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# Network Utilities of Future:

## Economics and Business Models


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# Overview

- Network Utilities, Business Models, and Business Economics
- A Network Business Model - From DNO to DSO
- Regulation and Innovation
- Consumer Behaviour
- Conclusions

# Network Utilities, Business Models, and Business Economics

# Business Models - Theories of the Firm

## Why firms exist:

- ***The Capabilities Approach*** - Firm exists because of their capabilities and core competencies
- ***The Property Rights View*** – A particular set of assets (firms) under joint ownership

## What determines firm size:

- ***Neoclassical view*** - Market size, entry barriers, technology
- ***Transaction cost view*** - Market vs. hierarchy - cost of discovering prices

# Business Models –
# Firm Scale, Scope, and Growth

- **Economies of Scale**
  - **Technical economies**: Size of *production*
  - **Non-technical economies**: Size of *the firm as a whole*
- **Economies of Scope**
  - **Products complement/substitute in service/quality and reduce average costs**
- **Firms tend to want to grow**
  - **Important for lumpy investments and R&D**

Source: Griffiths and Wall (20120

# A Network Utility Business Model - From DNO to DSO-DER

# New Business Models - Context

- ❖ Energy prices relatively low
- ❖ Low demand growth
- ❖ Low short-term price elasticity
  - o Competition in price can be unprofitable

➢ *So, What can a slow-growing/declining market offer to DNOs and other actors?*

***But, the value of energy services to consumers has never been higher***

# DSOs in Europe


**2,400** electricity distribution companies

**260 million** connected customers, of which **99%** residential customers and small businesses

**240,000** people employed[1]

**2,700 TWh** a year[1]

Unbundling applies to the more than **190 DSOs** with **100,000** and more end users

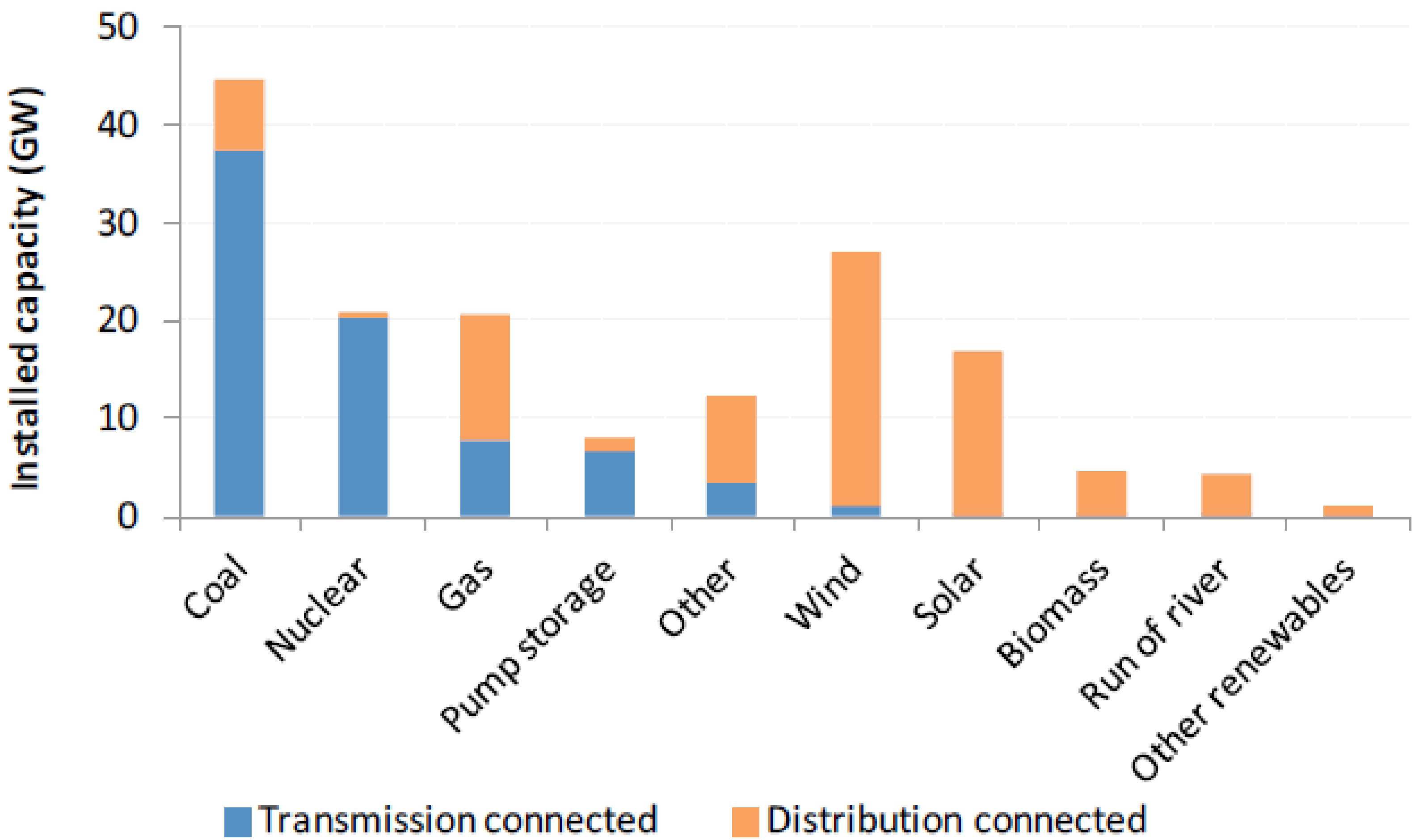
Source: Eurelectric (2013)

# No. of DNOs in Europe - Declining

| Country | Number of DSOs 1997 | Number of DSOs 2003 | Number of DSOs 2010 | Number of DSOs 2011 | Number of DSOs with ≥ 100.000 customers | Total Number of Connected Customers | < 1 kV Customers (LV) | 1- 100 kV Customers | > 100 kV Customers | Total distributed power (TWh) |
|---|---|---|---|---|---|---|---|---|---|---|
| AT | 137 | 137 | 138 | 138 | 13 | 5,870,000 | 5,700,000 | 150,000 | 100 | 61 |
| BE | 36 | 29 | 26 | 24 | 15 | 5,243,796 | 5,178,890 | 64,906 | 0 | 55 |
| BG | | 8 | 4 | 4 | 3 | 4,915,497 | 4,909,374 | 6,123 | 0 | 26 |
| CY | | | 1 | 1 | 1 | 535,050 | 512,972 | 646 | 0 | 5 |
| CZ | 8 | 8 | 3 | 3 | 3 | 5,837,119 | 5,812,727 | 24,258 | 134 | 65 |
| DE | 1000 | 900 | 896 | 880 | 75 | 49,294,962 | n.a. | n.a. | n.a. | 511 |
| DK | 211 | 119 | 76 | 72 | 6 | 3,277,000 | n.a. | n.a. | n.a. | 33 |
| EE | | | 36 | | 1 | 652,000 | 651,000 | 1,000 | 0 | 8 |
| ES | 540 | | 349 | | 5 | 27,786,798 | 27,682,771 | 103,630 | 397 | 278 |
| FI | 115 | 93 | 85 | | 7 | 3,309,146 | 3,305,268 | 3,761 | 117 | 60 |
| FR | | | 158 | | 5 | 33,999,393 | 33,903,690 | 95,703 | 0 | 384 |
| GR | | | 2 | 2 | 1 | 8,195,725 | 8,184,378 | 11,347 | 0 | 45 |
| HU | 6 | 6 | 6 | 6 | 6 | 5,527,463 | 5,520,991 | 6,334 | 138 | 37 |
| IE | 1 | 1 | 1 | 1 | 1 | 2,237,232 | 2,235,681 | 1,545 | 6 | 23 |
| IT | 200 | 195 | 135 | 144 | 2 | 31,423,623 | 31,331,656 | 90,949 | 1,018 | 264 |
| LT | 1 | 2 | 2 | 1 | 1 | 1,571,789 | 1,570,584 | 1,205 | 0 | 9 |
| LU | 12 | 11 | 8 | 6 | 1 | n.a. | n.a. | n.a. | n.a. | 5 |
| LV | | | 11 | 11 | 1 | 873,856 | 872,930 | 926 | 0 | 7 |
| NL | | 10 | 8 | 11 | 8 | 8,110,000 | n.a. | n.a. | n.a. | 109 |
| PL | 33 | 27 | 188 | 184 | 5 | 16,478,000 | 16,456,000 | 31,000 | 300 | 133 |
| PT | 4 | 1 | 13 | 13 | 3 | 6,137,611 | 6,113,839 | 23,772 | 0 | 52 |
| RO | 1 | 8 | 8 | | 8 | 2,639,318 | 2,633,625 | 5,602 | 91 | 54 |
| SE | 230 | 190 | 170 | 173 | 6 | 5,309,000 | 5,300,000 | 9,000 | n.a. | n.a. |
| SI | 2 | 5 | 1 | | 1 | 925,275 | 820,000 | 105,275 | 2 | 11 |
| SK | 4 | 4 | 3 | 3 | 3 | 2,392,418 | 2,379,672 | 12,664 | 82 | 20 |
| UK | 12 | 8 | 7 | 7 | 7 | 30,828,266 | n.a. | n.a. | n.a. | 326 |
| NO | 200 | 157 | 150 | 155 | 7 | n.a. | n.a. | n.a. | n.a. | 118 |

Source: Eurelectric (2013)

Figure 20 • Generation capacities by grid-level connection in Germany in 2010




Source: data from BNetzA, 2011a.

Source: IEA (2013)

# DER Aggregation Business Models – Who is Best

## ❖ Retailer-aggregator

- Is the aggregation arm of a retail company
- Can participate directly in the Balancing Mechanism
- Aggregates and sells the flexibility of its own retail customers

## ❖ Third party aggregator

- Does not own a retail licence
- Can participate in Ancillary Services, can access BM through partnership with a retailer, or become a retail-aggregator (get a retail licence)
- Aggregates and sells the flexibility of customers of any retailer

## ❖ How about the DSOs ?

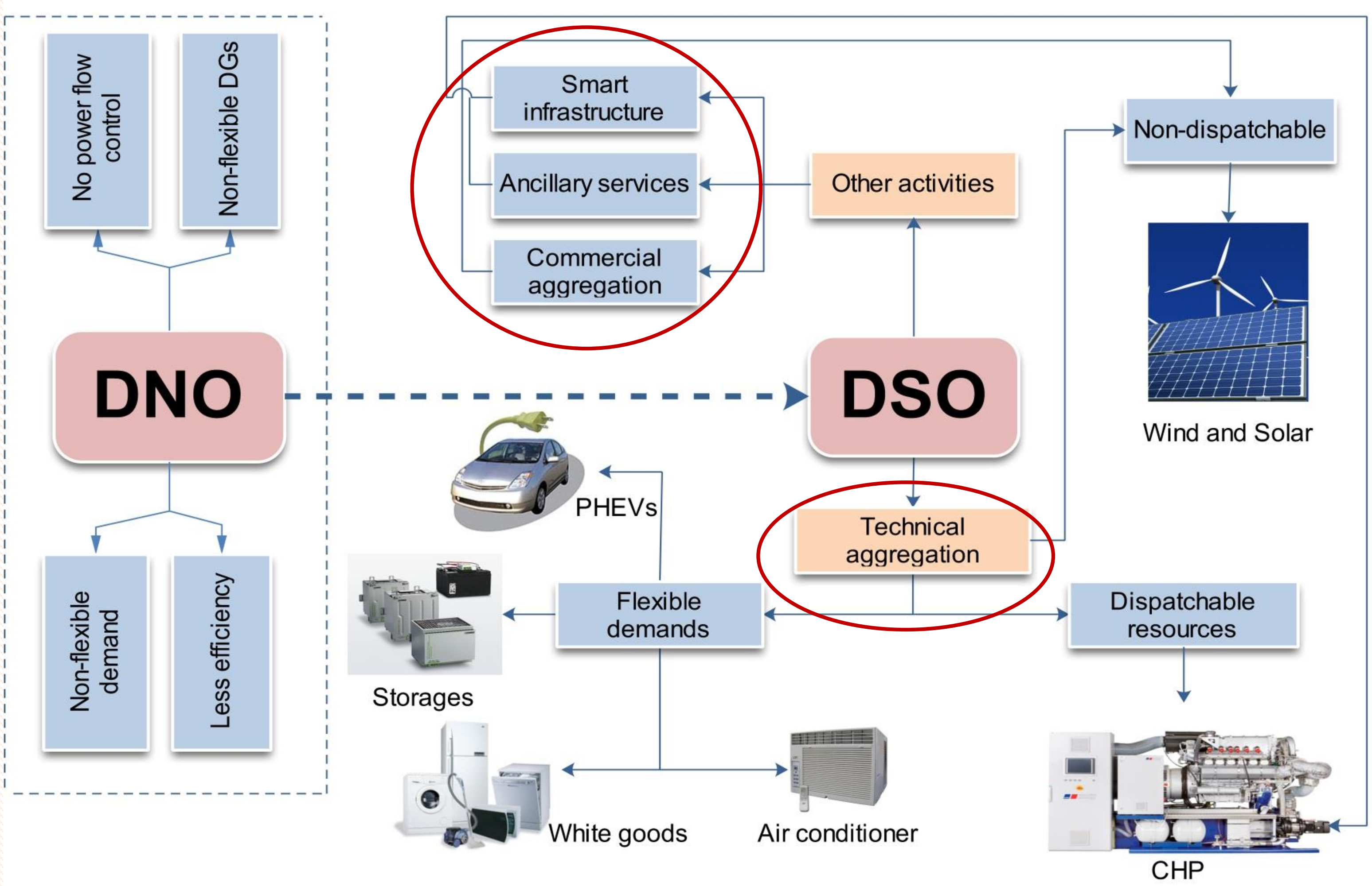
# A DSO-DER Model (1)

- **Aggregates DERs** (substitutes / complementary) – (i) DG, (ii) demand response, (iii) storage, (iv) network investments:

  - **Technical integration:**
    - Asset utilisation
    - Bidirectional power flows

  - **Economic integration:**
    - Constructs lowest cost **DER dispatch curves**
    - Connection or UoS charges
    - **"Competition for the market"**
    - Periodic **auctions/contracts** with existing/new actors
    - Small actors can enter through aggregators

# From DNO to DSO




Source: Poudineh and Jamasb (2014)

# A DSO-DER Model (2)

- Benefits from scale and scope
- Low transaction costs
- Can combine DERs with network investments
- Can contribute to national load balancing
- Uses local network knowledge

***Makes business economics sense***

# Regulation and Innovation

# The Future of the System?

# Pace of Technology Adoption – Can be Rapid

## Spot the Car

Easter morning 1900: 5th Ave, New York City. Spot the automobile.

Source: US National Archives.

## Spot the Horse

Easter morning 1913: 5th Ave, New York City. Spot the horse.


Source: George Grantham Bain Collection.

# Energy Economics: Early Visionaries

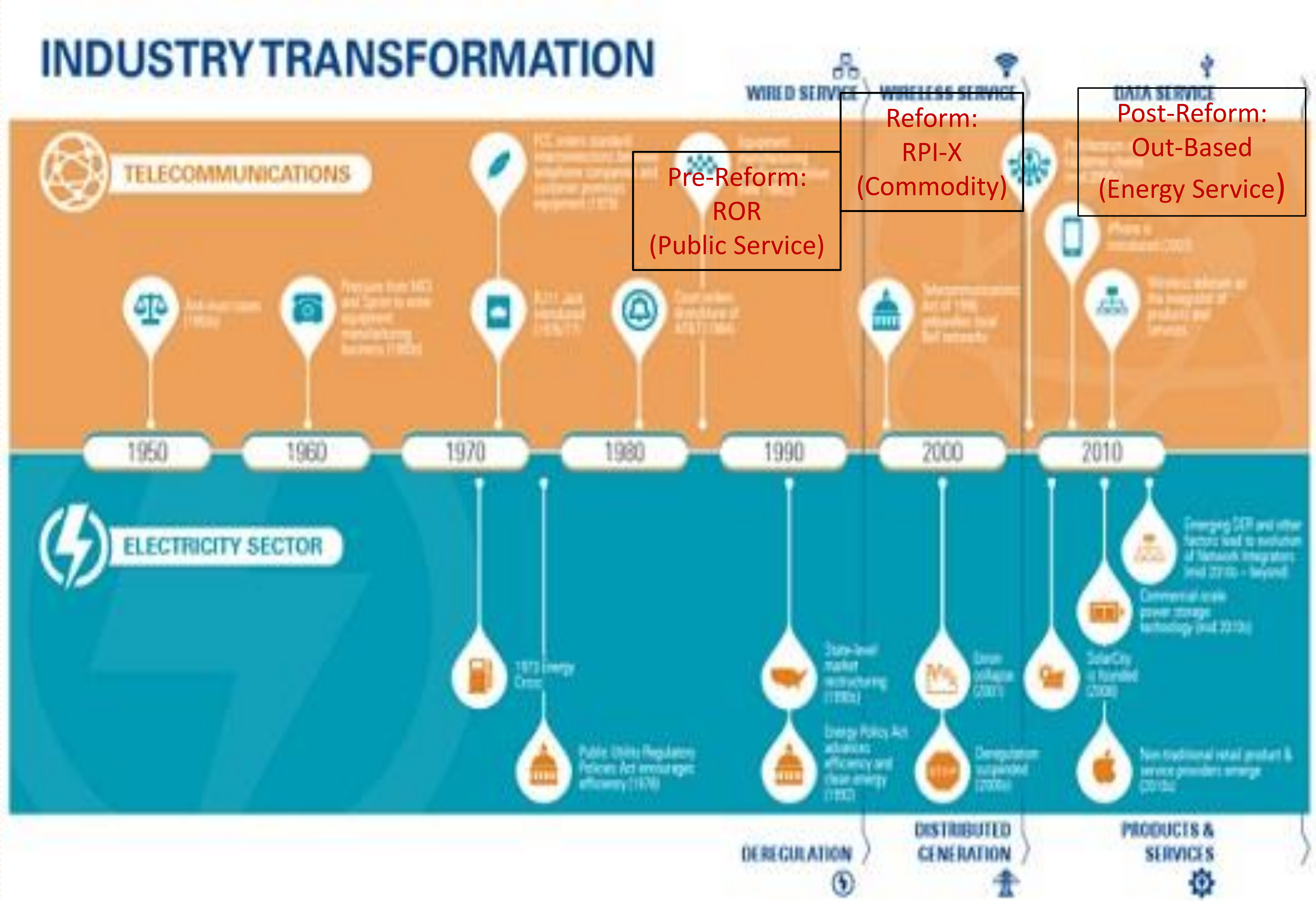
**W. Gladstone:** ***"Of what use is this electricity?"***

**M. Faraday:** ***"I do not know, but I suspect that one day you will tax it."***


***"We will make electric light so cheap that only the rich will be able to burn candles"*.**

**Edison (1879)**

Centre for Energy Regulation




http://www.smartgridnews.com/story/network-integrator-catalyst-center-innovation/2016-04-07

# Regulation for Future Grids

- **Need smart multi-output incentive regulation regimes, e.g. combining and balancing:**
  - Load management (storage can facilitate this)
  - Demand response
  - Dependence on / interface with HV grid
  - Loss reduction
  - Investment efficiency
  - Energy vector integration

# R&D and Innovation

- Energy sector among least R&D intensive industries
  - Why? Slow growth.
- Market failure
  - Social discount rate > Private discount rate
- Generation - the fastest growing segment is the renewables, which receives support
- **Networks** - nothing happens unless the regulator allows
- Allow experiments
  - Ofgem's Innovation Zones and LCNF schemes

# Consumer Behaviour and Social Acceptance

# Behavioural Economics

*"Examines when the behaviour of individuals may consistently and clearly differ from that predicted by the rational model of consumers as perfectly utility-maximising individuals (rational choice economics)."*

Bradford (2018)

# Behavioural Economics:
## Causes of behavioural errors

- **Time**: People value goods and things differently at different times – discounting?
- **Lack of Information and Uncertainty**: Can lead people to decisions that may not seem optimum from economic point of view
- **Herds and memes:** Influence by other people, e.g. group dynamics and peer pressure

Bradford (2018)

# Behavioural Economics

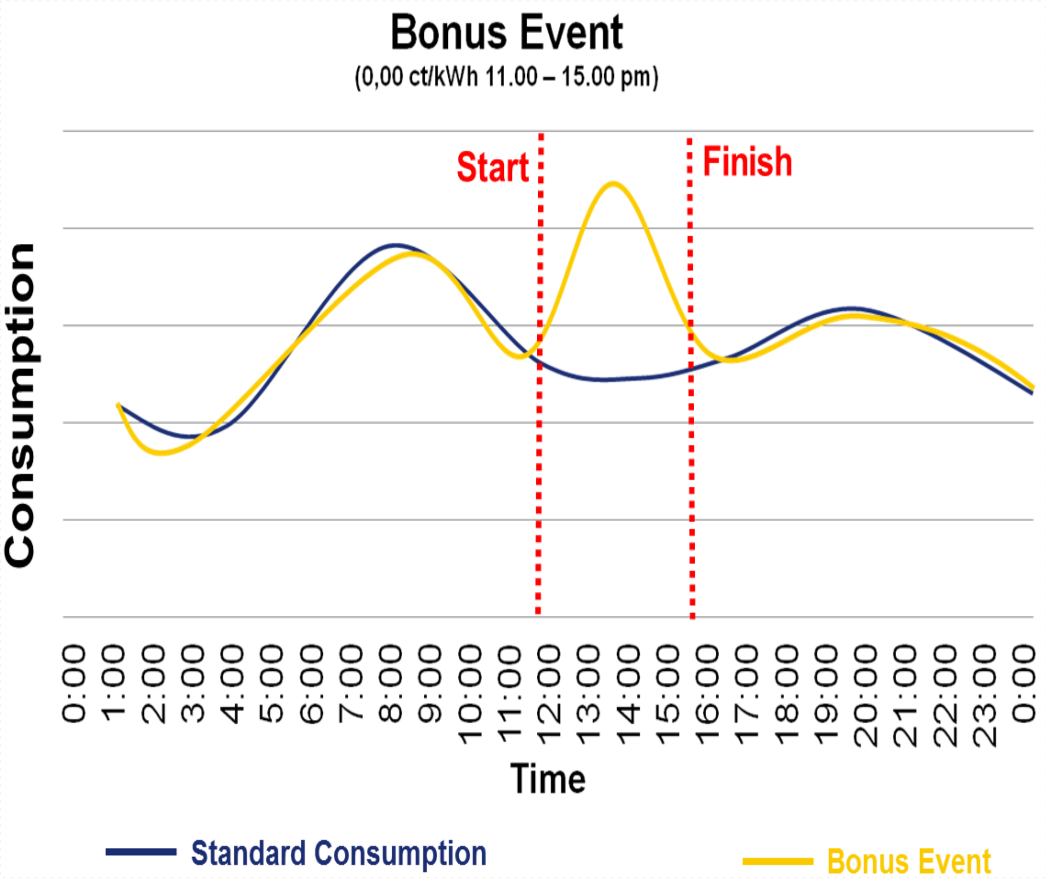
- Need to better understand consumer behaviour in energy demand and markets
- Consumers may behave with a budget
- We value things that we own more highly than equivalent things we could buy
- They value a windfall gain less than a regular expenditure

*The Economist*

***So, how measures are designed, labelled, and communicated matters for consumer behaviour***

# Consumer - Cost Minimizer or Utility Maximizer

**Figure 2: Example: Effect of tariff model within eTellingence**




Source: EWE AG.

http://www.e-energy.de/de/etelligence.php

# Customer vs. Citizen

- Need to recognize the dual end-user role
  - ‘Customer’ vs. ‘Citizen’
- Need to know when we talk to which

- Consumer are expected to behave in a certain way, so they may not respond well
- How policies are framed and communicated is important

***Need to place the focus on ‘empowering’ the consumer in the market place***

# Conclusions

- Theories of business economics can guide us to properties of future utility business models

- DSO has the scale for aggregating distributed resources
- 'System integration' benefits

- How to commercialise energy services?
- Promote innovation, R&D, experiments

- Technology, transaction costs, regulator define the boundaries between DSO and the market

***So, need suitable 'regulatory frameworks' for DSOs***

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# Thank you!

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# Open Networks Project Impact Assessment

**www.energynetworks.org**

http://www.energynetworks.org/assets/files/ONP%20-%20Impact%20Assessment%20Briefing%20Event%20-%20Glasgow%20slide%20pack.pdf

# What Future for DNOs?


**World A**
DSO Coordinates – a World where the DSO acts as the neutral market facilitator for all DER and provides services on a locational basis to National Grid in its role as the Electricity System Operator (ESO).

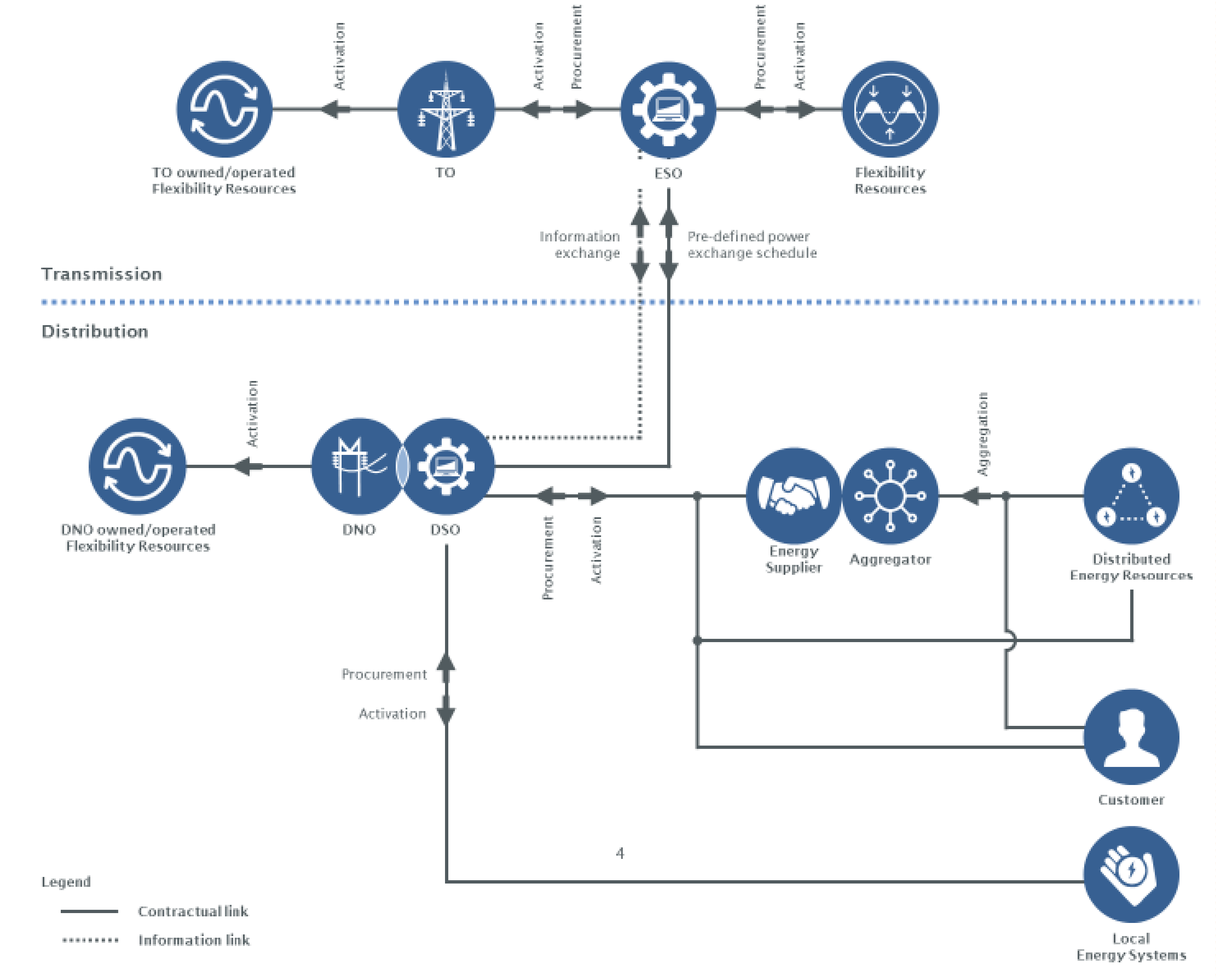
**World B**
Coordinated DSO-ESO procurement and dispatch – a World where the DSO and ESO work together to efficiently manage networks through coordinated procurement and dispatch of flexibility resource.

**World C**
Price-Driven Flexibility – a World where changes developed through Ofgem's reform of electricity network access and forward-looking charges have improved access arrangements and forward-looking signals for Customers.

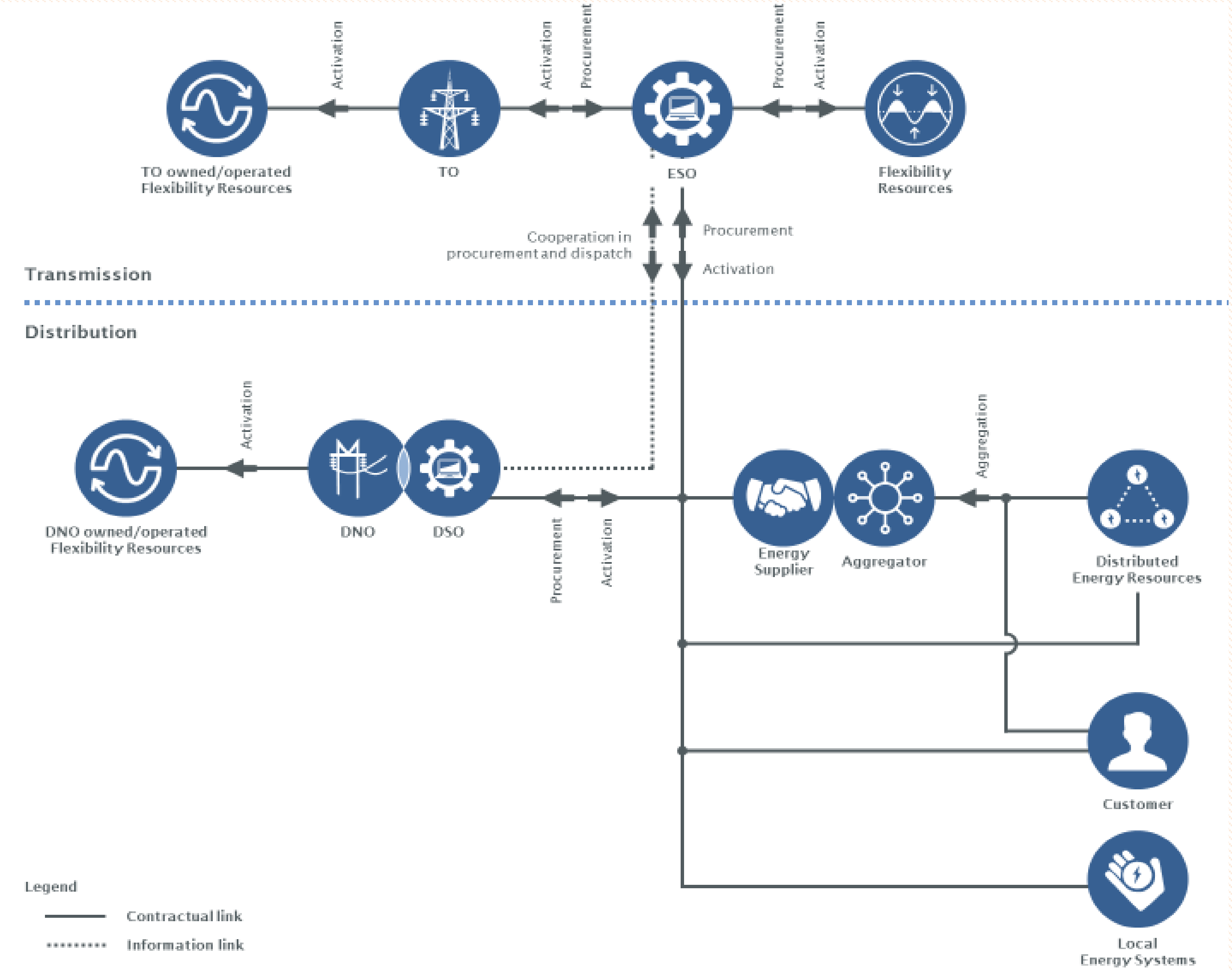
**World D**
ESO Coordinate(s) – a World where the ESO is the counterparty for DER with DSO's informing the ESO of their requirements.

**World E**
Flexibility Coordinator(s) – a World where a new national (or potentially regional) third-party acts as the neutral market facilitator for DER providing efficient services to the ESO and/or DSO as required.

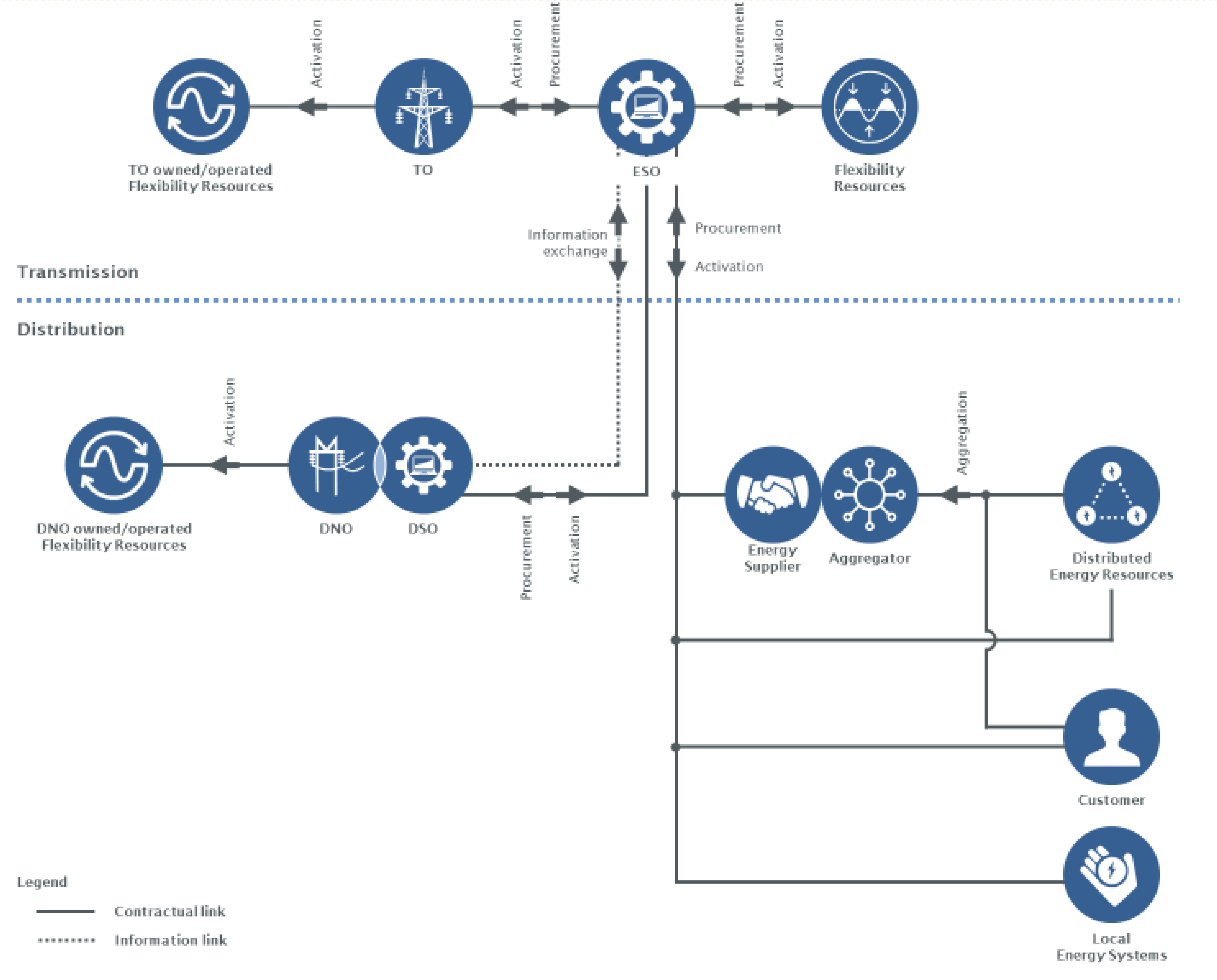
# World A: DSO Coordinates



# Worlds B: Coordinate Procurement and Dispatch
# World C: Price-Driven Flexibility



# World D: ESO Coordinates



# World E: Flexibility Coordinators