Electricity Policy
Research Group

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Future Electricity Technologies and Systems

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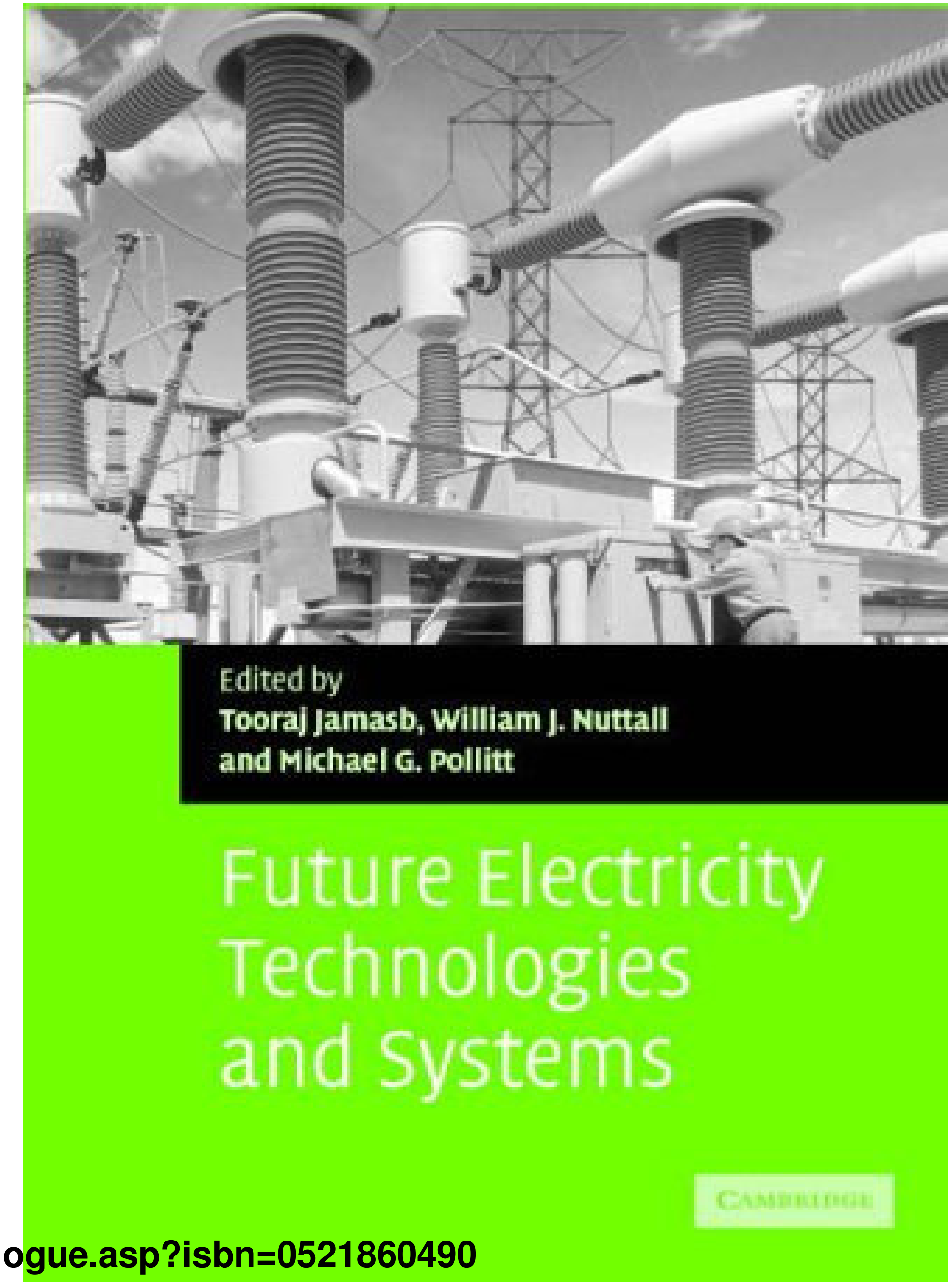

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Context

Table 3: Energy-Related CO_2 Emissions (million tonnes)
Source: IEA (2004a, p.75)

	OECD		**Transition Economics**		**Developing Countries**		**World**	
	2002	**2030**	**2002**	**2030**	**2002**	**2030**	**2002**	**2030**
Power Sector	4 793	6 191	1 270	1 639	3 354	8 941	9 417	16 771
Industry	1 723	1 949	400	618	1 954	3 000	4 076	5 576
Transport	3 384	4 856	285	531	1 245	3 353	4 914	8 739
Residential and Services	1 801	1 950	378	538	1 068	1 930	3 248	4 417
Other*	745	888	111	176	605	1 142	1 924	2 720
Total	12 446	15 833	2 444	3 501	8 226	18 365	23 579	38 214

* Includes international marine bunkers (for world totals only), other transformation and non-energy use.

Electricity, Carbon, and Renewables

- Electricity 60% of EUETS
- EU electricity from renewables 21% by 2010 (15%, 2001)
- UK 60% CO_2 reduction by 2050

Motivations for the book

- To allow a wide range of energy professionals to broaden their knowledge
  - e.g. to allow a wind specialist to learn about biomass.

- To stress the diversity of technological options.

- To offer a system perspective to specific technologies.

- To map long-term technological issues and possibilities

Content overview (1)

- **Part I: Renewable Generation Technologies**

- **Wind power**
  - *Poul Erik Morthorst (Risø)*
- **Solar Energy**
  - *Asim Mumtaz and Gehan Amaratunga (Univ. of Cambridge, Dept of Engineering)*
- **Bioenergy - Thermal Biomass**
  - *Tony Bridgwater (Aston University)*
- **Wave Energy**
  - *Tom Thorpe (Energetech Australia Pty. Ltd) and Robin Wallace (Univ. of Edinburgh)*

- **Part II: New Technologies for Thermal Generation**

- **CO_2 Capture, Transport and Storage**
  - *Nils Røkke (SINTEF Energy Research)*
- **Nuclear Energy**
  - *Malcolm Grimston (Imperial College)*
- **Minituarisation of the Generation**
  - *Andreas Biermann (International Energy Agency)*

Content overview (2)

- **Part III: Electricity Conversion and Transmission**

- **Superconductors**
  - *Archie Campbell (Univ. of Cambridge)*
- **Power Electronics**
  - *Tim Green and Carlos Hernández Arámburo (Imperial College)*
- **Sustainable Hydrogen**
  - *Peter P. Edwards, Martin Owen Jones, Matthew T. J. Lodge, Simon R. Johnson (Univ. of Oxford and Vladimir L. Kuznetsov (Univ. of Cardiff).*
- **Electrical Energy Storage**
  - *Alan Ruddell (Rutherford Appleton Laboratory)*

- **Part IV: End-Use Industrial Technologies**

- **Buildings**
  - *Wolfgang Eichhammer (Frauenhofer Institute fuer Systemtechnik und Innovationsfoschung, KA)*
- **Transport**
  - *Ronnie Belmans and Pieter Vermeyen (Katholieke Universiteit Leuven)*
- **End-Use Technologies**
  - *Lynn Price and Christina Galitsky (Lawrence Berkley National Laboratory) Ernst Worrell (Ecofys)*
- **Smart Metering in the UK**
  - *Hannah Devine-Wright and Patrick Devine-Wright (De Montfort University)*

Scenarios: UK Electricity Supply to 2050

(Elders et al., 2005)

Scenario name	*Economic growth*	*Technological growth*	*Environmental attitudes*	*Political & regulatory environment*
Strong Optimism	More than recently	Revolutionary	Stronger	Liberalised
Business as Usual	Same as recently	Evolutionary	As at present	Liberalised
Economic Downturn	Less than recently	Evolutionary	Weaker	Liberalised
Green Plus	Same as recently	Revolutionary	Much stronger	Liberalised
Technological Restriction	More than recently	Evolutionary	Stronger	Liberalised
Central Direction	Same as recently	Evolutionary	Stronger	Interventionist

2050 Technology Adoption in *Business as Usual* Scenario

Technology	Scope of application
Wind generation	Strong development (around 12GW of offshore capacity and 2-3GW onshore, totalling 12-15% of electrical energy generated)
Photovoltaic generation	Integrated into some new buildings, deeply embedded in distribution networks (less than 1GW, around 1% of energy)
Biomass electricity generation	Strong application of mainly smaller-scale plants and CHP (around 10GW, 10-15% of energy)
Wave generation	Some application in relatively small developments (up to 2-3GW in total, 3-5% of energy)
CO2 capture	Applied to a proportion of new CCGT and coal generators; 10-20GW of total capacity. Adopted for hydrogen production
Nuclear generation	One or two new stations using developments of existing technology (2-4GW, 5-10% of energy)
Microgeneration	Strong deployment, mainly using existing technology; total capacity of around 15GW, 20% of energy)

Comparing scenarios

Scenario	Total Generation Capacity (GW)	Renewable generation (% of Total Capacity)	Renewable generation (% of Total Energy)	Central generation (% of Total Capacity)	Central generation (% of Total Energy)
Current Situation	74[1]	7%	4%[2]	84%	90%
Strong Optimism	145	60-70%	50%	10-20%	10-20%
Business as Usual	110	40-50%	30%	45%	50%
Economic Downturn	55	20-30%	10-20%	65%	75%
Green Plus	110	90%	80%	0%	0%
Technological Restriction	135	50-60%	40%	30%	40-50%
Central Direction	100	60%	50-60%	20-25%	25-30%

Table 9: Summary of electricity generation in each scenario

Common issues to all technologies

- Market orientation
- Need for R+D and technology policy
- Price of fossil fuels
- Macro economic growth
- Public acceptance of technology

Conclusions

- Future electricity systems are likely to be diverse.
- Various technologies are at different points of the development stage - options in 2010 differ from those of 2020.
- Significant role for policy - to create the framework and balance R&DD and market