



# The Impact of Carbon Pricing

IFNEC Nuclear Finance Conference Paris, 12 May 2016

**Edward Kee** 

lasight in Representes"



"Since the dawn of the industrial revolution, the atmosphere has served as a free dumping ground for carbon gases. If people and industries are made to pay heavily for the privilege, they will inevitably be driven to develop cleaner fuels, cars and factories. Most of the industrialized world has accepted the need for either carbon taxes or strict regulation."

#### 3 Nov 2006, New York Times editorial



"Nuclear will make the difference between the world missing crucial climate targets or achieving them."

"The future of our planet and our descendants depends on basing decisions on facts, and letting go of long-held biases when it comes to nuclear power."

> 3 Dec 2015, The Guardian, James Hansen, Kerry Emanuel, Ken Caldeira and Tom Wigley

#### State and Trends of Carbon Pricing (World Bank 2015)





**IFNEC** Paris

3

#### State and Trends of Carbon Pricing (World Bank 2015)





12 May 2016



Price & mechanism	Emissions included	Use of revenue
Cap & Trade Carbon Tax	Electricity Transportation Industrial Commercial Residential Other	What revenue? Government use or revenue neutral?



	Cap & Trade	Carbon Tax
Emission level	Declining cap	Market responds with lower emissions
Carbon price	Market responds with increasing price	Increasing carbon tax

# Social cost of global warming?





**Emissions** 



Energy sources	Conversion dev	vices Pass	sive systems	Final services
Primary energy 475	Direct fuel use 272	Motion 175	Vehicle 106	_
	Diesel engine 58	Car 40	64	Passenger transport 23x10 <sup>12</sup> passenger-km
152 Oil 138	Petrol engine 41	Truck 38		
10.7	Aircraft engine 11	Plane 10 Ship 10 Train 8	64	Freight transport 46x10 <sup>12</sup> tonne-km
	Other engine To	Huin V	Factory 154	
50	Electric 55 motor	Driven system 56	Steel 34 68	Structure
54 Biomass		Hpat 233	Chemical 21	15X10° MPa~°m°
53	Oil burner 28	nu Steam system 67	Paper 13	
	Biomass 49	otean system or	Food 12 Aluminium 9 84	Sustenance
97 Gas 31	burner	Furnace 31	Other 47	28x10 <sup>18</sup> J (food)
5.3	Gas burner 47			
		Hot water system 23	56	Hygiene 1.5x10 <sup>12</sup> m <sup>3</sup> K (hot water)
4	Coal burner 31	Heated/cooled_86		2.8x1018 Nm (work)
127 Coal 44	Electric 58	space		
410	Electricity		90	Thermal comfort
96	Heat exchanger 20			30x10 <sup>-se</sup> m <sup>s</sup> K (air)
20 Nucleos	Cooler 33	Appliance 88	20	Communication
30 Nuclear 30	Light device 18		20	280x10 <sup>18</sup> bytes
15 Renewable 15	Heat Electronic 16	Illuminated space 18	19	480x10 <sup>18</sup> lm s
	Electricity generation 203	Other 67	Building 215	
Annual global flow of energy in 2005, EJ [10 <sup>18</sup> joules]	Annual global direct carb in 2005, Gt CO, [10 <sup>9</sup> tonr	on emissions nes of CO <sub>2</sub> ]		

in 2005, Gt CO<sub>2</sub> [10<sup>9</sup> tonnes of CO<sub>2</sub>]







### James Hansen, et al



- Carbon tax charged at origin for all greenhouse gas emitting energy fuels (e.g., oil, gas, coal)
- Carbon tax increases over time
- Revenue is returned to the public
- Limited role of government
  - Hands off revenue
  - Eliminate all subsidies and ad-hoc carbon control
- Will this support nuclear?

### **Economic Impact**



- Controlling carbon
  - Increase costs to consumers
  - Negative impact on economy
- Little political interest in increasing costs to voters or in depressing national economy
  - Small steps only
  - Wait for economy to improve
- A promise of carbon tax approach is recycling of revenue to mitigate negative impact on economy

De-carbonize electricity by 2050?



- Requires long-term shift in generation assets
  - Retire combustion-based generation
  - Add zero-carbon options (e.g., nuclear & renewables)
- Generation asset changes due to
  - Subsidies (e.g., renewables)
  - Political decisions (e.g., nuclear closure in Germany)
  - Environmental limits (e.g., coal power plants in US)
  - Generation planning (e.g., U.S. regulated/UK EMR)
  - Retirement (despite life/license extension)
- Carbon pricing?

### Nuclear investment needs certainty



- Nuclear generation investments are large, with long lead time, long asset life, need for long-term revenue adequacy and certainty
- Carbon pricing driven by government carbon policies – inherently uncertain (e.g., Australia)
- Key questions:
  - Carbon prices high enough to drive investment?
  - How long will generation asset changes take?
  - Will investors believe that carbon prices will remain?
  - What happens to existing generation assets?
  - Traditional vs. reformed electricity industry?

**IFNEC** Paris

# UK



- UK EMR focused on carbon goals, but uses methods separate from carbon pricing
- "Existing measures such as the carbon price floor or the Emissions Trading Scheme do not adequately meet the market failure which exists in the UK market."
- Different perspective:

HPC incentives = project-specific deal to get nuclear power built, with implicit carbon price embedded in overall incentive package

# U.S.



- CPP flawed approach to existing nuclear
  - Assumes existing nuclear operates until end of extended license period
  - More than 12 existing nuclear power plants are in danger of early retirement for economic reasons
- A different perspective apply carbon benefits in targeted unit-specific programs
  - Keep existing nuclear units in markets alive
    - Illinois Low Carbon Portfolio Standard
    - New York Clean Energy Standard
  - Planning in regulated utilities (e.g., Vogtle, Summer),
    where premium for nuclear = implicit carbon price

### Observations



- Electricity market failure carbon pricing may help, but not clear
- Carbon pricing is uncertain
  - Governments wary of economic impact
  - Little confidence in strong *and* long-term carbon pricing
  - Doubt that carbon pricing will support new nuclear
- Rethink economy-wide carbon approach and focus on specific projects (existing and new)
- Treat nuclear more like renewables?





#### **Edward Kee**

#### **Nuclear Economics Consulting Group**

+1 (202) 370-7713 edk@nuclear-economics.com www.nuclear-economics.com

> © Copyright 2016 NECG All rights reserved.