Energy (Renewable Transformation and Jobs) Bill 2023

Submission No: 41

Submitted by: GE Vernova

Publication:

Attachments: No attachment

Submitter Comments:

GE VERNOVA

8th January 2024

Committee Secretary
Transport and Resources Committee
Parliament House
George Street
Brisbane Qld 4000
By email: trc@parliament.qld.gov.au

Mark Benjamin
Director, Aeroderivative Gas Turbine Sales

99 Walker Street
North Sydney NSW 2064
Australia

[redacted]

gevernova.com

Dear Committee Secretary

GE Vernova is a division of General Electric focused on providing advanced, efficient natural-gas-powered technologies and services, along with decarbonization solutions that will help electrify a lower carbon future, including through its leadership of hydrogen-powered gas peaking capability.

GE has had a long association with Queensland; indeed prior to the formation of GE in 1892, electrical cables known as "Edison tubes" – named for their inventor and our founder Thomas Edison were purchased in 1883 to supply electricity to the parliamentary precinct from the Queensland Government Printer in William Street.

After assisting Queensland to electricity system adoption 140 years ago, GE Vernova is proud to assist Queensland in its electricity system transformation through the Queensland Energy and Jobs Plan and the Energy (Renewable Transformation and Jobs) Bill 2023.

Specifically, GE Vernova is working with CS Energy to deliver the Brigalow Peaking Power Plant - committed to in the QEJP - near the existing Kogan Creek Power Station on the western Darling Downs. The peaking plant will initially be capable of operating on 35% renewable hydrogen, with a pathway to 100% hydrogen over time.

The plant will consist of 12 GE aeroderivative turbines (LM2500XPRESS) with a capacity of 33 megawatts (MWs) per unit. Aeroderivative turbines are lightweight, with a relatively small footprint and a fast response rate. Renewable hydrogen will initially be sourced from CS Energy's Kogan Renewable Hydrogen Demonstration Plant. Production of renewable hydrogen is expected to be scaled up through the development of a commercial scale hydrogen production facility as part of the Kogan Clean Energy Hub.

The QEJP commits to 50% renewable energy generation by 2030, 70% by 2032 and 80% by 2035. The QEJP noted, on page 30, that "into the future, the SuperGrid will require around 3 GW of low to no emission gas to generate electricity at peak times, and to provide storage, firming and dispatchable capacity."

As the Brigalow Peaking Power Plant project demonstrates, technology is available to operate on a gas-hydrogen mix with a pathway to 100% hydrogen.

GE has more experience burning hydrogen than any other OEM. This experience goes back to the mid-1990s and includes more than 100 gas turbines that have accumulated more than 8 million hours of operation.

This experience has enabled GE to understand the unique challenges using hydrogen as a gas turbine fuel. As gas turbines are inherently fuel-flexible, they can be configured to operate on green hydrogen or similar fuels as a new unit, or be upgraded even after extended service on natural gas. The scope of the required modifications to configure a gas turbine to operate on hydrogen depends on the initial configuration of the gas turbine and the overall balance of plant, as well as the desired hydrogen concentration in the fuel.

In terms of the Bill, GE Vernova notes under Section 94 that the Queensland Energy System Advisory Board is required to:
(a) to prepare an annual progress statement for each financial year in relation to—
(i) the progress made during the financial year towards achieving the renewable energy targets; and
(ii) the progress made during the financial year in relation to the matters that are part of the optimal infrastructure pathway

GE Vernova believes this mechanism will provide transparency for the developers, suppliers and consumers from these electricity generation projects via the SuperGrid.

As an original equipment manufacturer, GE Vernova remains committed to working with the Queensland Government, its Government Owned Corporation, local suppliers and partners to deliver on the objectives of the Queensland Energy and Jobs Plan and the intent of this Bill.

GE Vernova commends the Bill to the Committee.

Sincerely

[redacted]

Mark Benjamin

[1] Engineering Heritage Queensland. "Edison Street Tubes Presentation", Parliament House, 9 August 2018
https://documents.parliament.qld.gov.au/getinvolved/events/2018EdisonTubesPresentation.pdf

"Edison Street Tubes" Presentation Parliament House-9th Aug. 2018

Engineering Heritage Queensland

- **Brian Becconsall- FIEAust.**

Retired Electrical Engineer- 48 years in Qld Electricity Industry, SEAQ, QEGB, QEC and Powerlink, and 2 years Overseas in Canada and USA, specialising in Transmission. Member EA Engineering Heritage Qld since 1988.

- **Stuart Wallace- FIEAust.**

Retired Electrical Engineer- a career of over 40 years mostly spent in consulting in the fields of power generation and transportation across the globe. Member EA Engineering Heritage Qld.

ENGINEERS AUSTRALIA

Brisbane's Electric Power Plants 1882—1888

1- Suttons Foundry 1882

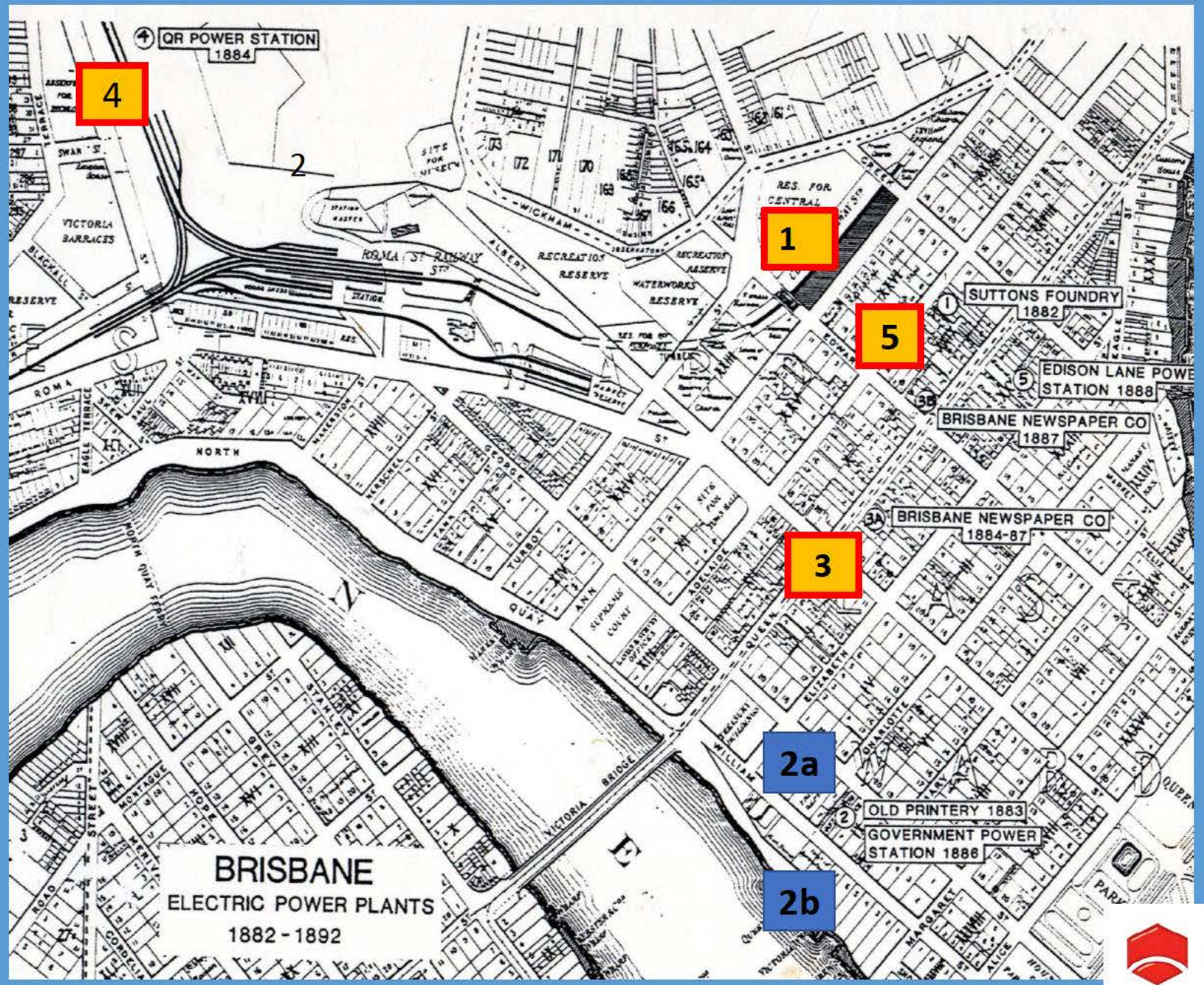
2a-Govt.Printery Trial 1883

3-Brisbane Newspaper 1884

4-QR Roma St Rail Yards 1884

2b- Govt Printery 1886

5- Edison Lane 1888



ENGINEERS AUSTRALIA

Edison Street Tubes- William St Brisbane

13 April 1883- Colonial Govt. accepted the Edison quote for £ 2485 pounds

- permanent incandescent lighting of Printery and Parliament House
- 2 Edison H Dynamos 30 kw 110 V DC at Printery
- 500 – 16 cp (60 w) lamps with carbon filaments, fittings, switches and wiring

June 1883- Smellie & Co to supply 2- 40hp Robey Steam Engines, boilers, shafting, belts, pulleys etc. Quote for £ 2747

1883-Andrew Petrie to build a Power station building at Printery £ 13,043

1883- Alfred Shaw (Agents for Edison Co) to fit 50 lights Council Chamber

- supply & install 1200 ft (366m) of two-core 110V DC ***Edison Street Tubes***

Quote for £ 1,000

-Tube order came from Edison's Indian & Colonial Electric Company London

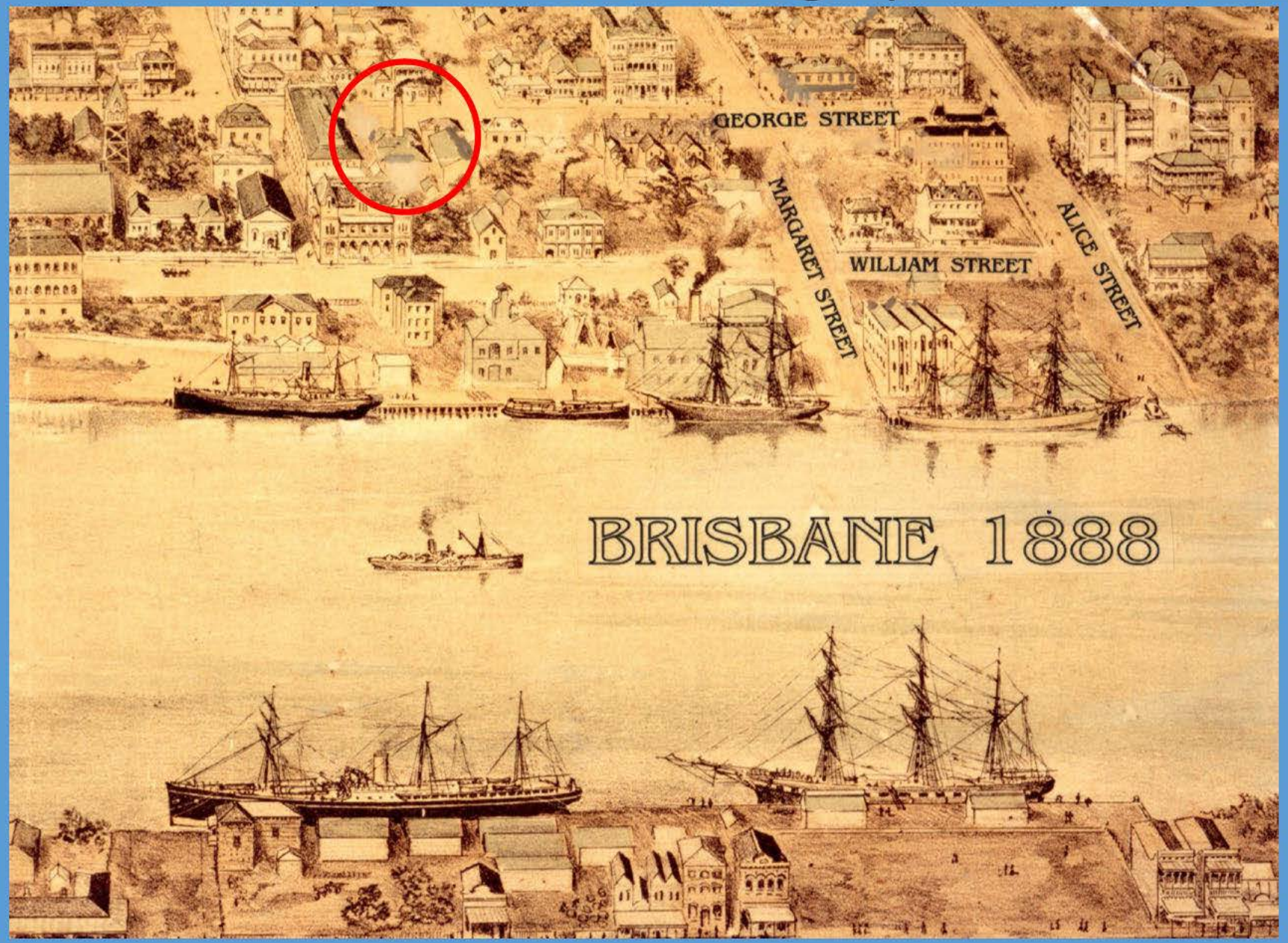
- likely surplus to their first use Jan.1882 Holborn Viaduct scheme, London

ENGINEERS AUSTRALIA

The Government Power Station Project

- 1884- Progress slow- Edison Engineer J. W. Snow died, replacement J. Mathieson was a failure, wiring condemned.
- The street mains trenching and restoration were responsibility of Brisbane Municipal Council, who employed J. Devenish at 17/9 shillings /chain.
- Given 20 working days, trench 12 inch wide and deep for 18 chains, with an 18 x 18 x 18 inch cut every 20 ft. for the joint boxes.
- Route documentation never found-only rediscovered and mapped by Energex/QM in 1992
- Consulting Electrical Engineer Edward Barton appointed to correct and finish work, handing over finished project to Govt Electrician T. Tomlinson
- July 1886 Scheme finally commissioned and operating- Total cost £19,000

Govt sector in 1888 Lithograph of Brisbane.

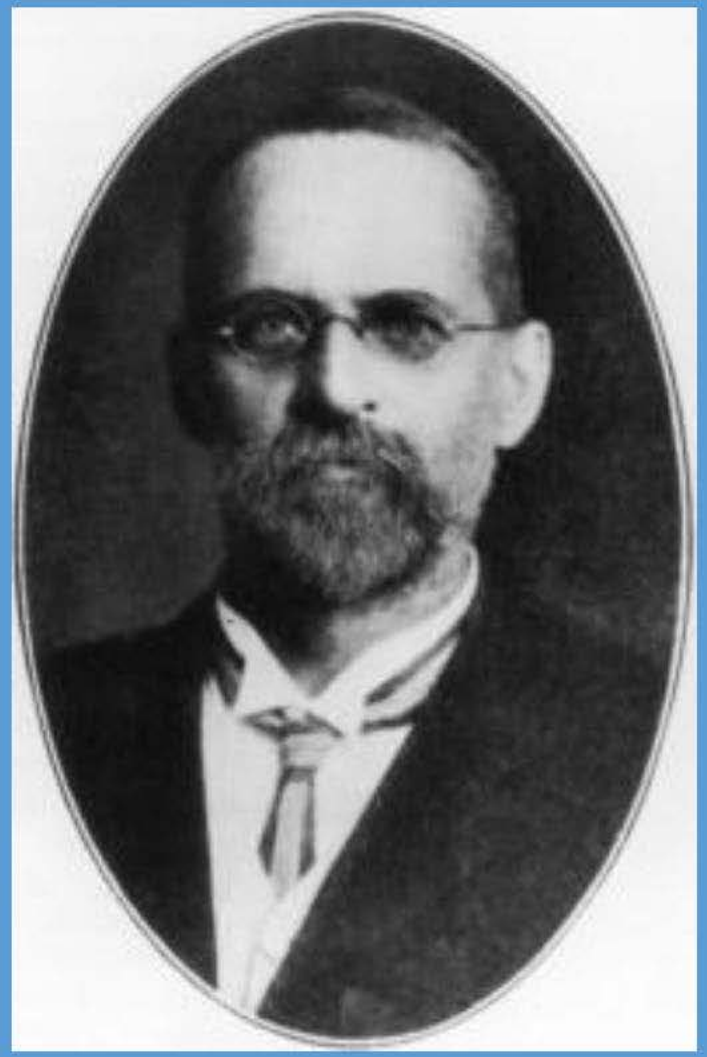


Artistic Reconstruction of Govt. Printery Power Station 1886 to 1909

- First centralised Power Station and network in Qld. Owned by the Colonial Govt.
- Supplied Govt. printery and Parliament House only with DC
- Total network scheme of Power Station, street mains, switching and lighting est. cost £19,275
- E. Barton appointed Govt. Electrician late 1886, and supervised operations until 1894

FIRST QUEENSLAND GOVERNMENT POWER STATION - 1886

Edward Barton- Pioneer Electrical Engineer

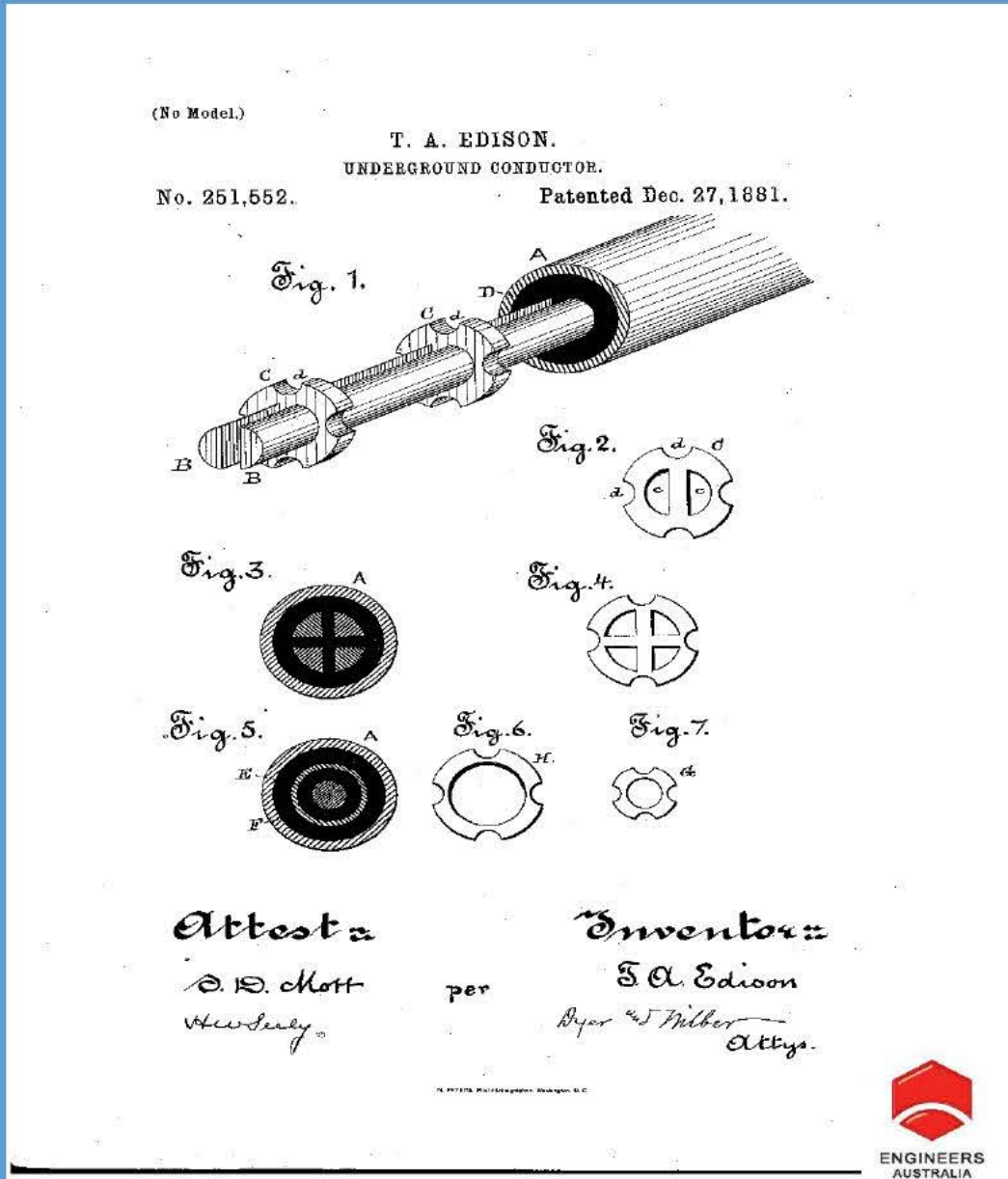


Printery Courtyard - Site of Original 1886 Power Station Photo 1992

ENGINEERS AUSTRALIA

Edison Tube Technology-Two core mains

- The original two-core tube patented by Edison in New York USA in Dec 1881, with 3 types conductors: a 2 & 4 segment, & a 2 concentric
- The 2 segment range had 10 sizes, with a No. 3 used 2 x 0.206 sq inch (2 x 133sq.mm) for William St.-surplus stock from Holborn, London
- Insulation used a compound of refined Trinidad pitch, linseed oil, beeswax, & paraffin wax.
- Manufactured by Edison Electric Tube Co. 65 Washington St New York.
- Brilliant engineer & works manager John Kruesi responsible for developing invention.


(No Model.)

T. A. EDISON.

UNDERGROUND CONDUCTOR.

No. 251,552. Patented Dec. 27, 1881.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Attest:

O. D. Mott

Witness

per

Inventor:

T. A. Edison

Dyer & Tilber

Attys.

Edison Tube Technology-Three core mains

- Three core tube - Edison in 1882 following Dr John Hopkinson 3 wire 220/110 V DC system introduction in England, to reduce voltage drop

- A cheaper/easier design adopted- copper rods wrapped spirally with jute rope- cluster held together by a smaller jute rope- inserted in same iron pipes. .

- Order placed in 1891 with Brush Electrical Engineering Co, London (who now held the Edison patents) for 420 yds (384m) at £1 /yard using 3 copper rod conductors each 0.12 sq inch (77 sq.mm) in 20 ft (6.1m) lengths.

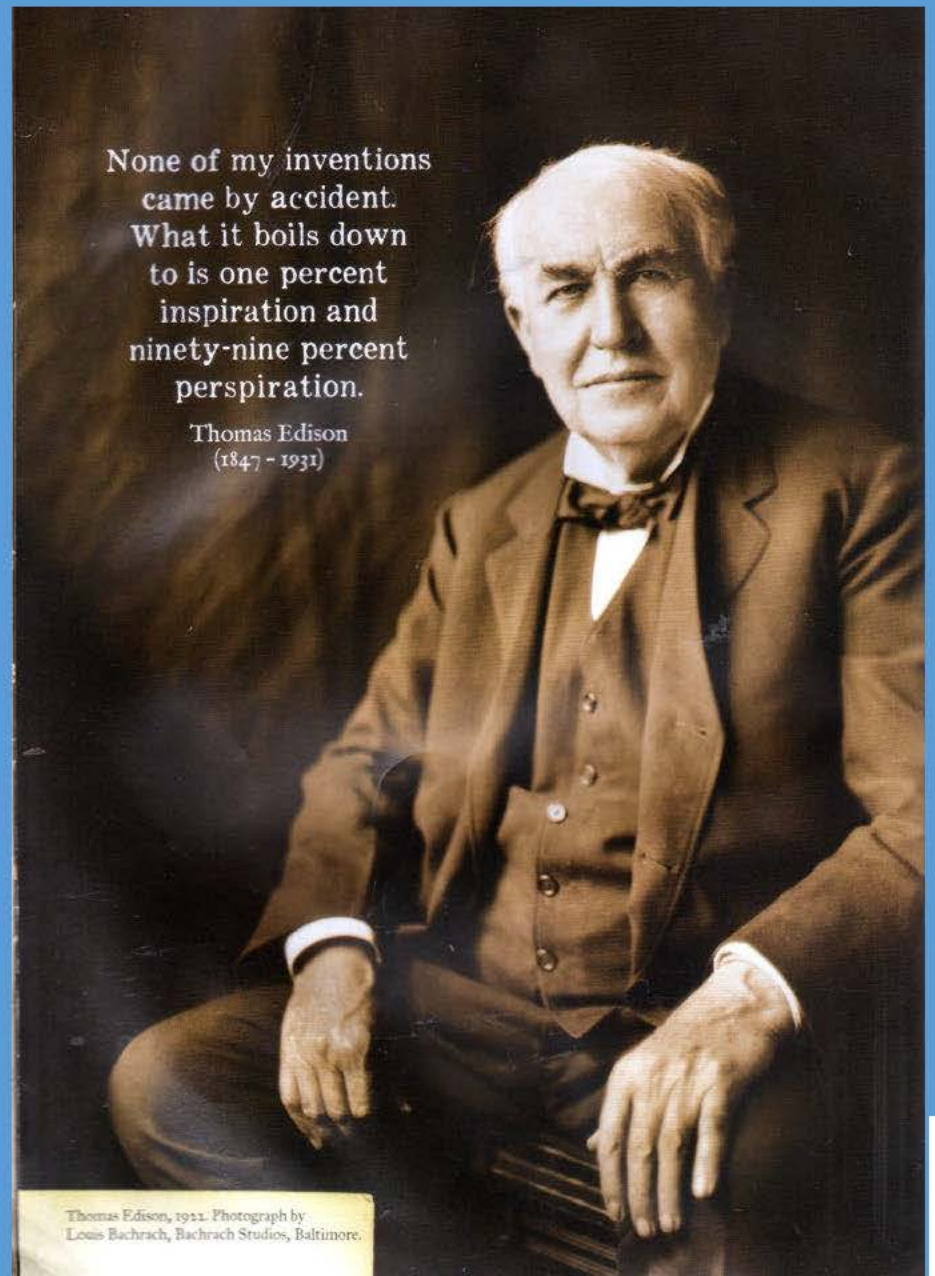
- This reduced voltage drop problems by using each of the 3 cores for separate buildings, and paralleling the 2 core for a return circuit.

Project completed/supervised by Govt. Electrician Edward Barton May 1892

ENGINEERS AUSTRALIA

Thomas Edison- The Wizard of Menlo Park.

- Born 1847 in Milan Ohio, USA
- Considered America's Greatest Inventor and Entrepreneur of mass production
- Holder of 1093 patents in USA alone
- Staunch advocate for DC systems versus Tesla/Westinghouse promoting AC.
- Developed the worlds first central electricity network concept-Steam Power Station, Mains, customers-
- Died 18 Oct 1931- At 8.59pm on 21st President Hoover ordered all lights in USA to be switched off for 1 min.



ENGINEERS AUSTRALIA

Electric Power System Developments late 1800's

- 1859- Faraday's first Lighthouse Arc Lighting- Dungeness UK

- 1860-70's- Arc Lighting developed commercial uses only- USA, UK, Europe
  Both DC and AC systems
- 1876- Edison sets up Menlo park, NJ, USA- first Industrial Research Lab

- 1879- Edison (USA) and Swan (UK) develop incandescent light bulb by finally
  "subdividing the electric light"

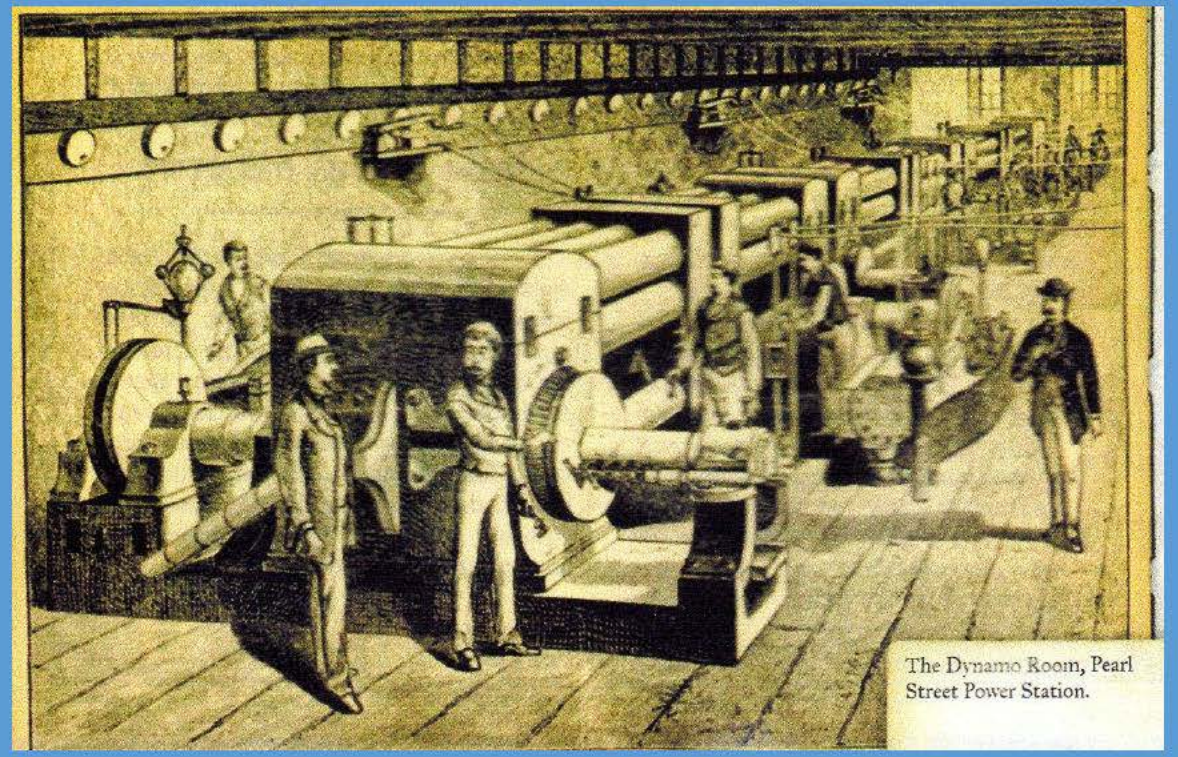
1881- Edison patents his "Electricity Central Station" concept involving
6 for dynamos, 32 for lamps, and 7 for distribution etc

Edison's Pearl St Power Station, NY- Sept 1882

Edison's first permanent Central Steam Station –Pearl St N.Y. USA

6 x 100 kW 110 V DC -a square mile network of Edison street tube ring mains and feeders involving 80,000 ft (24 km) of tubes in streets.

-by end 1882, supplied 193 buildings with 4000 lamps



First Commercial Light Bulbs –Edison and Swan

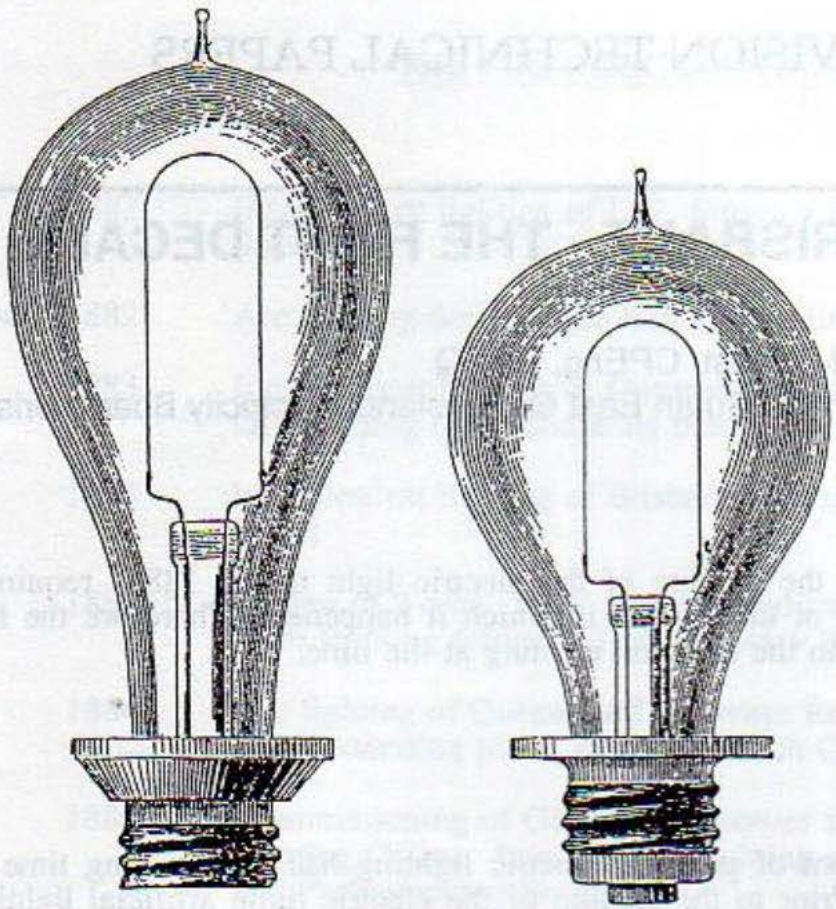


Fig 1 - Edison 16 cp (l) and 8 cp (r) carbon filament lamps, c1882

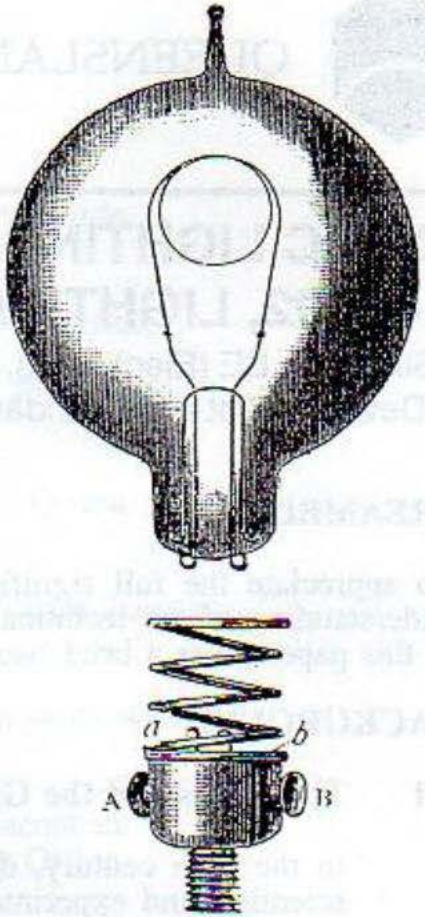
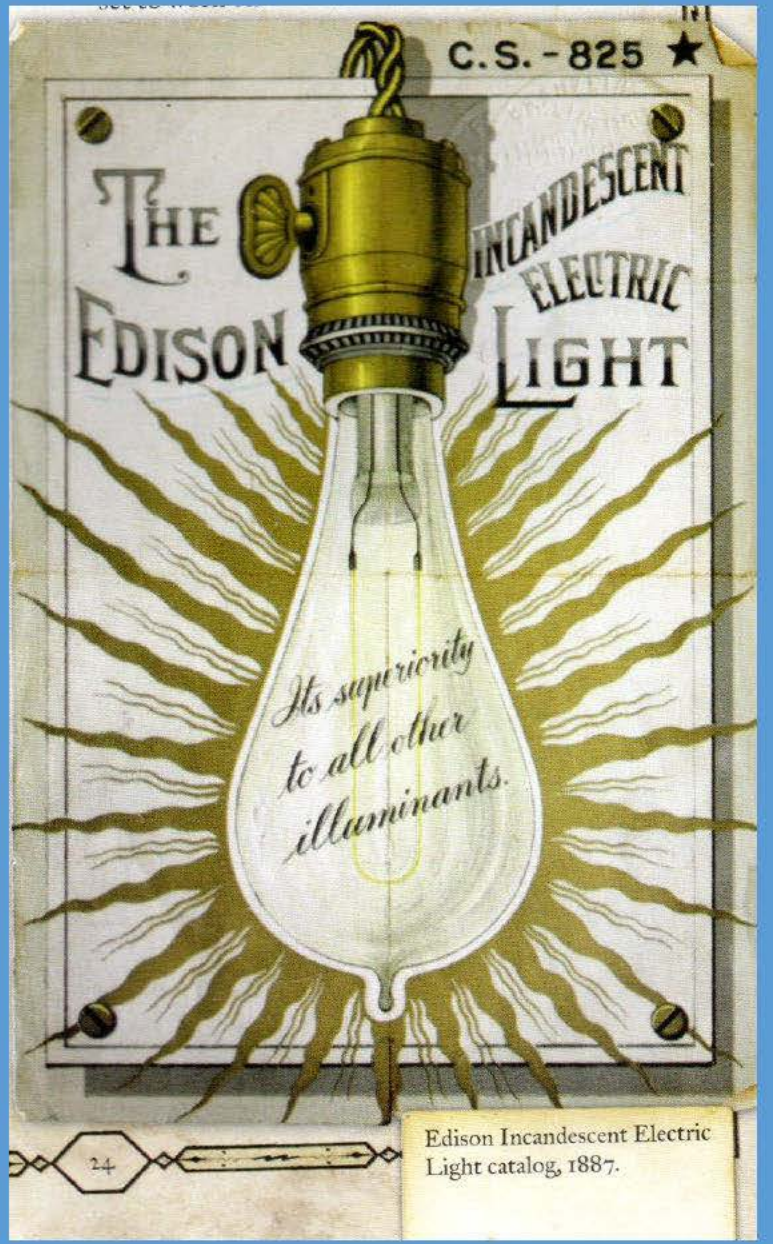


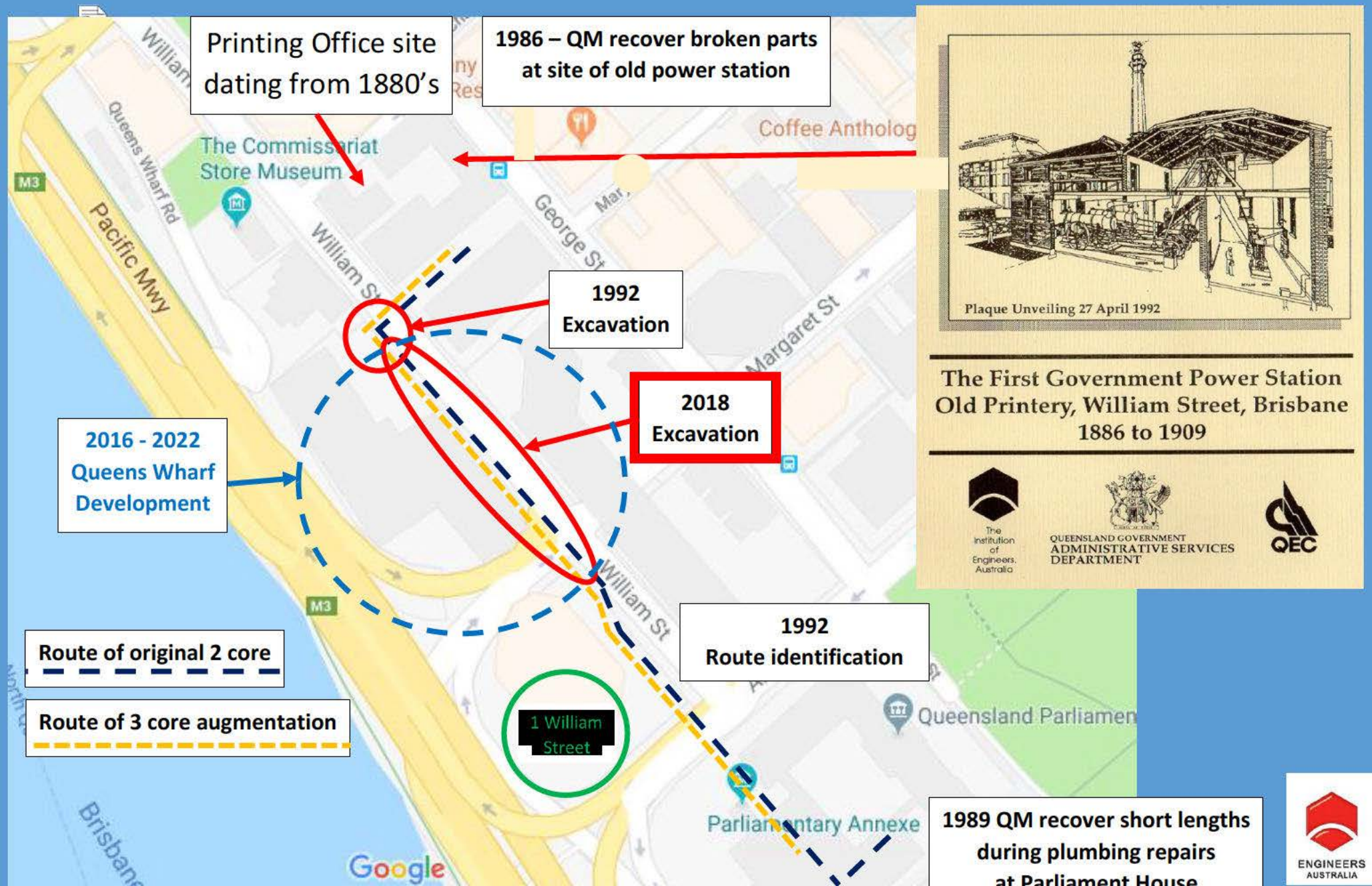
Fig 2 - Swan carbon filament lamp and socket, c1882



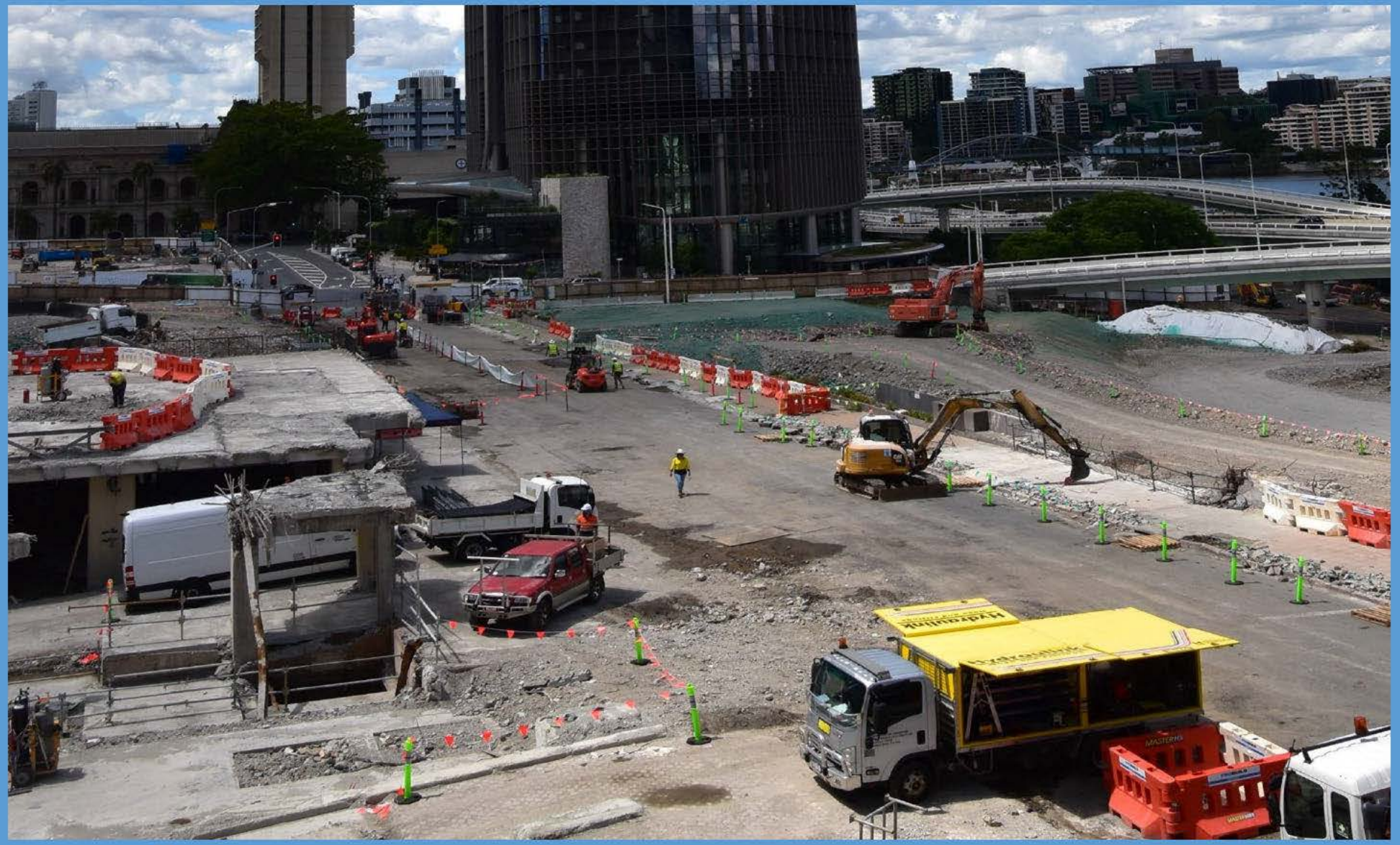
Edison Incandescent Electric Light catalog, 1887.

ENGINEERS AUSTRALIA

Location of 2018 Recovery



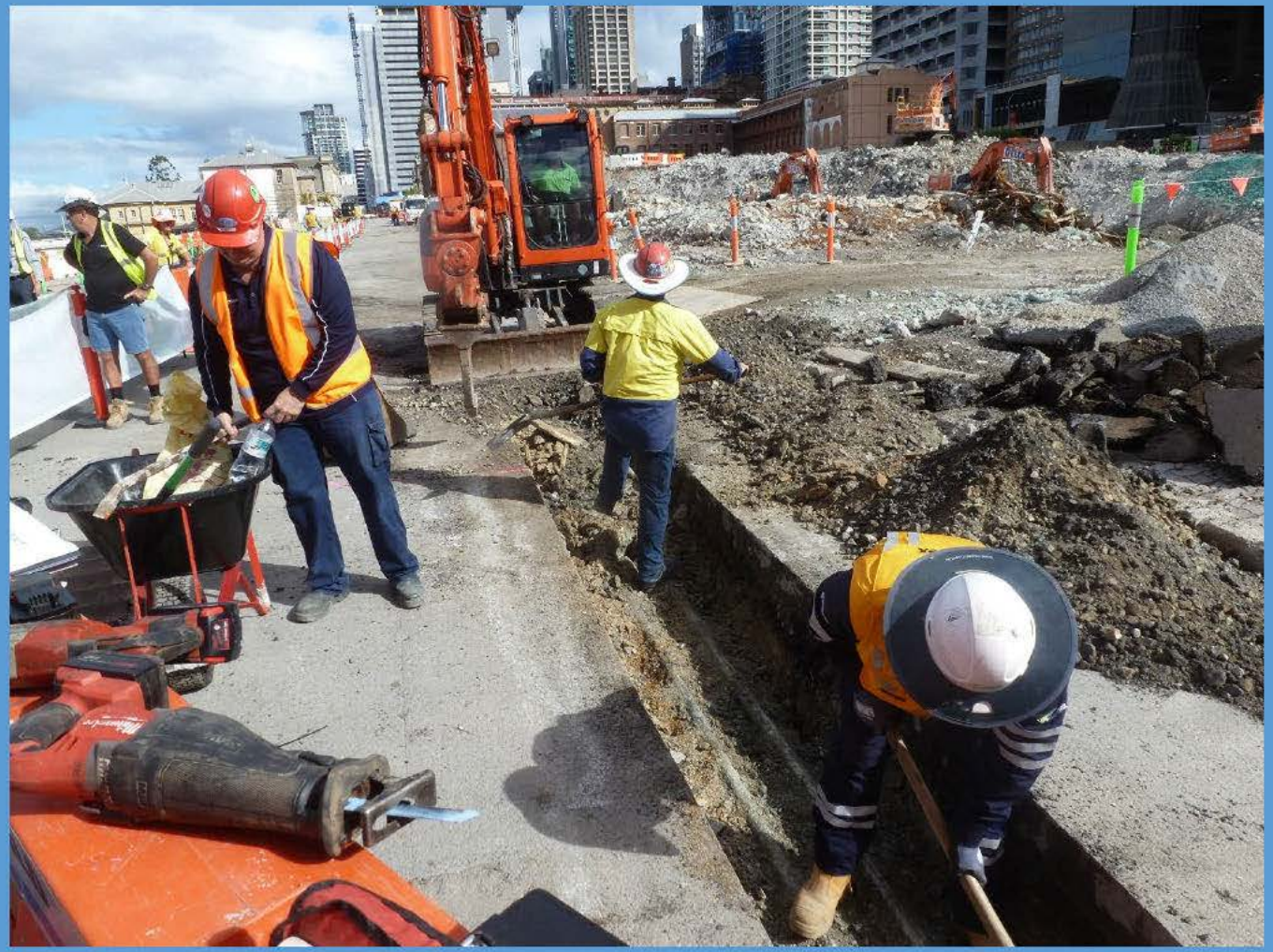
ENGINEERS AUSTRALIA

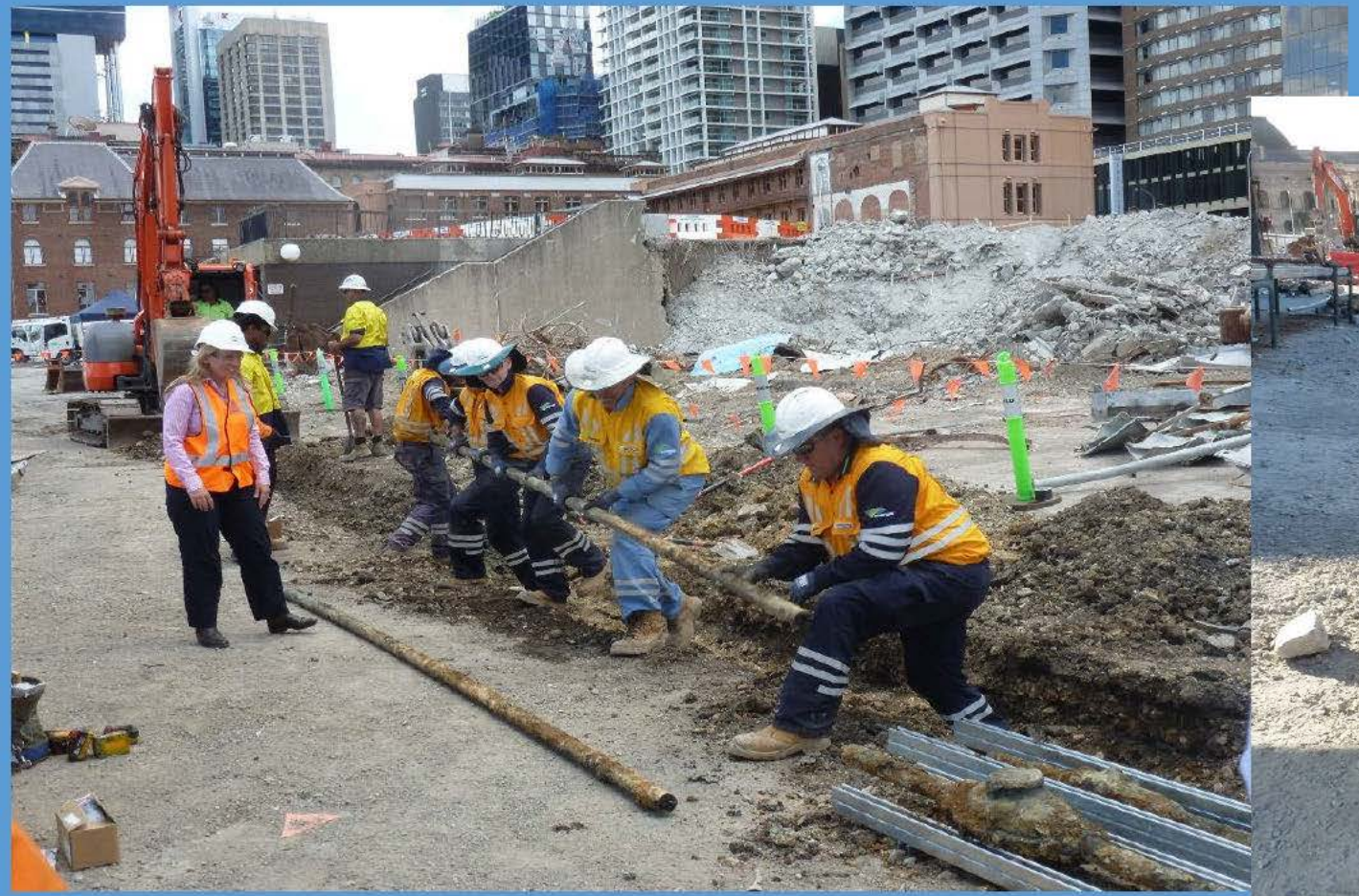


William Street site prior to 2018 excavation

ENGINEERS AUSTRALIA

Excavation starts Feb 6th 2018





Recovery process – lifting to crates

Archaeologists Cleaning

ENGINEERS AUSTRALIA

Recovery process – all tagged and taken to store

ENGINEERS AUSTRALIA

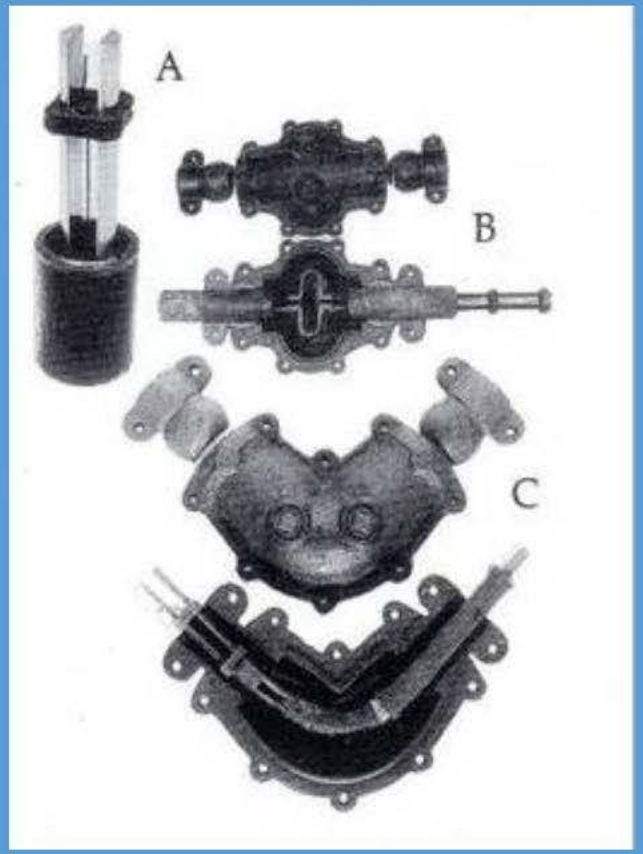
Samples were wire brushed and coated in fish oil

Condition varied but generally surprisingly good

A – 2 core street tube;

B - conductors connected to allow for expansion and movement;

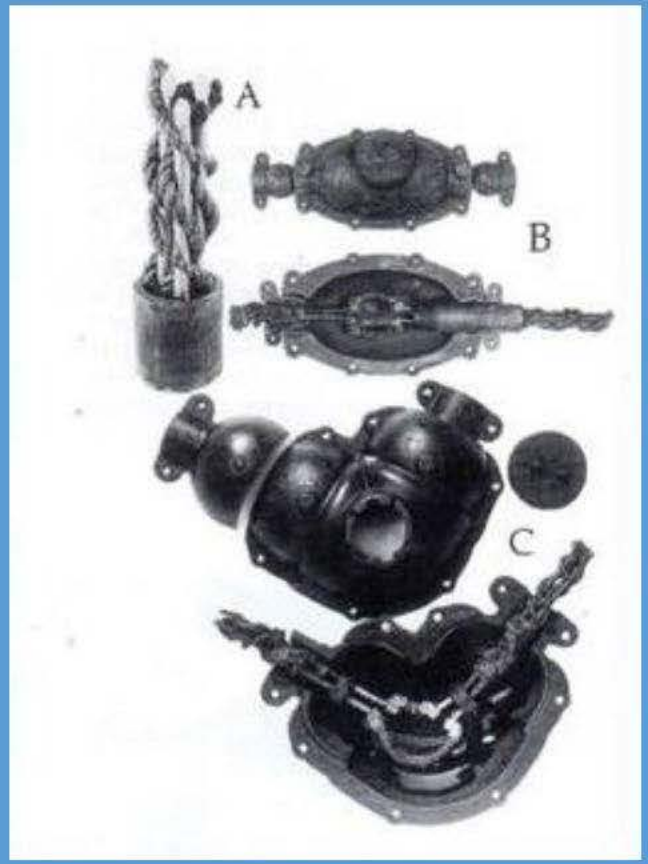
C - conductors connected by single core cable in 1892 as parallel return



A – 3 core street tube;

B – conductors connected with flexible copper braid cable to allow for expansion and movement.

C – as for B but at right angles

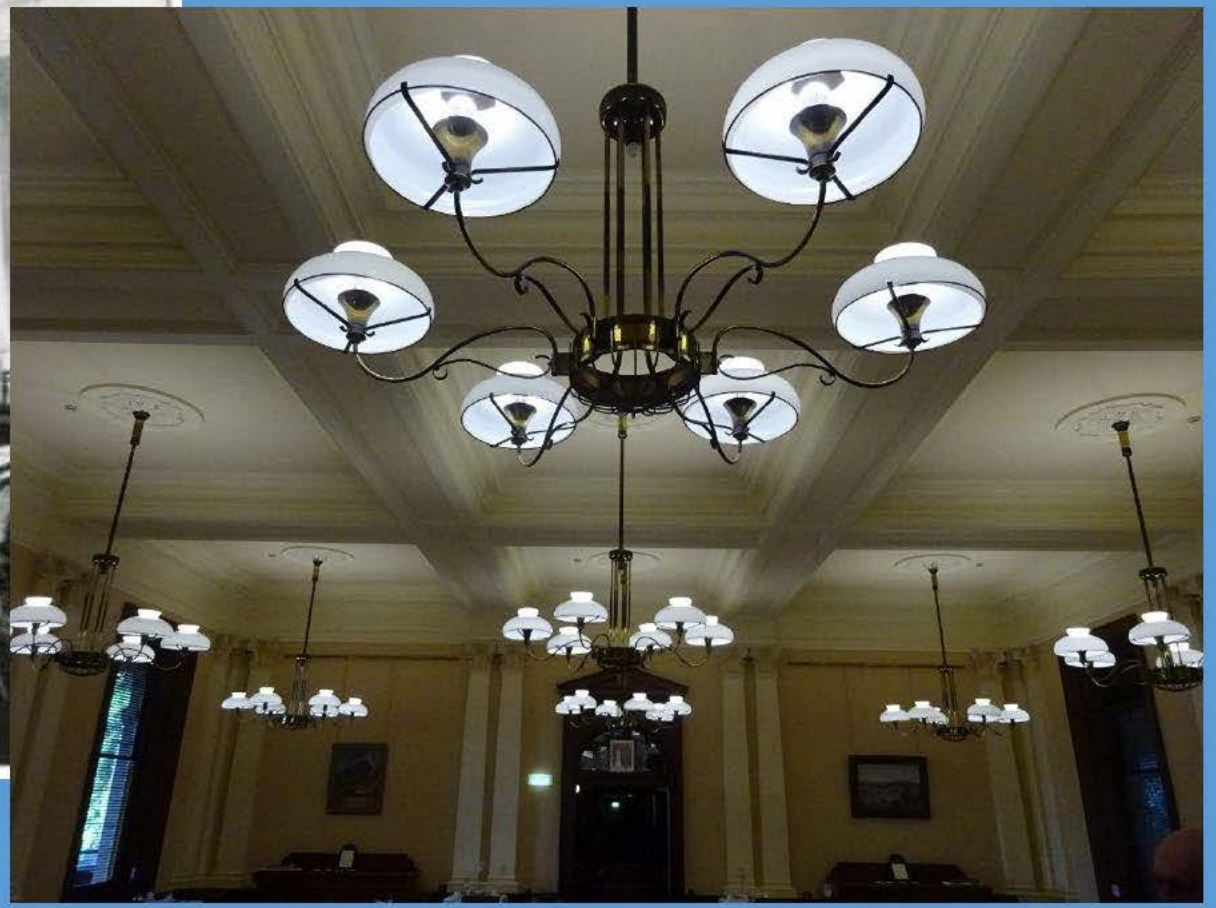


Junction “boxes” – cast iron & filled with insulation compound

Rare Intact Full 20’ lengths plus boxes being supplied to…

- Australian museums
  - Highfields, Toowoomba
  - Museum of Applied Arts & Sciences, Sydney
  - Electrical Museum, Tamworth
- Overseas museums
  - Edison Park Museum, NJ, USA
  - IEEE History Centre, NJ, USA
  - Smithsonian, Washington, USA
  - Science Museum, London, UK
- And
- Queensland Parliament House.

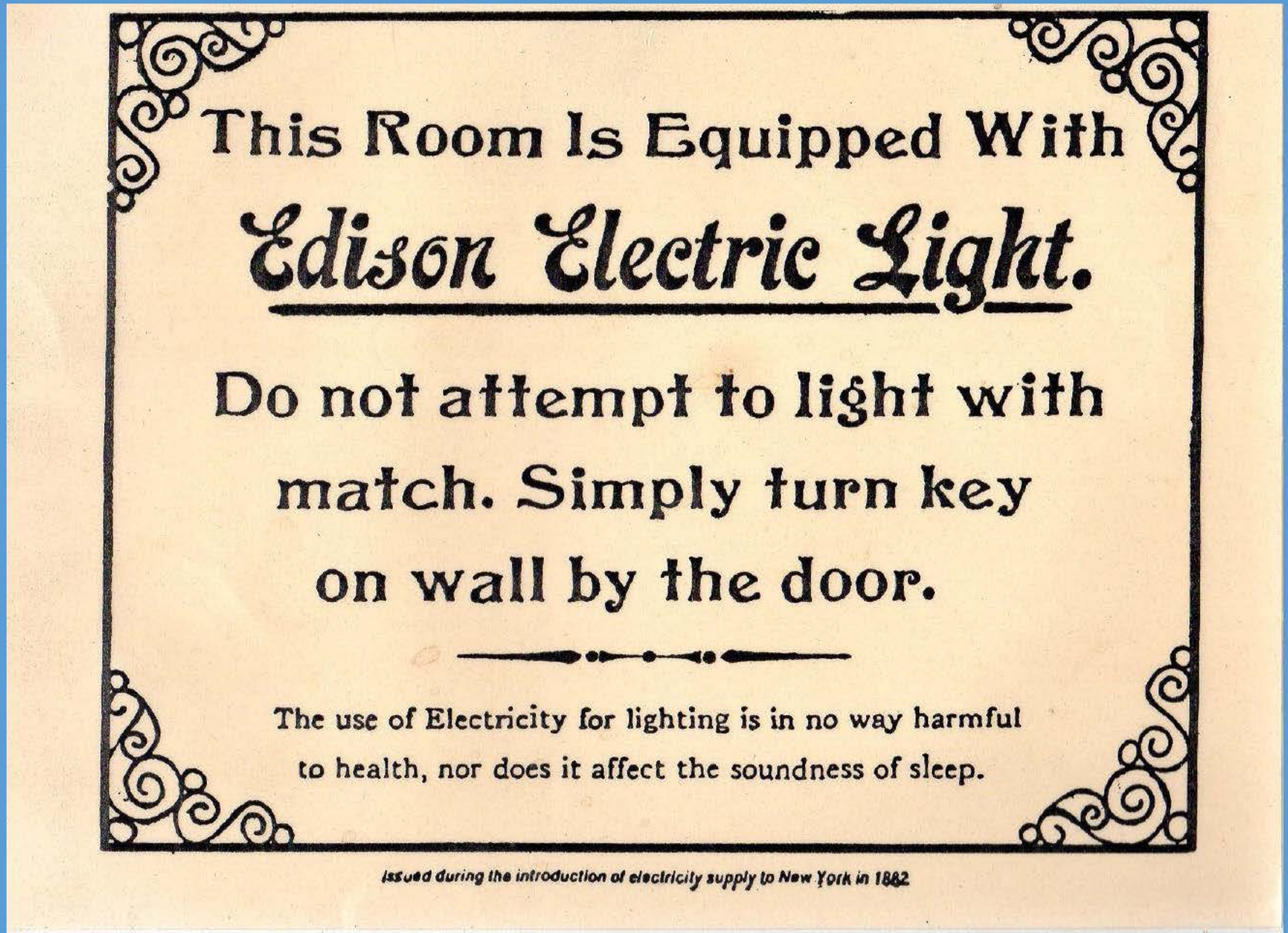
Parliament House Dining Room 1912 to 2018



Parliament House Library 1910 to 2018

ENGINEERS AUSTRALIA

Room Sign used by Edison for new Electric Lighting



Hydrogen Overview

TAKEAWAY: 01

GE supports customers in their decarbonization* journey, including hydrogen, carbon capture, coal-to-gas switching or other approaches.

TAKEAWAY: 02

GE has more than 100 gas turbines operating on hydrogen fuel blends that have accumulated more than 8 million hours of operation.

TAKEAWAY: 03

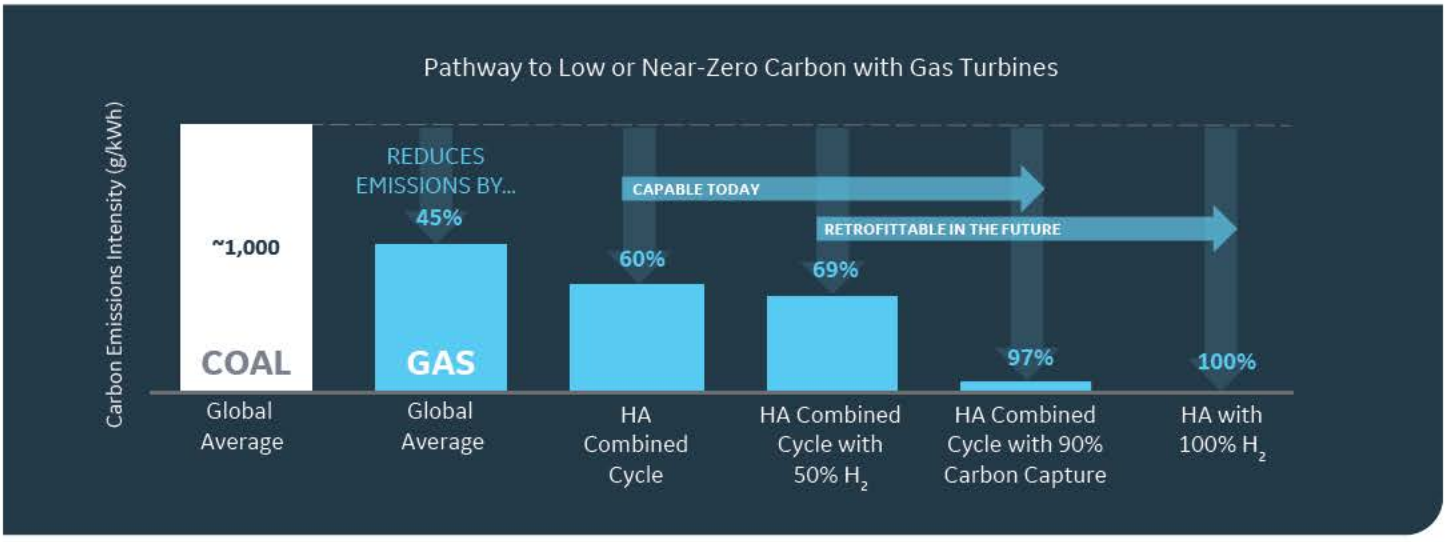
GE is partnering with customers on both hydrogen demonstration and commercial projects across the globe.

ENERGY TRANSITION: A DECADE OF ACTION

- The energy transition remains the greatest uncertainty for the power sector today. While the sense of urgency to address climate-change has never been higher, the pace and scale of investments must increase significantly in order to meet decarbonization goals.
- More work needs to be done to reduce the cost of hydrogen and carbon capture and sequestration technologies to accelerate their deployment. These technologies have the potential to significantly enable near-zero-carbon power generation and some governments are offering incentives to foster adoption.

HYDROGEN AS A FUEL FOR GAS TURBINES

- Burning hydrogen is a potential pathway to decarbonize gas turbines by replacing natural gas fuel with hydrogen, which has no carbon, and therefore, no CO_2 in the exhaust. One area to consider when burning hydrogen is that more NO_x may be produced compared to natural gas.
- Most (~95%) of the hydrogen produced today is produced using natural gas via the Steam Methane Reforming process, with the resultant CO_2 released to the atmosphere. This is called **"grey" hydrogen.**
- Adding a carbon capture system to this process results in **"blue" hydrogen.**
- So-called **"green" hydrogen** is produced by electrolyzing water into hydrogen and oxygen using renewable energy as the power source.
- **A gas turbine does not care which "color" hydrogen is used as fuel.**



OVER

CHALLENGING HYDROGEN ECONOMY

- Low carbon hydrogen fuel costs are trending lower, but are expected to remain 2–10X more expensive than natural gas at least through the end of the decade.
- Carbon taxes or other incentives may improve the economics of hydrogen compared to fossil fuels, but we anticipate that hydrogen will be used in long-haul transportation, maritime shipping, and industry before it is broadly adopted in the power sector.

DELIVERING VALUE FOR ITS CUSTOMERS

- Power plant operators are increasingly exploring the option to use hydrogen as a fuel and requesting OEMs to identify their specific capability.
- GE has more experience burning hydrogen than any other OEM. This experience goes back to the mid-1990s and includes more than 100 gas turbines that have accumulated more than 8 million** hours of operation. This experience enables us to understand the unique challenges using hydrogen as a gas turbine fuel.

RECENT DEMONSTRATION AND COMMERCIAL PROJECTS THAT USE OR PLAN TO USE HYDROGEN

Long Ridge Energy (USA)
Long Ridge Energy intends to begin blending hydrogen in their *new 7HA.02* gas turbine later this year. The owner's plan is to transition the plant to 100% hydrogen in 10 years.

NYPA Brentwood (USA)
New York Power Authority intends to demonstrate blending hydrogen and natural gas in an existing *LM6000* gas turbine in 2022.

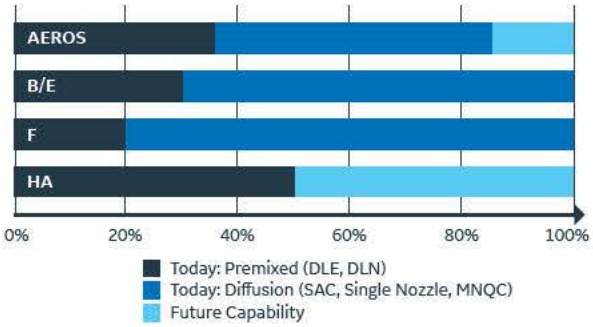
Tallawarra B (Australia)
EnergyAustralia intends to begin blending hydrogen in their *new 9F.05* gas turbine starting in 2025. This will be the first 9F gas turbine to operate on blends of hydrogen and natural gas.

Guangdong Huizhou (China)
Guangdong Energy Group intends to operate their new 9HA.01 gas turbines on a 10% blend of hydrogen and natural gas starting in 2023.

For more information, visit our website:
gepower.com/hydrogen

GE GAS TURBINE HYDROGEN CAPABILITY

- Each gas turbine model has specific capability for burning hydrogen, dictated primarily by the combustion system. Some are capable of burning 100% today.
- Our most advanced gas turbines, the 7HAs and 9HAs, are capable of burning as much as a 50/50 hydrogen/natural gas blend when using the DLN2.6e combustor.
- Work is underway to increase hydrogen burning capability across the portfolio, with a specific goal of achieving 100% capability for the HA machines.
- Existing gas power plants can be retrofitted to burn higher volumes of hydrogen than originally contemplated. These upgrades can be scheduled with planned outages to minimize the time the plant is not generating power, and for new units these capabilities can be part of the initial plant configuration or phased in over time as hydrogen becomes available.



CONCLUSION

- There is tremendous industry "buzz" around hydrogen, and it holds promise for decarbonizing the energy sector.
- However, because of the huge quantities of fuel needed for a gas power plant, questions remain about the timing of sufficient quantities of cost-competitive hydrogen for the power sector.
- Regardless of what challenges there are for building a hydrogen economy, our purpose is to support our customers on their hydrogen journey.
- Pilot projects are already demonstrating GE's technical leadership and innovation in decarbonization technology and we continue to build partnerships to deliver decarbonization solutions today, and at the same time build a more differentiated offering for our customers.

*Decarbonization in this paper is intended to mean the reduction of carbon emissions on a kilogram per megawatt hour basis.
**GE H_2 statistics as of September 2021: inclusive of both heavy-duty and aeroderivative gas turbines.