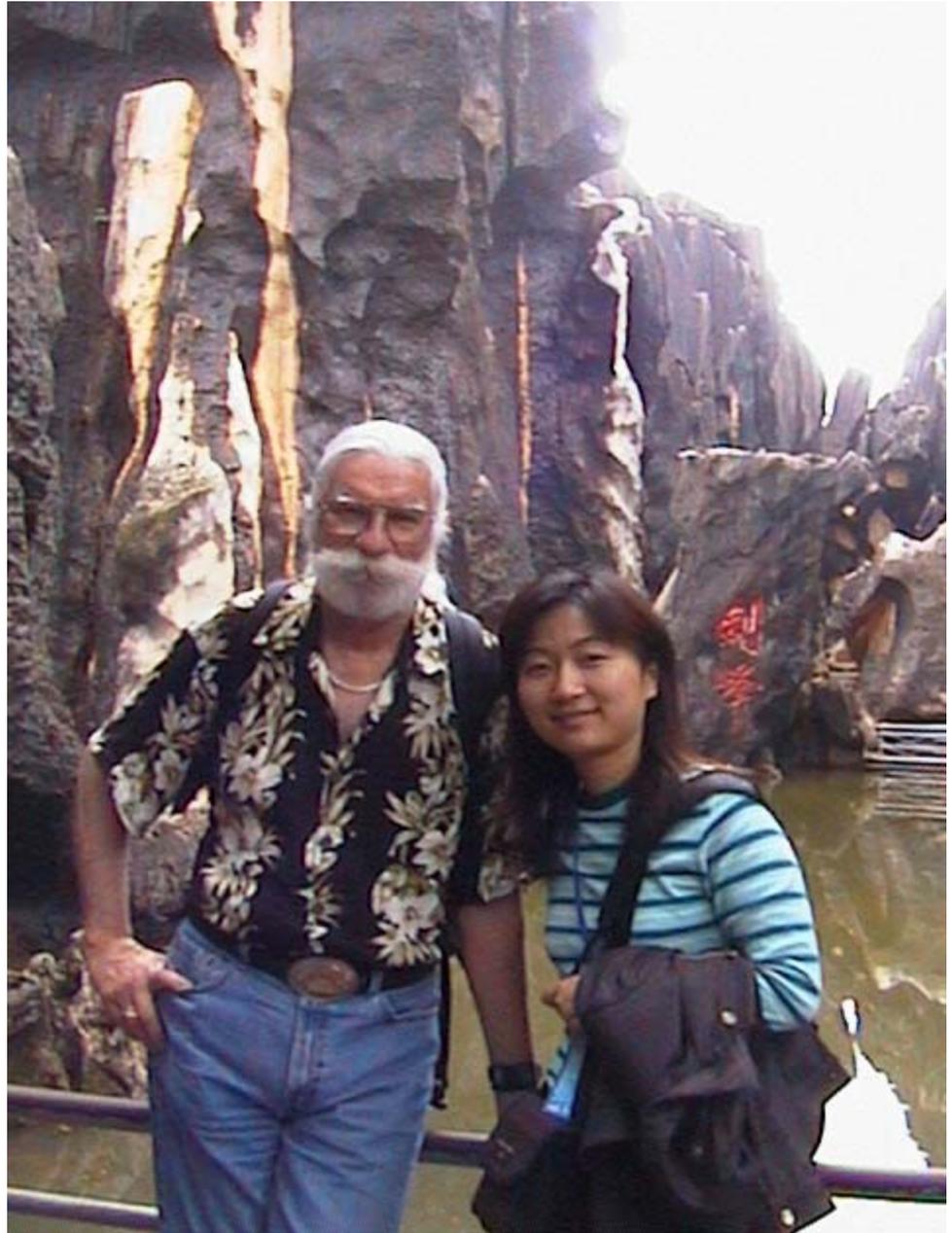
Helping to  
Promote  
US – Chinese  
Relations

---

*Glad you're not here,  
Dr. Grant & Friend*

---

Stone Forest  
Yunan Province, PRC  
June, 2004



# Recipe for a Room Temperature Superconductor

## 一、陈香普洱茶

中国十大名茶之一，是中国历史上最悠久的名茶，系皇室贡茶，《红楼梦》中亦称为女儿茶。以云南特有大叶种茶为原料，经传统工艺精致而成。其保存时间越长，滋味越醇厚，价值越高。茶汤褐红明亮，具有独特的陈香味道，有很高的保健功效。在日本、法国、香港、台湾，又被称为“美容茶”、“减肥茶”、“长寿茶”。

**冲泡方式：**直接用沸水冲泡，洗茶两遍后饮用，回味绵长。

**小知识：**传统中医学认为：陈香普洱茶是对身体没有任何副作用的茶，可以调节新陈代谢，降脂、降脂、降胆固醇，具有解油脂、减肥、助消化、暖胃、健脾、醒酒、抗寒、提气、排毒养颜的功效。经常饮用能抑制中风及血压升高、动脉硬化，对癌细胞有抑制作用。此外能很轻松、很舒适的减肥。也是最能保值增值，具备收藏价值的茶。

**小偏方：**5-7克茶叶加700毫升水煎煮，日服四次，对细菌性痢疾有较好的防治作用。

## 二、冷香

独特的冷茶，亦可热泡，但冷泡口感更佳，兼有桂花、兰花、梅花、茉莉花的香气，品饮有“暗香浮动月黄昏”的意境。

**冲泡方式：**1、沸水冲泡，直接饮用，亦可滤出茶汁放冰箱保鲜层保存30-60分钟后冷饮；

2、冷水冲泡，放置一段时间后直接饮用。

**小知识：**这道茶含有丰富的茶多酚、有机酸和维生素。热水冲泡常饮能调节中枢神经、促进脑部血液循环、缓解精神压力；冷水冲泡对神经衰弱、脑力衰退、健忘、抑郁有一定的效果，且健脾开胃，保肝护肾。

## 三、黄金贵

云南名茶，系历代贡茶，回味悠长，有“七泡有余香”的美誉。

**冲泡方式：**用沸水直接冲泡饮用，茶汤黄亮，饮之生津回甘，齿颊留香。

**小知识：**用煮过红枣的水直接冲泡，饭后饮用可以补血、养颜、调节内分泌。加入适量红糖，常喝可以促进胃液分泌，增强胃蠕动，对于胃寒、胃凉起到养胃、补胃的作用。常饮对身体有几方面的益处：1.消毒、灭菌、抗皮肤老化，能减少紫外线辐射对皮肤的损伤。2.喝剩的茶渣干透之后放入纱布袋中，洗澡时用于按摩，可滋养肌肤，去痒子。