

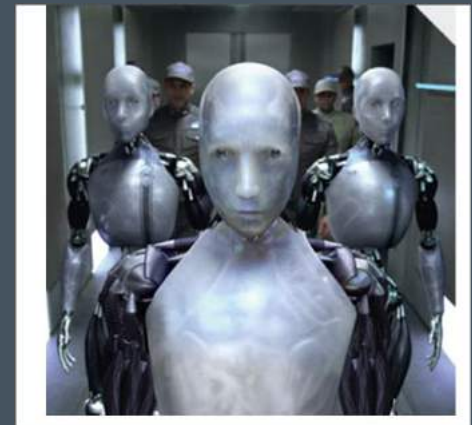


UNIVERSITY OF
BATH

How could suppliers and customers dramatically reduce future electricity bill?



Professor Furong Li
Chair in Electrical Power
Systems



Measures to Reduce Bills



3000kWh/yr

x

17pence/kWh

=

£500/yr



Energy
Efficiency



Lifestyle
Change

Topics

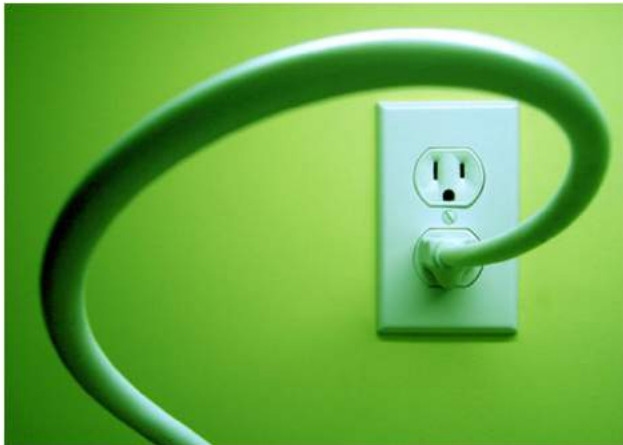


Electric Supply System

History of Supply and Prices

Options for the Future

Where Electricity Comes From?



Behind the wall?



From Power Station?



**WESTERN POWER
DISTRIBUTION**
Serving the South West and Wales

? or

npower

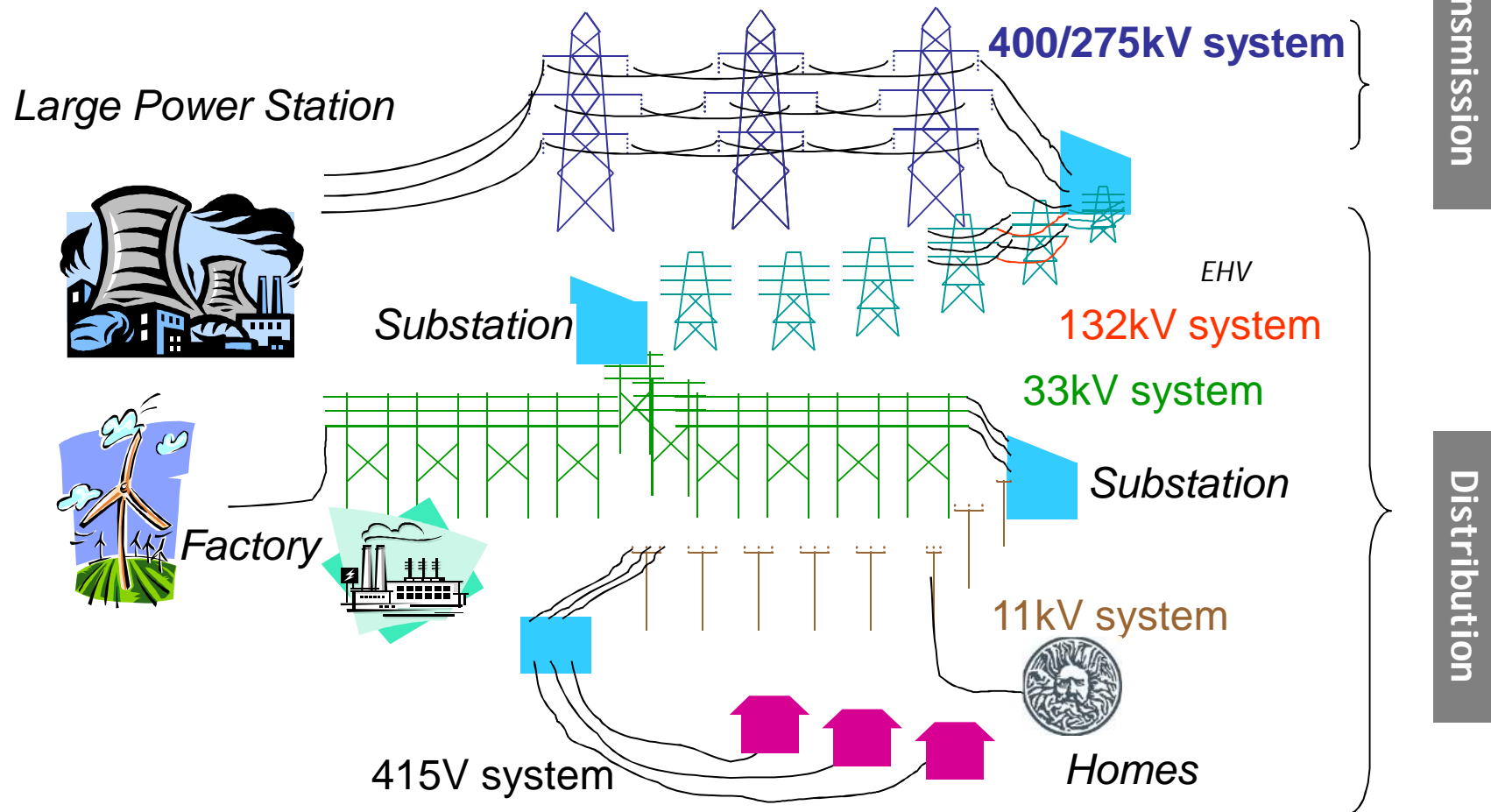
?



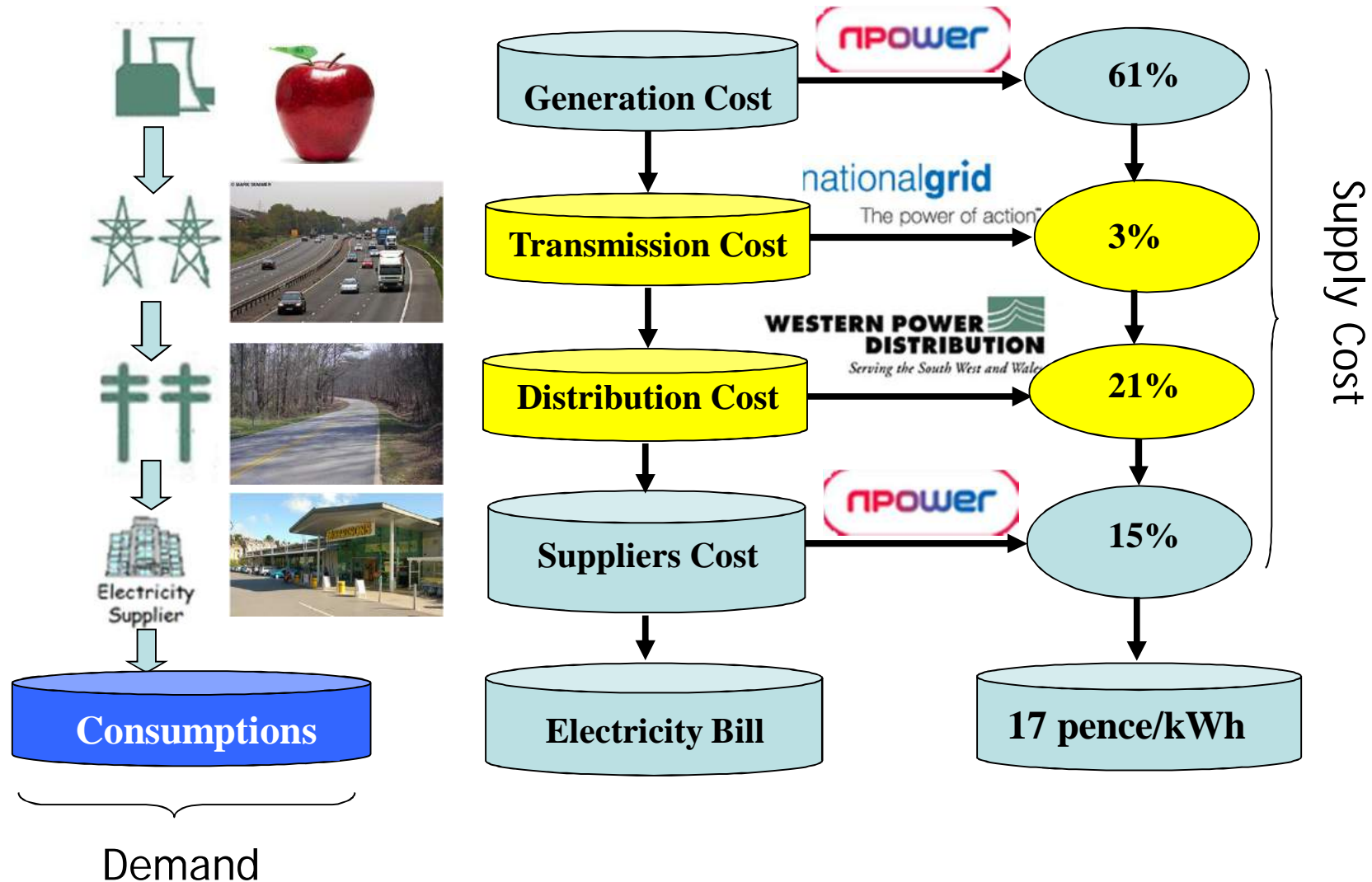
nationalgrid

?

Electric Supply Chain



Cost Breakdown of Our Electricity Bill



Our Annual Electricity Consumptions



3,000kWh/yr

£500/yr



33000



27, 000, 000 kWh/yr
(27 GWh/yr)

£2.28 million/yr



9000 houses



300, 000, 000,000 kWh/yr
(300TWh/yr)

£32 billion/yr

KWh	10^3
MWh	10^6
GWh	10^6
TWh	10^{12}

Topics



Electric Supply System

History of Supply and Prices

Options for the Future

First Public Electricity Supply Industry

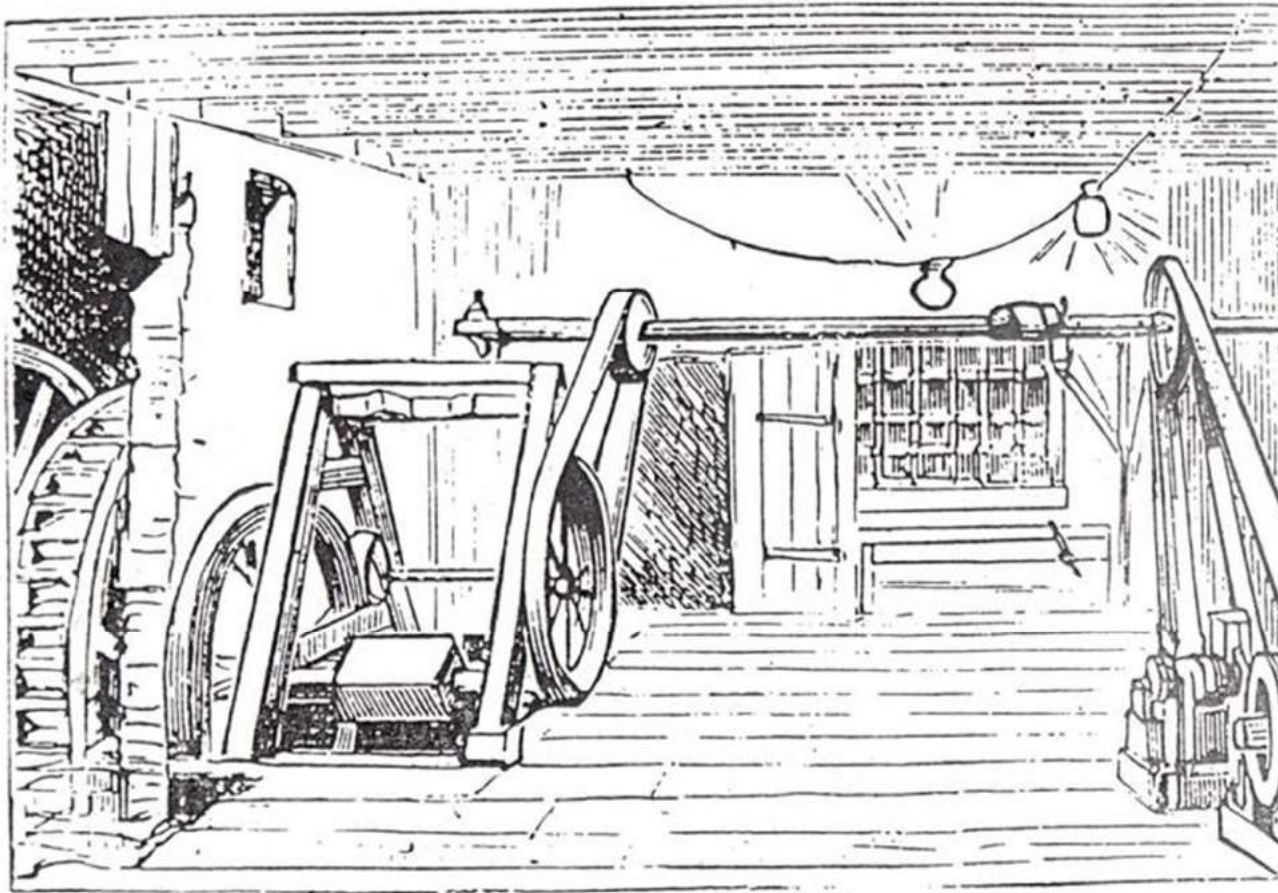


Incandescent lamps shone from three 24 ft high posts. The light that flooded the cobblestones of Godalming signalled the birth of the electricity supply industry.

Street lighting by gas
costed £238/yr

Three electric lights installed in
October 1881 at £195/yr

First Public Electricity Generation



*Generating
equipment at
the Westbrook
Mill, Godalming,
from
The Graphic
21 November 1881*

Water wheel the power source
Siemens generator converted
water power to electricity

Replaced by steam generator,
because it was neither
adequate nor reliable

Transition was not a Plain Sailing



Supply cost very high

Small number of customer

Short duration of supply
(6pm-11pm)



Nimby (not in my backyard)

*"They cause the houses
to vibrate like ships at
sea."*



Incandescent lamps shone from three 24 ft high posts. The light that flooded the cobblestones of Godalming signalled the birth of the electricity supply industry.

The Power of Alternatives

Economics required
400~500 private
customers

The lighting company
only secured 100

Contract did not renew



Incandescent lamps shone from three 24 ft high posts. The light that flooded the cobblestones of Godalming signalled the birth of the electricity supply industry.

**Revert to gas lighting in
1884**

**The gas lighting company
reduced the charges**

Godalming in Surrey
1881-1884

Chesterfield in Derbyshire
1881-1884

Edison station in London
1882 - 1886

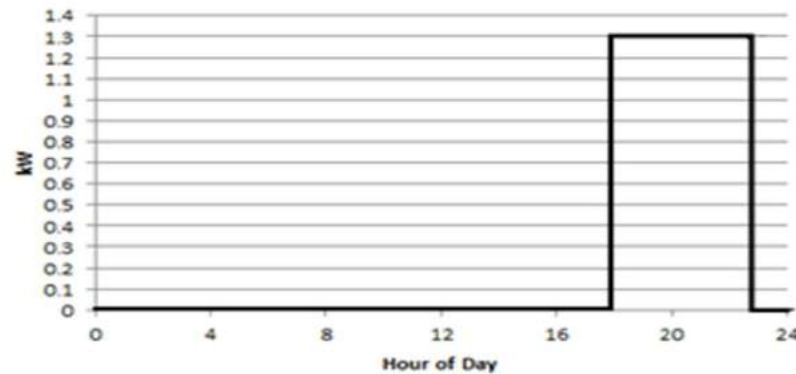
*How did Victorian
reintroduced electric
supply system back to
the society?*

Innovations

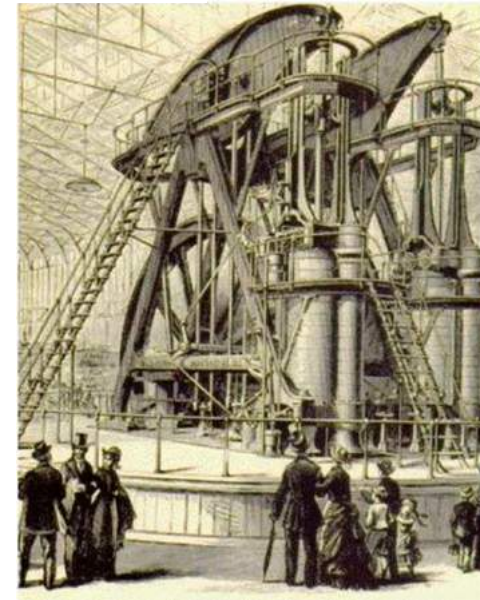
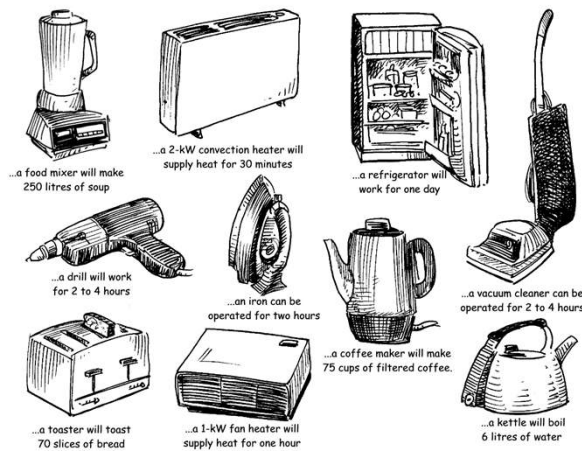
Innovations for Supply Efficiency

Day Time 'off-peak' Electric Use

Technical Innovations



Usage: 6pm-11pm



Innovations for Supply Efficiency



Commercial Innovations

Incentivising electricity use at the right time

Domestic Tariffs in 1916

Lighting

Peak Demand

2 pence/KWh

Heating
Cooking

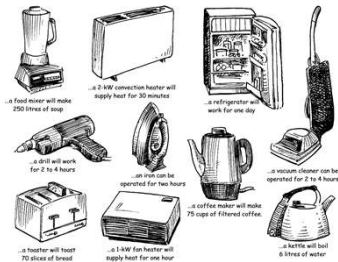
Off-Peak
Demand

0.6 pence/KWh

Vehicle
charging

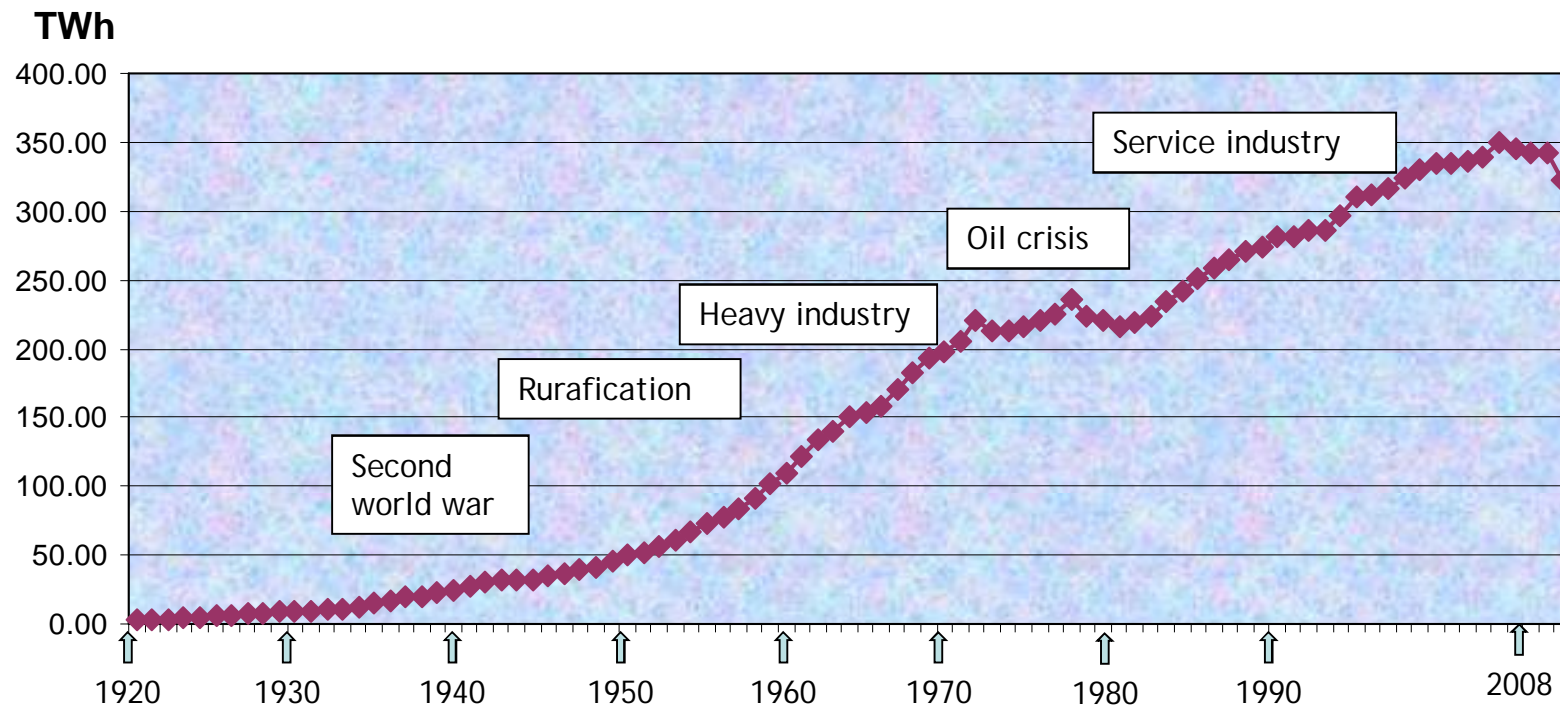
Super Off-Peak
Demand

0.2 pence/KWh



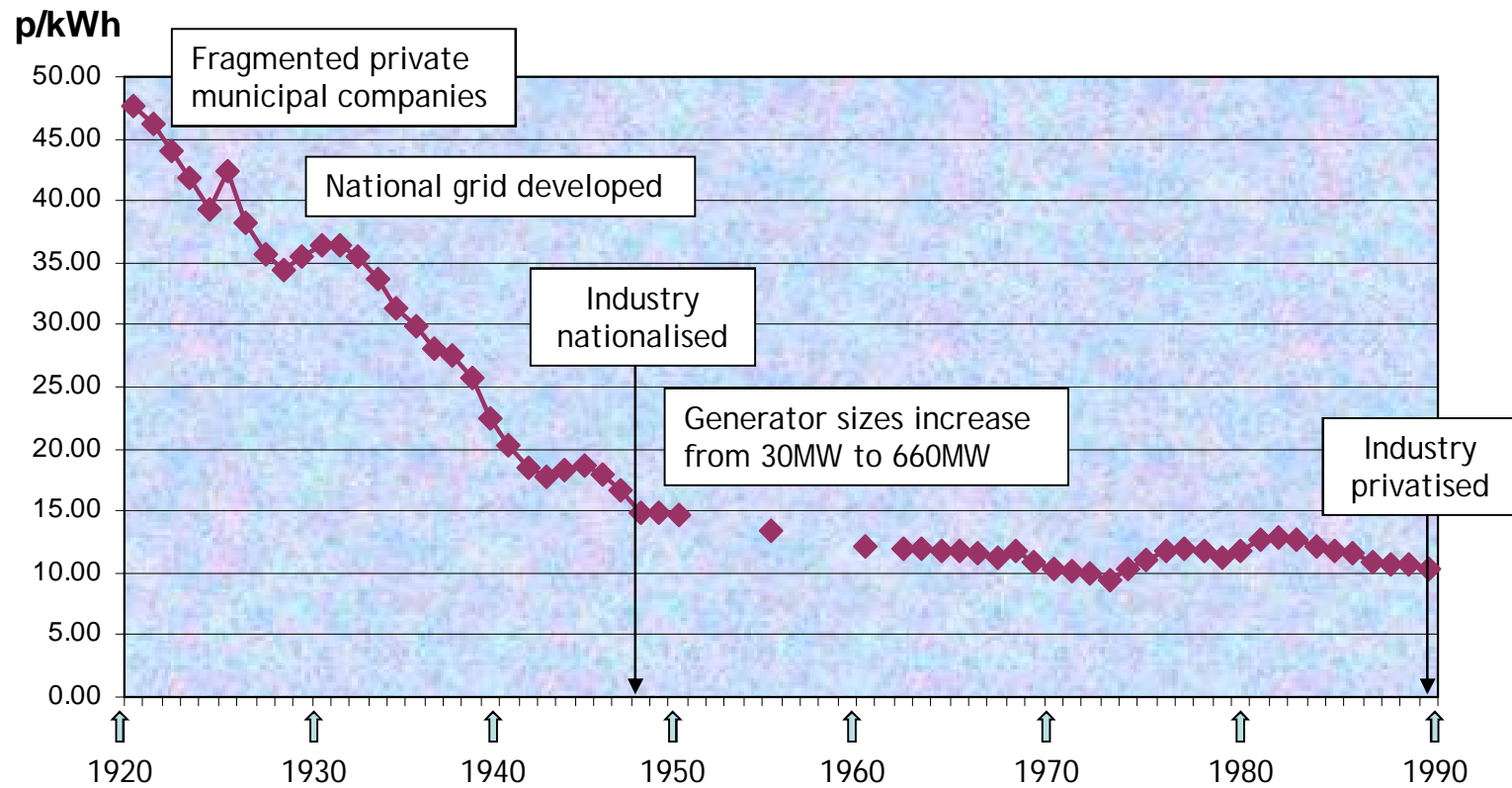
Consumption Movements 1920~ 2010

Electricity consumptions 1920 - 1990



Price Movements 1920 ~ 1990

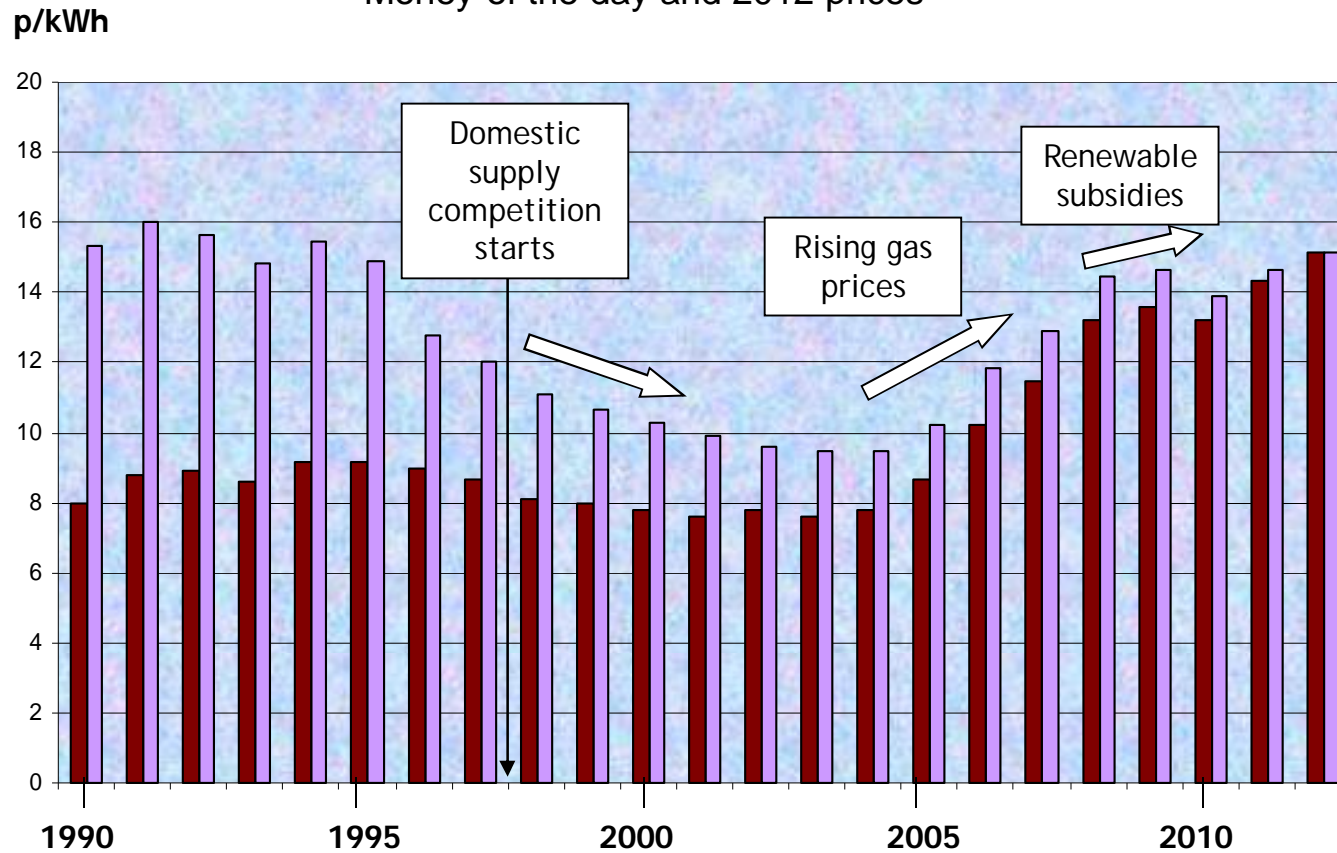
All User electricity prices Prices at 2012 values



Domestic Prices Since 1990

Residential prices in p/kWh

Money of the day and 2012 prices



Electricity Bills will Jump



BBC Sign in News Sport Weather iPlayer TV Radio

NEWS NORTHERN IRELAND

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Northern Ireland Politics

31 May 2013 Last updated at 15:19

Airtricity announces 17.8% electricity price increase

Airtricity, Northern Ireland's second biggest electricity supplier, has announced it is increasing prices by 17.8% from 1 July 2013.

The move matches that by Power NI, which is raising its prices by 17.8% from the same date.

Airtricity said it could not continue to absorb the significant increase in wholesale costs.



The company is increasing its prices from 1 July

Electric.co.uk News

SSE Warns People That Energy Bills Will Jump Again



Although people want to believe that energy bills have reached their max, SSE begs to differ. In fact, this UK energy giant has said that energy bills are likely to increase yet again. This announcement comes after the company announced a huge 27.5 percent increase in profits.

THE TIMES OF INDIA Lucknow

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Thiruvananthapuram Vadodara Varanasi Visakhapatnam

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Consumers' backlash at UP power tariff hike

TNN | Jun 2, 2013, 04:01 AM IST

BlackBerry Enterprise

BlackBerry.com/Enterprise-Service10 - Get details on managing devices w/ BlackBerry® Enterprise Service 10.

Ads by Google

READ MORE » [UPPERC](#) | [UP Power Tariff Hike](#) | [Akhilesh Yadav](#)



LUCKNOW: The power tariff hike announced by the UP Power Electricity Regulatory Commission (UPPERC) has evoked sharp reaction from consumers who termed the raise unjustified and uncalled for.

"The hike will affect the domestic consumer as it hits our budget directly and will increase financial burden" says Sarala Trivedi, a housewife. "The

Changing Energy Landscape



Low carbon
generation



Low carbon
consumption



MANUAL CONTROL

Hand operated switchgear, LV fuseboard and handwritten substation logbook.



Modernising
the legacy
infrastructure



Cost of the Low Carbon Transition



DEMAND SIDE RESPONSE: CONFLICT
BETWEEN SUPPLY AND NETWORK DRIVEN
OPTIMISATION

A report to DECC

November 2010

2050 Pathways - Alpha
(80% CO₂ Reduction
relative to 1990 level)

Business as
Usual

£158 billions

Gu, Zhang, Hu

Demand

Year	Peak demand (GW)	Total demand (TWh)
2050	137	730
2030	96	505
2009	58	314

Generation (GW)

GW	2009	2030	2050
Wind+marine	1.9	65.9	93.3
Solar	0.0	5.8	70.4
Other renewables	1.8	3.3	3.7
Nuclear	10.9	16.4	40.0
CCS coal	0.0	10.2	39.0
Gas	32.6	28.3	0.0
Coal	23.0	1.3	1.3
Oil	3.8	0.0	0.0
Hydro	1.5	1.1	1.1
Pumped storage	2.7	2.8	2.8
Total	78	135	252

Electricity Bills will Jump





BBC Sign in News Sport Weather iPlayer TV Radio

NEWS NORTHERN IRELAND

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Northern Ireland Politics



Disney Pixar
Up
MAY 29 3D



SSE

h people want to that energy bills reached their max, gs to differ. In fact, this UK energy giant has said that energy bills are likely to increase yet again. This announcement comes after the company announced a huge 27.5 percent increase in profits.

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Jaipur Kanpur Kolkata Kochi Kozhikode **Lucknow** Ludhiana Madurai Mangalore Mysore Nagpur Nashik Noida Patna

Thiruvananthapuram Vadodara Varanasi Visakhapatnam

You are here: Home > City > Lucknow

Are we powerless to change the direction but subject to the on-going price hike?

Innovations

Measures to Reduce Bills



3000kWh/yr

Reducing
quantity

17pence/kWh

Reducing
supply cost



Energy
Efficiency



Lifestyle
Change



Supply
Efficiency

Topics



Electric Supply System

History of Supply and Prices

Options for the Future

Innovations for Future Supply Efficiency



1. Innovations in generation development



2. Innovations in network development



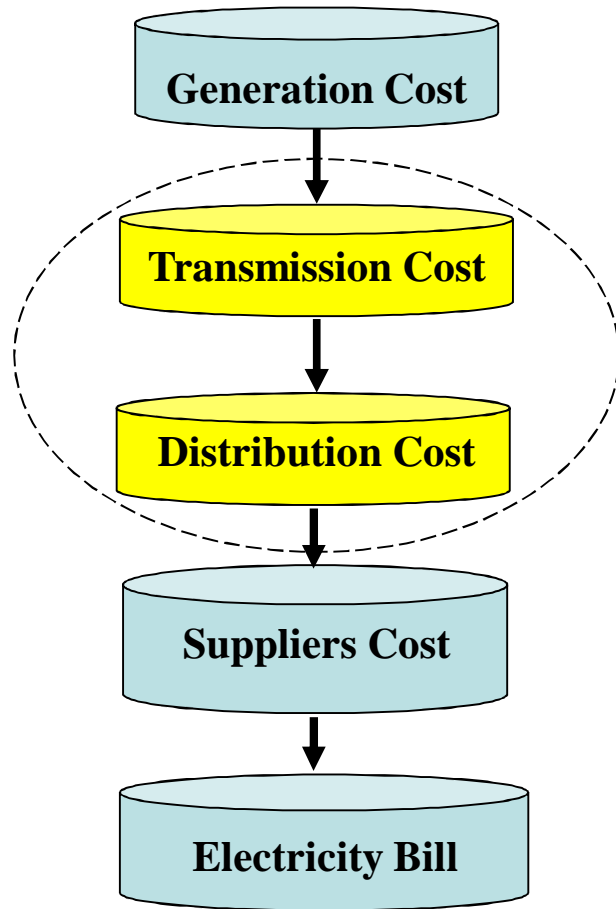
3. Innovations in supply



4. Innovations in consumptions



Innovations in network development



2. Innovations in network development



Old

Inefficient

Weak Locational Message Very Expensive

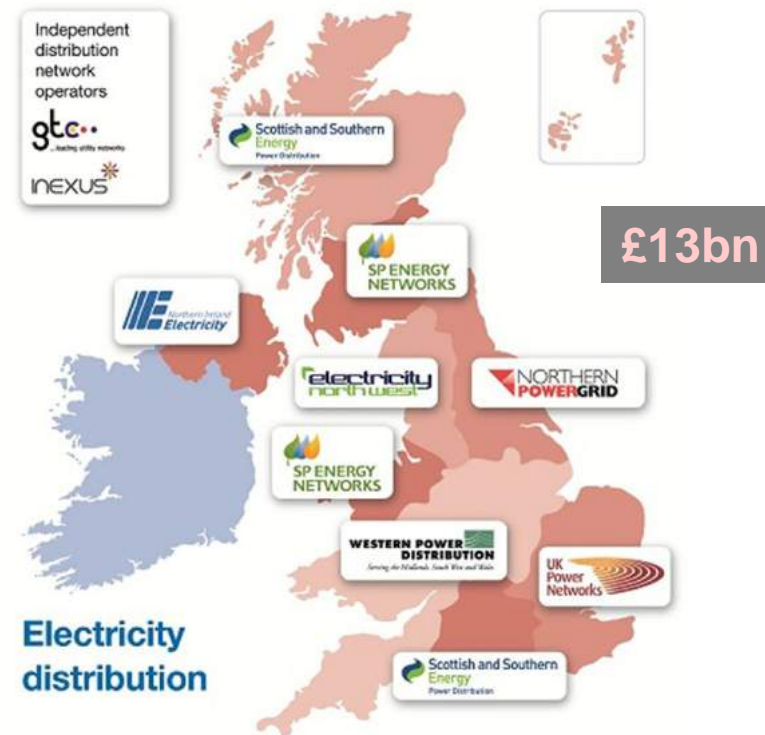
Use of system charges

Postage stamp
(pre-2007)



40% renewables

Predicted £5-6 billion
investment for 2010-2015
(2005)



21% share in average domestic bill

Key Attribute in Locational Charging



Impact to network
investment cost



WPD (Southwest)

Extra High Voltage (33KV-
132KV)

2000 locations

1400 circuits

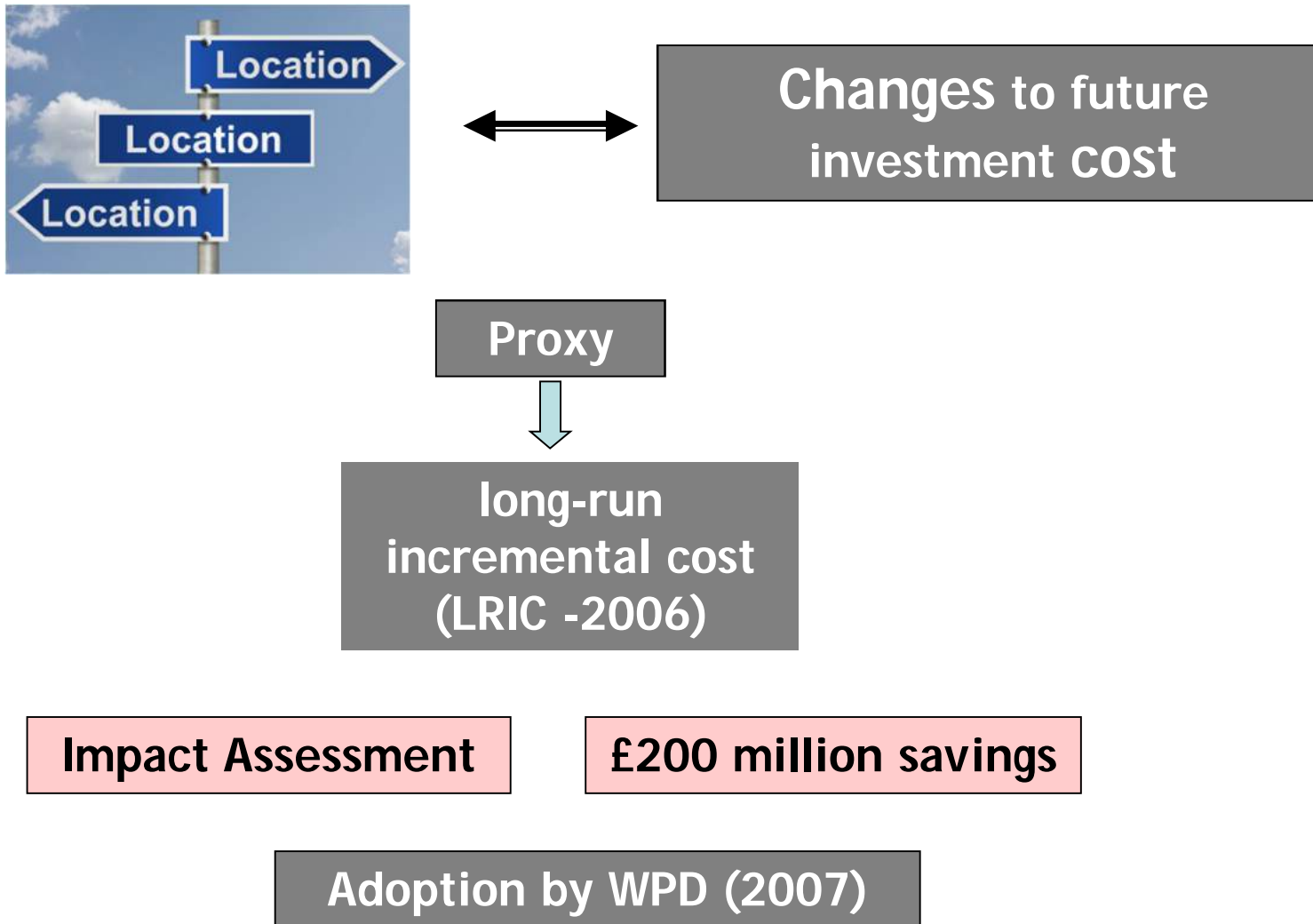
1044 transformers

Future cost evaluation

1 location 3 month

2000 locations 50 year

Long-run Incremental Cost Pricing



Wang, Kuri, Padhy, Gu, Heng, Matlosz,
Pudruth, Zhang, Li (B), Li (J)



Long-run Incremental Cost Pricing



ofgem Promoting choice and value
for all gas and electricity customers

**Delivering the electricity distribution structure of charges
project**

Document Type: Decision Document

Ref: 135/08

Date of Publication: 1 October 2008

We believe that LRIC presents
the most appropriate model
that has been developed for
EHV at this moment in time.



Long-run Incremental Cost Pricing

Brazil

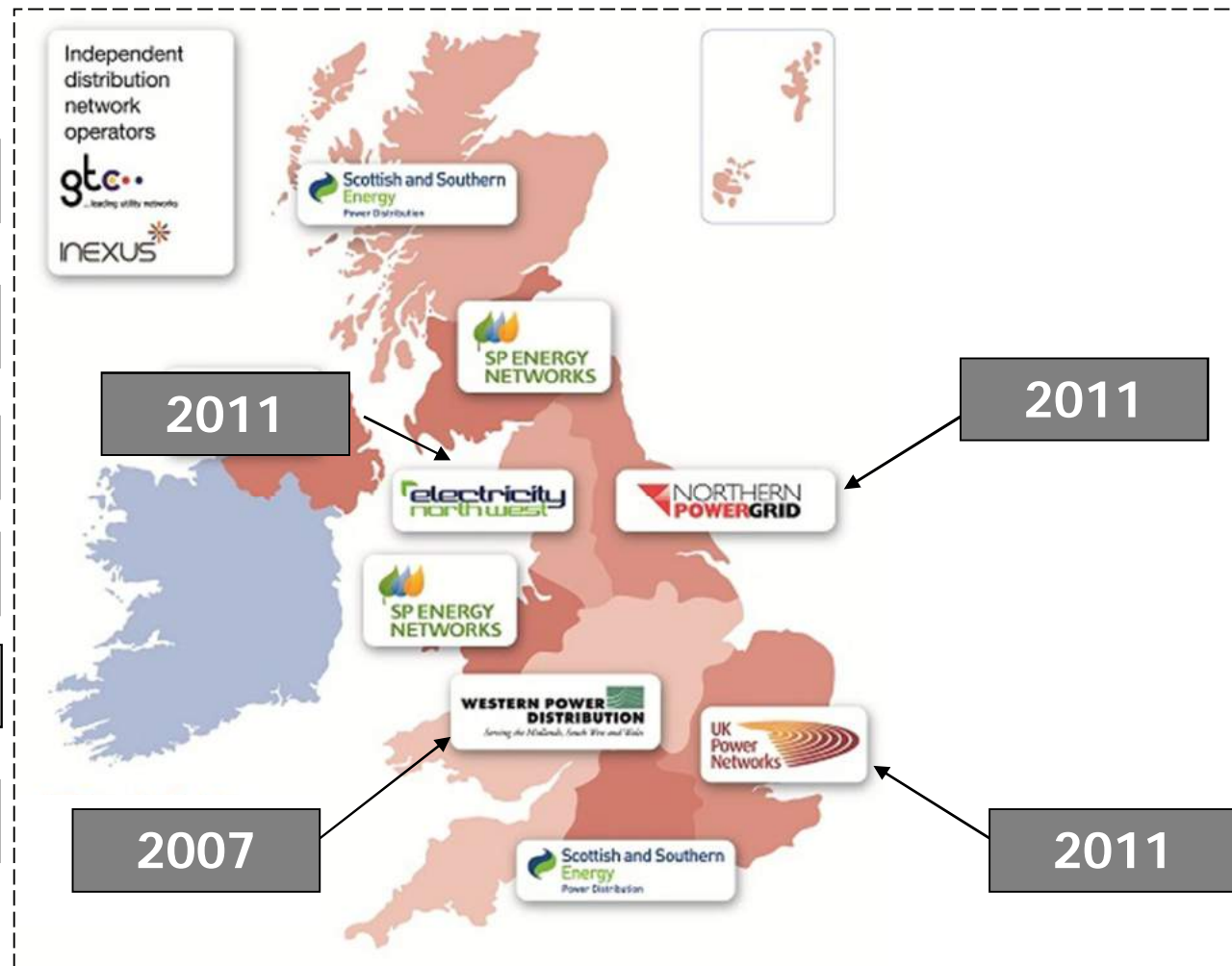
India

China

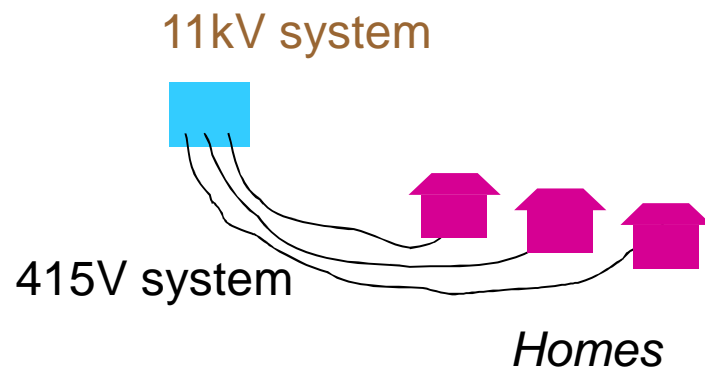
Demark

Germany

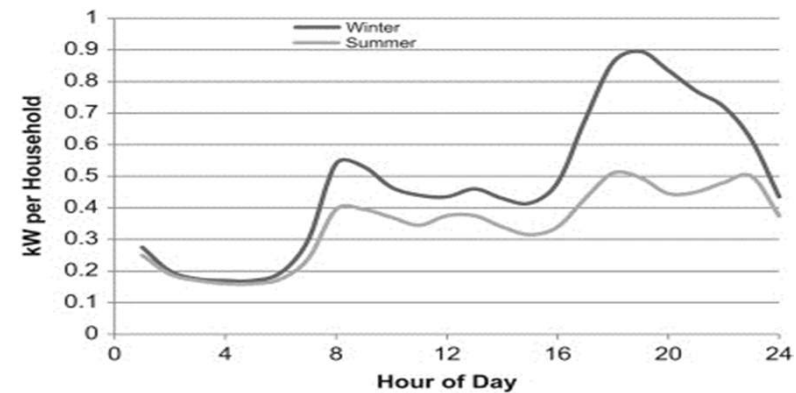
Lithuania



Low Visibility - Where is the Trough?



Total: 613,000



£2 Billions for full
visibility

Smart Grid Demonstration



*In the country of the blind,
one eyed man is the king.*

Template Solution



800 Substations

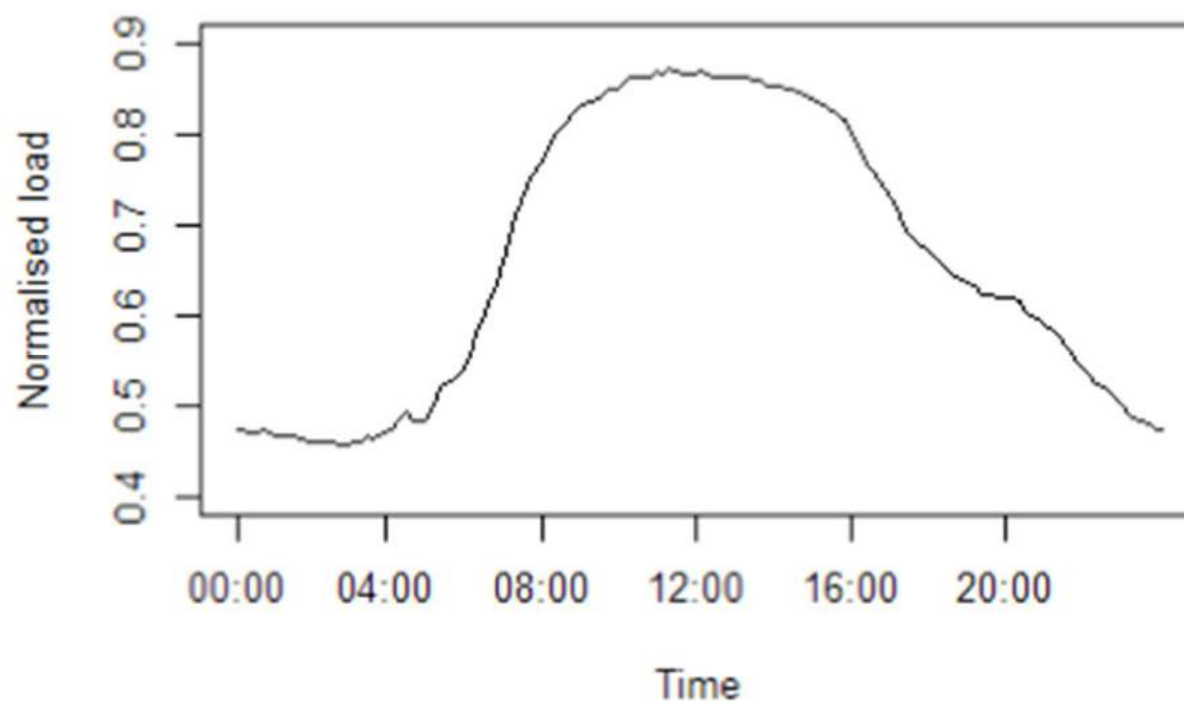
7000 Voltage
Monitors

Gu, Li (R), Yan, Zhao,
Martin, Shaddick, Walker



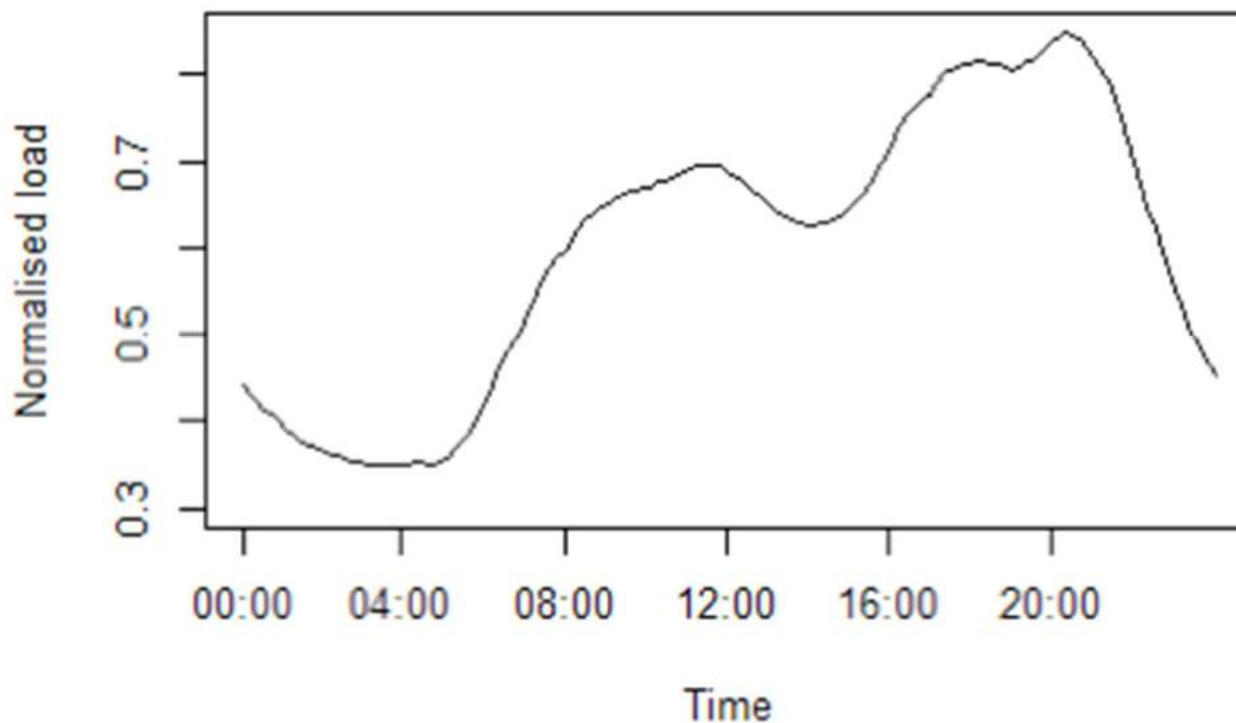
Low Voltage Templates

Cluster 1: High Industrial & Commercial Dominance (~80%)



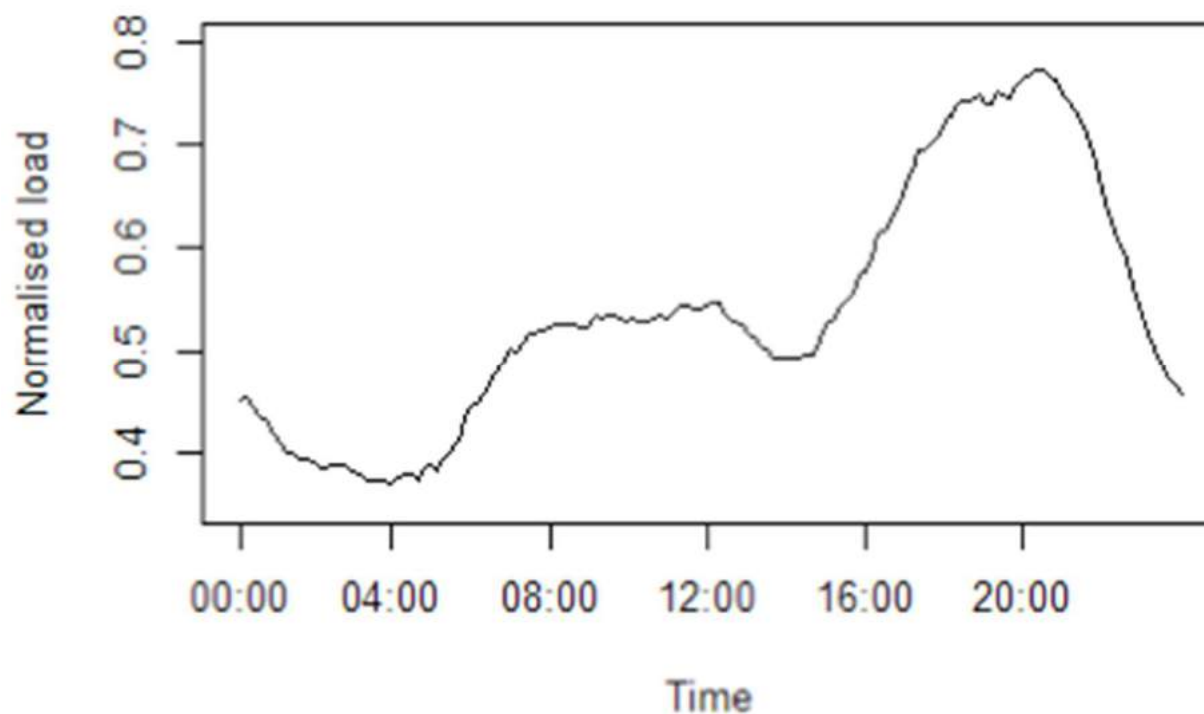
Low Voltage Templates

Cluster 4: High Domestic Dominance (~90%) (Modest Customer Size ~170)



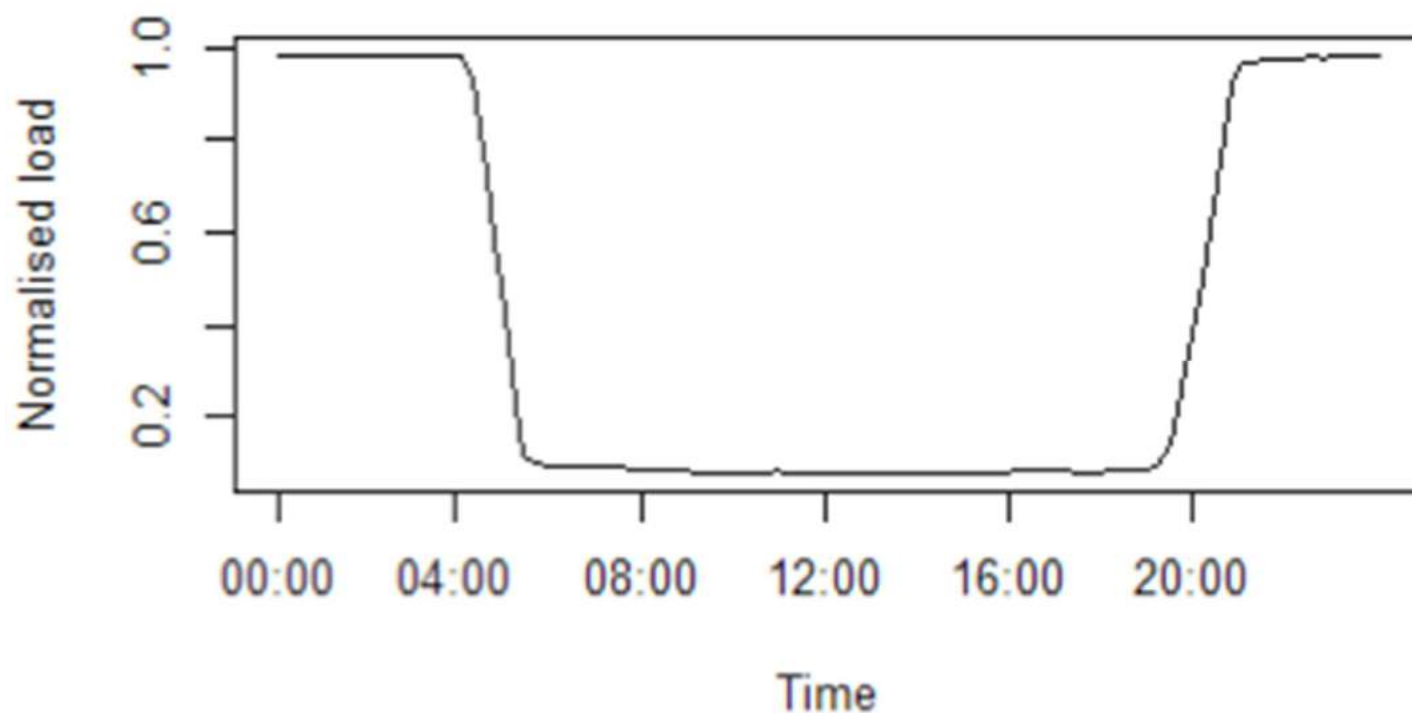
Low Voltage Templates

Cluster 5: High Domestic Dominance (~90%) (Low Customer Size ~70)

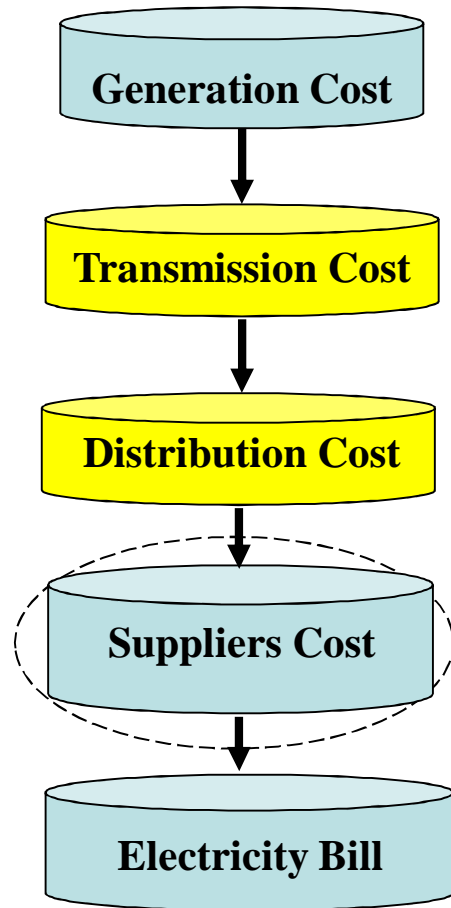


Low Voltage Templates

Cluster 10: Any thoughts?



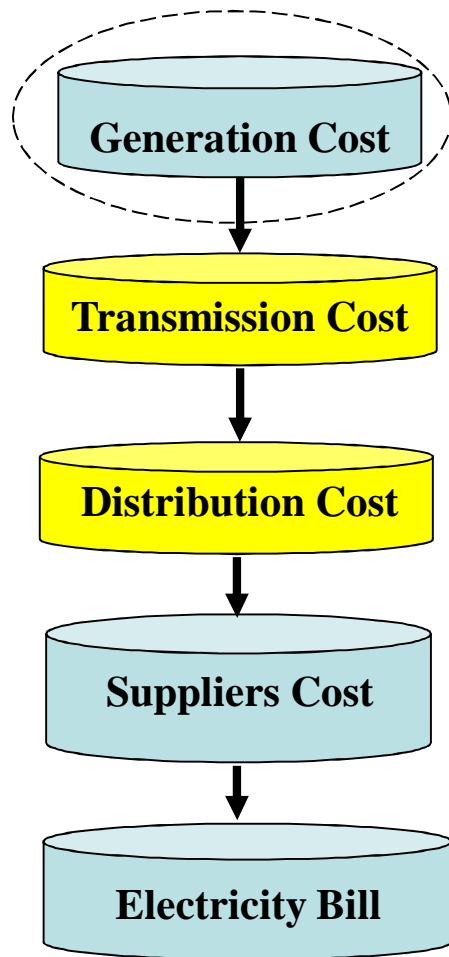
Innovations in Future Development



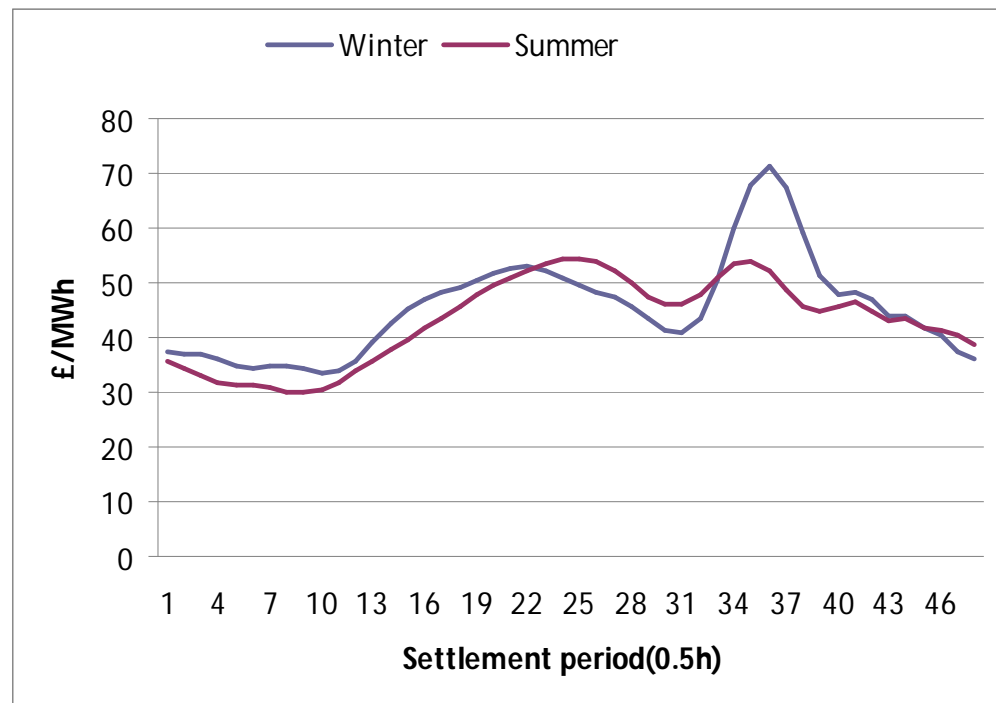
4. Innovations in supply



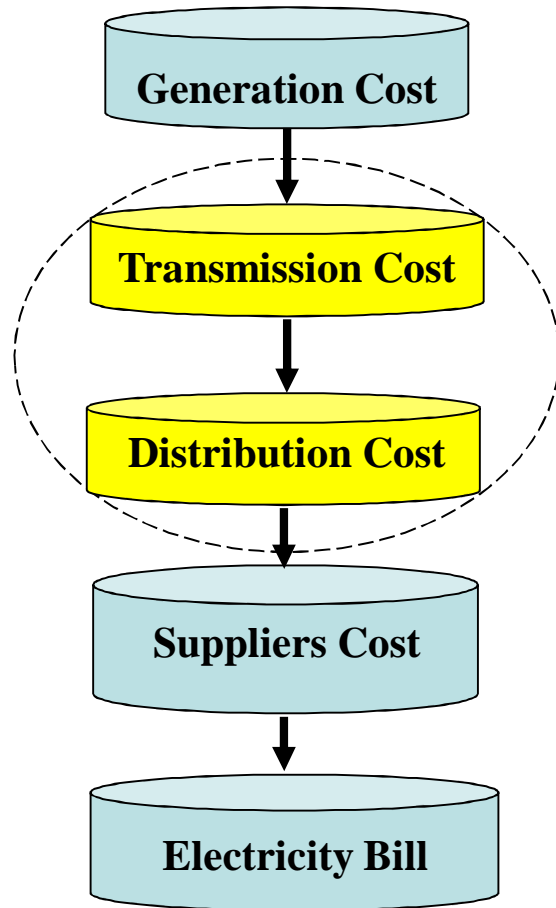
Price Variations in Generation



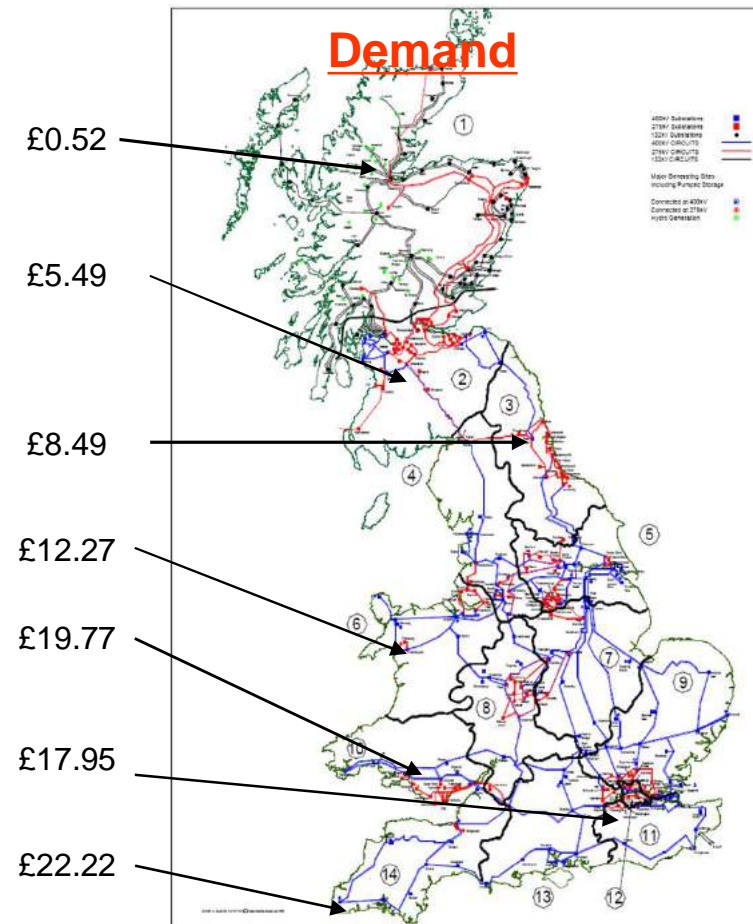
Vary with time



Price Variations in Networks

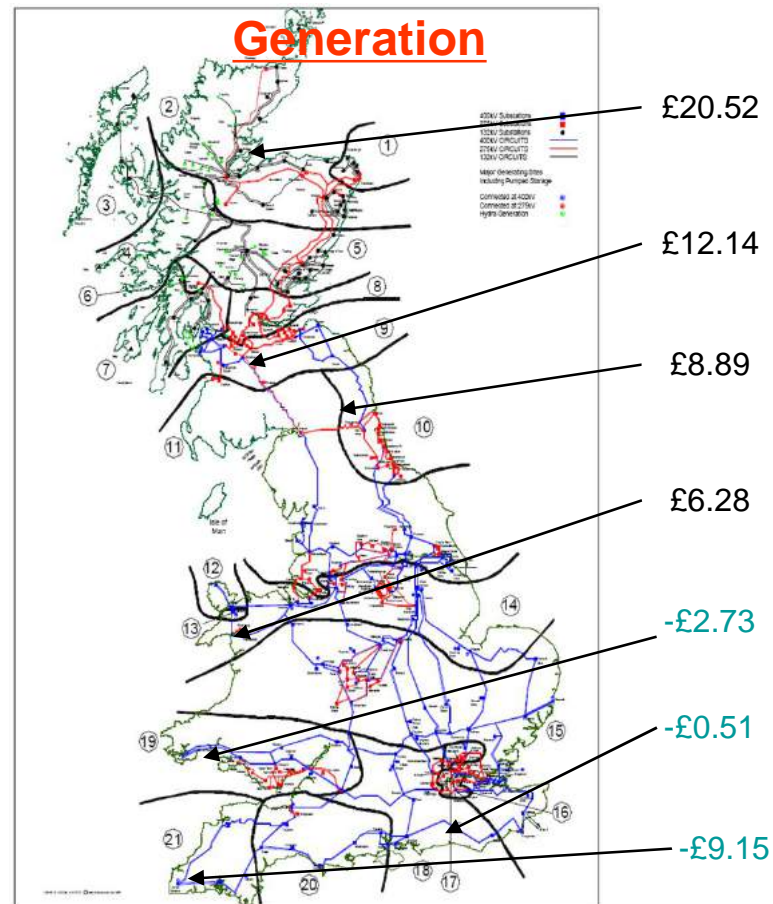
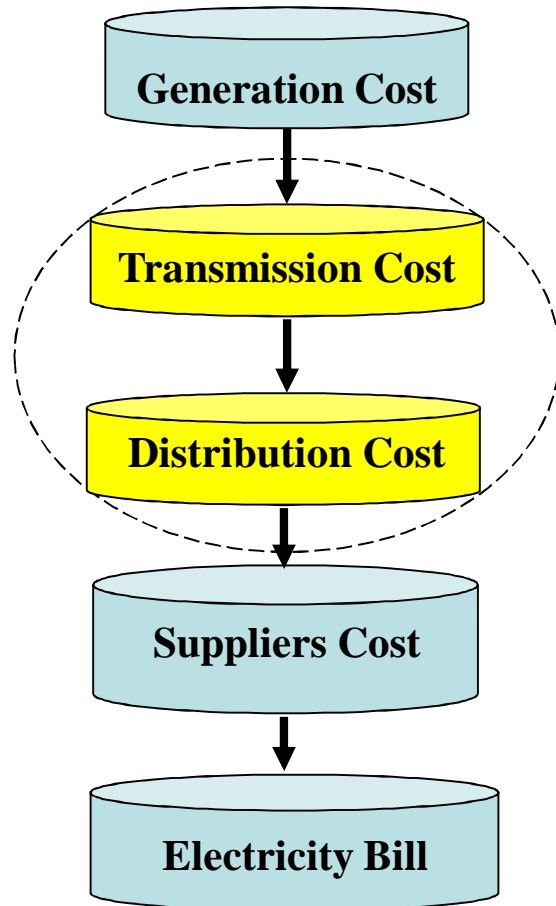


Vary with location

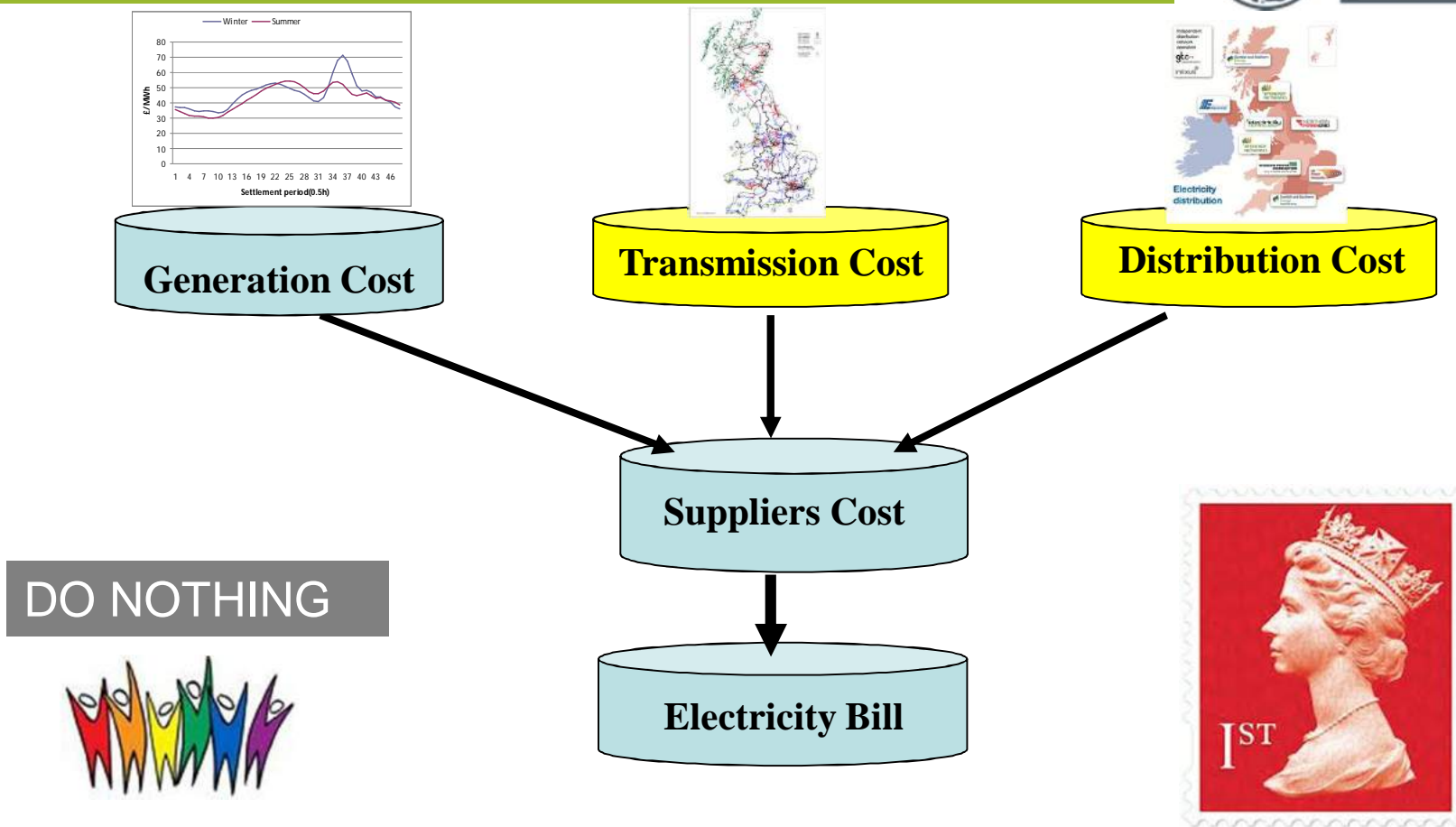


Price Variations in Networks

Vary with location



Tariffs for Domestic Consumers in 2012



Domestic unrestricted

17 pence/KWh

Domestic Tariffs in 2012

Victorian are far Superior

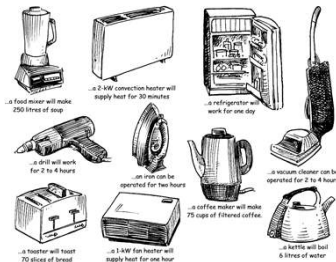
Domestic Tariffs in 1916



Lighting

Peak Demand

2 pence/KWh



Heating
Cooking

Off-Peak
Demand

0.6 pence/KWh



Vehicle
charging

Super Off-Peak
Demand

0.2 pence/KWh

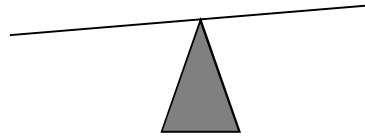
Victorian do not have smart meters

Role of Suppliers - Interface

Simplicity

System Needs

- i) energy surplus/deficit
- ii) network congestions
- iii) system frequency
- iv) local voltage
- v) reliability of supply
- vi) defer Generation, Transmission and Distribution investment



Simple

**Energy
Choices**



Electricity
Supplier



Sophistication

Proxy

Sophistication

Customer Needs and Response Capability

- i) Time of use
- ii) Type of use
- iii) Willingness to pay
- iv) willingness to be interrupted
- v) respect individual's lifestyle



Customers

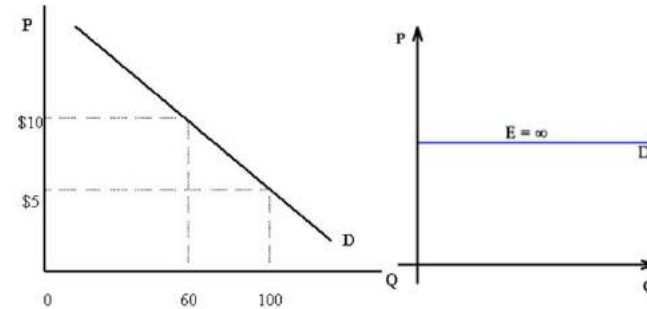
Carry on Regardless Very Expensive



Low tolerance to interruptions



No alternative



Low price elasticity



High tolerance to price rise

Role of Customers

Prosumers = Producers + Consumers



Putting local
communities at the
heart of energy use

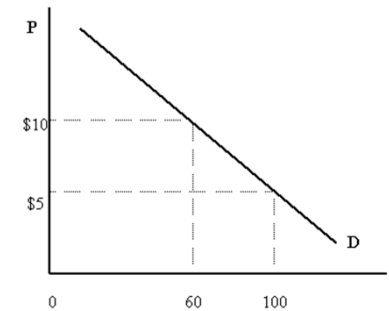


Cost and Value

Willingness to pay Willingness
to be interrupted



High Tolerance to
Supply Interruptions



High Price Elasticity



Alternative

Menu for Big Savings



Short-term



Long-term

Energy choices
and options with
clear “to do”
messages

How to substantially
reduce future
electricity bills?

Making informed
decisions



Medium-term



Vision of a Low Carbon Future (1879)



The state of society in 1880s

"We degrade a large population to the most loathsome labour in the pits.

We consume and poison the air, we load it with such quantities of smoke that the sun is barely visible."



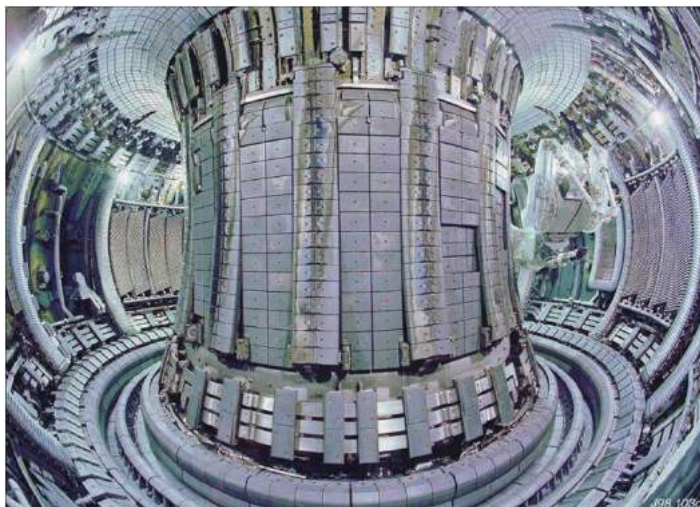
The low carbon future in 1880s

"Large steam engines will for a long time remain, small ones will be superseded

Gas will supersede the crude burning of coal for cooking and warming purposes, and a smokeless millennium will set in."



Vision of a Low Carbon Future (2013)



Nuclear fusion



Multi-functional domestic
prosumers



Wireless smart grid



Self-sufficient communities