

JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
RICE UNIVERSITY

*December 8,  
1998*

*Emerging Energy Technologies*

# Superconductivity: Energy Pipeline for the 21st Century

Paul M. Grant

pgrant@epri.com

[www.epri.com/staff\\_papers/sst](http://www.epri.com/staff_papers/sst)

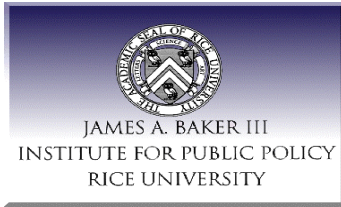
**EPRI**

**EPRI**

P. M. Grant

8 December 1998

*Superconductivity: Energy Pipeline for the 21st Century*

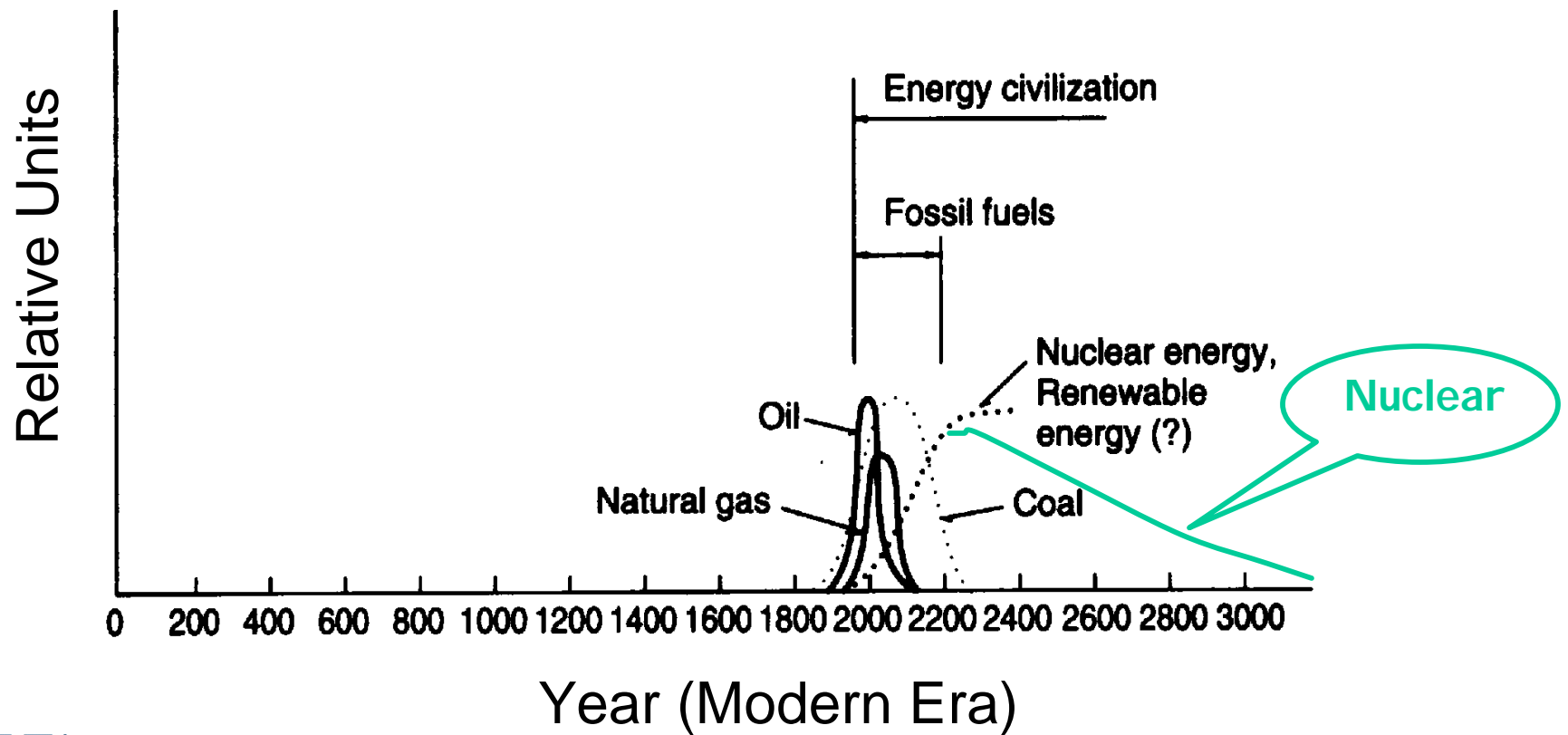


December 8,  
1998

# Energy Civilization

*Emerging Energy Technologies*

**Fig. 1 Production Volume of Energy Resources**

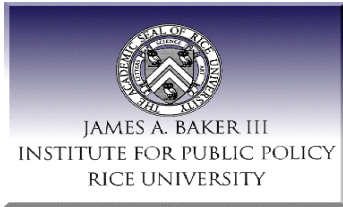


**EPRI**

P. M. Grant

8 December 1998

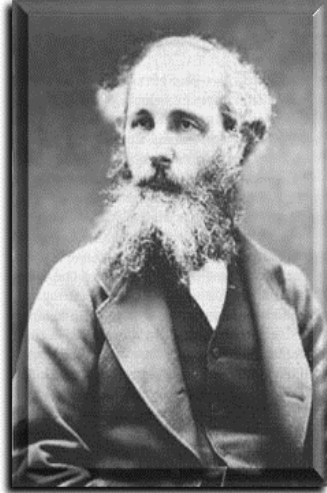
*Superconductivity: Energy Pipeline for the 21st Century*



JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
RICE UNIVERSITY

*December 8,  
1998*

## *Emerging Energy Technologies*



## Discoverers

# Fathers of Electricity

## Practitioners

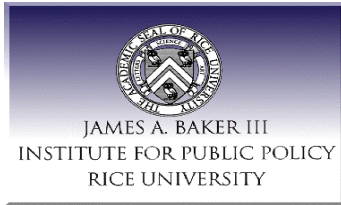


**EPRI**

P. M. Grant

8 December 1998

*Superconductivity: Energy Pipeline for the 21st Century*



JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
RICE UNIVERSITY

*December 8,  
1998*

*Emerging Energy Technologies*

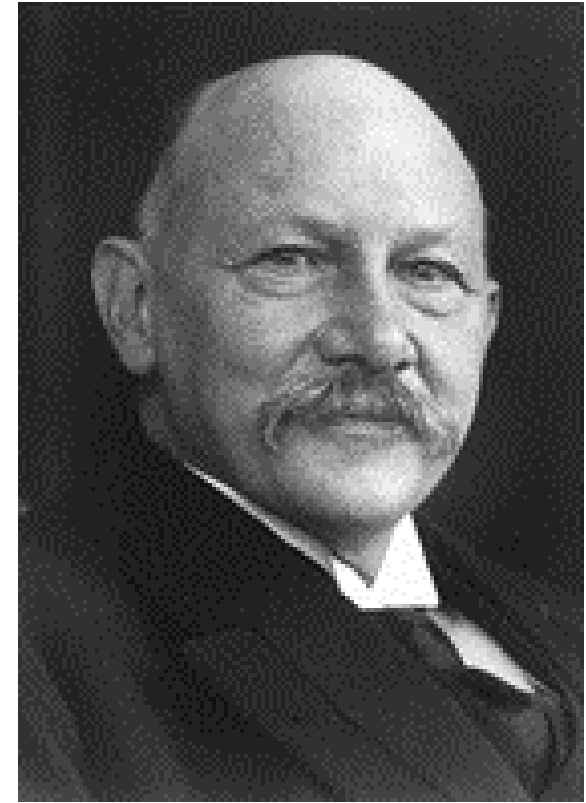
# Fathers of Cryogenics



*James Dewar*

**Dewar**

$\text{CH}_4$	112 K
O	90
$\text{N}_2$	77
Ne	27
$\text{H}_2$	20
He	4.2



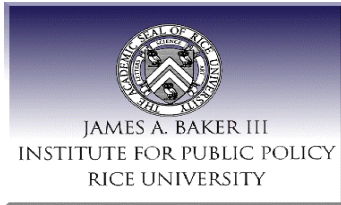
**Kammerlingh-Onnes**

**EPRI**

P. M. Grant

8 December 1998

*Superconductivity: Energy Pipeline for the 21st Century*



December 8,  
1998

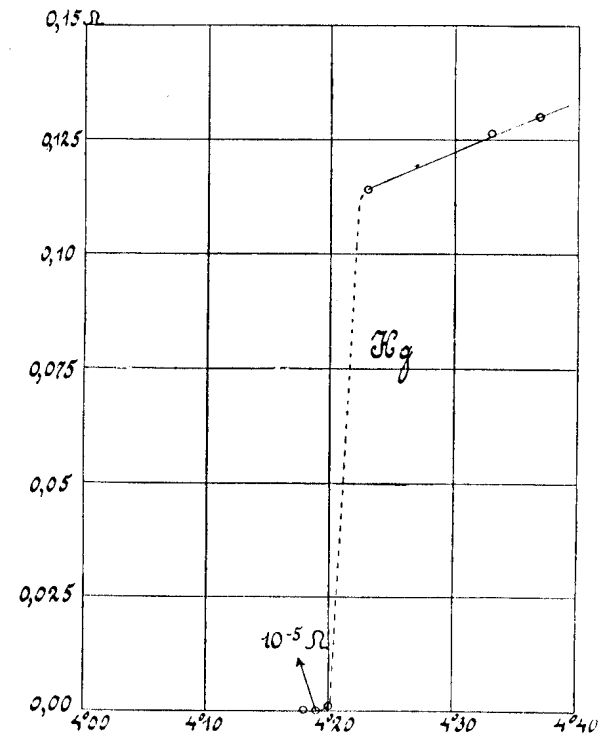
# A Big Surprise!

## Emerging Energy Technologies



Thus the mercury at 4.2 K has entered a new state, which, owing to its particular electrical properties, can be called the state of *superconductivity*

H. Kamerlingh-Onnes (1911)

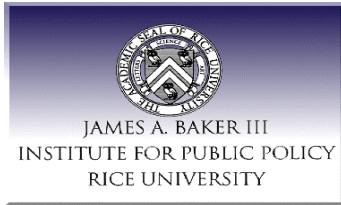


EPRI

P. M. Grant

8 December 1998

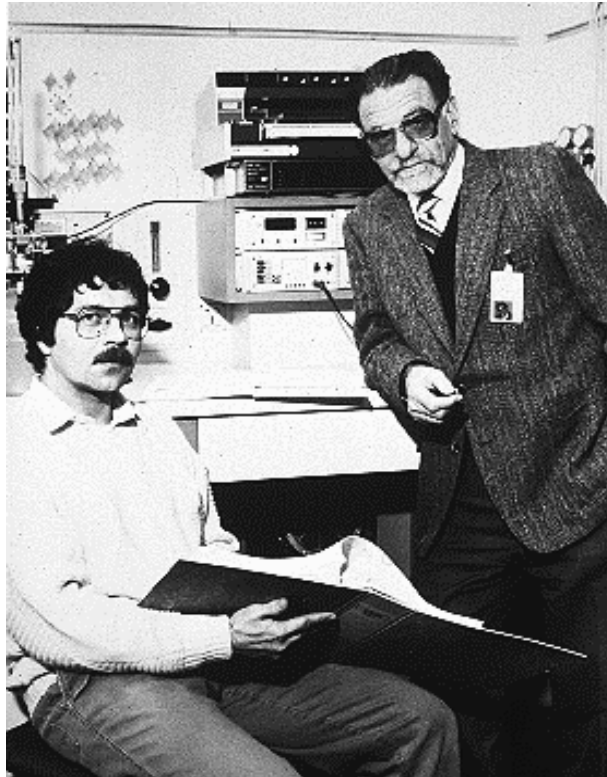
Superconductivity: Energy Pipeline for the 21st Century



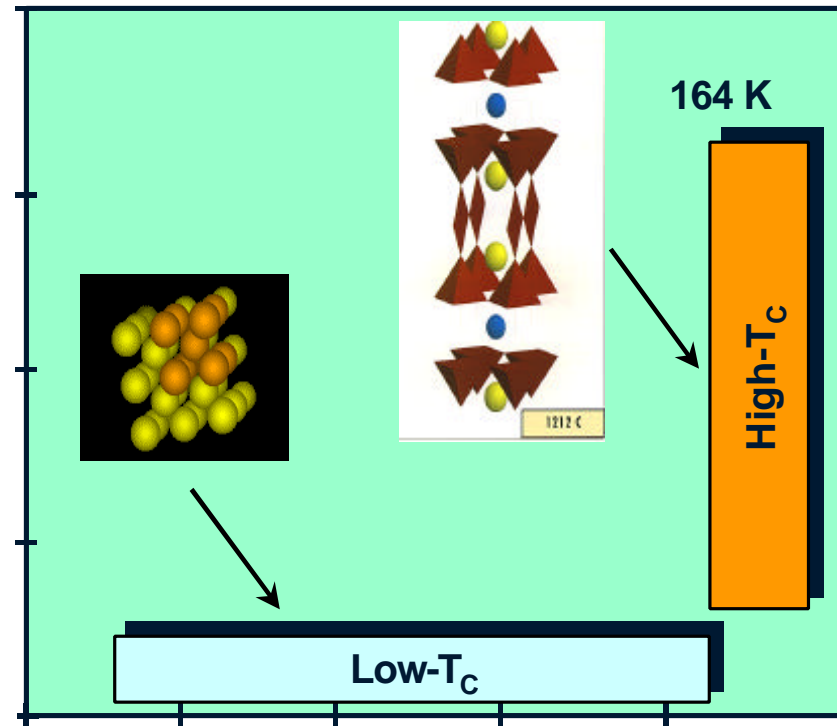
*December 8,  
1998*

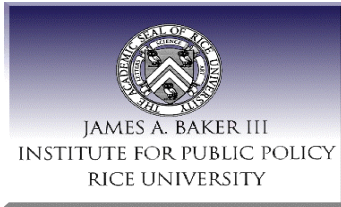
# Another Big Surprise!

*Emerging Energy Technologies*



**Bednorz and Mueller**  
**IBM Zuerich, 1986**

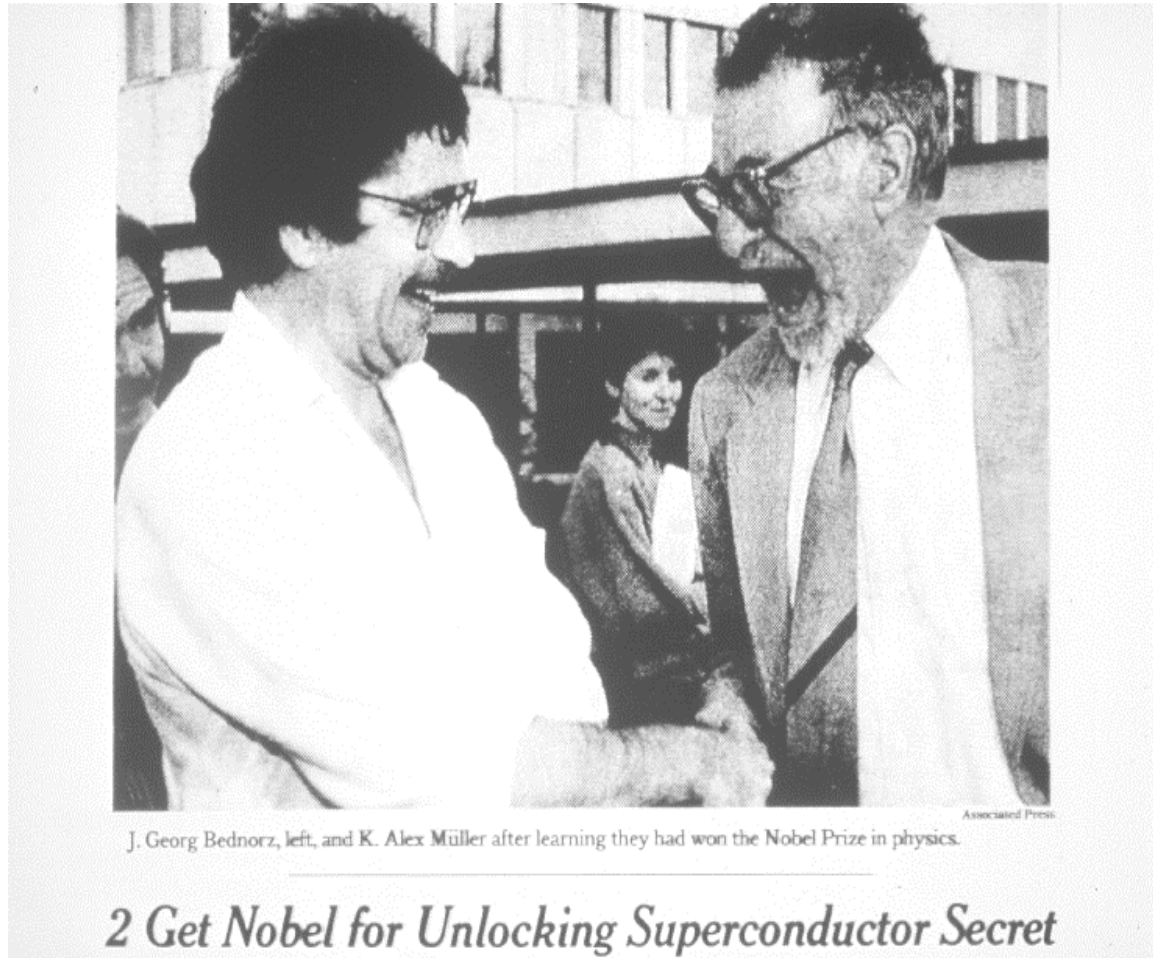




**December 8,  
1998**

# 1987: “The Prize!”

***Emerging Energy Technologies***



J. Georg Bednorz, left, and K. Alex Müller after learning they had won the Nobel Prize in physics.

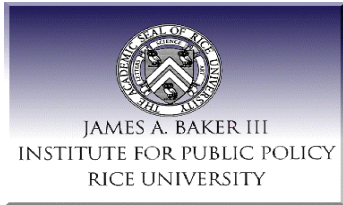
***2 Get Nobel for Unlocking Superconductor Secret***

**EPRI**

P. M. Grant

8 December 1998

***Superconductivity: Energy Pipeline for the 21st Century***

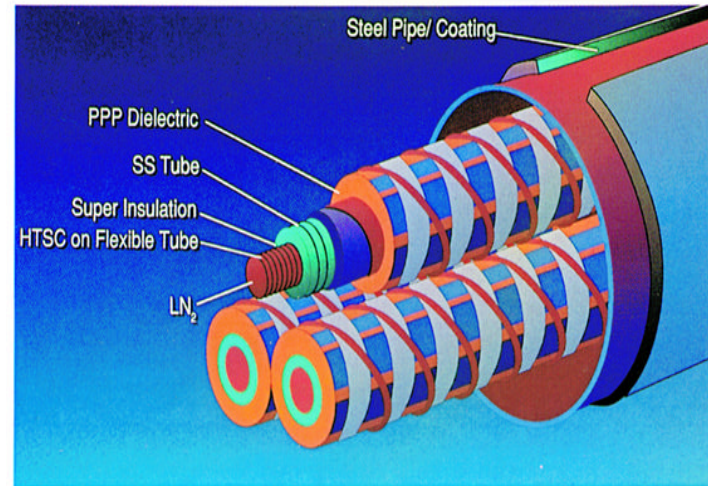
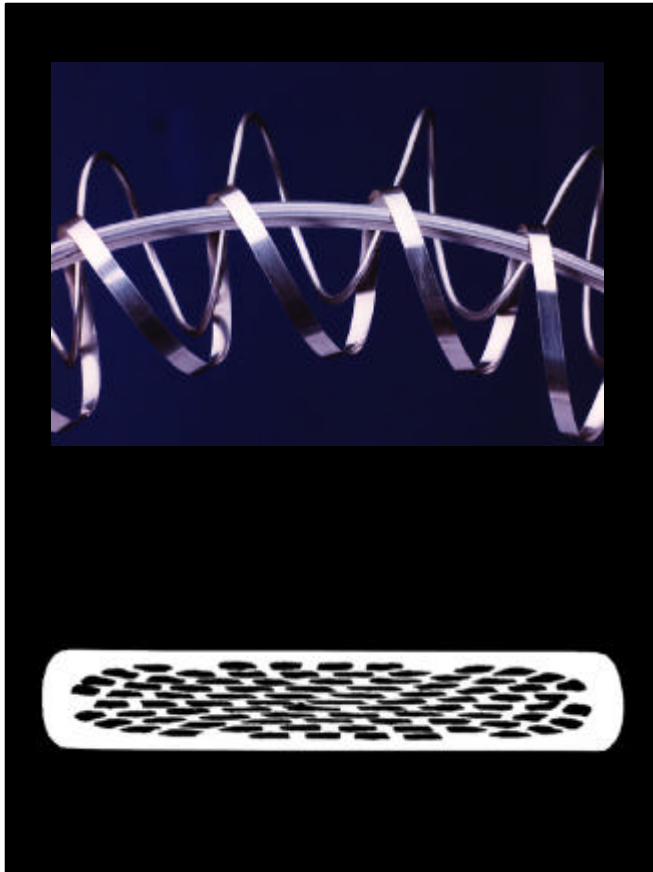


JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
RICE UNIVERSITY

*December 8,  
1998*

*Emerging Energy Technologies*

# Superconducting Wires for Cables



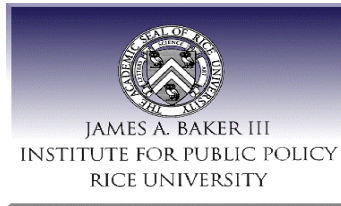
**EPRI**

P. M. Grant

8 December 1998

*Superconductivity: Energy Pipeline for the 21st Century*





JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
RICE UNIVERSITY

December 8,  
1998

# DTE HTS Cable

## Emerging Energy Technologies

### ENERGY SECRETARY RICHARDSON OPENS GATEWAY TO ELECTRICITY SUPERHIGHWAY

- Detroit Edison to begin use in 2000. \$5.5 M project in interurban substation
- Pirelli, ASC, Lotepro, EPRI
- "...help U.S. build ... its competitive position in world market for HTS applications." *DOE Sec. Richardson*
- "...revitalize older urban area in non-intrusive, environmentally friendly way." *R. J. Buckler, DTE CEO*

NY Times, 11/3/98

## Power Line Makes Use Of a Miracle Of Physics

By MALCOLM W. BROWNE

After 87 years of alternating exuberance and disappointment, and a decade after a famous conclave of physicists at which the key to success seemed to be within reach, the world's first superconducting power line is about to become a reality.

A superconducting line is one that will conduct huge electrical currents with far less resistance than that of a line made of metal wire, and that therefore conserves energy.

The first large-capacity superconducting line, to begin operation by mid-2000 in Detroit, will be only 400 feet long. But it will use only 250 pounds of a new kind of superconducting wire to carry as much current as the 18,000 pounds of copper wire the line will replace.

Experts say the line will demonstrate the practicability of large-scale superconducting power transmission and will be the first of many such lines. In announcing a contract providing for Federal support for the project, Energy Secretary Bill Richardson predicted two weeks ago that power lines like this one, exploiting the special properties of "high-temperature superconductors," could eventually save the nation \$6 billion a year. Another benefit is that the electricity industry could sharply reduce the pollution created by generating plants.

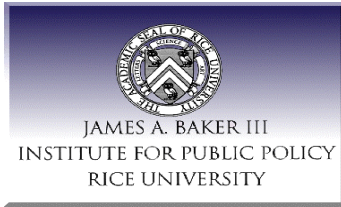
Lengths of the same superconducting cable up to 50 yards long have already been successfully tested, said Dr. Paul M. Grant, an expert in superconductivity at the Electric Power Research Institute in Palo Alto, Calif.

EPRI

P. M. Grant

8 December 1998

Superconductivity: Energy Pipeline for the 21st Century



JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
RICE UNIVERSITY

*December 8,  
1998*

# Frisbee Substation

*Emerging Energy Technologies*

**Substation  
Distribution  
Building**



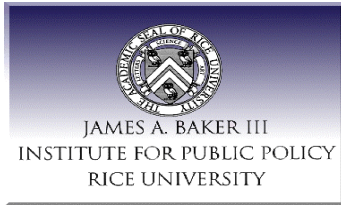
**Step-Down  
Transformer**

**EPRI**

P. M. Grant

8 December 1998

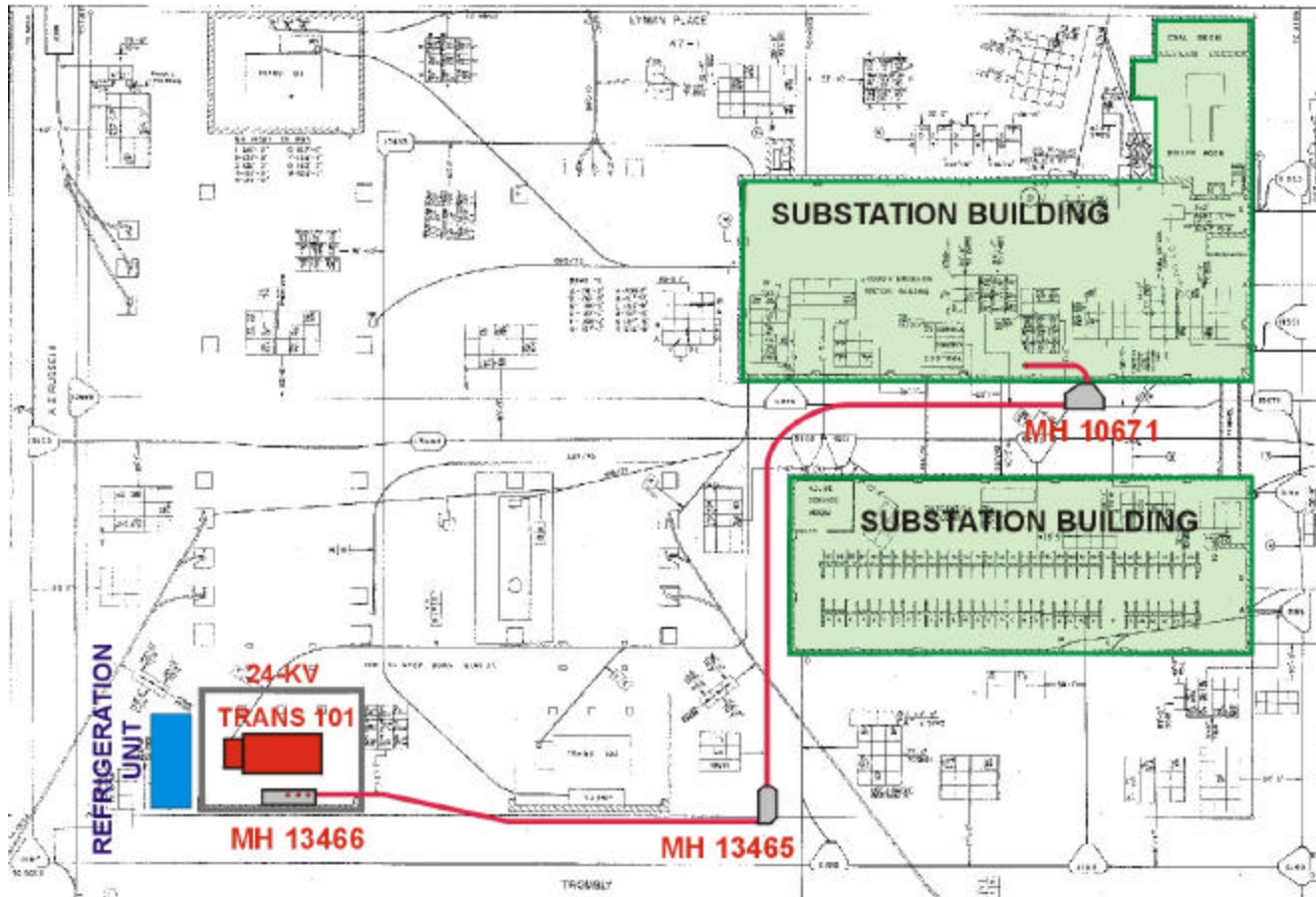
*Superconductivity: Energy Pipeline for the 21st Century*



*December 8,  
1998*

# Circuit Layout

*Emerging Energy Technologies*



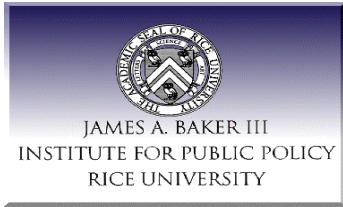
- 130 meters, 3 phase
- Five 90° Bends, 1 m radius
- One joint (MH 13465)
- Terminal at ends

**EPRI**

P. M. Grant

8 December 1998

*Superconductivity: Energy Pipeline for the 21st Century*

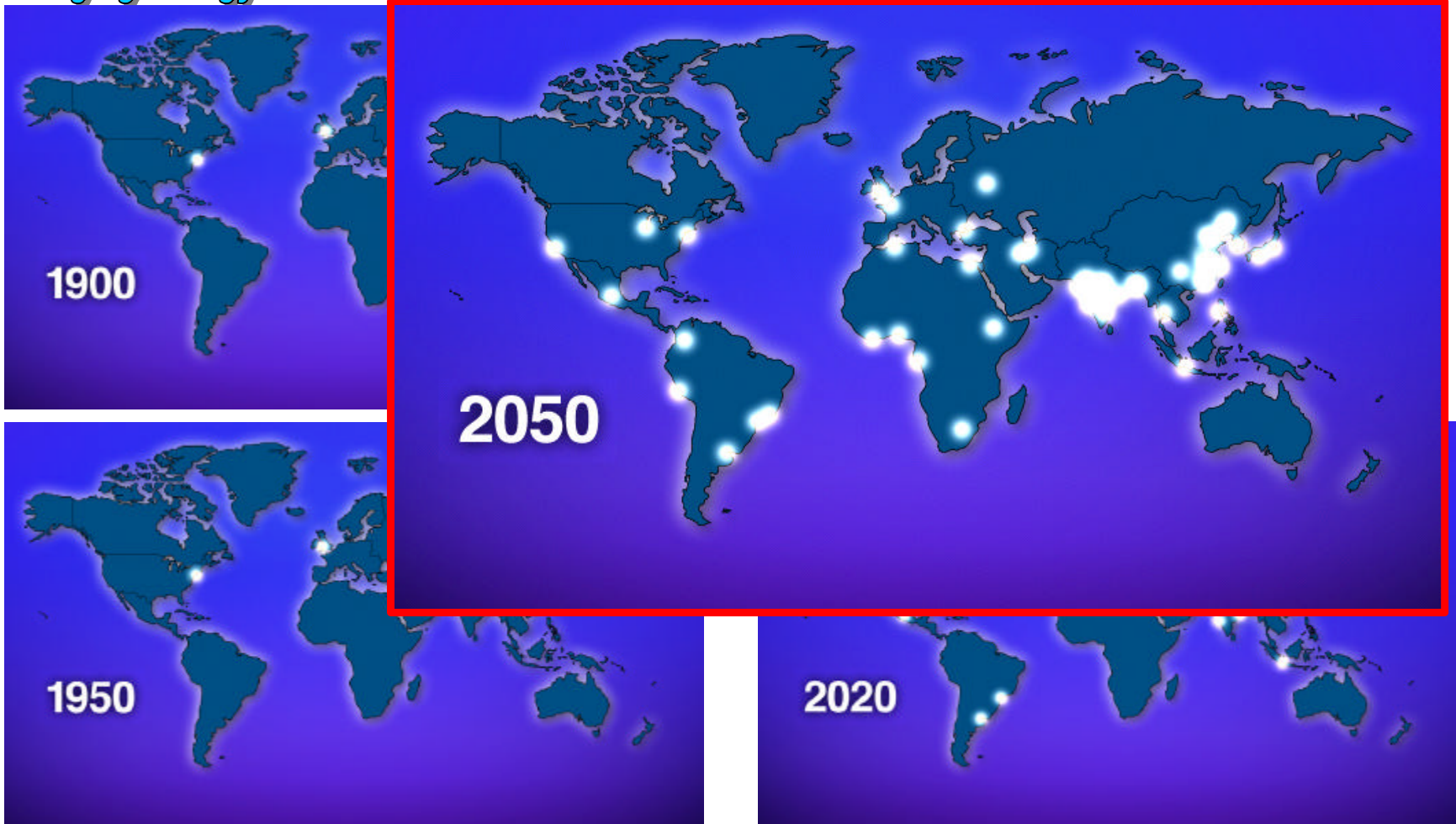


JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
RICE UNIVERSITY

*December 8,  
1998*

# Mega-Cities

*Emerging Energy Technologies*

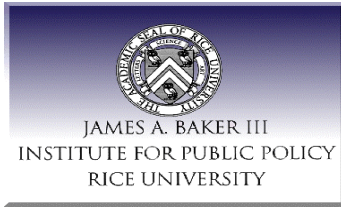


**EPRI**

P. M. Grant

8 December 1998

*Superconductivity: Energy Pipeline for the 21st Century*

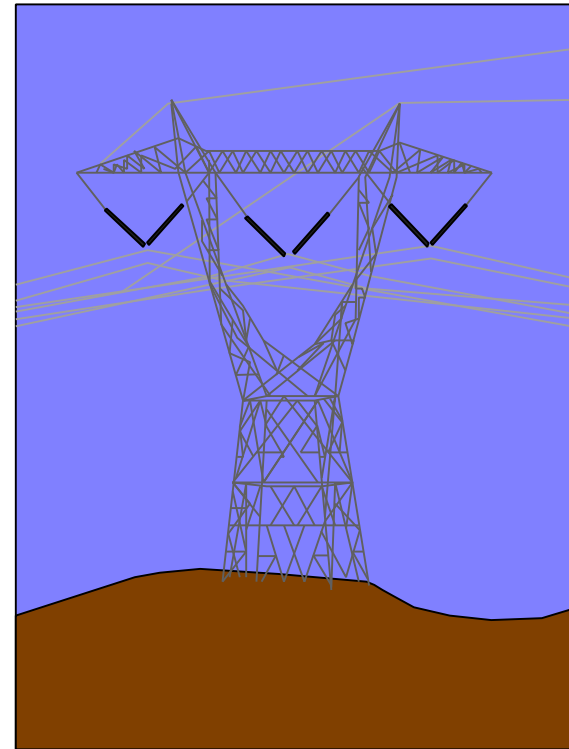
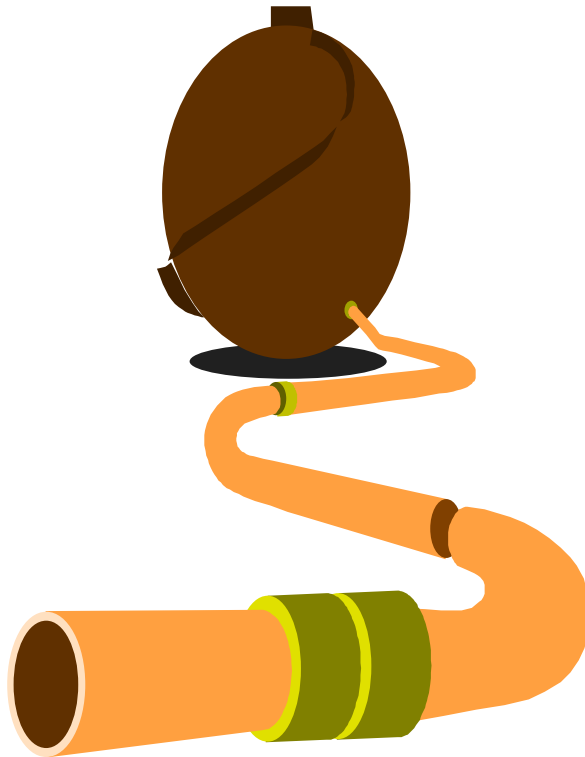


JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
RICE UNIVERSITY

*December 8,  
1998*

# Gas or Electricity? Pipes or Wires?

*Emerging Energy Technologies*

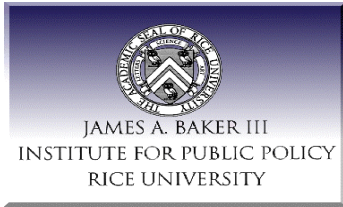


**EPRI**

P. M. Grant

8 December 1998

*Superconductivity: Energy Pipeline for the 21st Century*

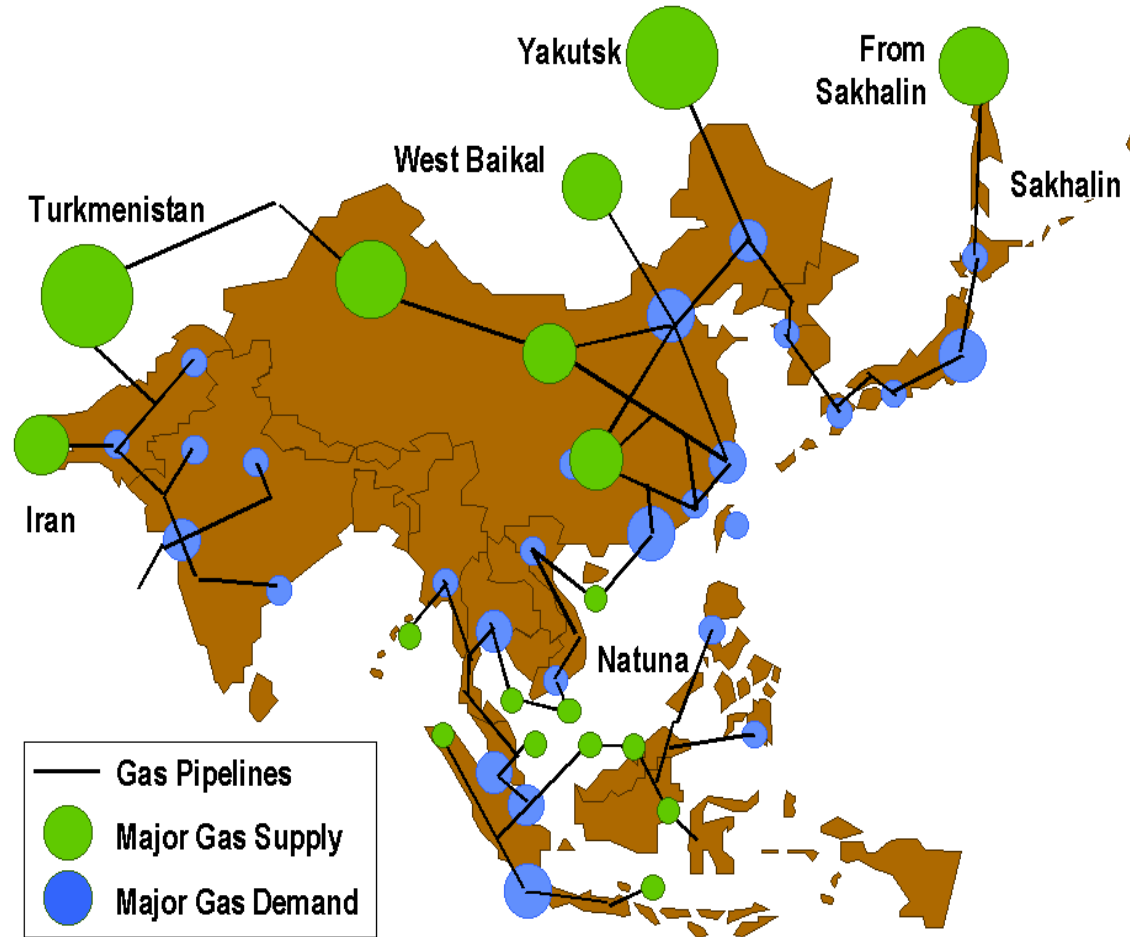


JAMES A. BAKER III  
INSTITUTE FOR PUBLIC POLICY  
RICE UNIVERSITY

*December 8,  
1998*

# “Fuel-Head” and/or Nuclear Generation

*Emerging Energy Technologies*

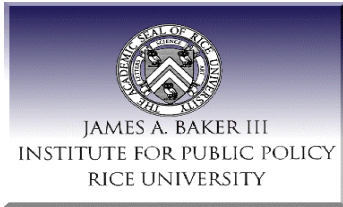


**EPRI**

P. M. Grant

8 December 1998

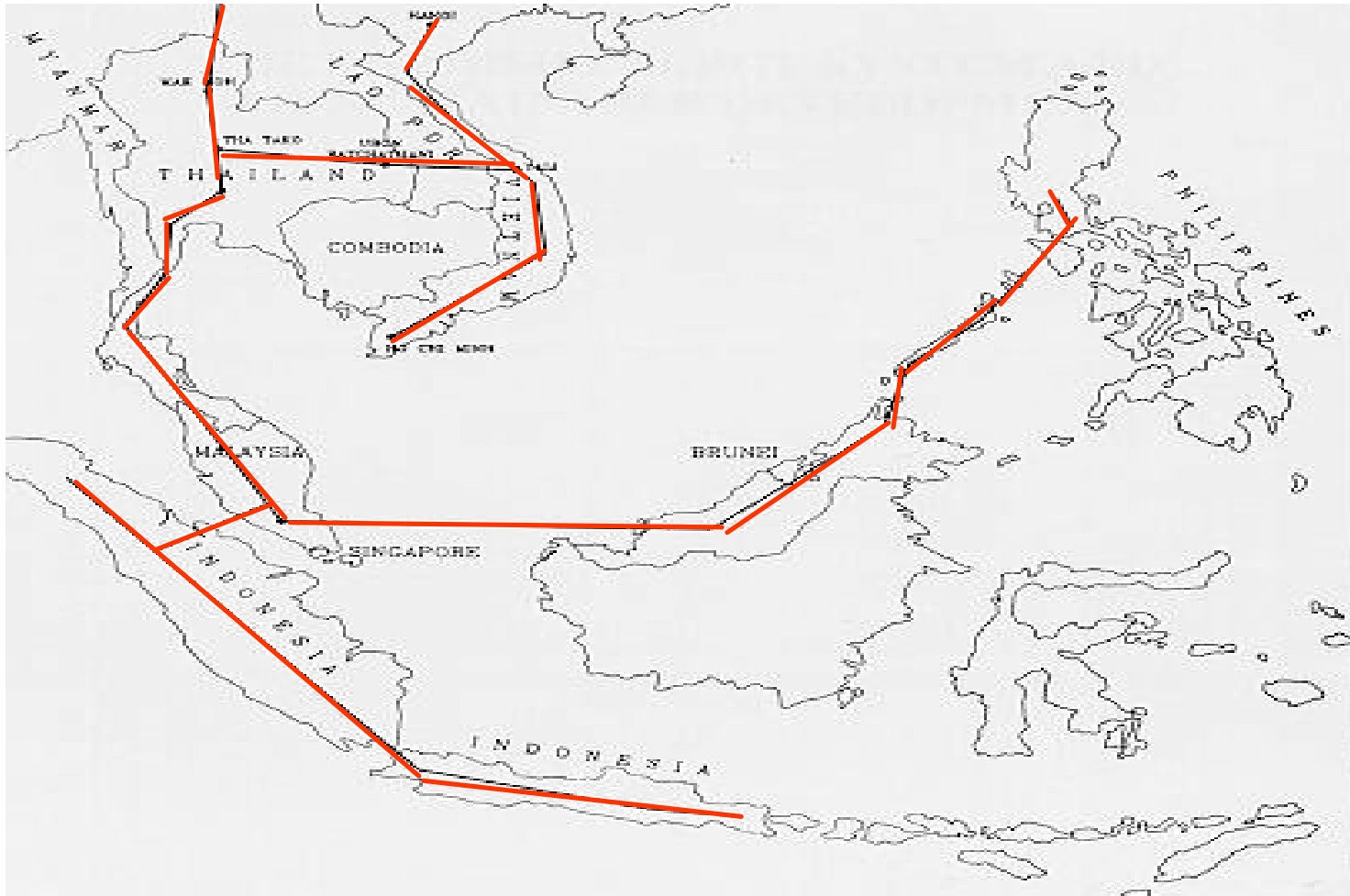
*Superconductivity: Energy Pipeline for the 21st Century*



*December 8,  
1998*

# Future Power Lines: Southeast Asia

*Emerging Energy Technologies*



**EPRI**

P. M. Grant

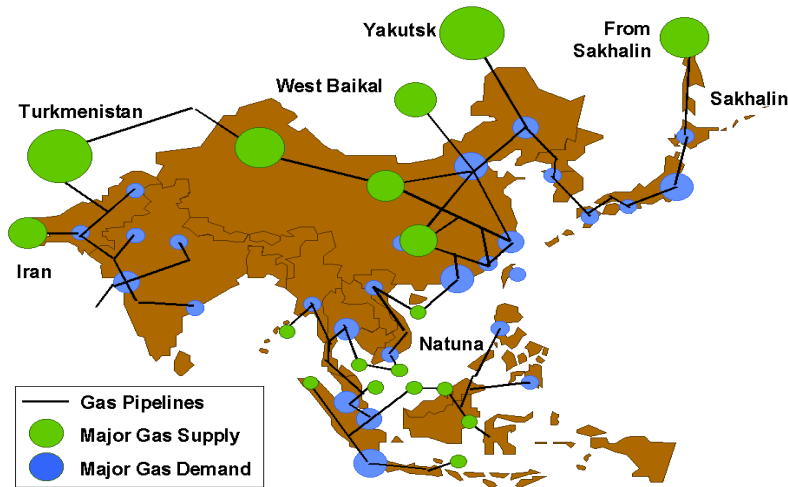
8 December 1998

*Superconductivity: Energy Pipeline for the 21st Century*

**December 8,  
1998**

# Global Electrification

## Emerging Energy Technologies





*December 8,  
1998*

*Emerging Energy Technologies*

# More Examples: South America

