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# Smart Networks and the Future of Regulation


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E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

# *Outline*

- Context

- Smarter regulation? RIIO
- Smarter policy? EMR
- Smarter market mechanisms
- Smarter governance
- Smarter business models
- Smarter ideas

- Conclusions

# *My Background*

- *Work for Ofgem on RPI-X@20 Review*
- *Advising Consumers' Association on EMR*
- *CIGRE-UK group on offshore transmission*
- *Work for Ofwat on ISOs*
- *Research on Energy Services*
- *Research on Innovation*

# CONTEXT

# *The objectives of energy policy*

- The impossible trinity:
  - –Competitiveness
  - –Energy Security
  - –Decarbonisation

- The other ones:
  - –Elimination of (energy) poverty
  - –Renewables??
  - –Green jobs/economy/technology???

# *European Energy Policy Context*

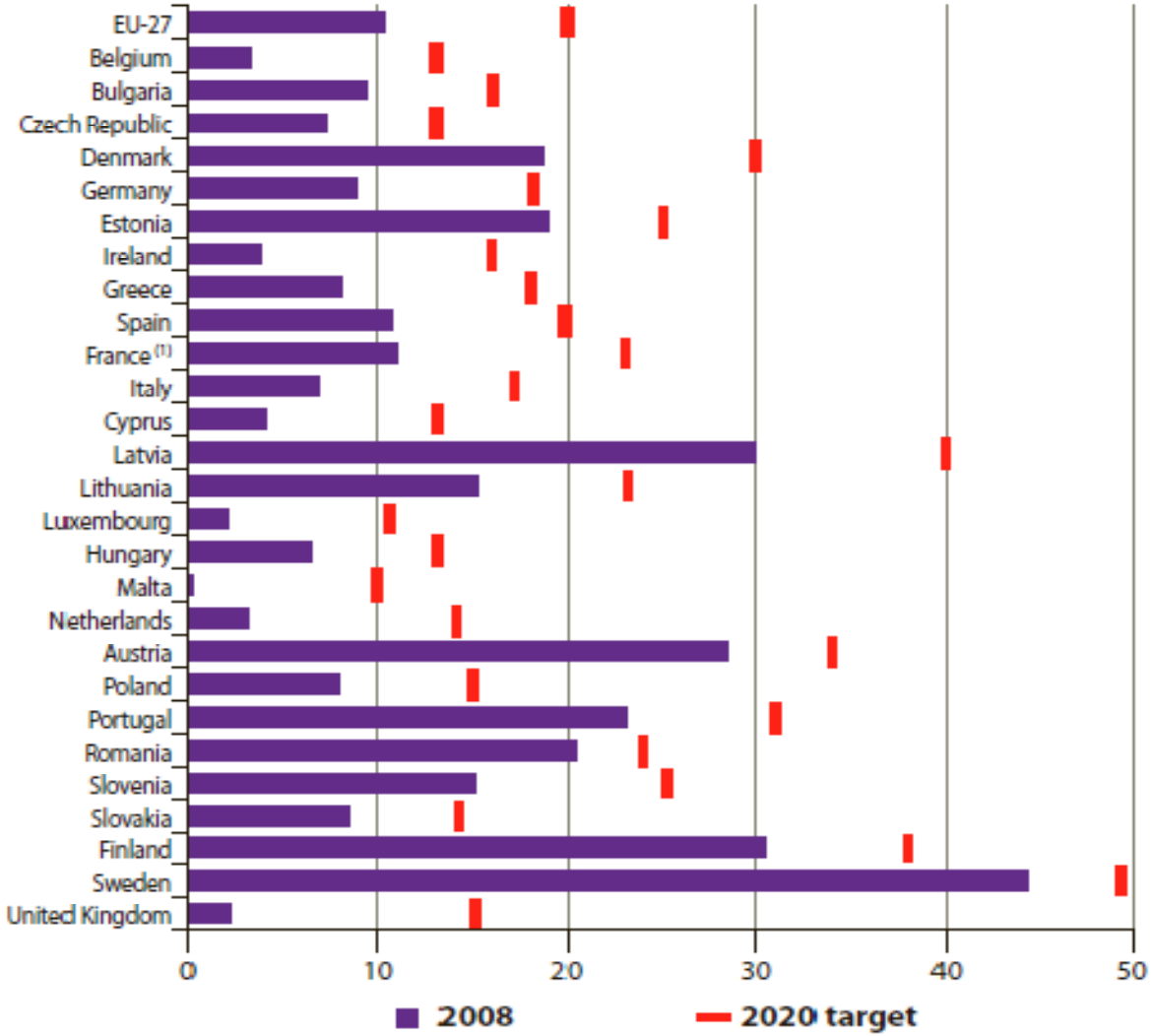
- 20-20-20 Targets for 2020:
- 20% reduction in CO2e (hard target)
- 20% renewable energy (indicative target)
- 20% reduction in energy intensity (aspirational target)

- Completion of Electricity and Gas markets (3rd Energy Package)

- Energy Security Directive, Energy Services Directive etc…

- Reality of patchy implementation

# EU Renewable Energy Targets




(1) "France métropolitaine", excluding the four overseas departments (French Guyana, Guadeloupe, Martinique and Réunion).

*Source:* Eurostat (Europe 2020 indicators — online data code: t2020_31)

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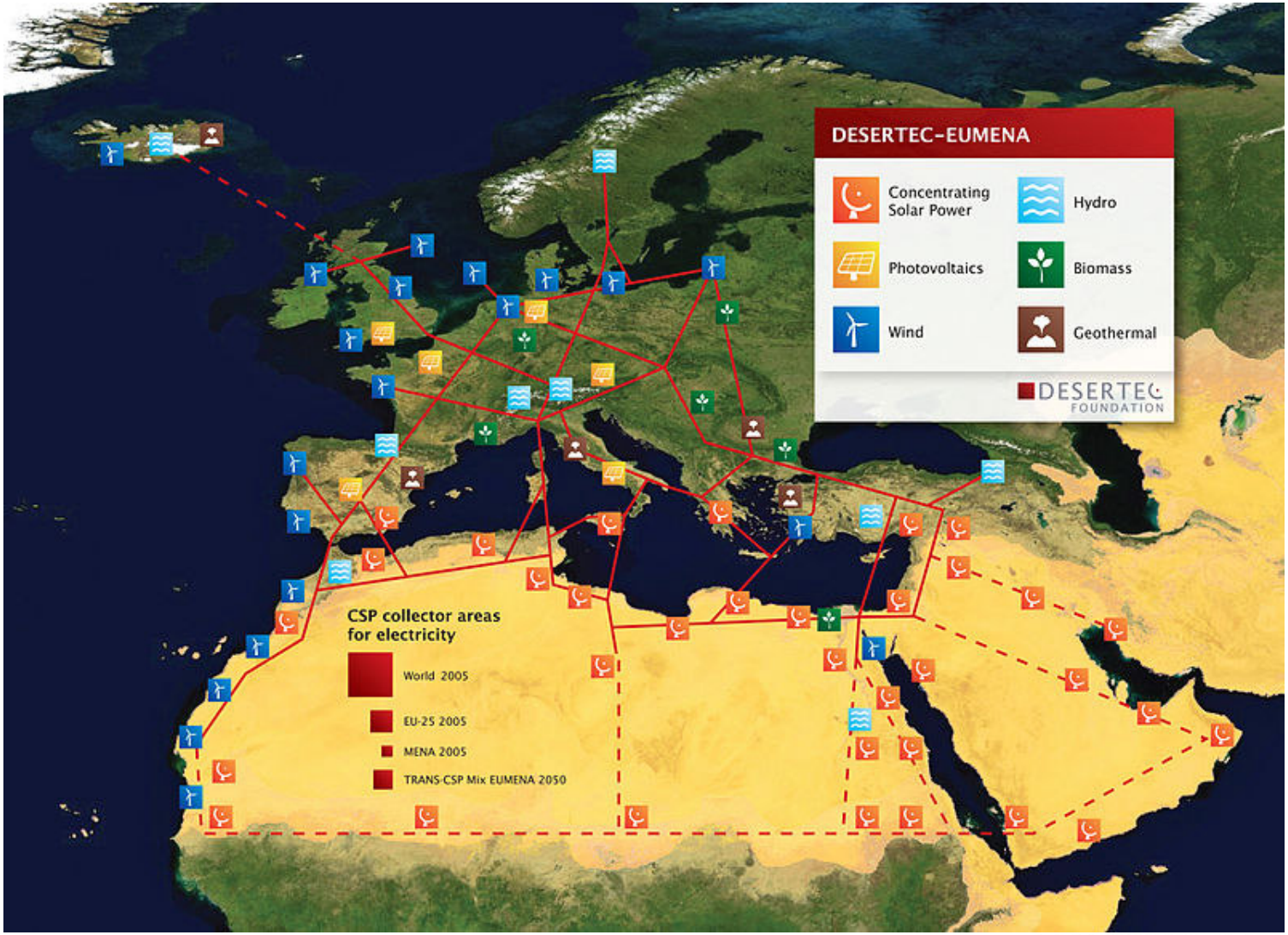
# A European Supergrid?




Source: http://www.desertec.org/fileadmin/downloads/press/DESERTEC-Map.zip

# SMARTER REGULATION:
# UK's RIIO

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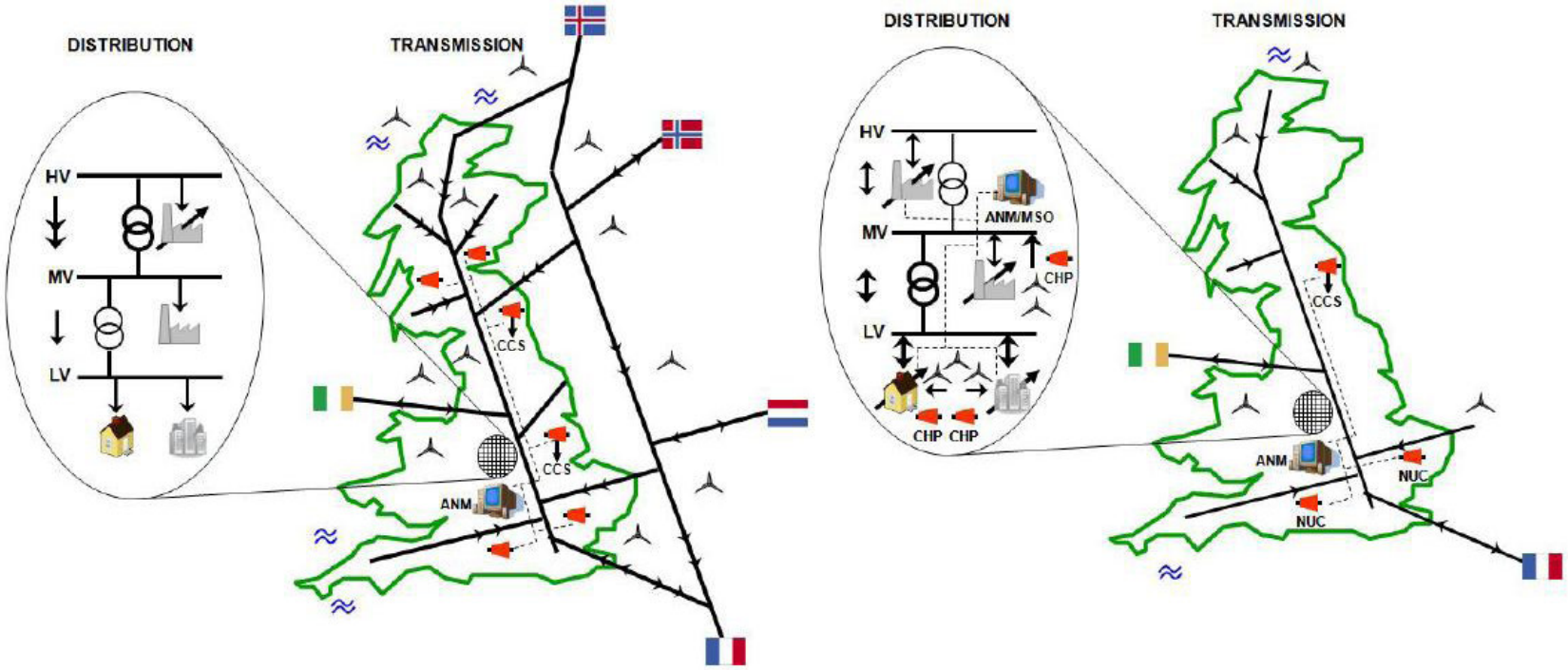
# An uncertain future – LENS




Big transmission and distribution

Micro-grids

See: Ault et al., 2008.

# *RPI-X@20 - Context*

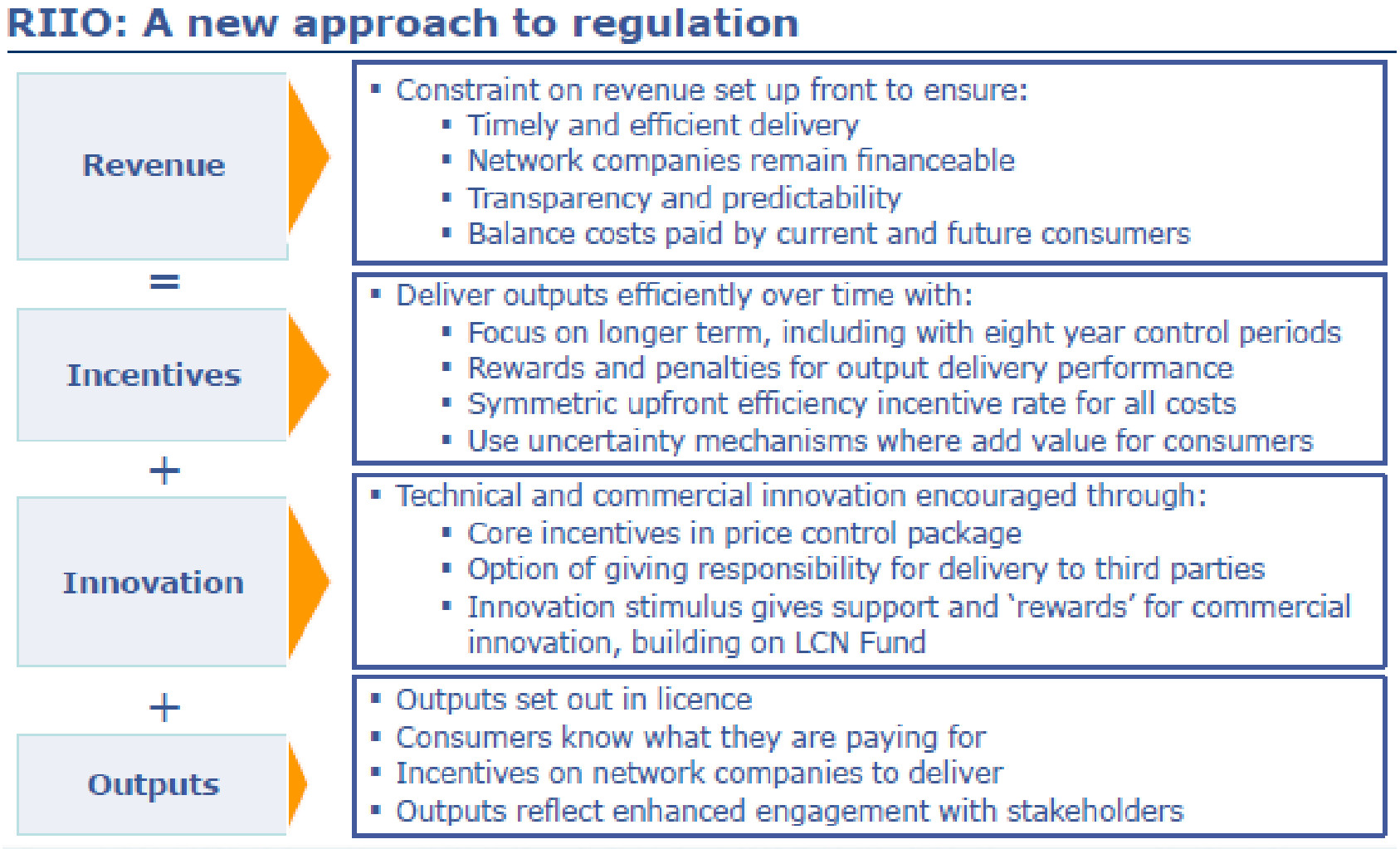
- Changing circumstances (Pollitt,08):
  - Investment needs rising (annualised):
  - Electricity distribution (+48%, 05-10 vs 00-05)
  - Electricity transmission (+79%, 00-05 vs 07-12)
  - Gas transmission (+23%, 02-05 vs 07-12)
  - Gas distribution (+30%, 02-07 vs 08-13)
- Network tariffs driven by capex not opex
- Network capex driven by subsidised renewables
- UK RPI-X@20 review areas (Ofgem, 09):
  - Customer Engagement
  - Sustainability
  - Scale and scope of innovation

# *RIIO vs RPI-X*

| | | |
|---|---|---|
| ▪ | **Goodbye** RPI-X | **Hello** RIIO (R is revenue, I is incentive, I is innovation is for output.) |
| ▪ | **Goodbye** 5 years | **Hello** 8 years |
| ▪ | **Goodbye** Poor customer involvement | **Hello** Customer Engagement |
| ▪ | **Not Revolution** but | **Evolution** – financial package gets worked through in real PCR's. |
| ▪ | **Commitment not to impair RCV** | Enables financial package to get support and introduction. |
| ▪ | **Great link to Discovery** | We are assisting in £40bn spend. |

Source: Ofgem City Briefing, July 2010, p.13.

# RIIO – Elements




Source: Ofgem City Briefing, July 2010, p.28.

# *Key elements and questions*

- Longer, potentially lighter price control
  - –Incentive properties ambiguous?
- Enhanced consumer engagement
  - –Did this go far enough?
- Wider definition of outputs
  - –How will these be determined?
- Enhanced innovation funding and incentives
  - –More competition/entry needed?
- Enhanced competition in delivery
  - –Role of tendering in lower costs?

# SMARTER POLICY:
# UK's Electricity Market Reform (EMR)

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# *(i) Low Carbon Generation*

The reform proposes the setting up of a system of contracts for differences (CFDs) whereby the government would contract with low-carbon generators to supply electricity at fixed prices for a prolonged period. These contracts would pay the generators the difference between the average wholesale price of electricity and the contract price.

# *(ii) Carbon Pricing*

The reform proposes the introduction of a carbon price support (CPS) based on the existing climate change levy (CCL). This would involve increasing the rate and coverage of the climate change levy to effectively increase the price of carbon emissions from the electricity sector in the UK above that in the rest of the EU.

(In 2011 budget £30/tonne by 2020)

# *(iii) Emissions Performance Standard*

Coal fired generation has average CO2 emissions of around 915g/kWh; a modern gas-fired power plant about 405g/kWh. The reform proposes an emissions performance standard (EPS) for all new power plants of either 600g/kWh or 450g/kWh, designed to rule out the building of new coal-fired power plants without carbon capture and storage (CCS) technology fitted.

# *(iv) Capacity Payments*

The reform proposes the introduction of a capacity mechanism (CM) to contract for the necessary amount of capacity to maintain security of supply. This would involve the introduction of payments to generators for maintaining availability, supplementing the market for units of electrical energy that exists at the moment. This deals with predicted low capacity margins by 2018.

# ***Proposed Reforms*** (Pollitt, 2011a)

- Capacity Markets ?
- Emissions Performance Standard ???
- Carbon Price Support YYY
- Low Carbon CFDs Y??

- Bill impacts:
  - Households: +33% by 2030
  - Businesses: +62% by 2030
  - Wholesale prices: +80% by 2024

# SMARTER MARKET MECHANISMS

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# *Rising T&D costs*

- Project Discovery *(Ofgem, 9/10/09, pp.94-5)*: E+G Distribution and Transmission investments in UK to 2025 are £47 to £53.4bn
- Electricity transmission and distribution charges rise £49-53 per customer (or 60%), more than proportionately.
- Offshore transmission alone could be £15+bn to 2020 (more than current onshore RAV).
- Cost of capital and competitive sourcing key.

# *Key questions for regulatory regime*

- What ensures network (T and large D) investments are necessary?
- What ensures network (T and large D) investments are delivered at least cost?

# *A competitive process*

- Still need a proposer of investments?
- Tendering processes expensive (vs regulation)
- May lead to duplication of assets
- Capital adequacy problems and non-delivery risks

# *Case 1: UK Offshore Transmission*

- 20 year contract, indexed to RPI, de-risked of actual energy flow and existence of wind park
- Round 1 and Round 2 tenders - transitional regime.
- Round 1, projects already built or being built. £1.1bn transfer value.
- Round 2, underway.
- Subsequent rounds - enduring regime originally intended (BFOO) or (FOO).

# *Lessons from Round 1*

- Lots of interest (£4bn vs £1.1bn).
- Low interest rates (19y debt, +200bps).
- Savings of £350m est.
- Potential for greater savings with DBOO.

# *The Future – more complex networks?*

- Offshore Auctions likely to work well for point-to-point transmission.
- Could have more complicated auctions (multi-criteria) auctions for radial links.
- No evidence of major benefit from meshed offshore networks (e.g. Morton et al. 06).
- Merchant links already being built offshore?
- Storage with renewables?

# *The Future –Allocating capacity?*

- Firm financial transmission rights (FTRs) exist for projects which have initiated connection.
- As more assets exist may be opportunities to sell access to new offshore generation projects.
- May need to have process for allocating unused transmission capacity (Nodal pricing?).
- Large amounts offshore generation raise issues on shore (Nodal pricing?) (see Leuthold et al., 05)
- ISO to do planning for offshore network development and have role in anticipating capacity?

# *Case 2: Merchant Interconnection* (Parail, 10)

- NorNed cable 700 MW.
- Investment in increments of 350MW.
- €11.5/MWh gives IRR of 10% for NorNed investment with a 20 year life.
- Estimated socially optimal capacity is 3,850MW.
- Lumpiness may stop the last 350MW investment.
- Difference between socially optimal and profit maximising interconnection capacity <10%.

# *Implementing Auctions?*

- Need to consider combinatorial (packages) / multi-criteria (different cost quality mix) auction (see Crampton et al., 2006) for radial network and interaction of this with ISO:
  - How would auction be designed?
    - Specified by ISO
    - Open ended bids
    - Information to be released at each stage
  - Who would run this auction?
  - How would it interact with ISO planning?
  - Fit with merchant international transmission links?
  - Need to run experimental auctions to test designs, preferably with informed participants

# SMARTER GOVERNANCE

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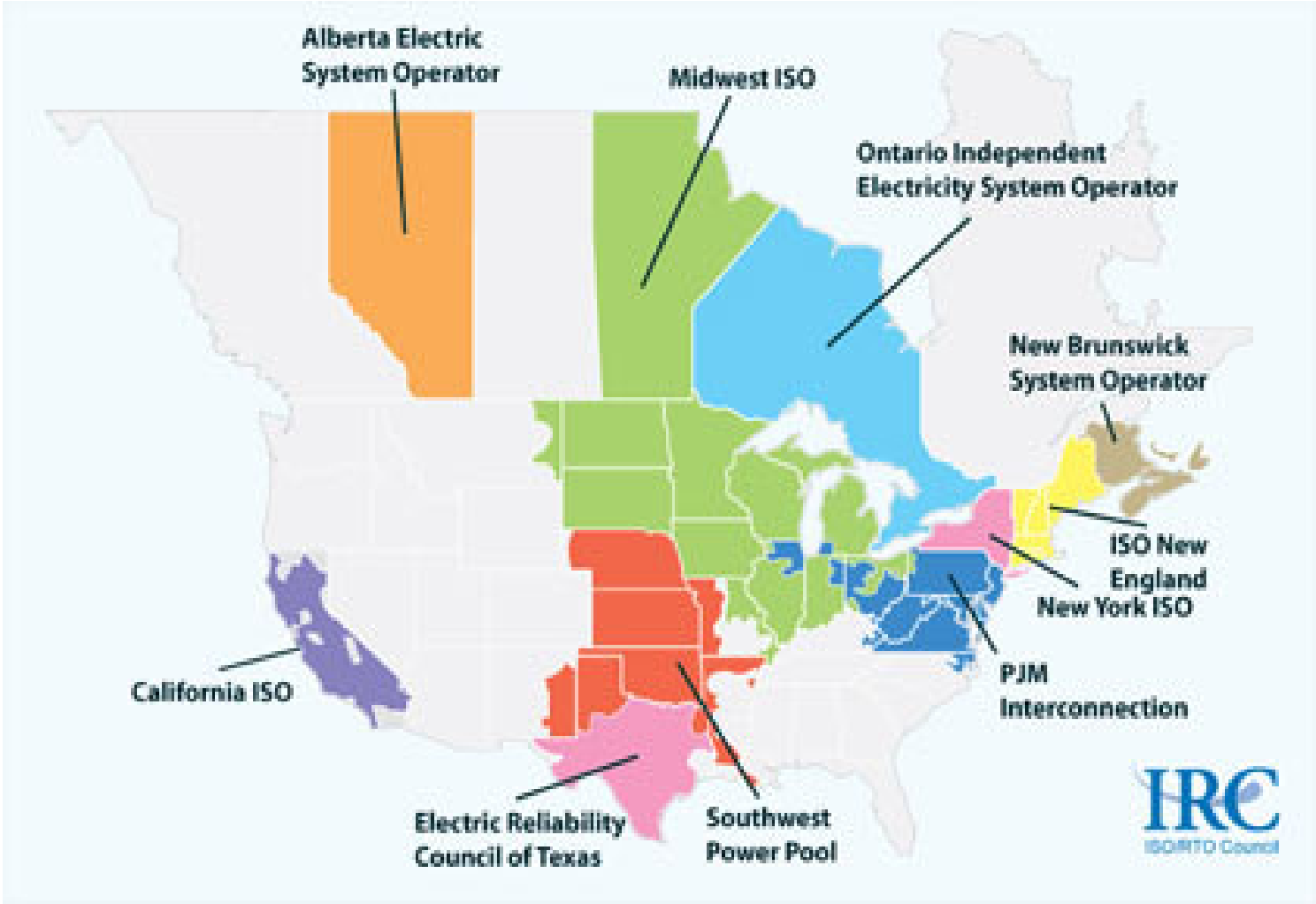
# *Background*

- 'Competition' in provision of networks leads to pressure to separate SO and TO(s).
- So do issues of regulator jurisdiction and competence.
- Evidence from US ISOs informative.

# US ISOs/RTOs




Source: http://www.isorto.org/atf/cf/%7B5B4E85C6-7EAC-40A0-8DC3-003829518EBD%7D/iso_rto_map_20090915.jpg

# ISO Budgets and Activities

| RTO/ ISO | Annual Budget and Debt Service ($ millions) | Employees | Historical Peak (MW) | Services Offered |
|---|---|---|---|---|
| **CAISO (US)** | 195.1 | 572 | 57,000 | • Energy market: day ahead, hour ahead, and real time.<br>• Spot market with locational marginal pricing.<br>• Ancillary services, and Financial Transmission Rights (FTR) market |
| **ERCOT (US)** | 176.1 | 670 | 65,700 | • Balancing energy<br>• Ancillary service markets with zonal congestion management.<br>• Market participants trade electricity bilaterally directly, through brokers and through the Intercontinental Exchange (ICE). |
| **MISO (US)** | 273.0 | 782 | 137,000 | • Midwest ISO administers a two-settlement (day ahead and real-time) energy market known as the Day-2 market. It produces hourly locational marginal prices (LMP).<br>• Midwest ISO administers an ancillary services market (Day 3) as well.<br>• Midwest ISO also administers a monthly financial transmission rights (FTR) allocation and auction. Midwest ISO is developing a capacity market proposal for early 2011. |
| **ISO-NE (US)** | 137.2 | 483 | 36,000 | • Energy market: two-settlement (day ahead and real-time) spot market with LMP<br>• Capacity market<br>• Forward reserves market,<br>• Regulation market<br>• Financial transmission rights market. |
| **NYISO (US)** | 119.5 | 452 | 33,000 | • Energy market: two-settlement (day ahead and real-time) spot market with LMP<br>• Regional and locational capacity market<br>• Financial transmission rights market. |
| **PJM (US)** | 252.0 | 725 | 167,000 | • Energy market: two-settlement (day ahead and real-time) spot market with LMP (prices calculated at each bus every five minutes)<br>• Capacity markets (RPM)<br>• Ancillary services markets<br>• Financial transmission rights (FTR) market |
| **SPP (US)** | 76.2 | 476 | 50,000 | • Transmission service on the transmission facilities owned by its members and operates the region's real-time energy imbalance service (EIS) market. Market participants trade physical electricity bilaterally, either directly or through brokers, and through the EIS market.<br>• Balancing Function |

# *Governance Issues* *(cf.Joskow)*

- Independence from what?
- Incentives vs Not-for-profit
- Cost control for globally small internal costs
- Relationship with regulation = ?

# *Independence Issue*

- ITSO experience in UK
  - SO around 7% of total ITSO revenue
  - c.50% SO revenue exposure
- Alberta for profit ISO: 1998-2003
- Alliance RTO proposal in Midwest: 1999-01
- Increasingly fully independent board, with advisory group of stakeholders

# *Ideal Model for SO*

| Missions | Ideal first best ISO | PJM (US) | ERCOT* (US) | NGC (GB ) |
|---|---|---|---|---|
| **Management of:** ***Congestion*** | **Nodal pricing** | Yes. | Nodal pricing effective since December 1 2010 | None: redispatch. |
| ***Losses*** | **Fixed rate** | Yes, nodal pricing discussed. | Nodal in progress. | Yes |
| **Network development** ***Investments*** | **Social cost minimisation, centralised by SO (congestion threshold criteria)** | No. | Responsible for System planning coordination. | Mainly engineering criteria; fuzzy economic criteria. |
| ***Tariffs*** | **Zonal tariffs + Accommodation capacities** | Partly, no accommodation capacity. Deep cost for new investments, artificially zonal UoS tariffs. | No | Zonal use of system tariffs, zonal accommodation capacities |
| **Coordination with TSOs** | **By standardisation** | Yes, in progress. | The gird is not synchronously interconnected to the rest of the US. | No, but little need of coordination. |

Source: Rious and Plumel, 2006; Rious, 2006

# *Problems of splitting SO/TO* (Lieb-Doczy et al.08)

- *Mismatched incentives.*
- *Efficient information transfer.*
- *Coordination of planning, maintenance and expansion of the network.*
- *Effectiveness of emergency procedures.*
- *Costly dispute resolution procedures.*
- *Financial liabilities and risk allocation issues.*

- The creation of an ISO in Scotland (integrated with that in England and Wales) created its own problems:
  - Different classification of transmission voltages between England and Wales and Scotland created problems for the ISO in defining what assets it had operational control over.
  - Different price control settlements in Scotland and England lead to difficulties in creating uniform transmission arrangements.

# *Paying for the SO*

- Internal vs External SO costs
- Grid Management Charge
- Transparency
- Allocation between Generation and Load
- Mainly charged in relation to MWh for ISOs

# *Evidence on FTRs*

- NYISO Transmission Congestion Contract (TCC, a form of FTR) market exhibits systematic underbidding for transmission rights (i.e. monopsony buying power) in auctions where there were less than two bidders on average. Zhang (2009)
- NY FTR market getting more efficient over time, except in the NY City – Long Island which can be explained by unforeseen shocks. Adamson et al. (2010)
- The situation in gas markets is much less complicated because gas can be stored and loop flows are not an issue (e.g. in UK).
- International  merchant interconnectors offer FTRs and do so almost as efficiently as the theoretical social optimum. Parail (2010)
- LMP based pricing with an FTR auction for access to a merchant piece of network (overseen by an ISO) might facilitate much more trade than is currently the case.

# SMARTER
# BUSINESS MODELS

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# *How do industries evolve?*

- The electricity sector needs to evolve significantly.

- Stylised facts about industries (Geroski, 1995):

- Incumbents have an advantage.
- There is lots of small scale entry and exit.
- Entrants take 5-10 years to become large.
- Incumbents don't respond to entrants immediately.
- Diversifying entry more successful than de novo entry.
- Technological and regulatory changes facilitate entry.

# *'Dominance by birthright'?*

- Example of the dominance of US Radio producers in television production (Klepper and Simons, 2000).

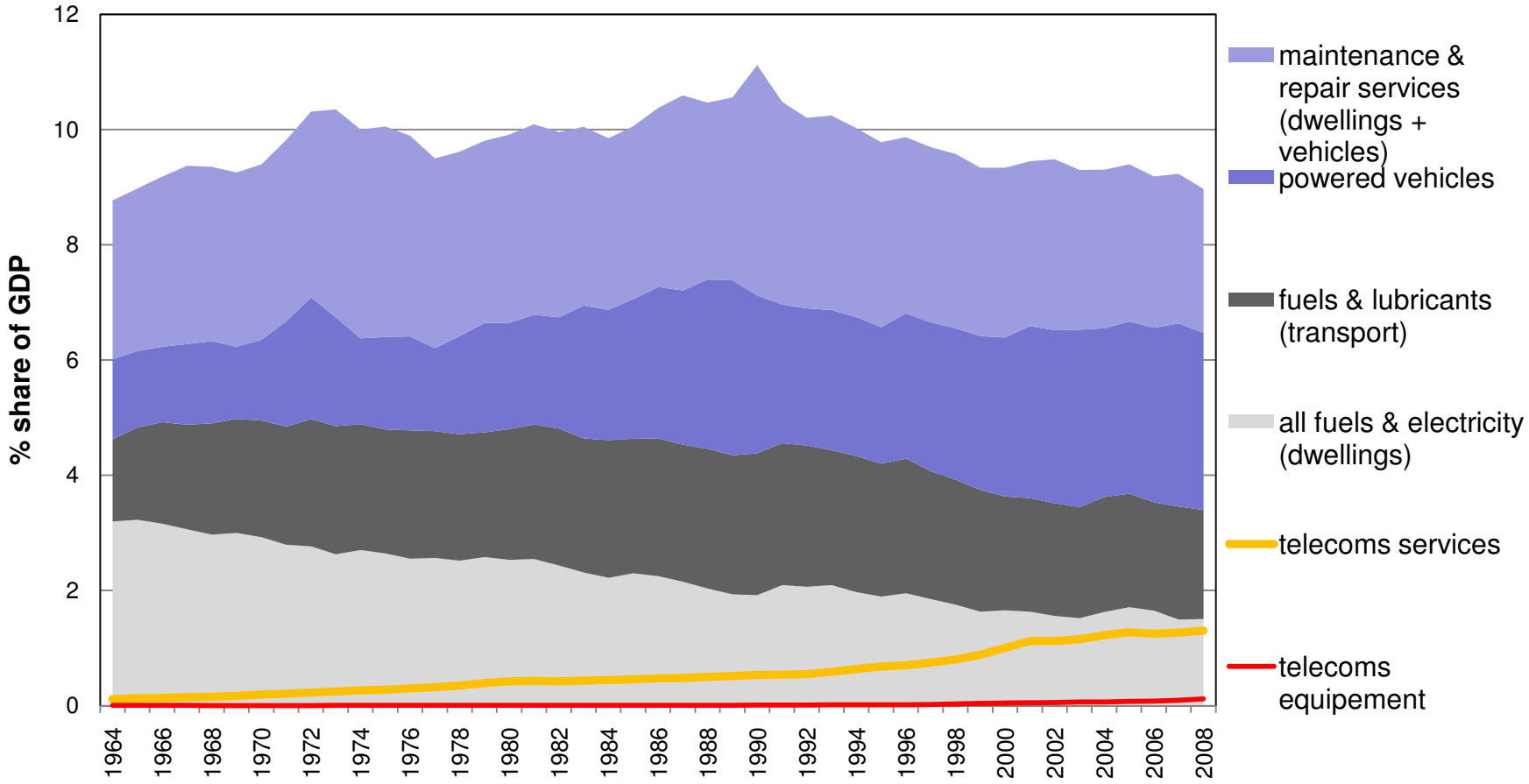
- Pre-existing firms in related industry have advantage in new ones.
  - This may be true for individuals with prior experience.
- Government policies can promote learning by new entrants (Japanese TV producers).
  - How policy can best help entrants?

# *Observations from telecoms*

- Key role of technology in evolution
- Important roles for:
  - Regulation
  - Competition Policy
- Deconstruction of value chain (Li and Whalley, 2002):
  - From value chains to value networks
  - Multiple entry and exit points
  - Complex business relations

# Energy services spending

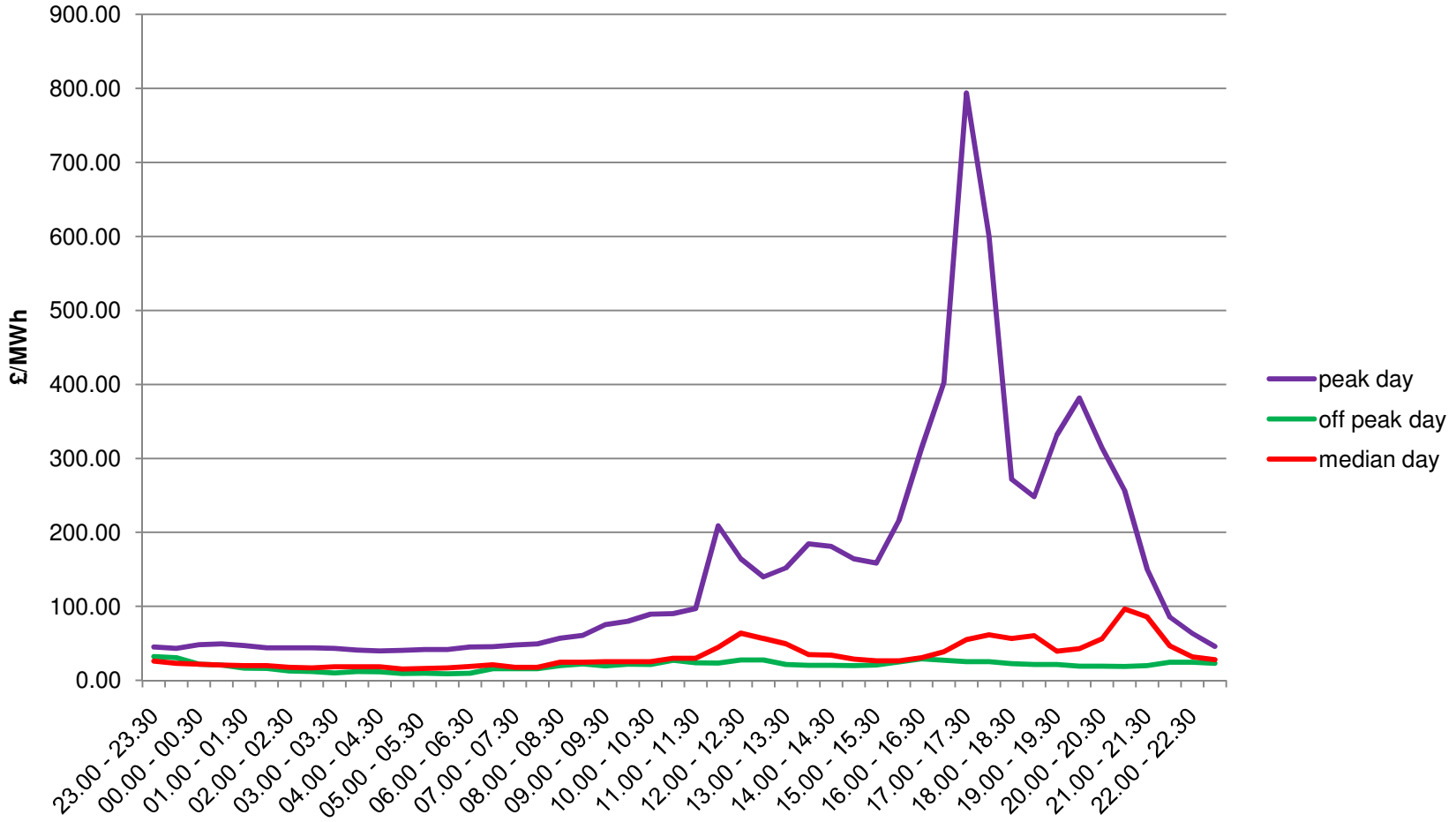
## consumers spending as share of UK GDP




*Source: ONS, chained volume terms, http://www.statistics.gov.uk/STATBASE/Product.asp?vlnk=242*

# *Market Opportunities: Fundamentals*

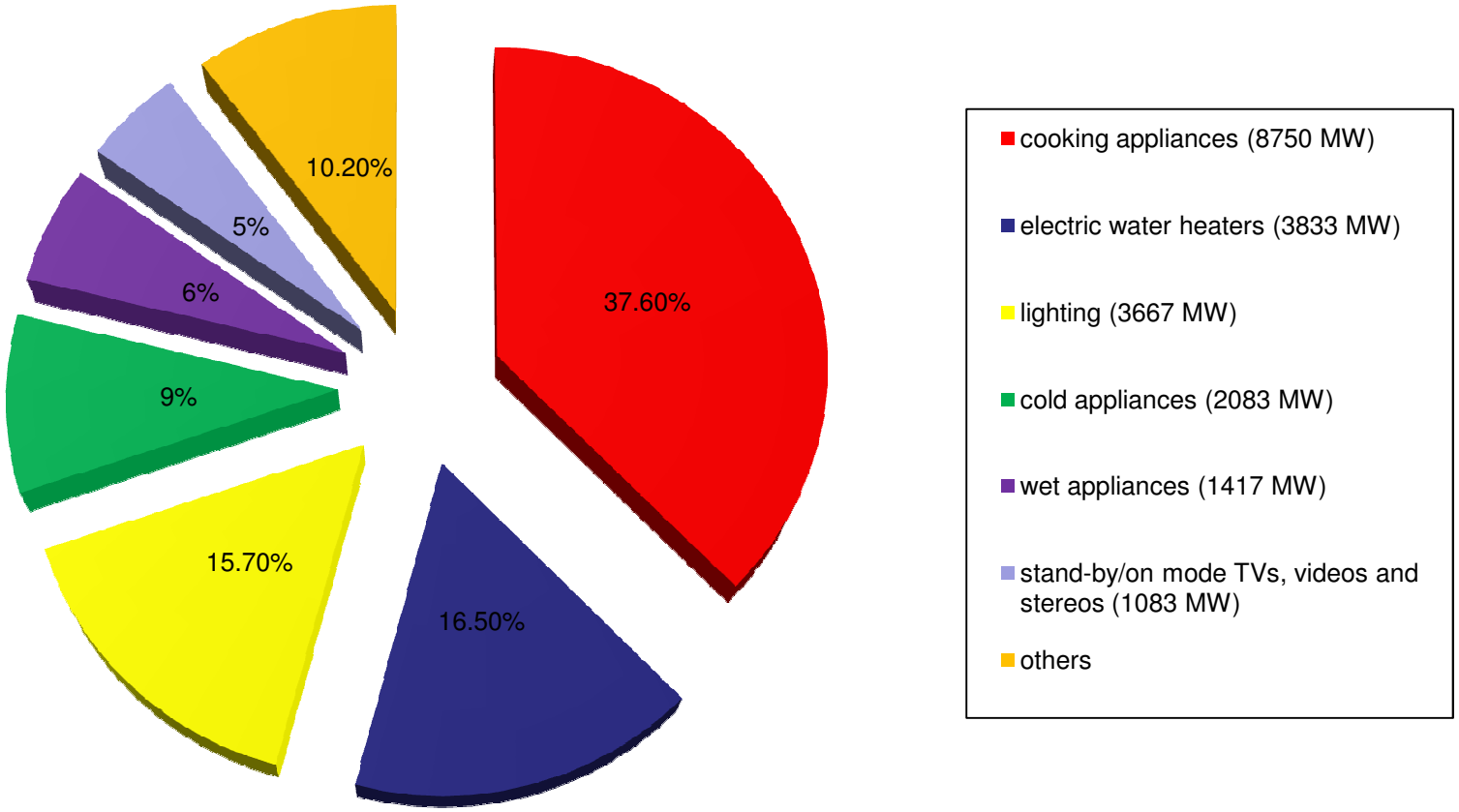
## Electricity Prices in GB (2009)




*Source: APX, http://www.apxgroup.com/index.php?id=61*

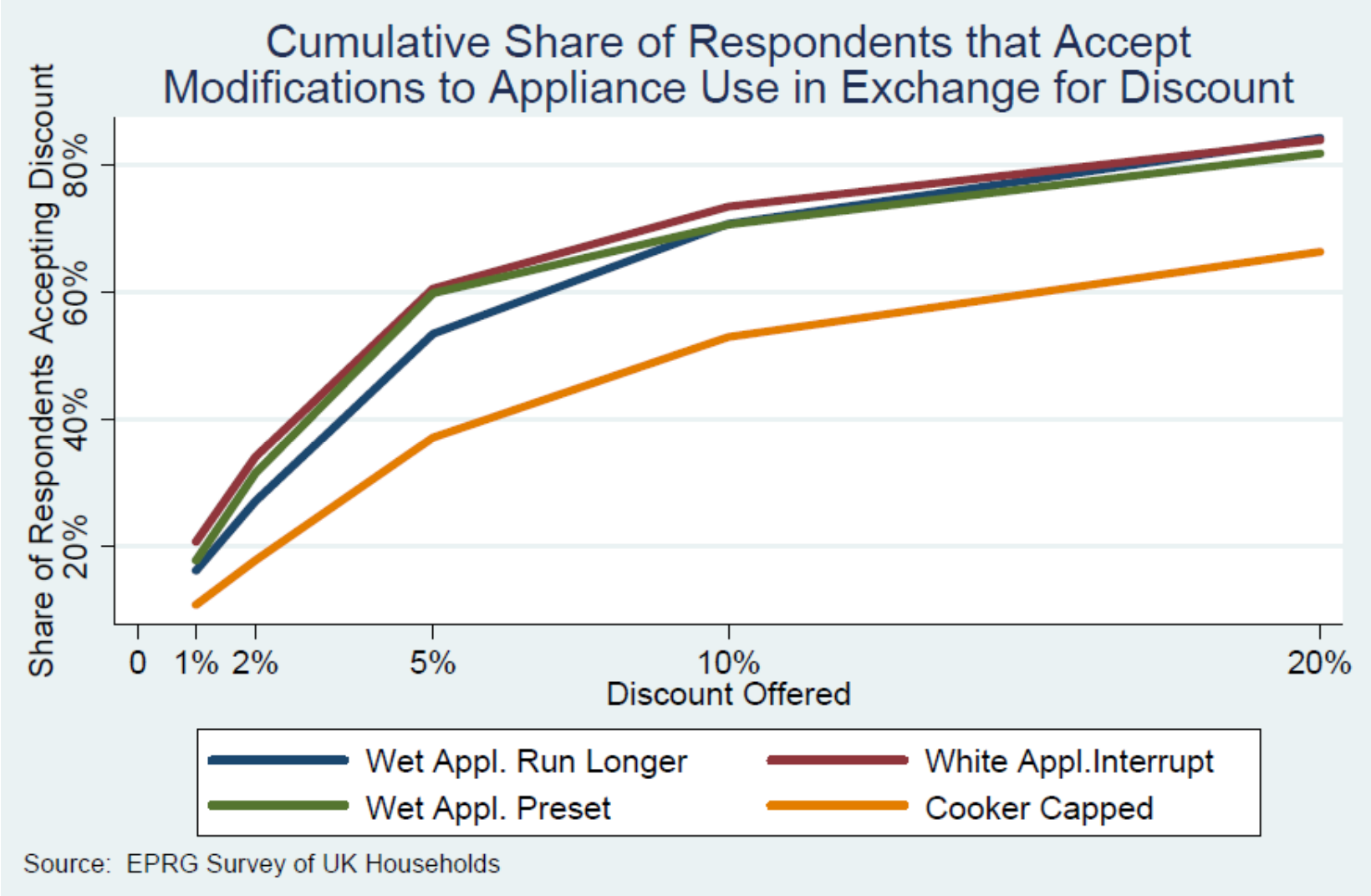
# *Market Opportunities: Shiftable load*

Household peak in the UK (5-6 pm, responsible for 45% of system peak):
*breakdown by appliance type, whole UK, typical winter week-day (52016 MW)*




*Source: adapted from Lampaditou, E. and M. Leach (2005)*

# *Market opportunities: Consumer interest?*




Source: Platchkov et al., 2011.

# *Some 'Known Unknowns'*

- What outturn response elasticities could be:
  - London Congestion Charge experience (-0.42 actual against -0.15 predicted. (Evans, 08)
- What innovations might come along
  - Telecoms suggests expect the unexpected (e.g. growth of SMS)
- Which diversifying entrants will enter
- How consumers will react
  - UK smart meter trials appear to be disappointing
  - Non-rational behaviour likely

# *The Future for Energy Services?*

- Convergence between electricity, heat and transport sectors?
- Entrants from other sectors?
- Marketer/Retailer led business models?
- Interventions from regulator to force incumbents to facilitate new business models?

- Telecoms suggests any of these possible (and probably welcome).

# SMARTER IDEAS

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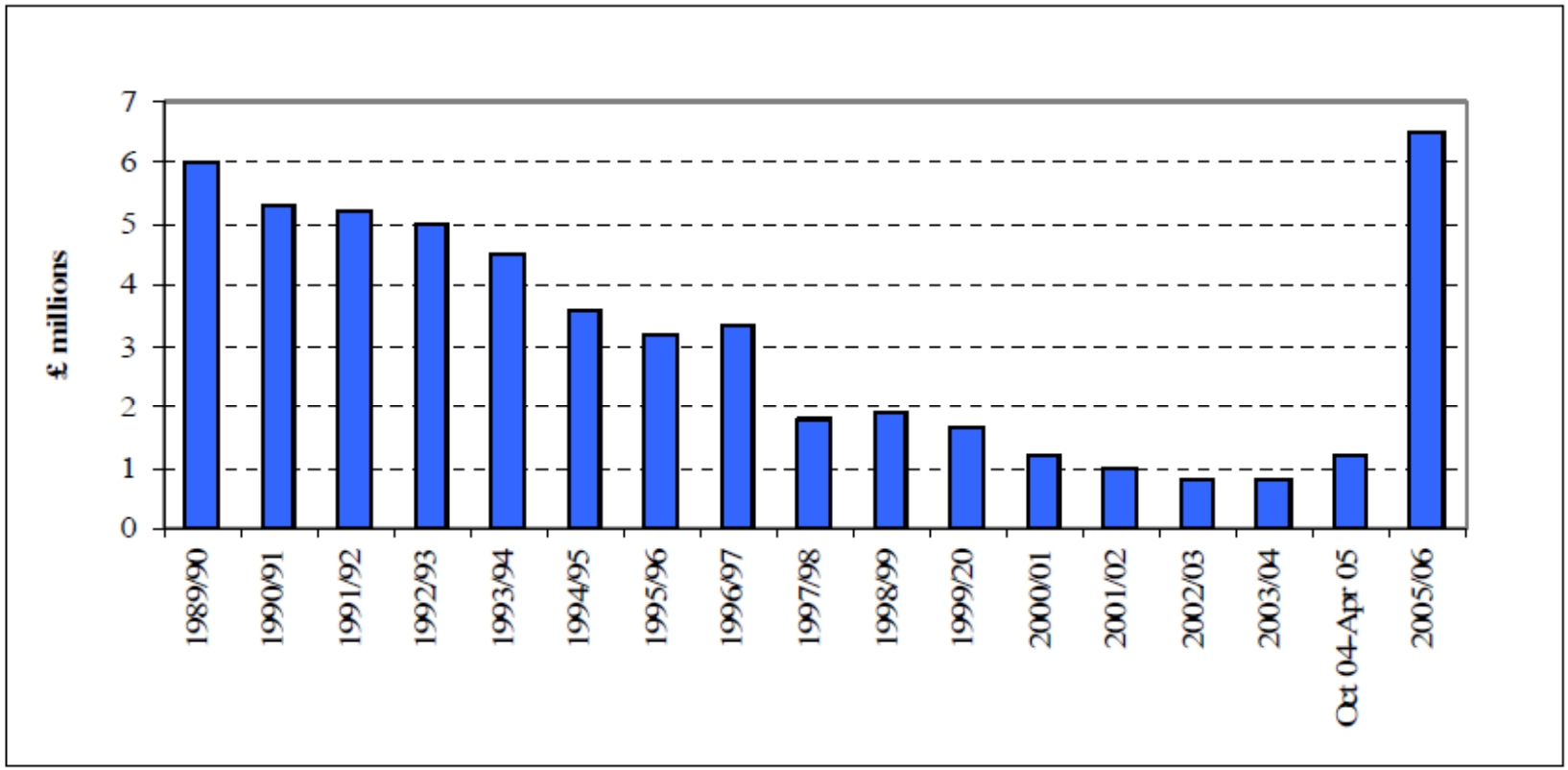
# Deregulation and R&D expenditure

**R&D expenditure in GB distribution companies**

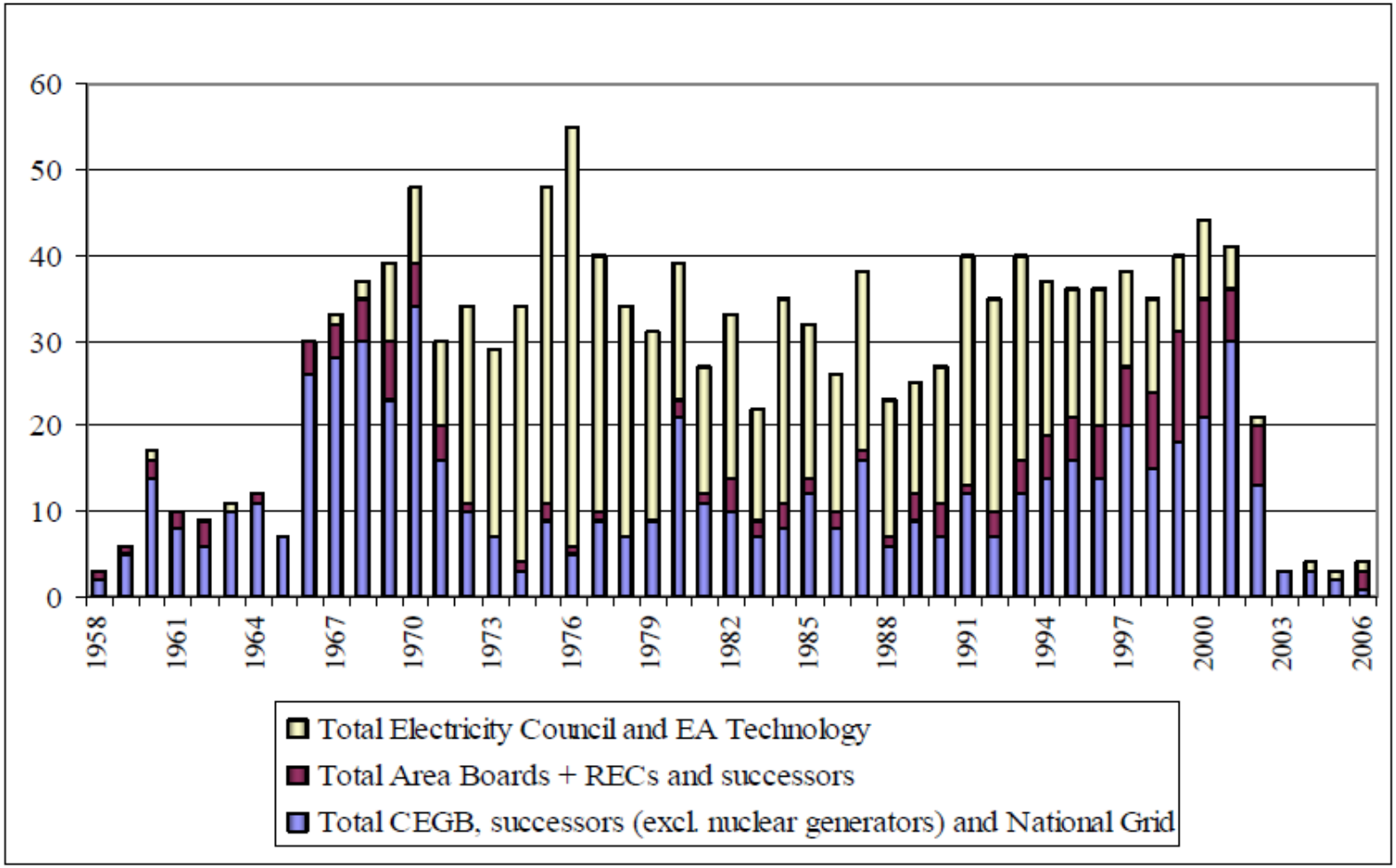



Notes: *Data from 1989/90 to 2003/04 is for collaborative spending on R&D amongst the DNOs through a single provider. For comparison, in 2003/04 the R&D spending of the DNOs was £2.1 (see Ofgem, 2004, p.160). **Data from October 2004 – April 2005 and 2005/06 shows reported total IFI spend.

Source: Ofgem, 2007, in Jamasb and Pollitt, 09, p.14.

# Deregulation and Innovation

**Patent count for the UK whole electricity sector (excluding nuclear)**




Source: Jamasb and Pollitt, 2009, p.16.

# *Low Carbon Networks Fund*

- £500m over 5 years, i.e. 2.5% of DNO revenue, 2010-15.
- First tier £16m per year (replaces Innovation Funding Incentive (IFI)).
- Second tier £64m per year projects in annual competition judged by expert panel.
- A discretionary reward totalling £100m for successful completion and exceptional projects.

- 2nd tier projects must:
- accelerate the development of a low carbon energy sector.
- have a direct impact on the operation of the distribution network.
- have potential to deliver net benefits to existing and/or future customers.
- generate new knowledge that can be shared amongst all network operators.

# New projects funded

## Low Carbon London – a learning journey

**The company:** UK Power Networks *

**The key concept:** A network to serve a low-carbon city

**The area:** London

**Amount awarded:** £24.3 million (£36.1 million total project)

**Period of project:** January 2011 – June 2014

**Other key partners:** Sainsbury's; Siemens; Imperial College; EDF Energy Customers Plc ; Logica; Smarter Grid Solutions; Greater London Authority; London Development Agency; EnerNOC; Flexitricity; Transport for London; National Grid; Lower Lea Valley Smart Buildings Project; Logica; RWE npower; Institute for Sustainability

**The project:**

- Implements new tariffs, in conjunction with energy retailers, for electric vehicle charging points for people who want to charge their cars away from home. Works on the back of Transport for London's Plugged in Places scheme, which will roll out 25,000 electric vehicle charging points by 2015, supporting 100,000 electric vehicles.
- Emulates a 2020 energy scenario, using the Learning Laboratory, Imperial College, to test how low-carbon technologies on a large scale impact the networks.
- Installs at least 5,000 smart meters and monitors the information from them across 10 boroughs.
- Sainsbury's will provide information from its fleet of electric delivery vehicles and from its charging points for customers' own electric cars.
- London has the highest concentration of electricity demand and carbon emissions in Great Britain. And the most demanding carbon reduction targets (60 per cent reduction on 1990 levels by 2025).
- Focuses on the 10 London Low Carbon Zones; the London Development Agency's Green Enterprise District; Central London; and the Olympic Park and Village.

In 2010, 11 bids for 2nd tier projects, 4 funded.

<u>Concepts:</u>

-Making customers and networks work better together

- *A network to serve a low carbon city*

-New ways to connect renewable generation to distribution networks

-*Understanding the impact of low-carbon technologies on the network*

**Total project value: £102.4m**
**Total awarded: £61.7m**

Source: Ofgem, 2010c, including, p.5.

# CONCLUSIONS

# *Summary*

- Context complex, dynamic and difficult to predict.
- RPI-X being ‘adapted’.
- Radical decarbonisation and large increases in renewables driving sector.
- More sophisticated market mechanisms possible.
- New governance structures needed.
- New players desirable and need to be supported.
- Regulation for innovation will throw up ideas and be significant.
- Things will not turn out as we predict!

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