



Renewable Energy – Aspects of Design

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BLACKFISH

ENGINEERING DESIGN AND PRODUCT DEVELOPMENT

Agenda

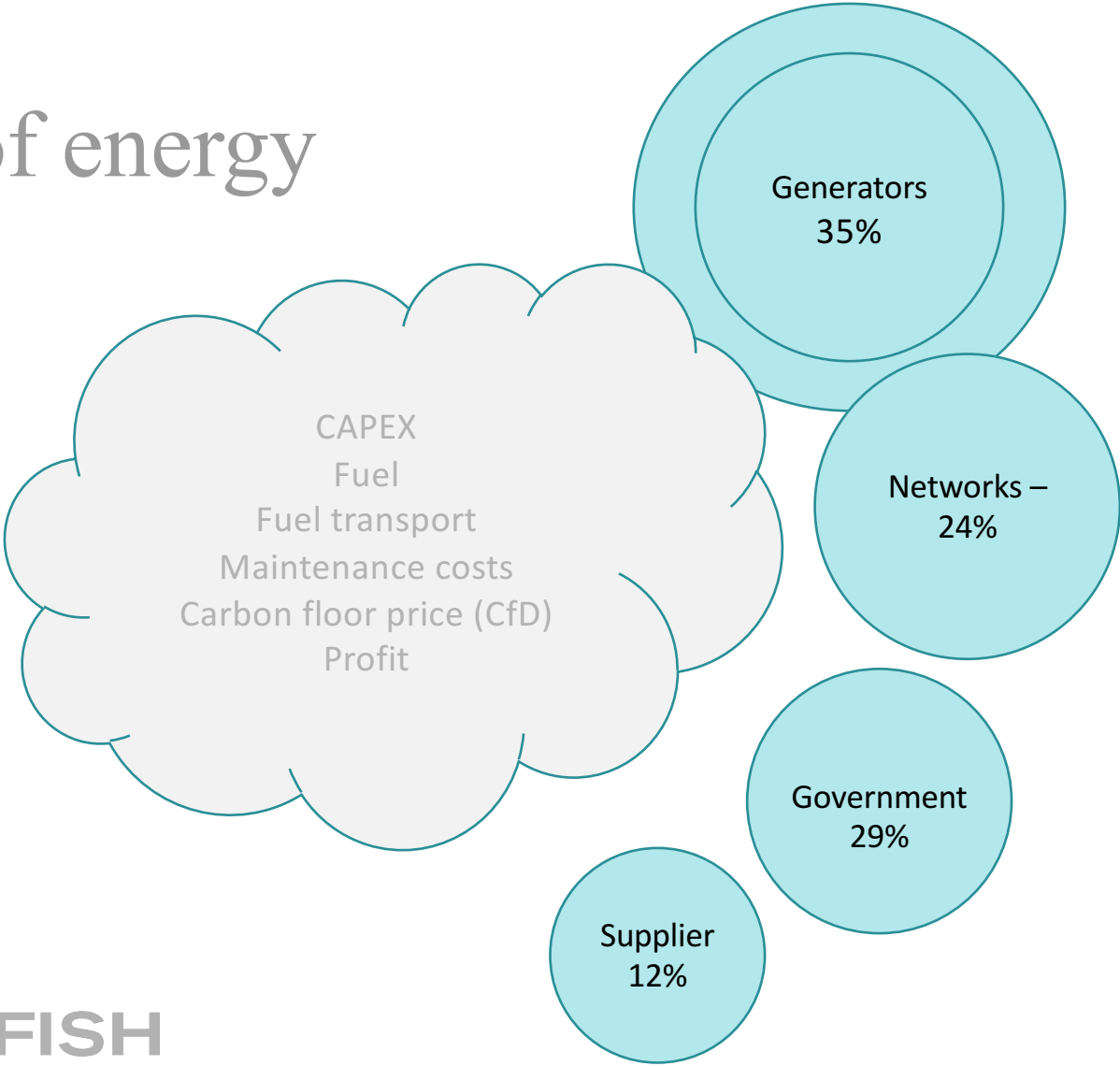
- A bit about me
- Back to school
 - Cost of energy
 - Energy Demand
 - Challenges
- Types of renewables
- Wind and tidal machines
 - Design of a turbine
 - Design choices
- Positive news

A bit about me

- Chartered Engineer, 19 years experience
- Rolls Royce: gas turbine blade design and manufacture
- Airbus fuel: tank flammability assessments
- Tidal Generation: tidal turbine design
 - 500kW & 1MW demonstrator – concept, design, build, assemble, test. Generated 1500MWhrs
 - 1.4MW turbine – concept, design
 - Pitch control systems, structures, fabrication, gearboxes, bearings
- Blackfish Engineering – offering engineering solutions to unique challenges in renewables

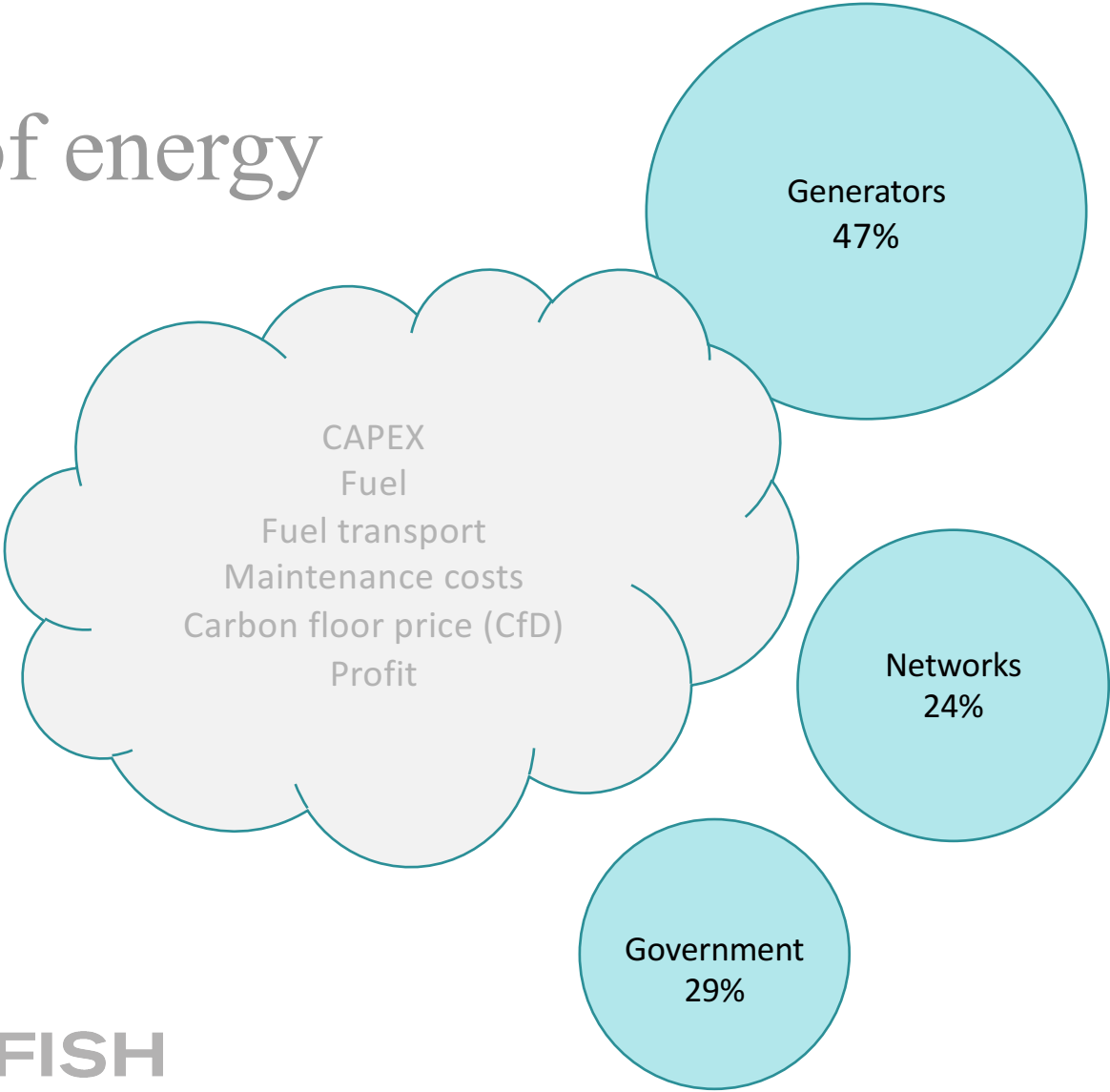
Cost of energy

You pay 10.95p / kWhr (incl VAT)



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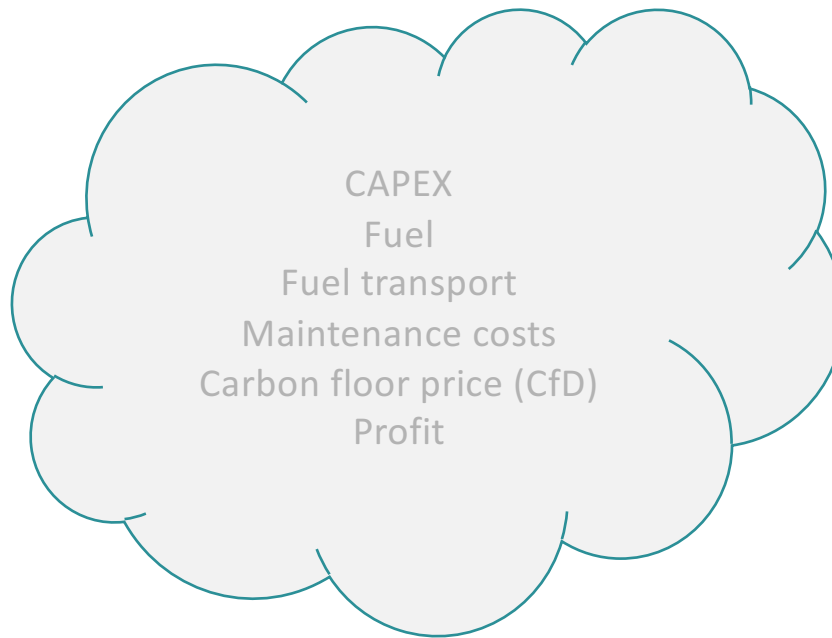


AKA British Gas, SSE, EON, EDF, Npower, Scottish power

AKA National Grid plc, Formerly CEGB

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The case for renewables:

Based on operating costs, no argument

Free fuel

No fuel transport

Assume low carbon economy

However...

Fixed costs

Load factor

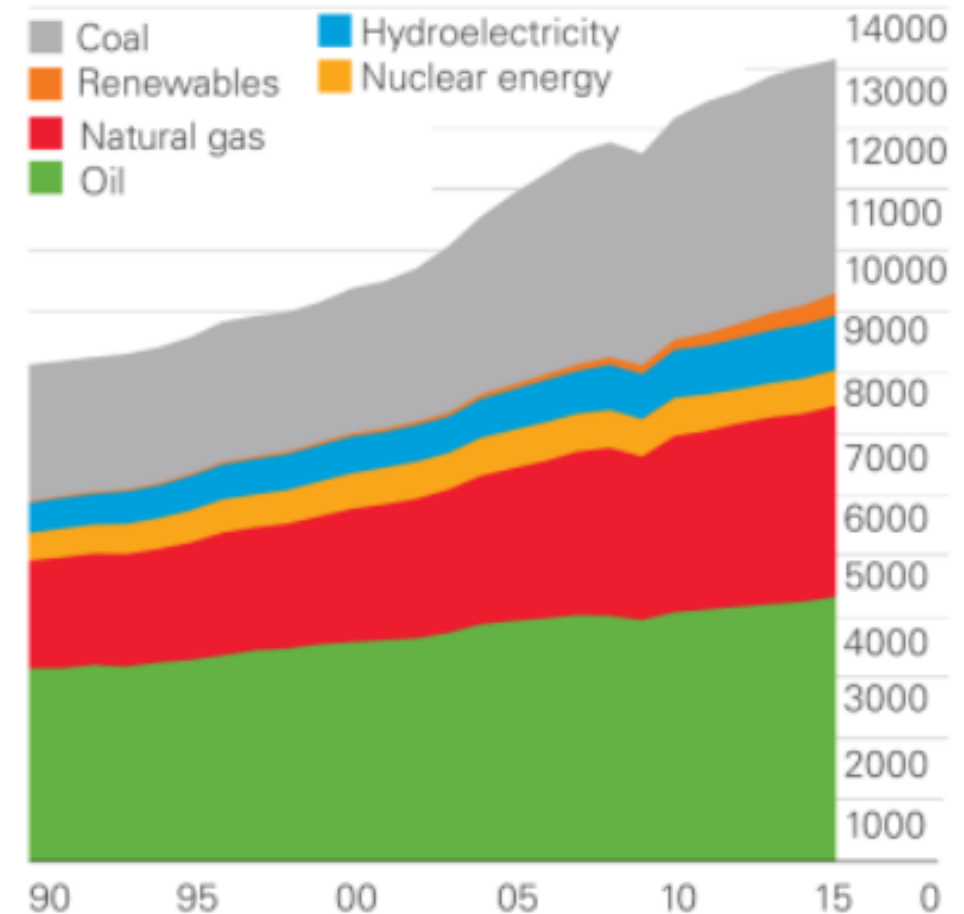
Economies of scale

make the LCOE argument weaker

Demand

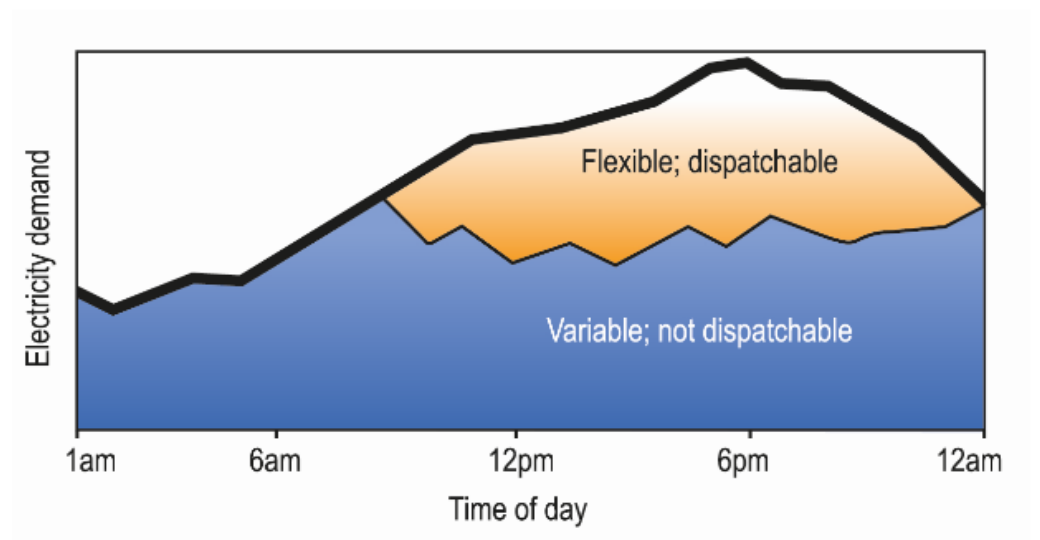
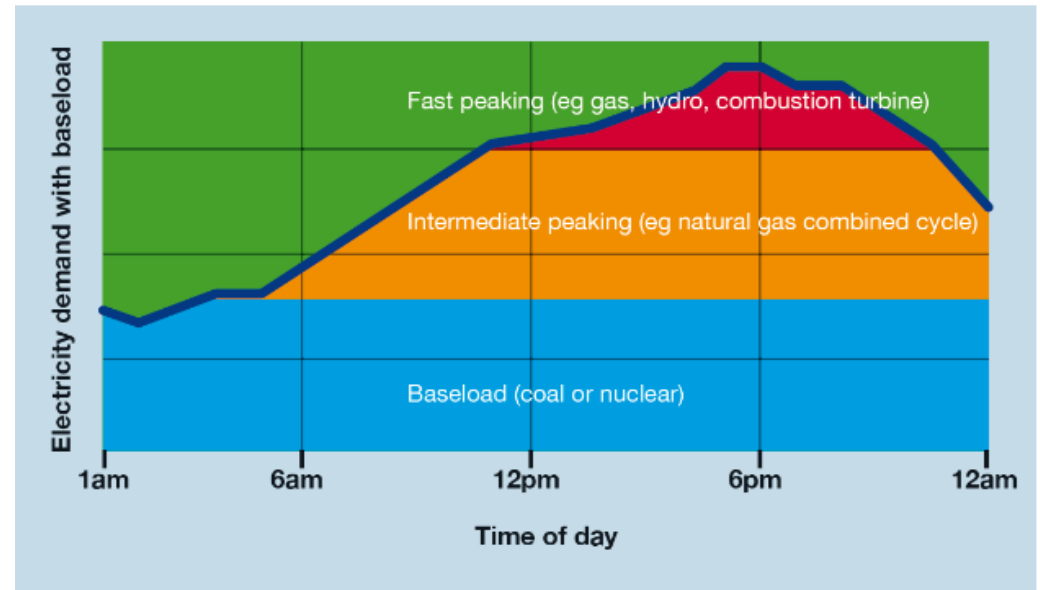
- Ever increasing demand
 - Increasing population
 - Industrial countries (BRIC, MINT)
- Increasing electrification
 - Trains
 - Cars
 - Automation
 - Cooling / heating
 - Cooking
 - Battery charging

Primary energy world consumption 2015
(million tonnes oil equivalent)



Demand

- Classic viewpoint
 - Baseload (nuclear, coal)
 - Intermediate (CCG)
 - Peak (Gas, hydro)
- The future?
 - Balance renewable fluctuations from variety of sources
 - Diverse renewable supplies
 - Smart metering (switch off AC, ultra high use industrial)
 - Storage



Energy density – how much bang per kg of fuel

| Fuel | MWhrs / kg |
|-------------------|-------------------------------|
| Nuclear Fusion H2 | 0.00012 |
| Nuclear fusion Ur | 0.00046 |
| Gas | 66 |
| Diesel | 80 |
| LNG | 97 |
| Coal | 150 |
| Wood | 600 |
| Wind | 112.9m m ³ air |
| Tidal | 2.4m m ³ water |
| Sunshine | 7000 m ² PV panels |

1 MWhr powers

- ~650 houses for 1 hour
- 10kW shower for 100 hours
- Play on computer for 12000 hours
- 6000 hours of LCD TV
- Charge you mobile for 1m hours
- Power a 1000m² super market for 3.5 days
- Power 50m² office building for 3 weeks