deutsche nanoschicht

Conectus

Notizen vom International Superconductivity Summit

Michael Bäcker, Chairman CONECTUS
CONsortium of European Companies determined To Use Superconductivity
www.conectus.org

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Conectus

The central objective of Conectus is to strengthen the basis for commercial applications of superconductivity for stakeholders in Europe.

Conectus

…is a consortium of European companies with the shared vision that commercialization of superconductivity will translate into significant benefits to economy and society.

…provides a platform for industry to exchange information and to provide a united voice on public policy issues of common interest to superconductivity stakeholders.

Conectus members

…seek to ensure that the benefits of superconductivity are fully realized by decision-makers in industry, academia and governments.

…unite to advocate for key priorities and adequate government support focused on superconductor-related research, development and demonstration projects.

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Conectus

Conectus members have the opportunity to interact directly with leading companies and individuals in the field that is growing worldwide into a vital 21st century industry. Each year in autumn, Conectus members also participate in the International Superconductivity Industry Summit (ISIS), a meeting with experts from all over the globe.

The ISIS organisation currently comprises five members representing their respective nations or regions:

- National Institute of Advanced Industrial Science and Technology (**AIST**) – Japan
- Coalition for the Commercial Application of Superconductors (**CCAS**) – U.S.A.
- Consortium of European Countries Determined to Use Superconductivity (**CONECTUS**) – Europe
- Korean Industry Confederation for Commercialization of Superconductivity (**KICS**) – South Korea
- Joint Stock Company Russian Superconductor (**RSC**) – Russian Federation
- Institute of Electrical Engineering, Chinese Academy of Science (**IEE-CAS**)

Japan

- Cable projects
- Cooling systems

Triaxial cable development for IPB

SWCC Creating for the Future

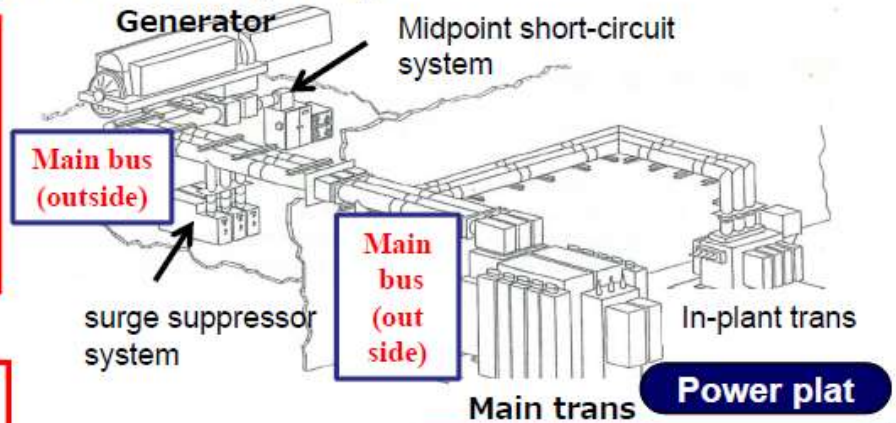
Supported by NEDO (FY 2014-2016)

As an item for energy saving technology, superconducting cable is very effective. The target of this development is reduction of J oule heat generated by Isolated power bus (IPB)

Heat loss by Joule heat
Conventional (10kA) :
4.3kW/m/three phase
Superconductor Bus (10kA) :
0.04kW/m/three phase
99% of energy saving is possible

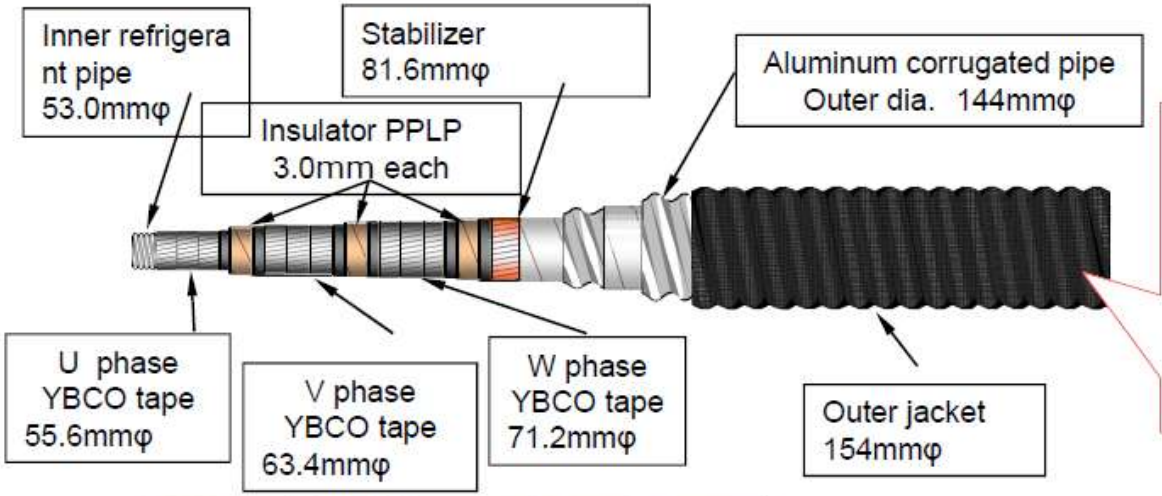
Assumption of loss all over Japan
→ 311.3MW of total energy loss
Energy loss
(converted in oil amount) 24.4X10⁴kL/y

- **Huge energy saving should be achieved by using superconductor**
- **IBP is a good application because of low voltage & large capacity application**

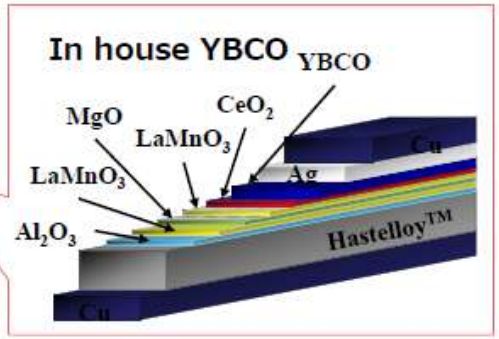


Energy saving
Size reduction
Short construction period

Triaxial cable development for IPB



Configuration of triaxial superconducting bus



Phase	Designed Ic (A)	Result (A)
U	4,220	4,250
V	5,450	>4,500
W	5,370	>4,500

SWCC used ordinary cable manufacturing machine using for UHV cable.
We modified them for superconductor and achieved making cables as designed.

Distribution cable in plants which keep LN2

Supported by NEDO (FY 2017-2019/planning FY 2020-2021)

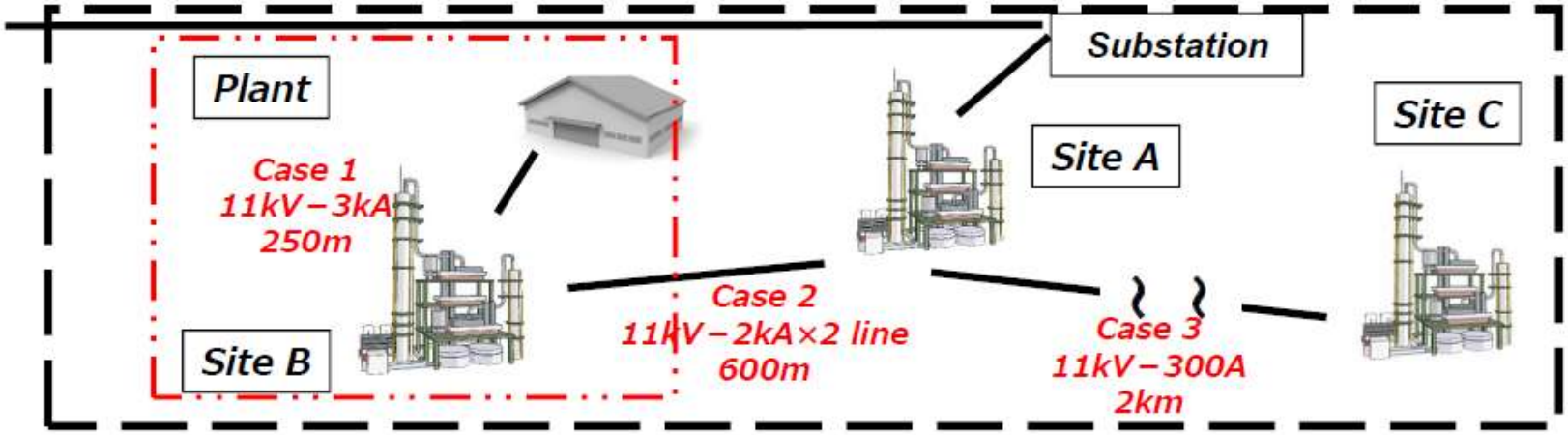
Background

- In Japan, market research indicated that many plants intending to renew the infrastructures seek items for energy saving technology.
- They interested in using superconducting cable but problems are initial cost and cooling cost.

Concepts of this proposal

- To apply renewal demands in large scale plant
- To use aged power line for bypass line
- To use LN2 as a coolant or heat sink using in the plant

Developments for lower cost and lower heat loss are necessary!!



“NeoKelvin ® -Turbo 10kW “ announced to be marketed

Taiyo Nippon Sanso Corporation develops cooling neon-based turbo refrigerator

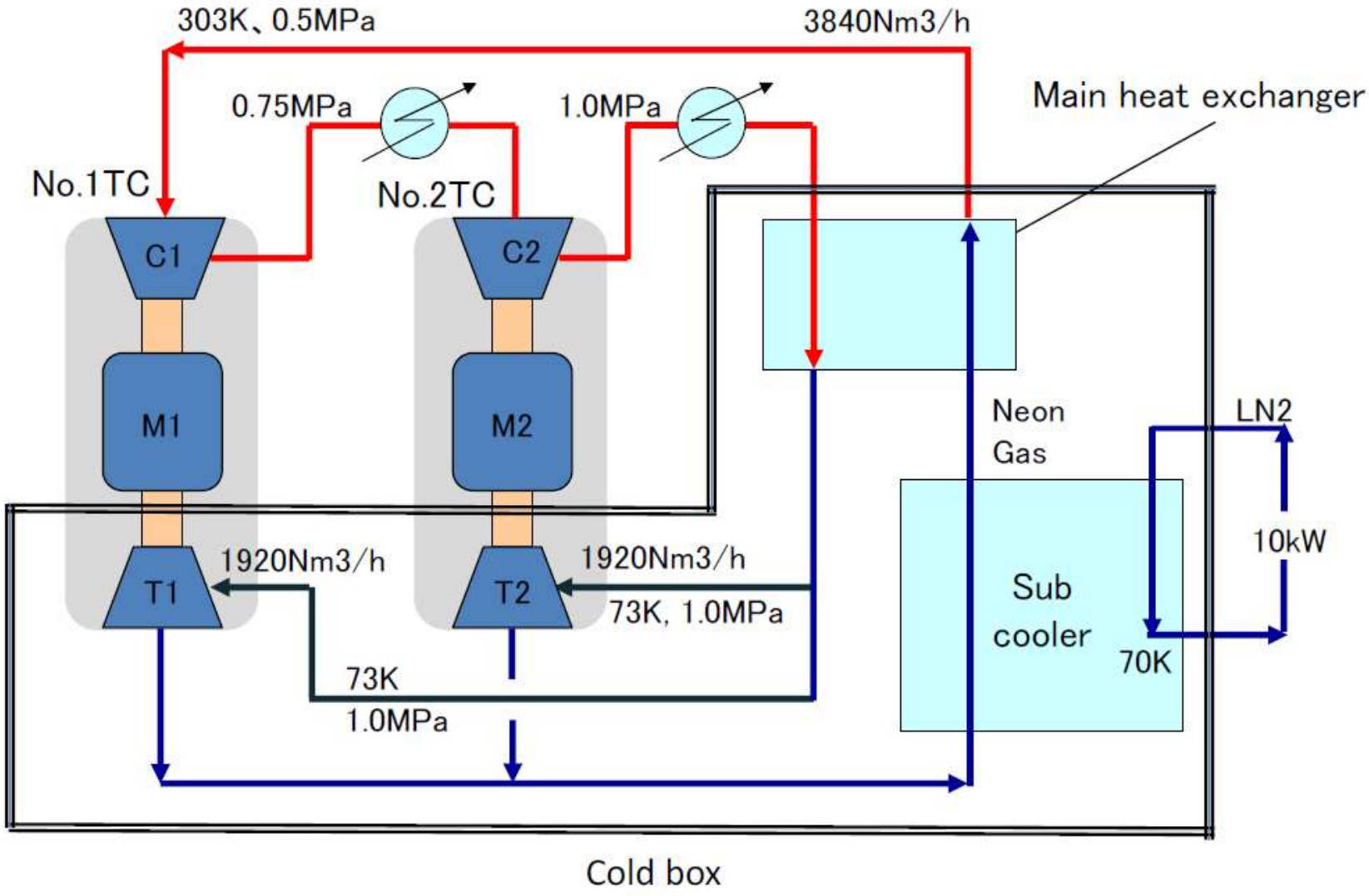
(News source : Gasworld July 29, 2016)

Taiyo Nippon Sanso Corporation (TNSC) has developed a turbo-Brayton refrigerator, termed the NeoKelvin®-Turbo 10kW, which can cool high-temperature superconducting power applications at -200ºC by using neon (Ne) gas as the working fluid.

NeoKelvin ® -Turbo 10kW

TAIYO NIPPON SANSO
The Gas Professionals

Flow diagram of NeoKelvin® -Turbo 10kW



TAIYO NIPPON SANSO
The Gas Professionals

Installation

- 10kW Refrigerator consists from 4 units
  - Cold box (Main unit)
  - Control unit
  - Power supply unit
  - Gas charging unit
- Easy connecting of signal and power cable between each units
- Will take 2 or 3 days for Installation

Loading of Cold box

Installing of Cold box

Installing of
Gas charge unit

TAIYO NIPPON SANSO
The Gas Professionals

NeoKelvin -Turbo User List

Year	User	Type	# of sets
2013	LSC/KEPCO	2kW Prototype	1
2014	Ishikari Project	2kW Commercial type	3
2015	LSC/KEPCO	10kW Prototype	1
2015	Research institute in Japan	2kW Commercial type	1
2016	Electric cable company in Japan	2kW Commercial type	1
2017	KEPCO	10kW Commercial type (7.5kW spec.)	1
2018	SuperOx	2kW Commercial type	3

TAIYO NIPPON SANSO
The Gas Professionals

Commercial Brayton cooling system

- **Specifications**
  - Capacity ・・・ Cooling Capacity: 5 kW@77K
  - Efficiency ・・・ COP: 0.08
  - Maintenance interval ・・・ 30,000 hours

Byayton NeO

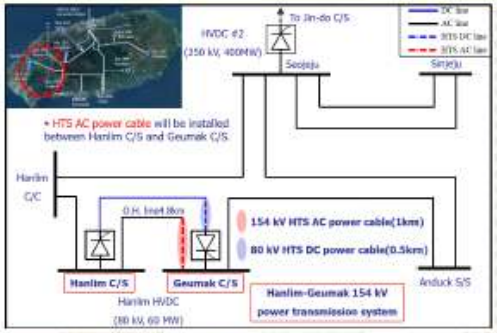
MAYEKAWA

Korea

- Cable projects

HTS power application R&D in Korea last 15 years (2001~2016)

KERI 한국전기연구원 KOREA ELECTROTECHNOLOGY RESEARCH INSTITUTE



JEJU Project(2011.07~2016.10), 10M$/yr, 5yrs

- HTS **DC** Power Cable; 80 kV, 250 MVA, 500 m
- HTS **AC** Power Cable; 154 kV, 600 MVA, 1 km
  - grid connected operation to deliver from wind farm
- SFCL was considered to install in the grid (no effect)
- **KEPCO (funded and grid opened)**

ICHEON(2009.01~2013.12), 5M$/yr

- HTS **Power Cable**; 22.9kV, 50MVA, 410m (KEPRI, LS, KERI, etc.)
- HTS Power cable; 22.9kV, 120MVA 100m
  - grid connected operation (test grid)
- **SFCL**; 22.9kV, 630A class (KEPRI, LS, etc.)
- SFCL; 22.9kV, 3kA class
  - grid connected operation (test grid)
- **KEPCO (funded and grid opened), Korea has only one utility company.**

DAPAS(2001.06~2011.03), 10M$/yr

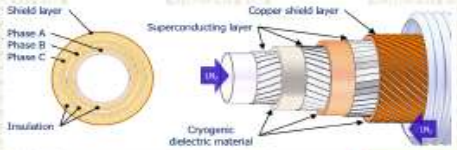
- HTS **Power Cable**; 22.9 kV and 154 kV class (KERI, LS, KEPRI, etc.)
- HTS **Transformer**; 154 kV class core technology (KPU, etc.)
- **SFCL**; 22.9 kV, 600 A and 3 kA class, 154 kV core tech. (KEPRI, LS, etc.)
- HTS **Motor**; 5 MVA class (DHI, KERI, etc.)
- **2G wire**; 1 km, 500 A/cm_width (KERI, SuNam, etc.)
- **CAST (Project Management)**

2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019

New projects on HTS power cables in Korea

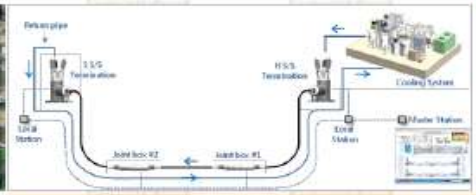
KERI
한국전기연구원
KOREA ELECTROTECHNOLOGY RESEARCH INSTITUTE

FCL type cable project (2017.05~2020.04)



2km project (2017.08~2022.07)

- HTS **Power Cable**; 23 kV, 50 MVA
- Tri-axial type HTS power cable



SHINGAL Project(2016.09~2018.12), 10M$

- **HTS Power Cable**; 22.9 kV, 50 MVA, 1 km
- Real grid connection(commercialization)
- **KEPCO (fully funded)**

JEJU Project(2011.07~2016.10), 10M$/yr, 5yrs

- HTS **DC** Power Cable; 80 kV, 250 MVA, 500 m
- HTS **AC** Power Cable; 154 kV, 600 MVA, 1 km
- SFCL was considered to install in the grid (result: no effect)
- **KEPCO (funded and grid opened)**

ICHEON(2009.01~2013.12), 5M$/yr

- HTS **Power Cable**; 22.9kV, 50MVA, 410m (KEPRI, LS, KERI, etc.)
- HTS Power cable; 22.9kV, 120MVA 100m
- **SFCL**; 22.9kV, 630A class (KEPRI, LS, etc.)
- SFCL; 22.9kV, 3kA class
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- **SFCL**; 22.9 kV, 600 A and 3 kA class, 154 kV core tech. (KEPRI, LS, etc.)
- HTS **Motor**; 5 MVA class (DHI, KERI, etc.)
- **2G wire**; 1 km, 500 A/cm_width (KERI, SuNam, etc.)
- **CAST (Project Management)**

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

World 1st fully commercialized HTS power cable installation

KERI
한국전기연구원
KOREA ELECTROTECHNOLOGY RESEARCH INSTITUTE

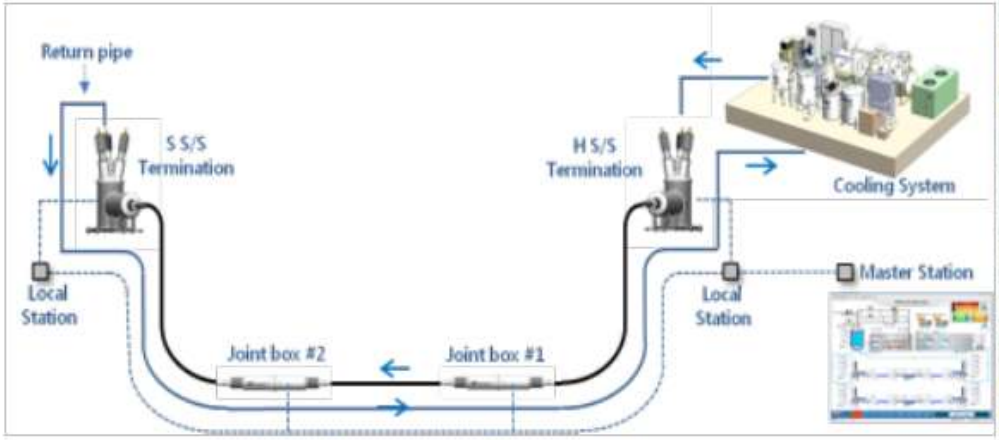
- First commercialization

*100% funded by KEPCO

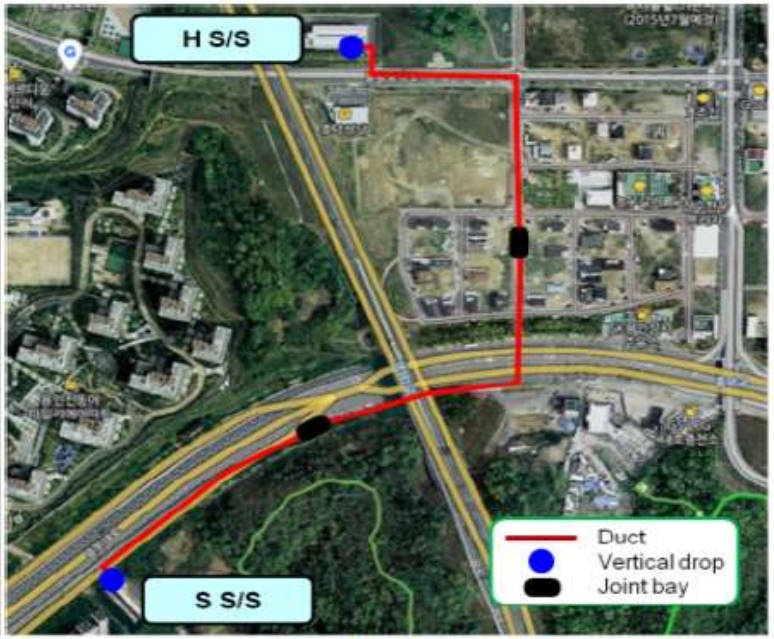
R&D in advance ▶ Pilot demonstration ▶ **Commercialization**

KEPCO LS Cable

- ✓ Shingal project (Shingal S/S ~ Heungdeok S/S) :
  - Project period: Sep., 2016 ~ Dec., 2018
  - System configuration: AC23 kV 50 MVA, 1 km-cct(duct) + 7.5 kW @69 K Turbo Brayton Cooling system
  - Project cost: USD10M
  - Status : On going



System configuration

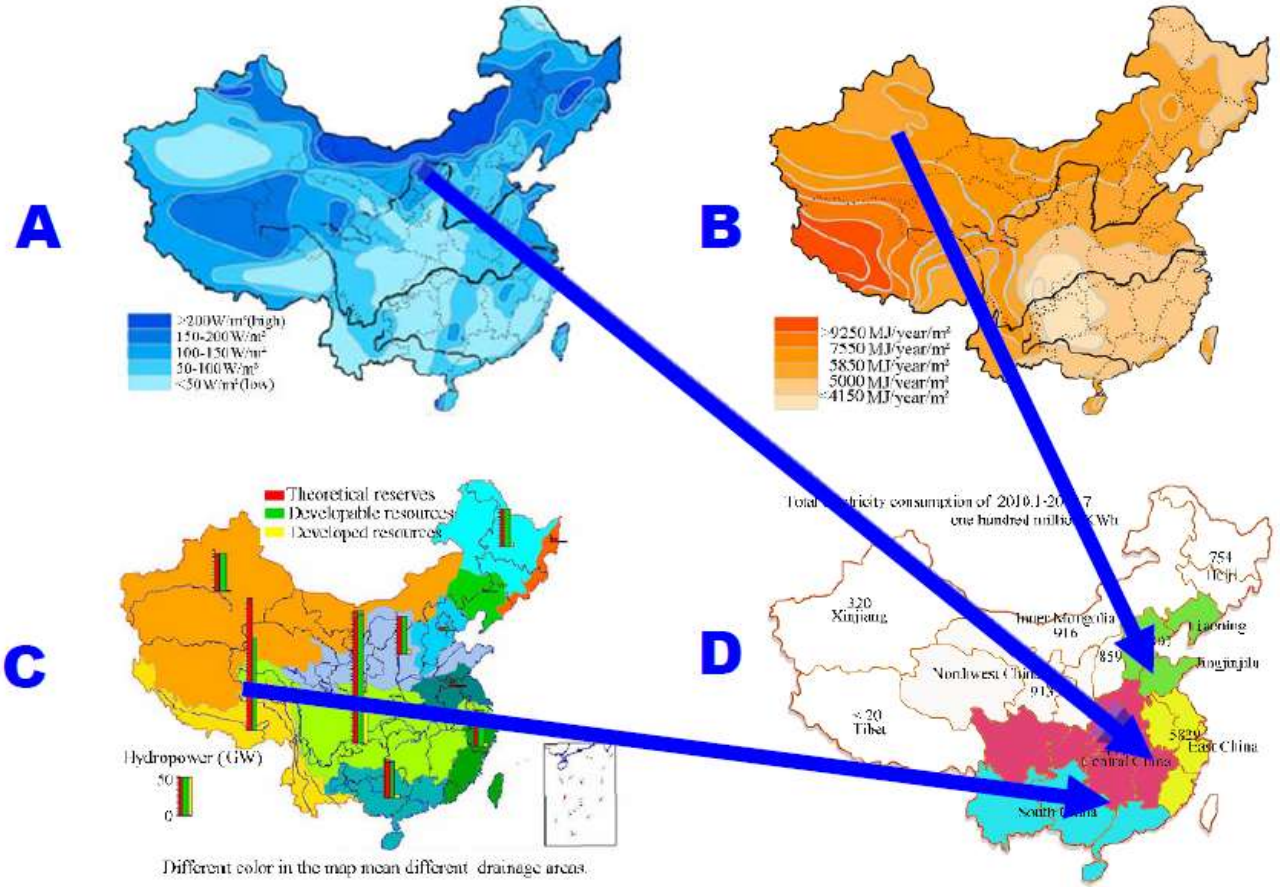


Installation Site

China

- Future power transmission
- Cable projects

The Distributions of RE and Load Centers of China



A-Wind Power, B-Solar Energy, C-Hydropower, D-Load center

Future power transmission — DC power transmission

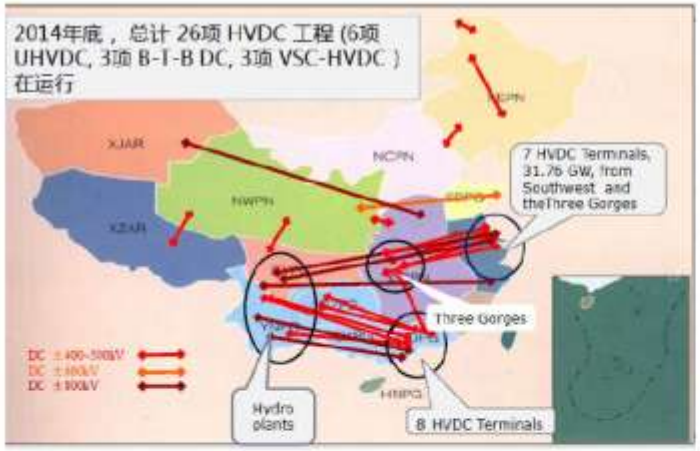
- For DC power grid, no stability problems as AC power grid has ;
- DC power transmission: long distance with high efficiency and high transmission capacity ;
- DC mode is more suitable for connection of renewable energies ;
- DC mode is flexible to achieve bidirectional flow control ;

图3 亚洲直流电网示意图

A conceptual envisage of the future DC Grid of Asian
——By Qingyong Zhou at China Electric Power Institute

Future power transmission — R&D on HTS energy pipeline

INSTITUTE OF ELECTRICAL ENGINEERING, CHINESE ACADEMY OF SCIENCES



Power transmission from West to East

Gas transmission from West to East

If the LNG and electricity can transferred by one superconducting energy pipeline, it would be a wonderful solution for China's future energy transmission system.

10m, 10kV/1kA energy pipeline prototype

HTS distribution cables

INSTITUTE OF ELECTRICAL ENGINEERING,
CHINESE ACADEMY OF SCIENCES

Supported by Shanghai Municipal Commission of Economy and Information & State Grid Corporation of China

Russia

- Fault current limiter

SuperOx SFCL 220 kV

- Type tests underway according to IEEE C37.302-2015 standard
- Lightning impulse withstand voltage (950 kV) – **successful**
- AC withstand voltage (440 kV) - **successful**

Specification	Unit	Value
Nominal voltage (line)	kV	220
Maximum operating voltage	kV	252
Lightning impulse withstand voltage	kV	950
AC withstand voltage	kV	440
Nominal frequency	Hz	50
Nominal current (RMS)	A	1200
Resistivity (limiting state)	Ohm	40
Installation - SFCL		Outdoor
Installation - Cryogenics		Indoor

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Thanks for your attention

CONsortium of European Companies determined To Use Superconductivity
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