

# Session 4

## Green Environment and Sustainable Development for Emerging Economies

### GHG, Transportation and Rational Behavior

Associate Professor Anthony Chin  
Department of Economics, NUS  
[anthonychin@nus.edu.sg](mailto:anthonychin@nus.edu.sg)

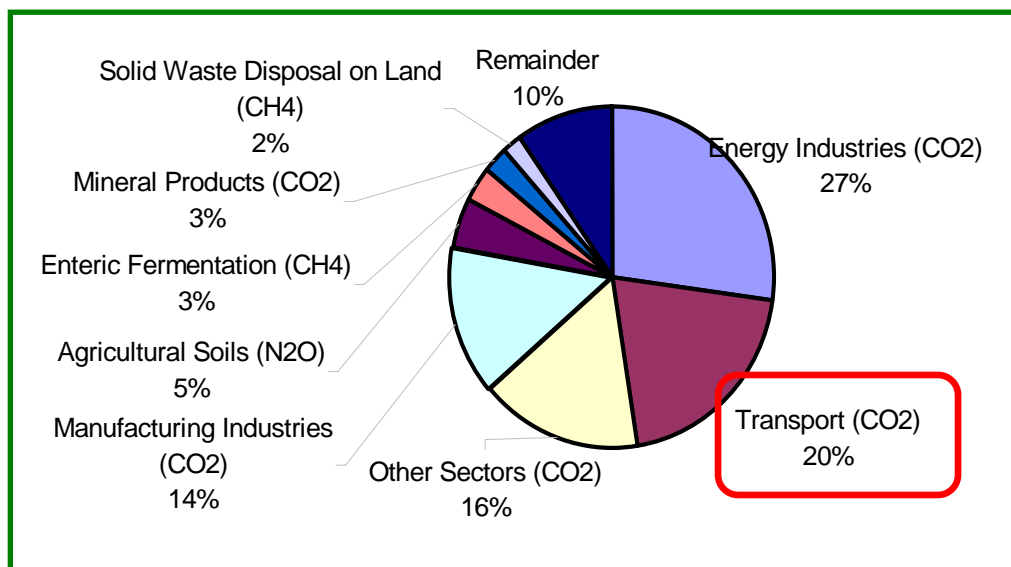
PECC Conference on 11/20/2009  
Economic Crisis &  
Recovery, 9-10 October  
2009

Security of supply and climate change are high on the global energy agenda. And the transport sector is no exception as virtually every means of transport by land, air and sea uses fossil fuels and thus emits CO<sub>2</sub>. Energy consumption for transport purposes represents 20% of the world's total energy consumption.

***ScienceDaily***  
*(July 27, 2009)*

# Sources of CO<sub>2</sub> Emissions

Sources of CO<sub>2</sub> contributors in 2007 (kilo tonnes) World



Road transport contributes close to 80 per cent to climate change. Air transport contributes 13 per cent, sea transport 7 per cent and rail contributes just half a per cent of total emissions from the transport sector.

<http://www.unep.org/climateutral/Topics/Transport/tabid/154/Default.aspx>

Sources of CO<sub>2</sub> contributors in 2005 (kilo tonnes) Singapore

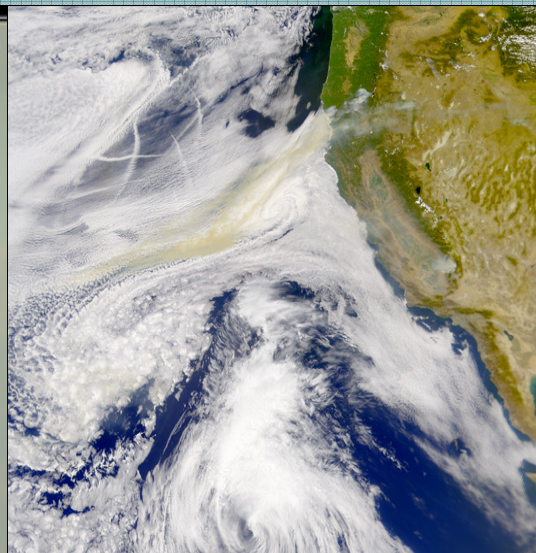
	Electricity Generation	Industry	Transport	Buildings	Consumers/ Household	Others
Primary Consumption (combust fuel)	19,315 (48%)	13,465 (33%)	7,056 (17%)	325 (1%)	216 (1%)	–
Secondary Consumption (use electricity)	–	8,328 (21%)	930 (2%)	5,910 (15%)	3,415 (8%)	732 (2%)
Overall	–	21,793 (54%)	7,986 (19%)	6,235 (16%)	3,631 (9%)	732 (2%)
Total CO <sub>2</sub> = 40,377 kilo tonnes						

Source: National Environment Agency

# World Aircraft Movements

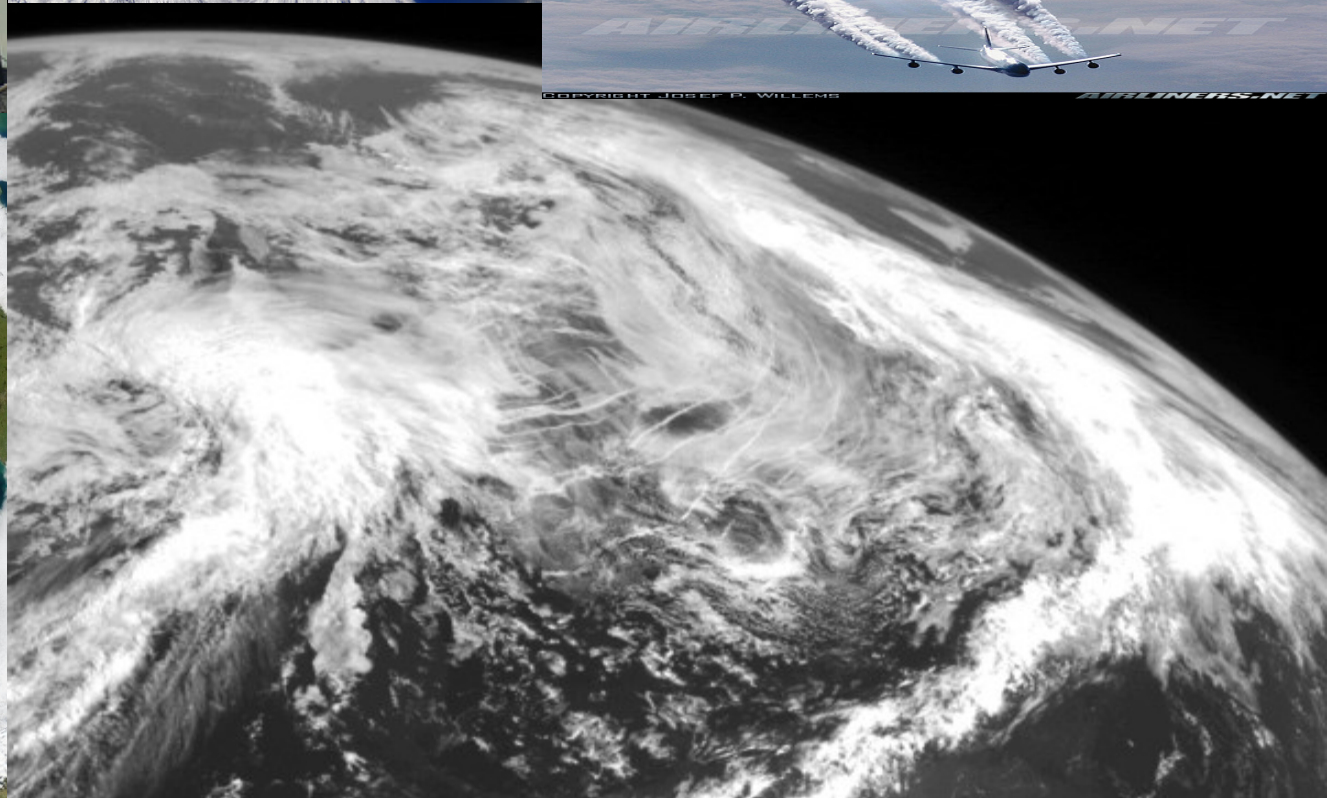
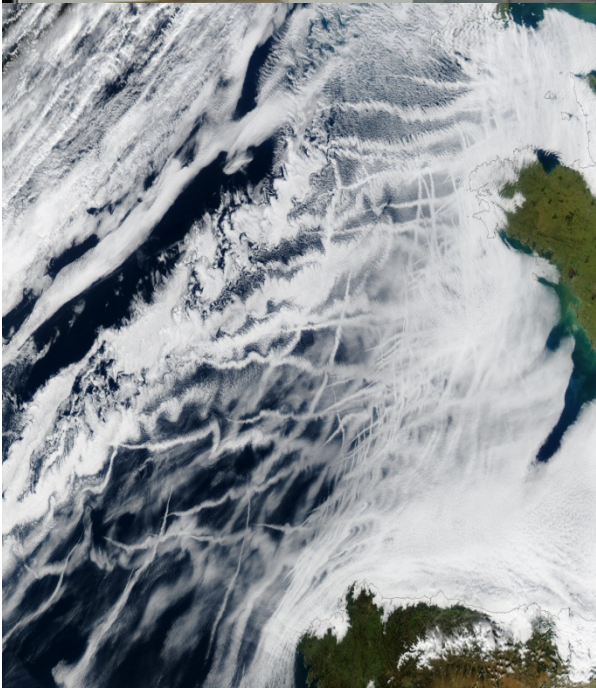






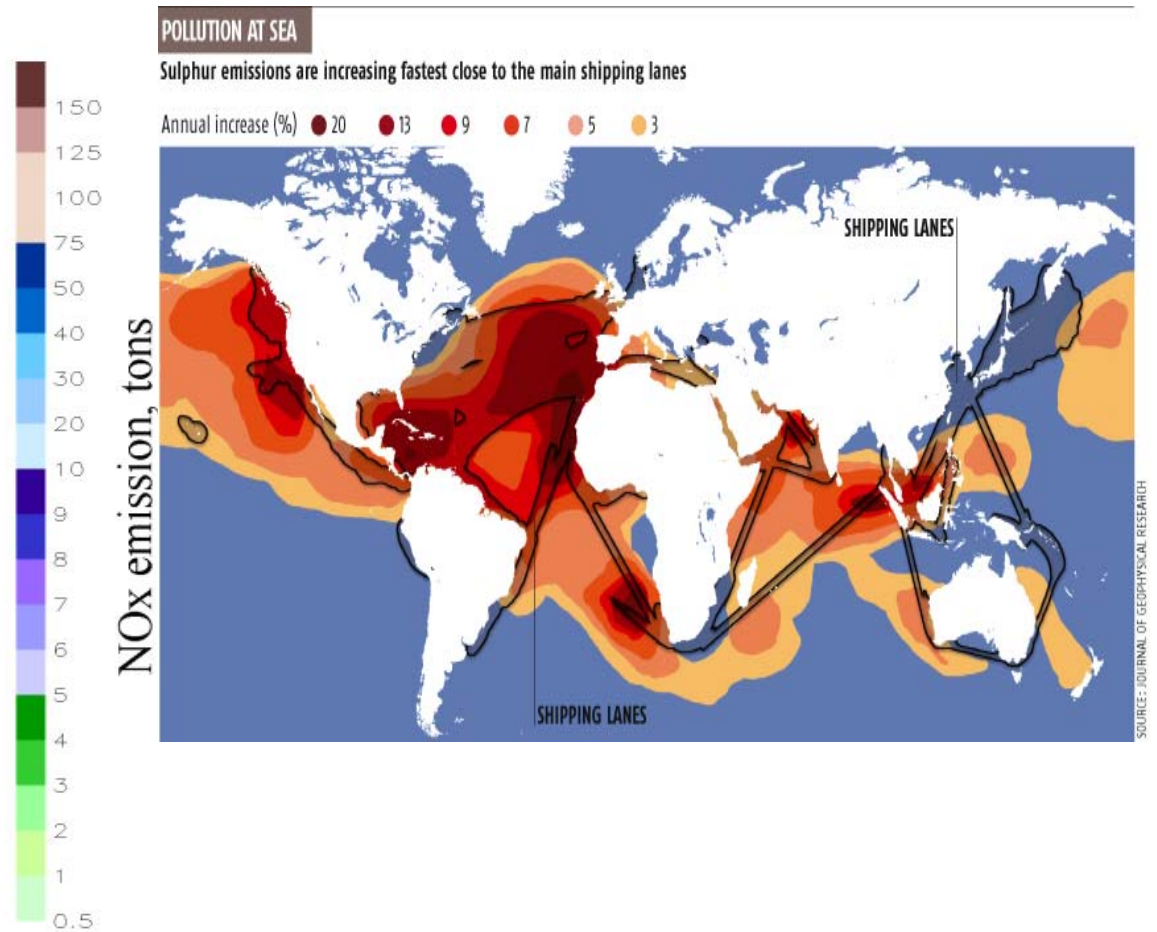
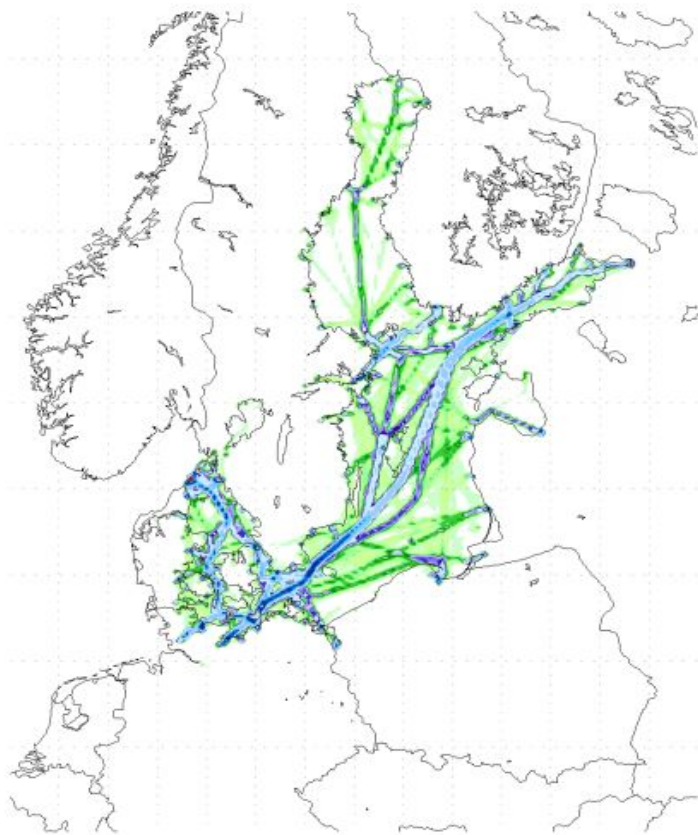
PECC Conference on  
Economic Crisis &  
Recovery, 9-10 October  
2009

11/20/2009

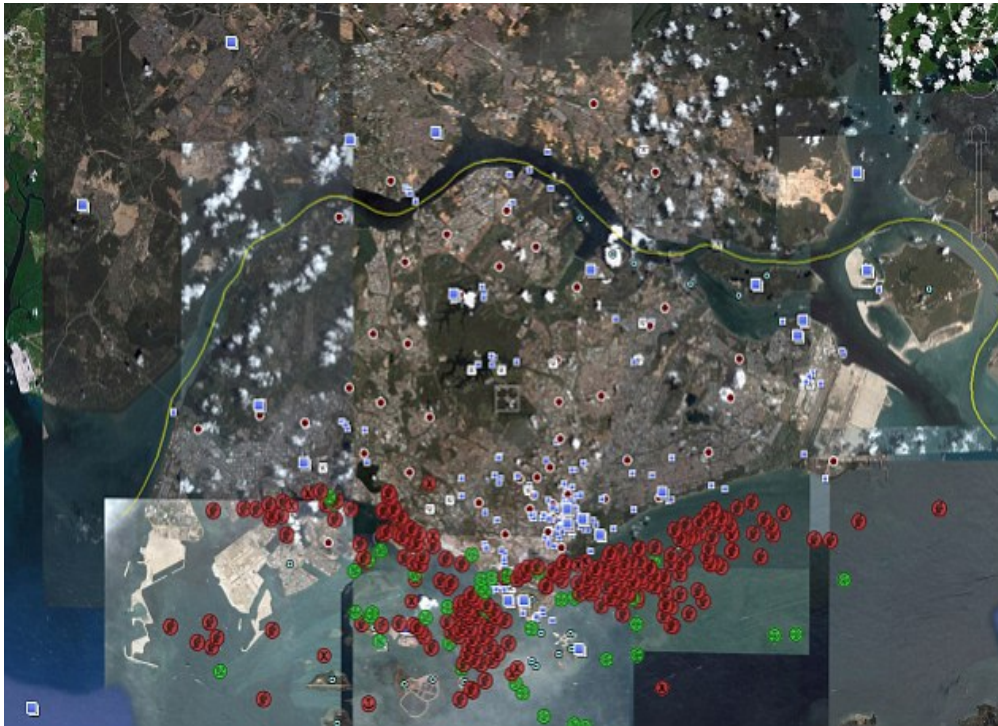




## Total NOx emission, March 2007



PECC Conference on  
Economic Crisis &  
Recovery, 9-10 October  
2009



© Richard Jones / Sinopix



# Budget cars rule!

PECC Conference on  
Economic Crisis &  
Recovery, 9-10 October  
2009

11/20/2009

## USD 3,900

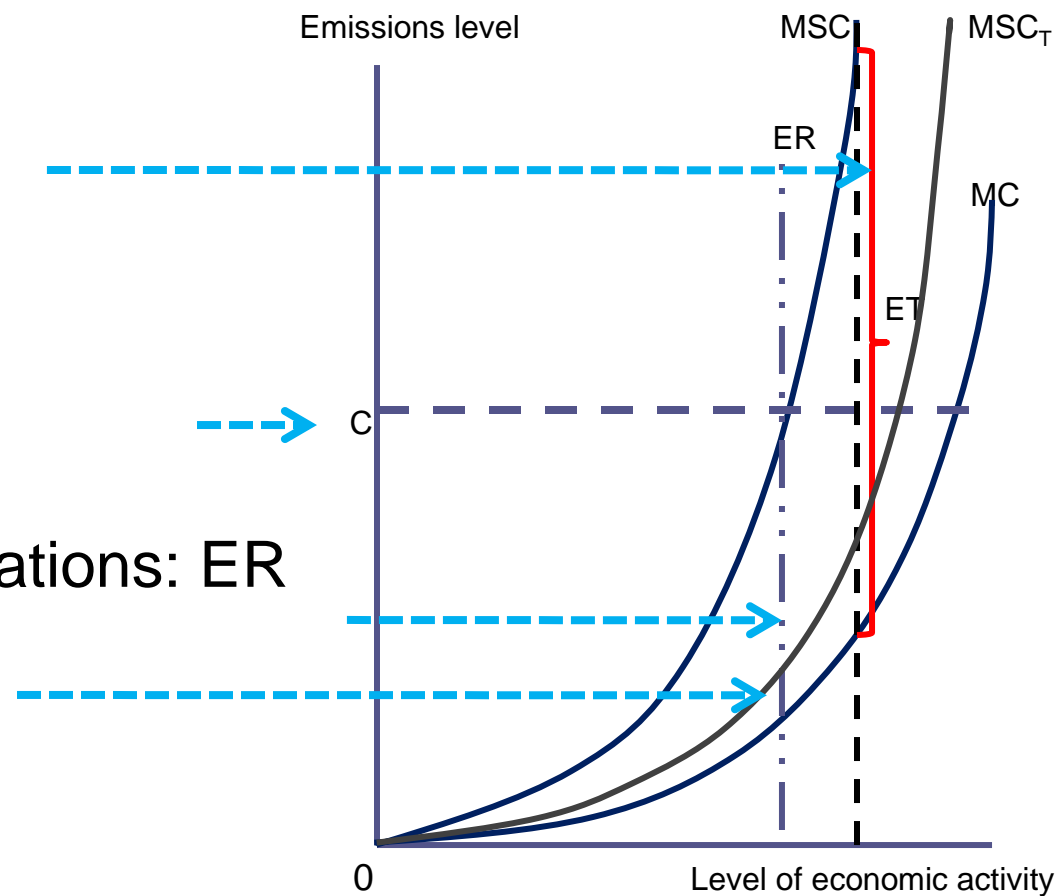
0.8 l





# Economic solutions

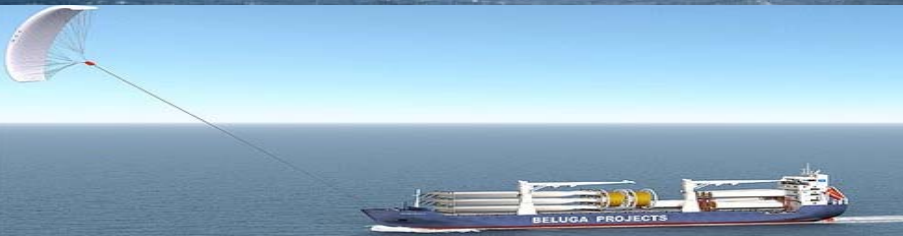
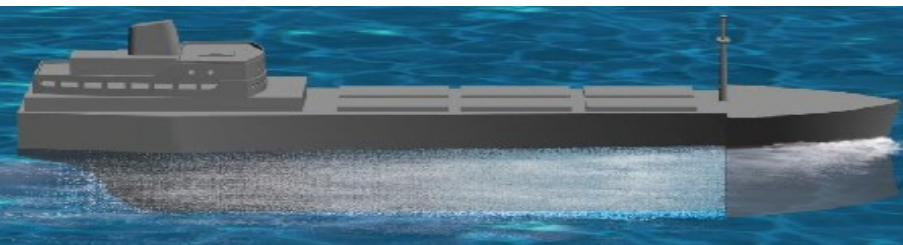
- Emission taxes:  $ET$
- Cap AND Trade:  $C$
- Cap on trade:  $C$
- Environmental regulations:  $ER$
- Technology:  $MSC_T$



# Holistic approach

- Technology: Information and Vehicle
- Psychology
- Marketing
- Economic instruments
- Traffic Engineering & Management
- Alternative efficient and 'green modes'

# Green Technology

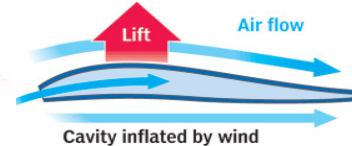


787 Dreamliner and A380 generate about 20% less carbon dioxide than their predecessors.

An Airbus A380 being loaded with synthetic GTL aviation fuel

© Rolls-Royce PLC 2008

## ■ Cross-section



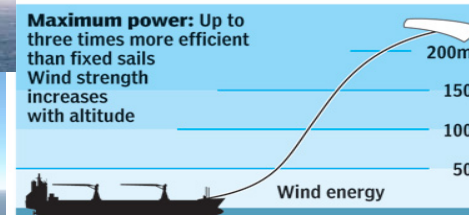
■ **Control pod:** Automatically aligns kite – based on wind direction, force, ship route and speed – by pulling control cords



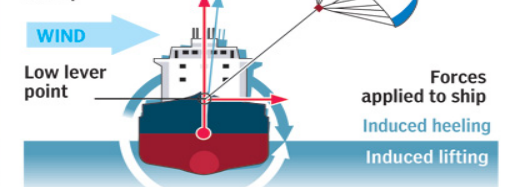
■ **Sailing direction:** SkySail can be used to sail at up to 50° against wind

SkySail saving 10-35%

**Maximum power:** Up to three times more efficient than fixed sails  
Wind strength increases with altitude



**Stability:** Lift force minimizes heeling of ship



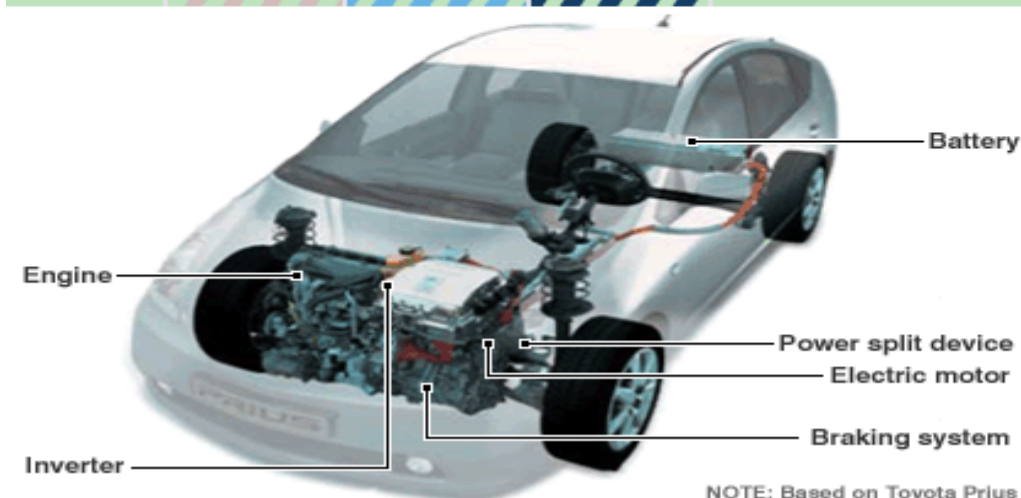
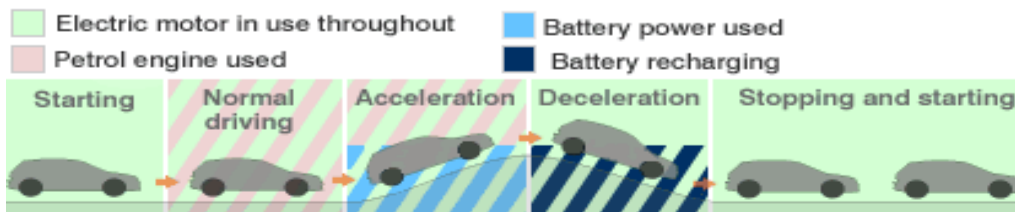
SOURCES: SKYSAILS, BELUGA GROUP, WINTECC PROJECT

GRAPHIC NEWS / NATIONAL POST



# KEY COMPONENTS OF A HYBRID CAR

Many hybrid cars cut fuel consumption by combining a petrol engine with additional power sources - such as battery power



Category	Current Quota Premium	Previous Quota Premium	▲/▼	Difference
A (1600cc and below, taxi)	S\$5,116	S\$4,890	▲	S\$226
B (1601cc and above)	S\$5,001	S\$5,101	▼	S\$100
C (Goods Vehicle and Bus)	S\$5,600	S\$5,300	▲	S\$300
D (Motorcycles)	S\$912	S\$958	▼	S\$46
E (Open)	S\$5,982	S\$5,700	▼	S\$282

**Quota Premium**  
(March 2009 2nd Open Bidding)

# Key mitigation technologies and practices by sector

## IPCC Fourth Assessment Report, 2007

Sector	Key mitigation technologies and practices currently commercially available	Key mitigation technologies and practices projected to be commercialized before 2030
Energy Supply	Improved supply and distribution efficiency; fuel switching from <u>coal</u> to <u>gas</u> ; <u>nuclear power</u> ; <u>renewable heat and power</u> ( <u>hydropower</u> , <u>solar</u> , <u>wind</u> , <u>geothermal</u> and <u>bioenergy</u> ); <u>combined heat and power</u> ; early applications of <u>CCS</u> (e.g. storage of removed CO <sub>2</sub> from natural gas)	Carbon Capture and Storage (CCS) for gas, biomass and coal-fired electricity generating facilities; advanced nuclear power; advanced renewable energy, including <u>tidal</u> and <u>waves energy</u> , <u>concentrating solar</u> , and <u>solar PV</u> .
Transport	More fuel efficient vehicles; <u>hybrid vehicles</u> ; cleaner diesel vehicles; <u>biofuels</u> ; modal shifts from <u>road transport</u> to <u>rail</u> and <u>public transport</u> systems; non-motorized transport ( <u>cycling</u> , <u>walking</u> ); land-use and <u>transport planning</u>	Second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles with more powerful and reliable batteries
Buildings	<u>Efficient lighting</u> and <u>day light</u> ; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improved <u>insulation</u> ; <u>passive</u> and <u>active solar</u> design for heating and cooling; alternative refrigeration fluids, recovery and recycle of fluorinated gases	Integrated design of commercial buildings including technologies, such as <u>intelligent meters</u> that provide feedback and control; <u>solar PV integrated in buildings</u>
Industry	More efficient end-use electrical equipment; <u>heat</u> and <u>power recovery</u> ; material <u>recycling</u> and substitution; control of non-CO <sub>2</sub> gas emissions; and a wide array of process-specific technologies	Advanced energy efficiency; CCS for <u>cement</u> , <u>ammonia</u> , and <u>iron</u> manufacture; inert <u>electrodes</u> for aluminum manufacture

## What lies at the heart of making green choice?

- The dilemma is, not that opposition to reducing Green House Gas emissions is too high but that support is too low;
- Decisions are more often governed by emotions than by analysis; more by its meaning than by its monetary value.



# Decarbonise road transport!



(M6 Toll) Tariff	
Mon - Fri	Sat - Sun
£2.70	£2.50
£4.70	£4.50
£9.40	£9.00
£9.40	£9.00

- Ultra low carbon vehicles increasing the efficiency of existing engines and systems
- Market reality: Rechargeable electric or hybrid electric vehicle.
- Traffic congestion: Speedier maintenance, better information systems, and promoting the use of in-car technology i.e. intelligent speed adaptation.
- “If everyone switched to diesel vehicles, CO2 emissions would drop by 30 per cent overnight,” Andrew Didlick, Peugeot, Director Public Affairs, UK.
- Longer- term: Network expansion, which could cut carbon emissions by improving traffic flow, and also improve urban air quality by moving through traffic onto bypasses.

# Human Behavior

- Human beings bear little more than a passing resemblance to the "economic man" of classic economics textbooks. **We're messy creatures, not altogether skilled at maximizing value, or efficiency, or all those other things our self-interest is supposed to drive us to attain.**

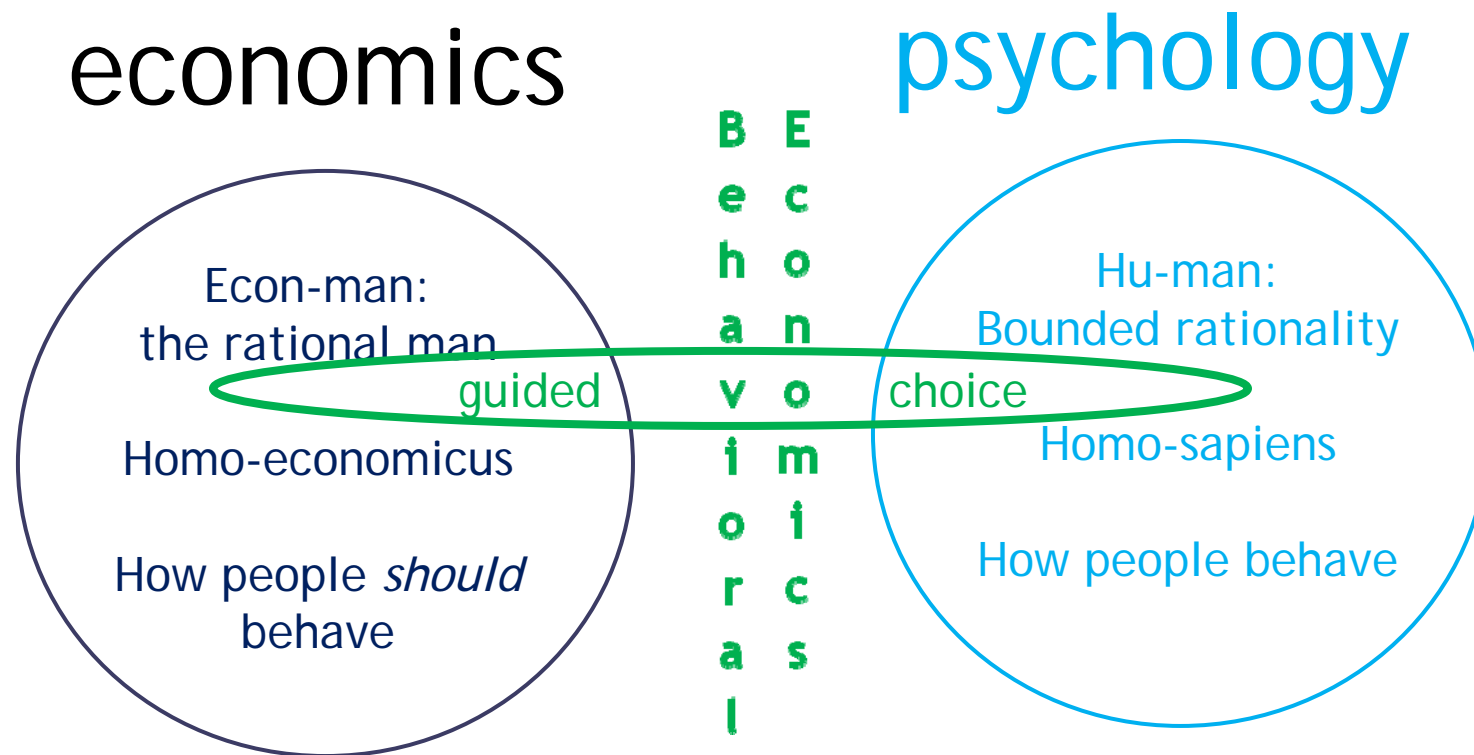
Cass Sunstein & Richard Thaler, *Nudge*; Dan Ariely, *Predictably Irrational*; George Akerlof & Robert Shiller, *Animal Spirits*

- "People make bad choices!"**

Barry Schwartz, *The Paradox of Choice*

- "choice architecture"**: framing how decision makers can gently scoot people towards better choices
- "information architecture or interaction design"**: understand today's information-rich world is confusing, and give focus attention to crafting the environment in which people make choices gives us, "a fighting chance of knowing what we're doing."

# Paradigms in human behavior





# Guiding behavior 1

- Designing **Advanced Traveller Information Services** (ATIS) that benefit individuals and transport systems;
- Recent evidence showed that even when provided with **explicit information** on their travel choices, **travellers** turn out to interpret and value this information in a way that systematically violates the assumptions of rational behaviour.
- Travellers are **heavily influenced by context**, i.e. the manner in which travel information is being presented.
- Salience: It is difficult to the driver to easily imagine the air pollution and climate change caused by carbon emissions.

PECC Conference on  
Economic Crisis &  
Recovery, 9-10 October  
2009

11/20/2009


# Getting the message across!

GoGreenWithSMRT | Login - Windows Internet Explorer


https://www.smrtisgreen.com/

File Edit View Favorites Tools Help

GoGreenWithSMRT | Login



## JOIN THE GREEN REVOLUTION



Home Join the Revolution Promotion Tell-a-Friend Draw Results Gallery Supporters and Partners Contact

### Better by Train. Better by Bus. Let's clear the air. Public Transport is better.

A carbon footprint is the impact of our daily activities on the environment, in particular climate change. It is measured by the amount of carbon dioxide we produce.

You can reduce your carbon footprint by 91% with the train, and 67% with the bus.

In a year, your carbon footprint is 29kg when you take an SMRT train and 101kg when you take an SMRT bus. If you take a car, your carbon footprint is 308kg.

Act for the environment. Take public transport.

### Join the Green Revolution

**Win 1-year free travel for four  
1 May - 30 Sep 09**

Do your bit for the environment by making public transport your choice mode. Win 1-year free travel for a family of four when you travel on SMRT trains, LRT and buses.

### Double your winning chances!

**HOW?**

- SMS ez-link card no., Name, NRIC/FIN/Passport no. to 9737 5608
- [GoGreenwithSMRT.com](http://GoGreenwithSMRT.com)
- Drop off completed form at any Passenger Service Centre at SMRT MRT stations or bus interchanges

### September Draw Winners

**3-month free travel with SMRT**

146-800-818	Adult ez-link
1000-0800-4242-0541	Adult ez-link
1000-0800-3139-9014	Adult ez-link
1000-0800-0892-0340	Adult ez-link
SXXXX516B	U Sattibabu

### JOIN US!

**Raffles Place MRT Station (Raffles Xchange)**  
15 Oct 09 | 12.30pm

Win free travel on SMRT trains, LRT and buses.

### Login

As a registered user, you may update your profile, change your password, view your chances and register new ez-link cards.

NRIC/FIN/Passport No.

Password

Forgot password? Click [here](#)  
Can't login? [Contact Us](#)

Login

### SMRT Green Heroes

Be an SMRT Green Hero!

EN English (United States) ?

Local intranet | Protected Mode: On 100%

Inbox - Microsoft O... Microsoft PowerPoi... SMRT Website - Mo... GoGreenWithSMRT ... TPT LAND Document1 - Micro...

5:32 PM

## Guiding behavior 2

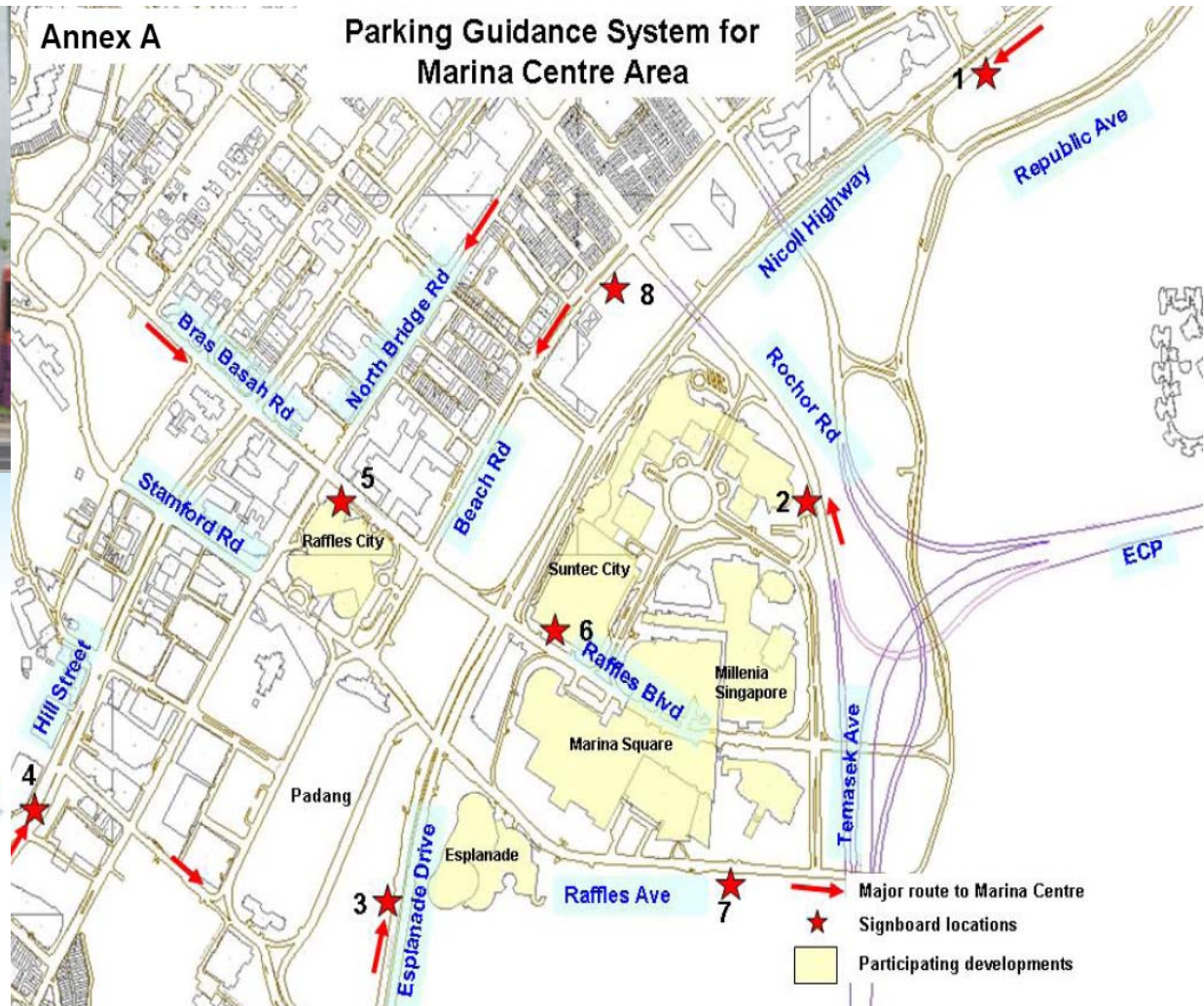
- In-vehicle data recorders on drivers' behaviour:  
Visibility and doing the right thing
- Provide drivers with environmental costs, against some targets or against previous performance, could provide them with a psychological incentive to change their behaviour.
- Choice architecture + measures to influence choice



# Parking Guiding System



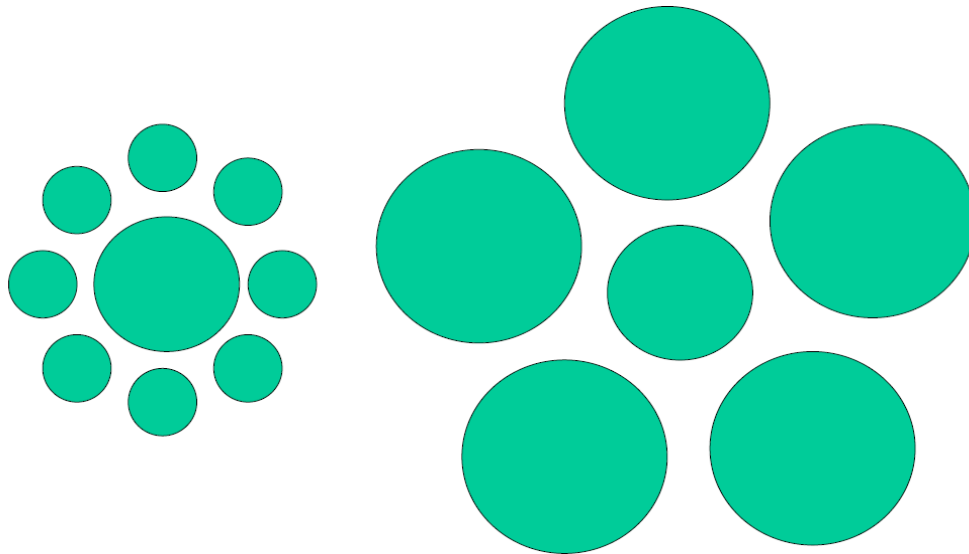
System Architecture of PGS



## Guiding behavior 3 Road-pricing

- Get prices right through taxes / subsidies;
- Recognize bounded rationality :
- Travelers do not always associate their behaviour with the relevant costs;
- Guided choice helps individuals overcome cognitive biases, highlight the better choices, and increase the size and the speed of behavioural change - without restricting choices or limiting travellers' freedom of choice.

# It's the context!



A nudge is any small feature in the environment that attracts our attention and alter our behaviour



Urinal at Schiphol, Amsterdam



# Smart Meter & Light synchronization



A traffic light synchronization program in Texas **reduced delays by 24.6 percent and fuel consumption by 14.2 percent.**

A similar program in Austin Texas saved commuters **2.3 million hours of their time and 1.2 million gallons of fuel usage.**

U.S. Department of  
Transportation Report





# Nudging through the design of information

## Loss Aversion

Commuting Choices:

By car: 35 minutes

By MRT: 25 minutes



By Car : 35 minutes

By MRT : You SAVE 10 minutes



By MRT : 25 minutes

By Car : You take 10 minutes LONGER

# In conclusion

“The challenge we have now is to **shape how we navigate that information in meaningful ways**. The people who truly figure that out, are going to be the ones to run the world.”

*Barry Schwartz, Professor of Social Theory and Social Action, Swarthmore College*

“Climate change is shaping global markets and global consumer attitudes. There will be winners and losers. Companies who seize the opportunities, who adopt environmental, social and governance policies and who evolve, innovate and respond to these challenges are likely to be the pioneers and industry leaders of the 21st century.”

*Director*

*Achim Steiner, UNEP Executive*