Occam Lecture

From High Carbon Baby to Low Carbon Boardroom

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Good Energy

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“Saving our planet, lifting people out of poverty, advancing economic growth... these are one and the same fight.

We must connect the dots between climate change, water scarcity, energy shortages, global health, food security and women's empowerment. Solutions to one problem must be solutions for all”

Ban Ki-moon. UN Secretary General
Following the Thread

- Studied Physics at Merton (1986) with Atmospheric Physics as speciality

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Facts and Changing Attitudes

Atmospheric CO₂ at Mauna Loa Observatory

- Scripps Institution of Oceanography
- NOAA Earth System Research Laboratory

YEAR

PARTS PER MILLION


Temperature Anomaly (°C)

1880 1900 1920 1940 1960 1980 2000 2020

NASA Goddard Institute for Space Studies
Hadley Center/Climate Research Unit
NOAA National Center for Environmental Information
Japanese Meteorological Agency

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And the thread continues on….

- Economics Masters at Birkbeck College, London
- Internship in European Commission and the European Parliament on carbon taxation
Grid Infrastructure Bias

- Built in mid 20th Century with few improvements since
- Interconnectors – a useful flexibility option that requires transmission
- National Grid maintain 50Hz frequency across the grid
Who is Good Energy?

Using 100% renewable electricity from British sunshine, wind and rain.
What is our Purpose?

To keep the world a habitable place by avoiding climate change and make the UK more energy self-sufficient

Enabling customers and independent renewable generators to play a part

Working to ensure the right legislative framework for renewables

Delivering this as part of a commercial business model
What do we do?

Good Energy’s projected 2015-2016 electricity fuel mix:

- Wind 54%
- Solar 21%
- Hydro 4%
- Biogas 21%
• I wanted to work with people - it's all about the customers
• Created the “blueprint” for a low carbon economy
• We were radical and very entrepreneurial
• No-one in the city believed that a concept like Good Energy would work
• So we turned it on its head and asked our customers if they would invest
How do we influence

- Natural Environment Research Council (NERC)
  - Award judging panel

- Energy UK Board
  - Small supplier voice

- Ofgem steering groups
  - Influence energy policy

- Founding supporter of POWERful Women
  - Influence business and inspire others
First Impact Awards 2015 recognised and rewarded the contribution of NERC science in four research areas fundamental to policy or business:

- **Economic Impact**: Water and gas monitoring instruments and job creation
- **Societal Impact**: Butterfly conservation in a changing climate
- **Early-Career Impact**: Extreme weather warnings
- **International Impact**: Ozone layer protection and
Climate Change: Science and Policy

- **Climate Science and Technology**
  - Accepted among the scientific community: IPCC Working Group 1
  - Sensitivities difficult to determine accurately (e.g., CO$_2$)
  - Innovation and research always improving (e.g., Solar PV)

- **Political Challenges and Messaging**
  - Short-termism and underlying principles
  - Paris Agreement and compromises – Finance flows
  - Global problem with distributed local impacts
  - Difficult to translate global risk into local reality into personal action
Energy Evolution

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UK Generation mix

2014
- Gas: 29.8%
- Coal: 29.7%
- Nuclear: 18.8%
- Renewables: 19.1%
- Oil & other: 2.6%

2015
- Gas: 29.5%
- Coal: 22.6%
- Nuclear: 20.8%
- Renewables: 24.7%
- Oil & other: 2.4%
Energy Revolution: Digitisation and Decentralisation

Software

Sensors

Semiconductors

Solar

Storage

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Battery Cost Projections

Battery costs are coming down faster than expected

Tesla’s Powerwall was 7 years ahead of industry average forecasts in 2014 and 25 years ahead of US EIA forecasts

Storage cost: (\$/kWh)

- Competitiveness Threshold
- BNEF
- Navigant
- Average 2014 forecast
- Tesla Adjusted Cost-Curve
- EIA EV-200 Li-ion

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Carbon Tracker

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Solar Deployment Projections

- Repowering (30 years lifetime)
- Net added capacity WEO 2015
- WEO 2013; spatially averaged values
- Gross added capacity WEO 2015
- Net added capacity (real data)
- WEO 2014; spatially averaged values

Energy Watch Group

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Solar Photovoltaics - Concept

- SUNLIGHT
- FRONT electrode (-)
- Anti-reflection coating
- N-type silicon (P+)
- P-type silicon (B-)
- BACK electrode (+)

INVERTER

Current
Solar Photovoltaics - Perovskite

The mineral perovskite

![Diagram of the mineral perovskite]

Typical perovskite solar absorber

![Diagram of a typical perovskite solar absorber]

- Theoretical Limits on Si efficiency reached c.25%
- Oxford PV: Perovskite structure – tuneable energy gap and low cost
- Double-layered increases theoretical efficiency to >30%
Low carbon world looks pretty different
Thank you for listening.

Questions?