European Electricity Markets Structure and Trading

Phase II: Wholesale Competition and Crossborder Trade

Modelling and Managing Competitive Electricity Markets

30 September – 3 October 2003

John Bower

Overview

European electricity market overview

The Directive and retail supply competition

Unresolved regulatory issues

BREAK

Issues in transmission economics

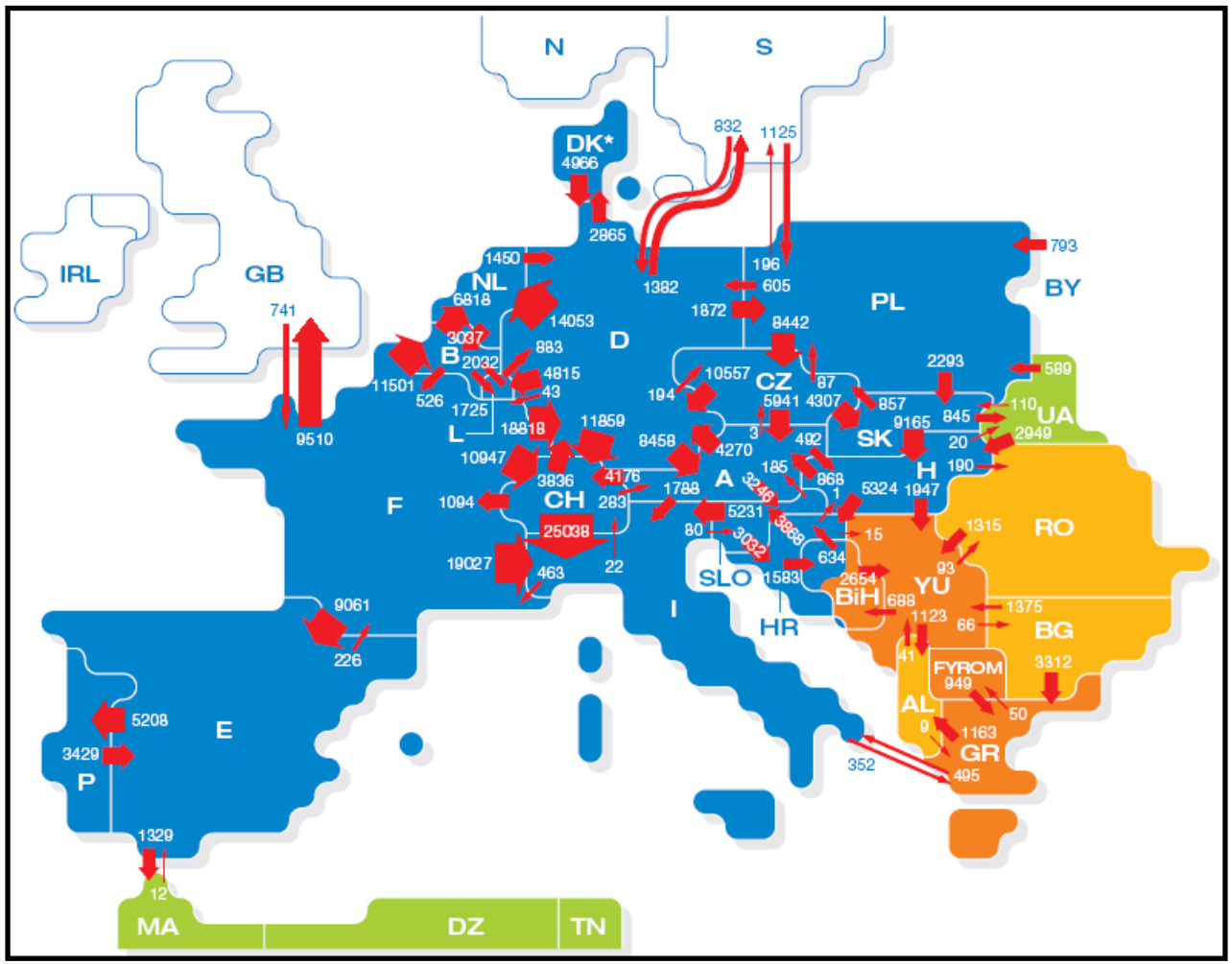
Measuring market integration

Case study briefing

Issues in transmission economics

EC wants cross-border trade to increase competition between national generators but…

UCTE PHYSICAL ELECTRICITY FLOWS (MWh) IN 2002

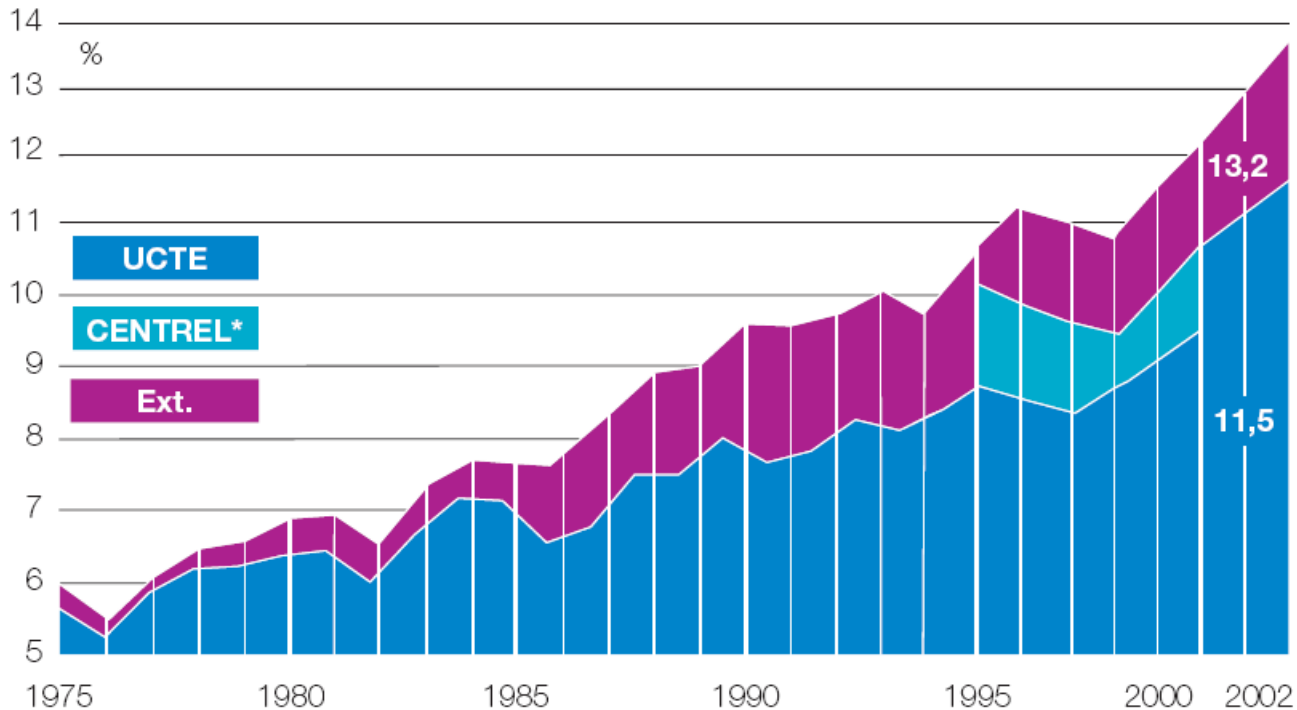


Source: UCTE

Issues in transmission economics

…. says import/export trade is hindered by lack of cross-border transmission capacity

IMPORT/EXPORT PERCENTAGE OF NET ELECTRICITY CONSUMPTION IN 2002



UCTE = Sum of exchanges between the UCTE countries

CENTREL = Sum of exchanges between the UCTE countries and CENTREL

Ext. = Exchanges with third countries

Source: UCTE Memo 2002

Issues in transmission economics

US administration aims to facilitate transmission investment via market based solutions …

US TRANSMISSION INVESTMENT POLICY (NTGS 2002)

"Our objective is simple: to provide our citizens with a reliable supply of electricity at the lowest possible cost,…."

"We will work to unleash innovation and strengthen our markets to allow entrepreneurs to develop a more advanced and robust transmission system that meets growing energy demand in the years ahead."

Secretary of Energy Spencer Abraham (remarks before the Secretary of Energy Advisory Board (SEAB) public meeting)

… the Nation's outdated transmission system was not designed to support today's regional, competitive electricity markets. Investment in the transmission system has not kept pace with the growth in generation and the increasing demand for electricity. Transmission bottlenecks threaten reliability and cost consumers hundreds of millions of dollars each year.

US Department of Energy press release comment on *National Transmission Grid Study 2002*

Issues in transmission economics

… while the EC takes a much more centrally planned view …

EU TRANSMISSION INVESTMENT POLICY PROPOSAL

"The effects of (such) congestion on the internal market are self-evident. The current level of interconnector availability when combined with the method of allocation has tended to lead to maintenance of retail price differentials between markets."

"…. action at the Community and Member State level is vital to resolve bottlenecks, or ensure the construction of "missing links", that industry alone will not address."

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND COUNCIL: European Energy Infrastructure

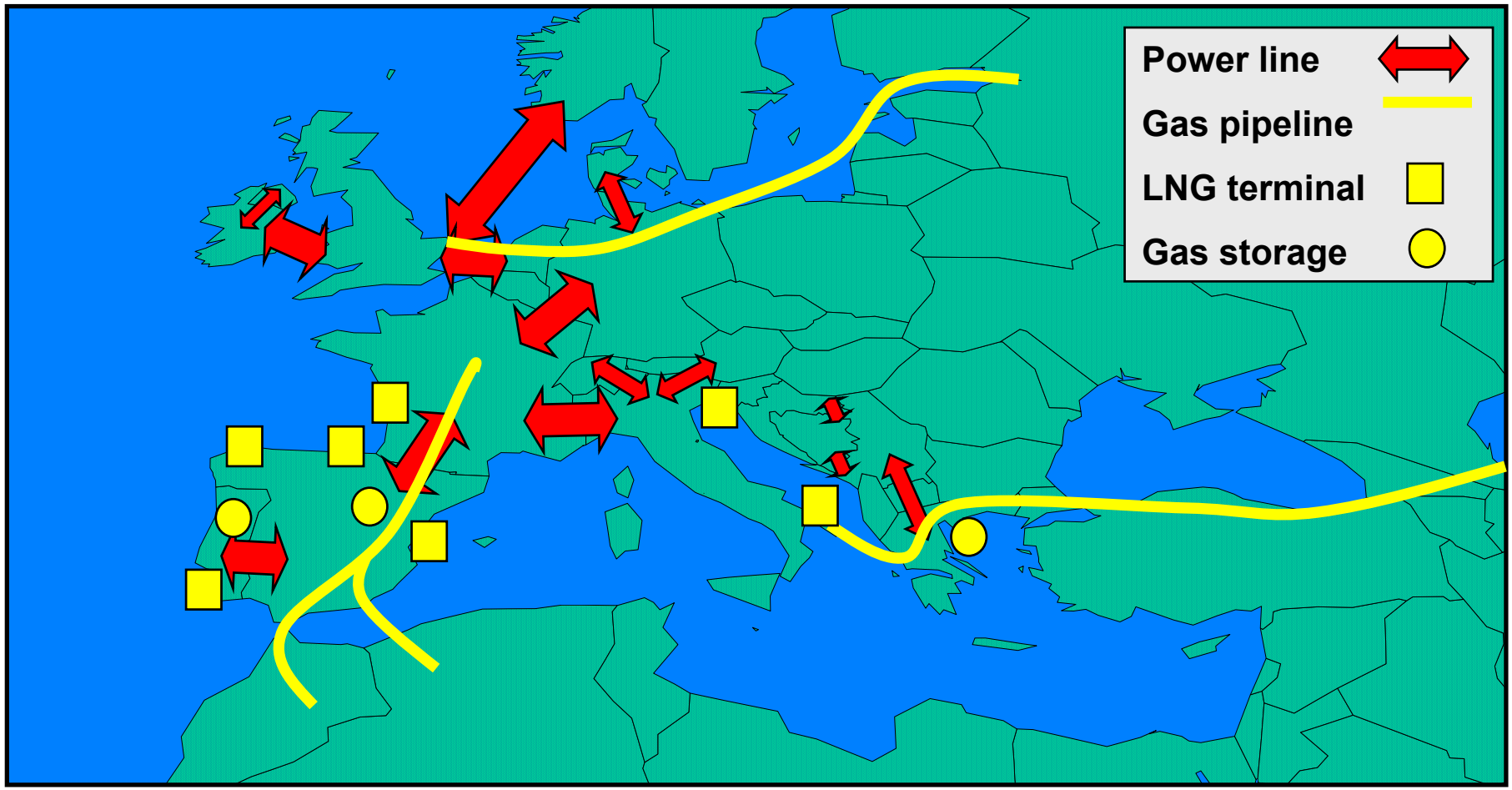
"In addition to focussing EU political support via the TEN (Trans European Network) programme, the maximum level of possible Community co-financing is a proposed increase from 10% to a ceiling of 20% of total investment costs for Priority Projects of European Interest."

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND COUNCIL: Proposal amending Decision No 1254/96/EC laying down a series of guidelines for trans-European energy networks (to Barcelona European Council March 2002)

Issues in transmission economics

… identifying 7 priority axes for electricity (5 for gas) encompassing 67 (15) projects…

TENS INTERCONNECTOR PROJECTS OF COMMON INTEREST



Issues in transmission economics

… and proposing to subsidise investment to complete Internal Electricity Market (IEM)

PROPOSALS ADOPTED BY BARCELONA EUROPEAN COUNCIL (MARCH 2002)

1. Increase retail electricity market competition to 60% of demand by 2005

2. Full financial (not legal) separation of generation, transmission, distribution, supply

3. Encourage mechanisms to compensate TSOs for loop flow in transit countries

4. Encourage mechanisms to allocate scarce capacity on congested cross-border routes

5. Electricity interconnections to equal 10% of demand for each member state by 2005

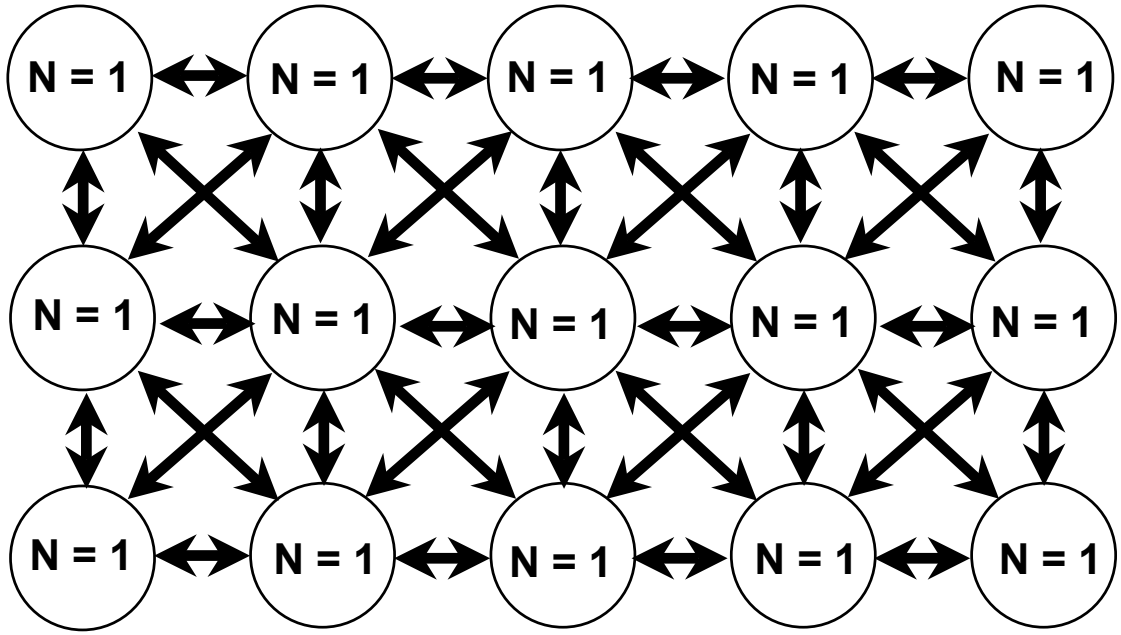
7. Identify 7 electricity transmission priority axes (~ 67 projects) of European interest

8. Subsidise building transmission lines on axes up to 20% from central EU funds

Issues in transmission economics

Aim is to make national monopolies/oligopolies face one perfectly competitive IEM…

NATIONAL MONOPOLIES: WITH CROSSBORDER TRANSMISSION CAPACITY



P = Price k = Marginal Cost = 20 A = Constant = 50000 E=Elasticity = 50

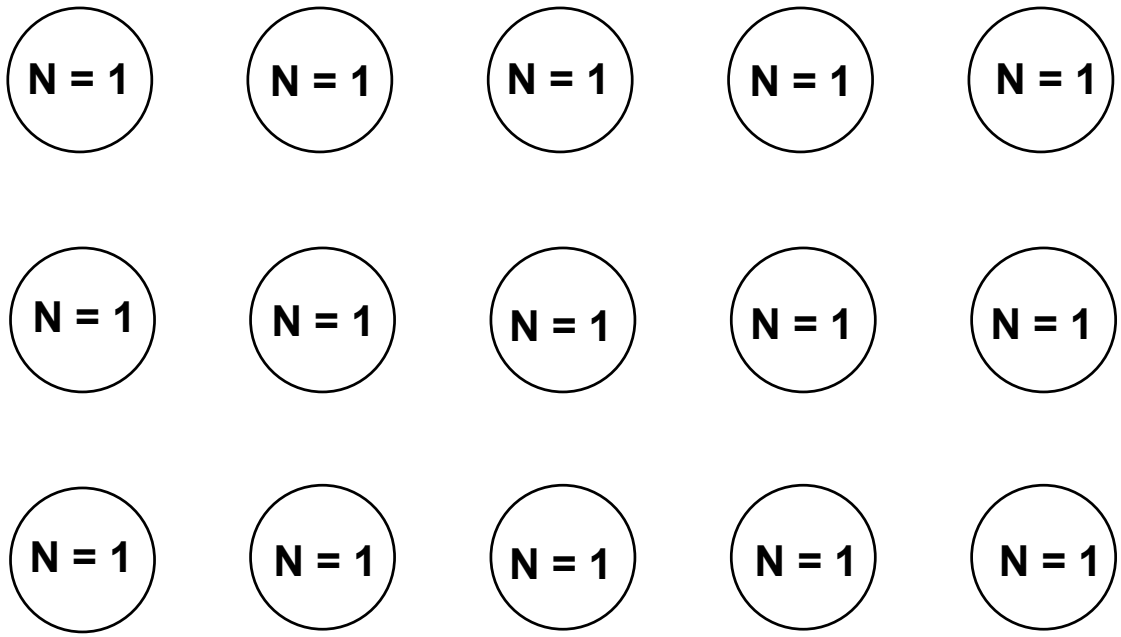
*Capacity on each Transmission Route = **50000** Net Flow Between Countries = **0***

$$P_{competitive} = 20$$

Issues in transmission economics

… rather than 15 imperfectly competitive largely isolated national markets

NATIONAL MONOPOLIES: WITHOUT CROSSBORDER TRANSMISSION CAPACITY



P = Price k = Marginal Cost = 20 A = Constant = 50000 E=Elasticity = 50

*Capacity on each Transmission Route = **0** Net Flow Between Countries = **0***

$P_{monopoly} = A/2E + k/2 = 50000/(2*50) + (20/2) = 510$ $P_{regulated} = 50$

Issues in transmission economics

Difference in power price between pairs of locations equals theoretical transmission cost

FUNDAMENTAL NO ARBITRAGE RELATIONSHIP

$$T_{ij} = P_i - P_j$$

Where:

T_{ij} = Transmission Cost between locations *i* and *j*

P_i = Power Price at location *i*

P_j = Power Price at location *j*

$$T_{ij} = T_{Cij} + T_{Lij}$$

Where:

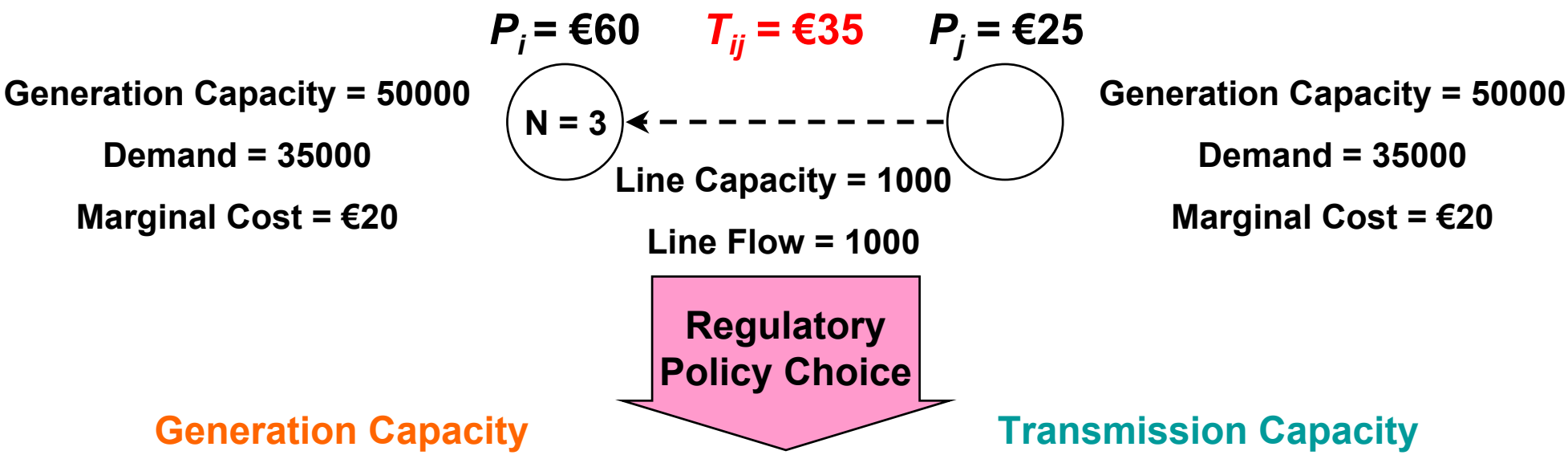
T_{Cij} = Congestion Charge between locations *i* and *j*

T_{Lij} = Transmission Loss between locations *i* and *j*

Issues in transmission economics

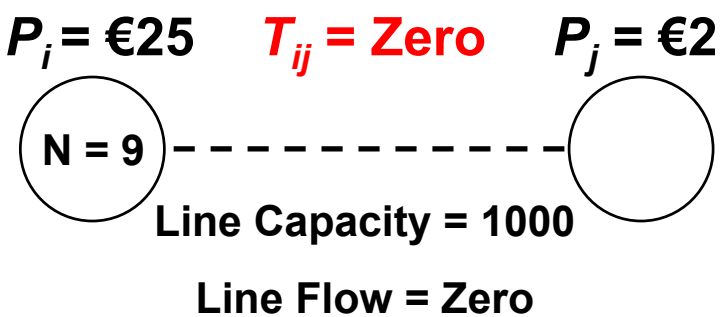
Transmission is not congested if prices in a pair of market locations are equal

EQUIVALENT COMPETITIVE OUTCOMES

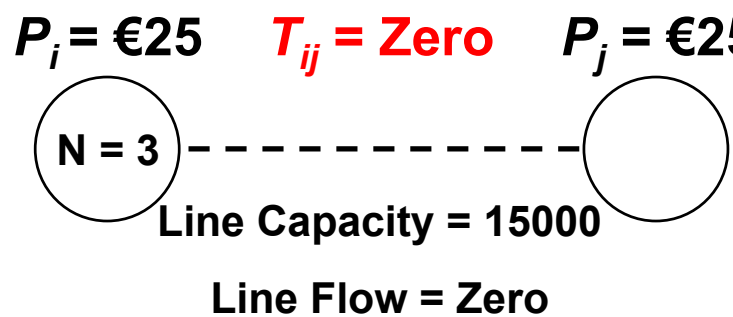


Regulatory Policy Choice

Generation Capacity Divestment



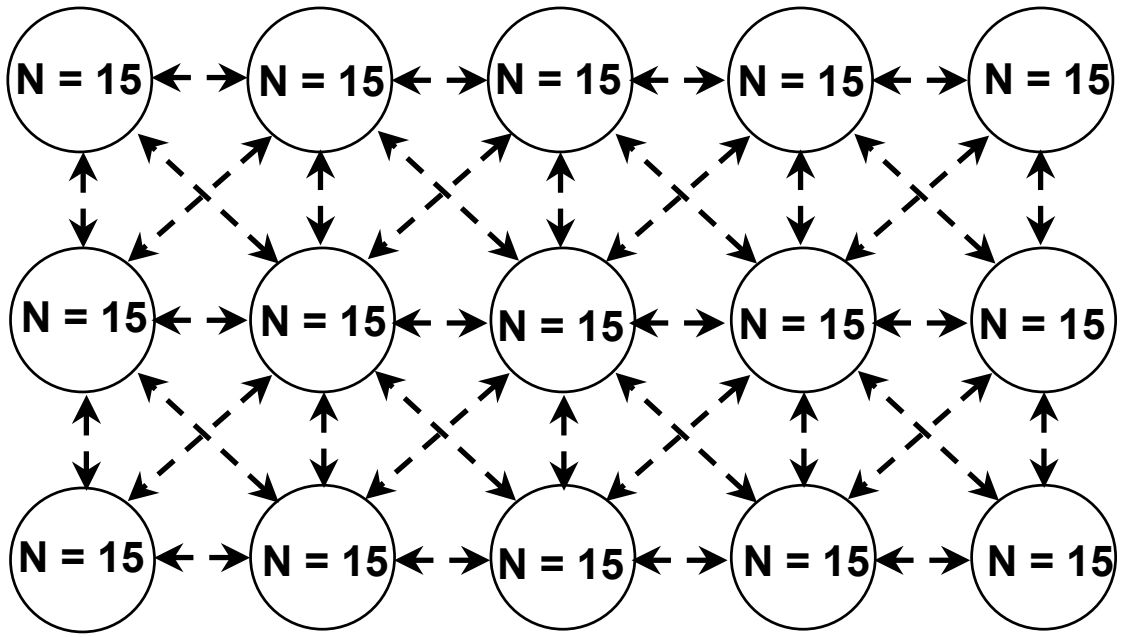
Transmission Capacity Investment



Issues in transmission economics

EC need not subsidise investment if it breaks up dominant firms to increase competition

COMPETITIVE MARKETS: EXISTING CROSSBORDER TRANSMISSION CAPACITY



P = Price k = Marginal Cost = 10 A = Constant = 50000 E=Elasticity = 50

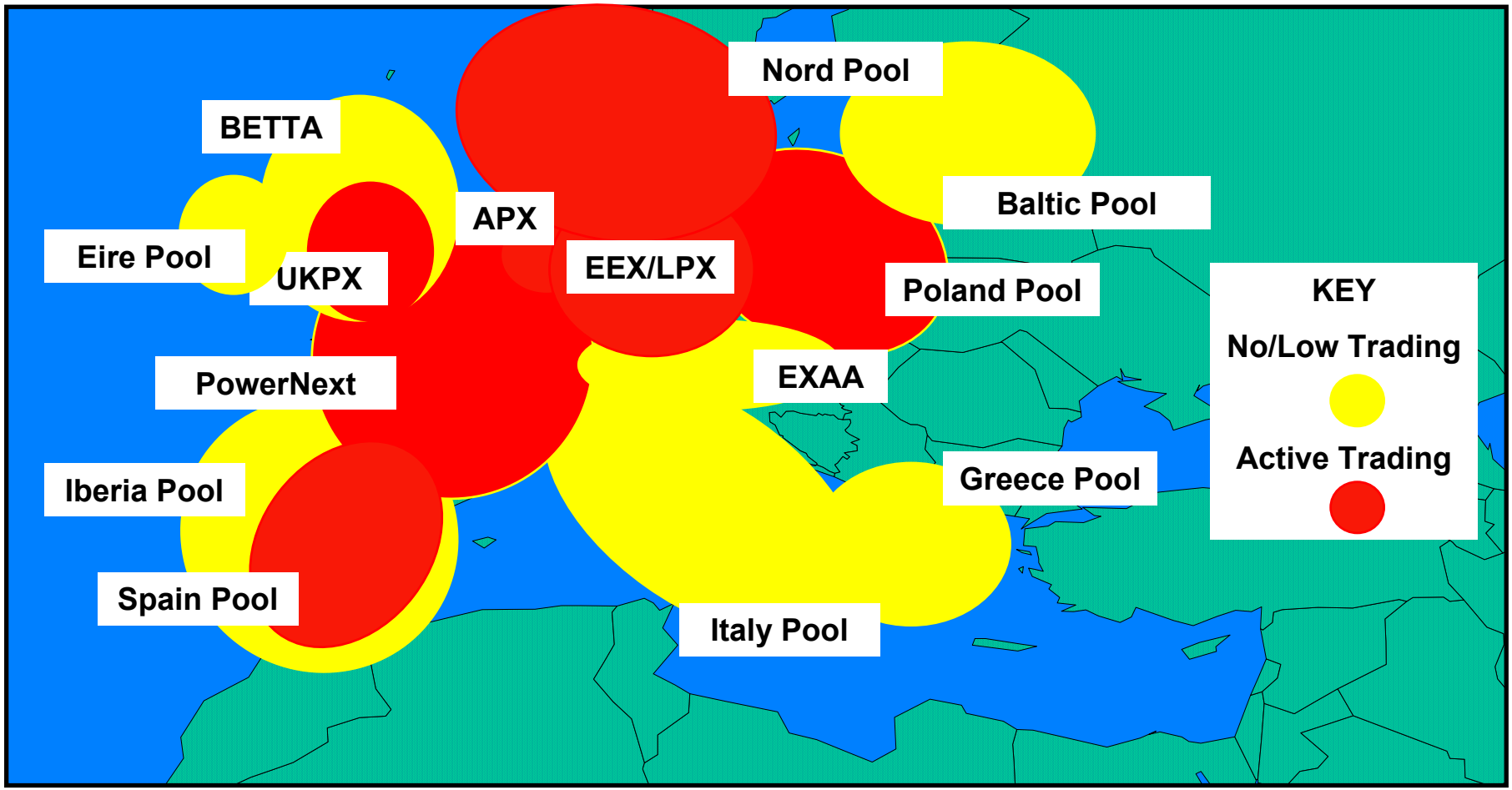
*Capacity on each Transmission Route = **1000** Net Flow Between Countries = **0***

$$P_{competitive} = 20$$

Measuring market integration

Reliable exchange traded day-ahead wholesale prices became available in 2001…

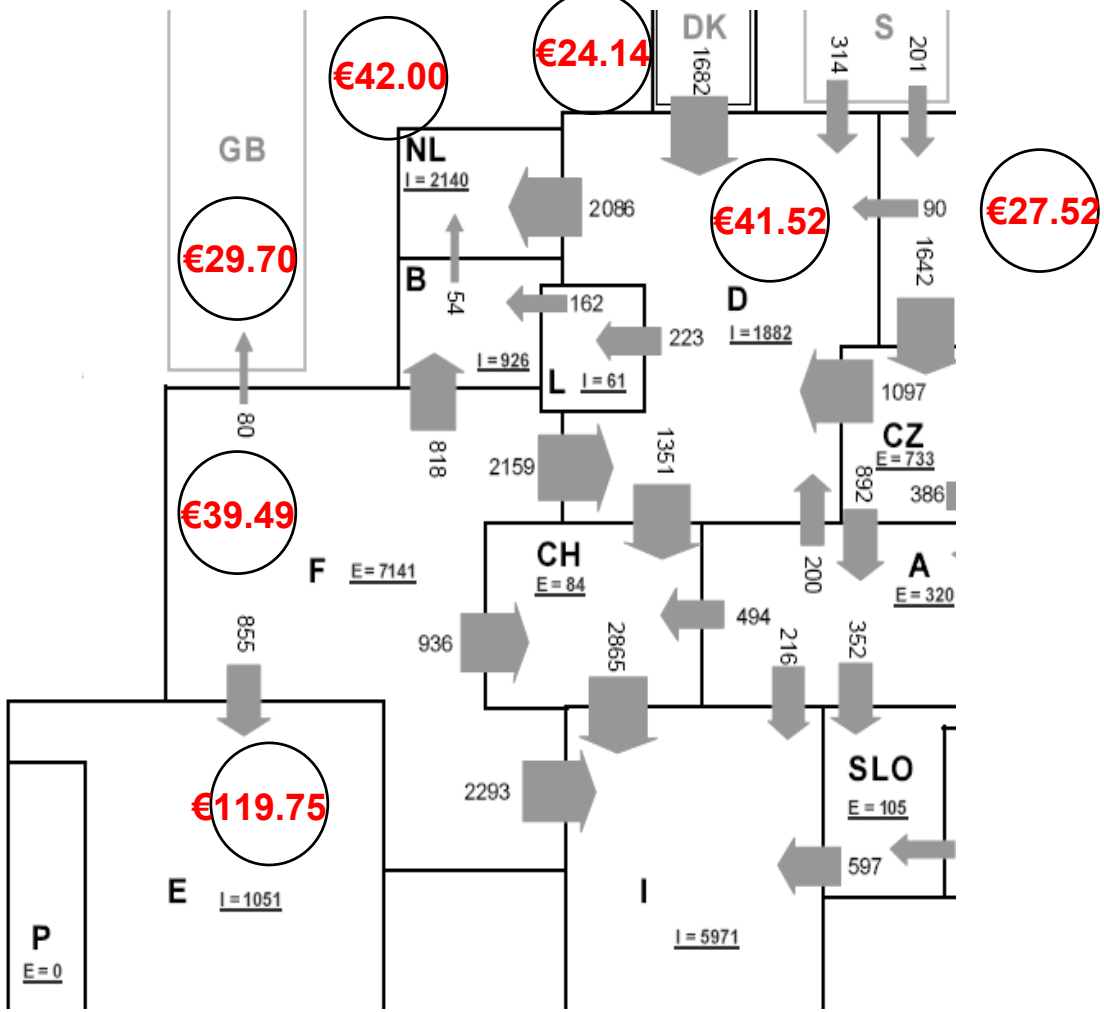
DELIVERY LOCATIONS FOR EUROPEAN ELECTRICTY EXCHANGES IN 2002



Measuring market integration

… combined with UCTE power flows allows wholesale market integration to be studied

POWER FLOWS AND DAY-AHEAD PRICES (16 JAN 2002 11.00 CET)

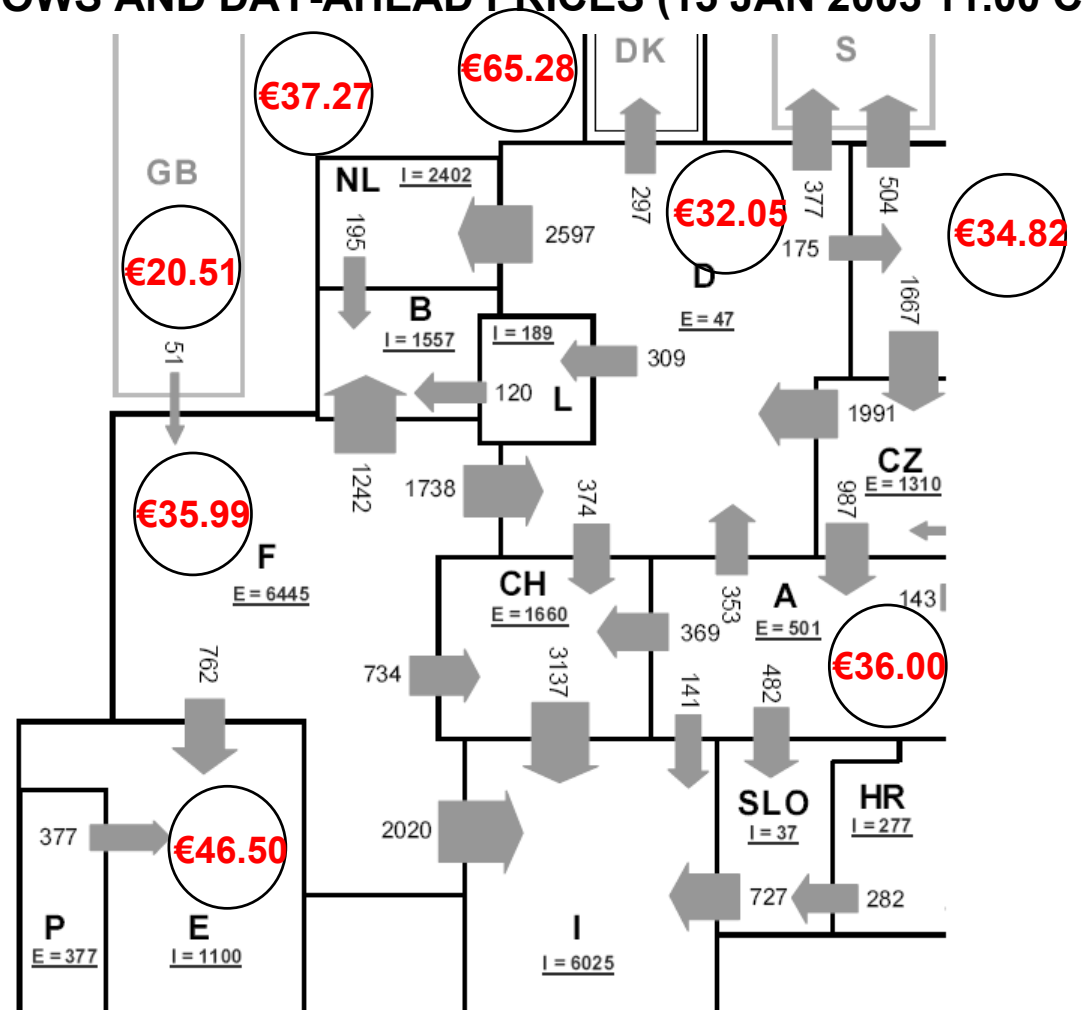


Source: UCTE and power exchanges

Measuring market integration

Shows persistent (NL-DE and ES-DE) and temporary (DE-NO) locational price differences

POWER FLOWS AND DAY-AHEAD PRICES (15 JAN 2003 11.00 CET)



Source: UCTE and power exchanges

Measuring market integration

Single European electric market exists but market power raises prices in some locations

WHAT IS REALLY HAPPENING?

1. Price differences in retail markets do not necessarily reflect wholesale price differences

2. Arbitrage should equilibrate prices in pairs of locations with no transmission constraints

3. Physical flows will be zero if prices in a pair of locations are equal

4. Cost of transmission should equals price difference between a pair of locations

5. Transmission constraints appear if pairs of locational prices are not equal

6. Generator market power (NL-DE and ES-DE) and vertical integration cause constraints

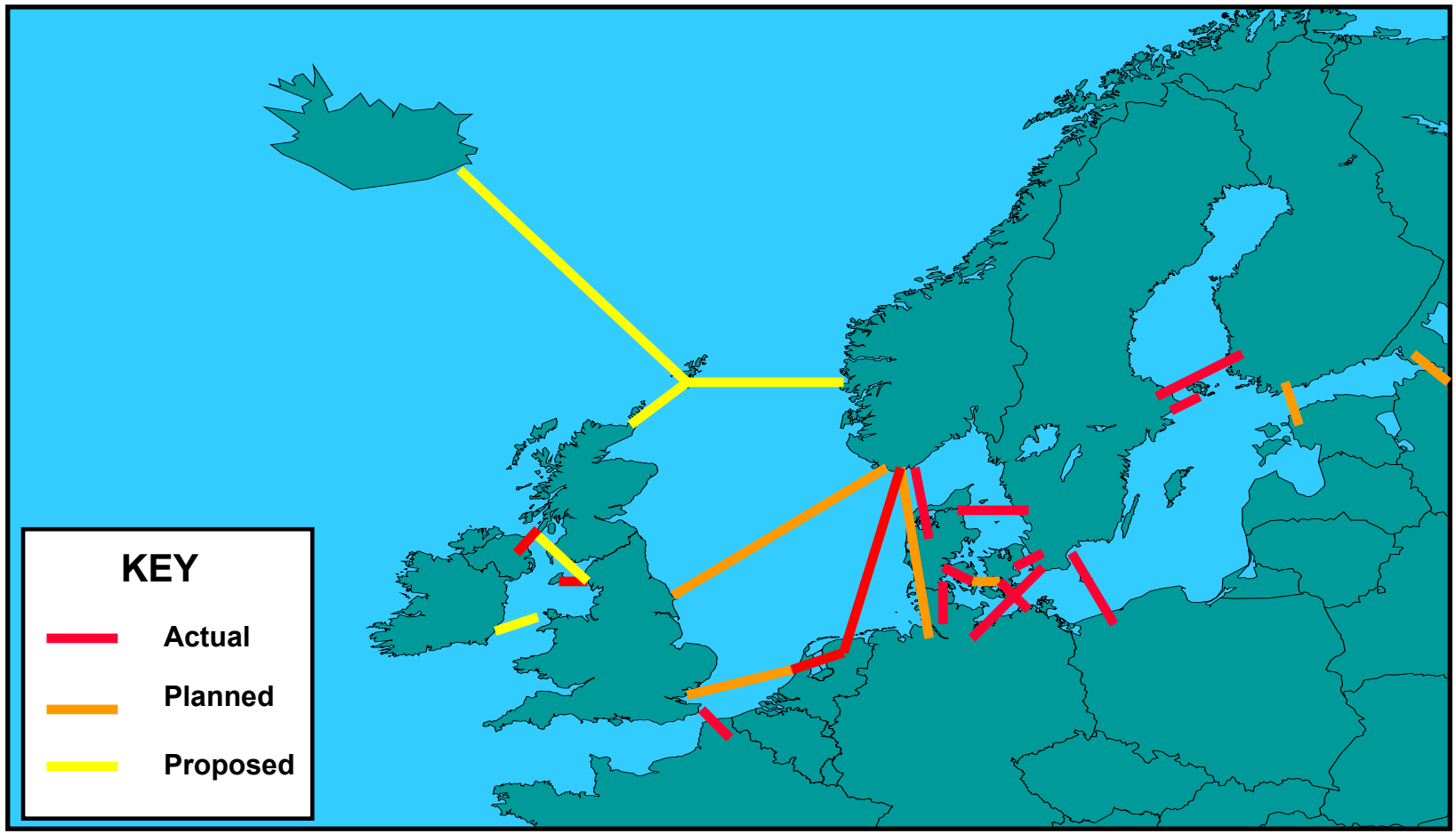
7. Transaction cost and ETSO tariff of €2-3/MWh partly responsible for differentials

8. Transmission trading mechanisms still evolving so arbitrage is inefficient

Case study briefing

DC cable links UK–France but is UK–Norway or UK–Netherlands cable viable?

DC INTERCONNECTORS IN NWE ELECTRICITY MARKET



Case study briefing

Alternating current (AC) is the transmission method used within interconnected grids

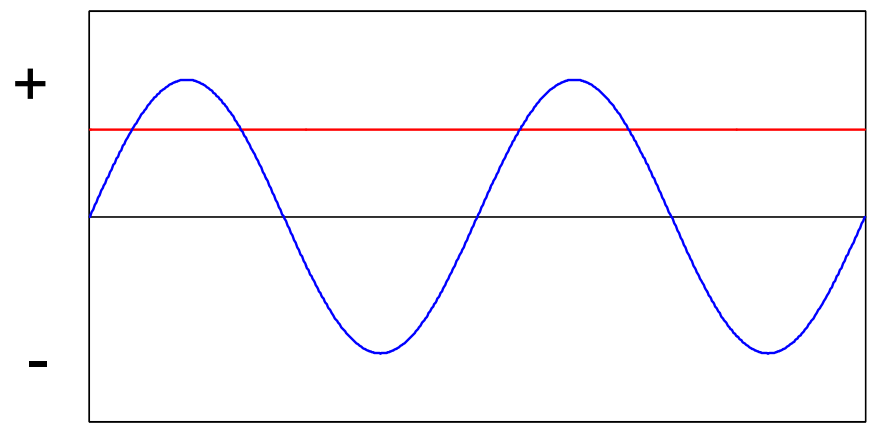
AC VS DC TRANSMISSION CHARACTERISTICS

Direct Current

- **DC** the type of power that typically comes from a battery
- **AC** the type of power that typically comes from a household plug

- **DC** flows in one direction in the circuit
- **AC** flows first in one direction then in the opposite direction in the circuit

- **DC** voltage has a fixed polarity
- **AC** voltage switches polarity back and forth



Case study briefing

Direct Current has a number of advantages and is mainly used to connect between grids

DC TRANSMISSION ADVANTAGES AND DISADVANTAGES

- **Advantages**
  - Can be used to connect large AC systems but do not need to synchronise them
  - Can be used to interconnect large AC systems on different frequencies
  - Move power over longer subsea distances than AC (limit is 45km)
  - Long overland routes at higher power than AC with towers / insulators less expensive
  - Lower cable costs than AC as it uses ground as one circuit
  - Transmission losses are lower as well as EMR emissions than AC
  - Easy to control current flows than AC and no loop flow problem
- **Disadvantages**
  - Thyristor (converter) stations at each end are expensive compared to AC substations
  - Filters required to ensure acceptable waveforms on AC side
  - Limited multiterminal DC networks because no acceptable DC circuit breakers

Source: Partly drawn from Weedy, B.M., Cory, B.J. (1998) “Electric Power Systems” Fourth Edition. Wiley

Case study briefing

No loop flow on DC lines means physical transit and contract path is identical…

UK – NORWAY NORTH SEA INTERCONNECTOR (NSI) PROPOSAL

- Biggest ever subsea interconnector (750km, 1200 MW, €1bn, complete late 2007)
- NGC / Statnett share construction cost and physical risks 50:50
- Statnett will recover some cost via a regulated 'security tariff' and some via market
- NGC share will be outside Ofgem regulation and take full 'merchant' risk
- Transit rights will be auctioned in regular tenders
- A secondary transit rights market market may develop to manage risk

Condemned by Norwegian National Audit Office as a waste and NGC yet to decide!

Case study briefing

… so UK-France DC link auction of transmission capacity has been relatively efficient

RTE-NGC AUCTION FOR CROSS-CHANNEL DC INTECONNECTOR SINCE 1 APRIL 2001

- Non-discriminatory access to the full Interconnector capacity (1996 MW) in both directions
- Capacity in the direction England to France will be sold through annual and daily auctions
- Capacity in the direction France to England will be available through three year contracts obtained through a competitive tender process and annual and daily auctions.
- Each auction will provide the facility to resell capacity acquired either in a previous auction, or under a three-year contract
- A “Use It or Lose It” principle will apply – any capacity not used will be resold by NGC / RTE.
- Compatible transit contracts across the RTE network will be available

Source: Full details of auction rules and results published on (www.nationalgrid.com/uk) and RTE’s (www.rte-france.com)

Speaker

John Bower is a Senior Research Fellow at the Oxford Institute for Energy Studies which is an independent research charity affiliated to Oxford University and dedicated to advanced research in the social science aspects of energy. John joined OIES in November 2001 and his research interest is in the emergence and evolution of integrated cross-border electricity and gas markets. Specifically; the development of efficient pricing and investment mechanisms for energy, transmission capacity, and emissions.

Before joining the OIES, John completed his PhD at London Business School and his previous career was in the commodity industry. His experience ranges from energy trading, at Marc Rich & Co, to risk management consultancy, with Coopers & Lybrand, advising commodity traders, producers and processors in base metal, precious metal, 'softs' and energy markets. Immediately prior to his PhD he was Global Controller Metals/Commodities at Deutsche Morgan Grenfell.

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