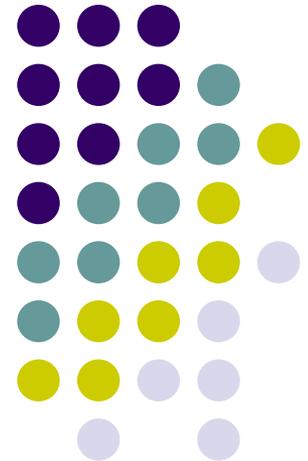
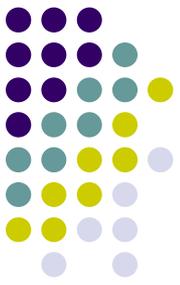


# Ecological Modernization & Environmental Innovation: What is the role of environmental regulation?

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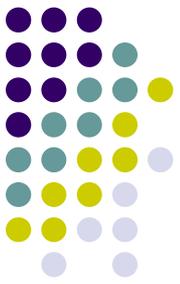


# Env Innovation & Economic Performance



- Environmental innovation (EI)
  - a critical means to achieve both *economic gain* and *environmental performance* in the Ecological Modernization Theory (EMT).
- Adoption of EI has the potential of
  - reducing emissions and the consumption of resources
  - improving the eco-efficiency to bring about better competitiveness
- Purpose of this paper
  - to investigate the conditions that govern the adaptation and diffusion of EI and policies that can mostly effectively stimulate the industry to engage in EI

# Defining Environmental Innovation



- **General Definition of Environmental Innovation**  
Measures of relevant actors which help develop new ideas, behaviour, products and processes, apply or introduce them and which contribute to a reduction of environmental burdens, an improvement in resource efficiency as well as economic gains (Porter and Van der Linde, 1995b; Gouldson and Murphy, 1998; Rennings, 2000)
- **EM-based Environmental Innovation**  
Any innovation measures that contributes to an improvement in environmental efficiency as well as economic benefits for firms adopting such measure.
- **This study focuses on EM-based Technological Environmental Innovation**

# EM-based environmental policy (I)



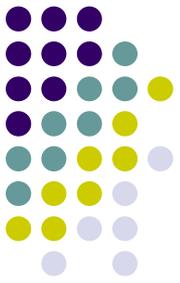
- the traditional command & control regulation (C&C REG) policy approach are less effective in creating favourable conditions for environmentally sound practices and behaviour
- increasingly replaced by market-based and voluntary measures
- However, the success of incentive-based and voluntary measures depend, to a certain extent, on the willingness of firms to commit to TEI and the removal of barriers such as uncertainty, negative externality, spillover problem, info. asymmetry.

# EM-based environmental policy (II)

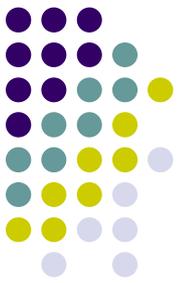


- However, the success of incentive-based and voluntary measures depend on
  - the willingness of firms to commit to TEI
  - the removal of barriers such as uncertainty, negative externality, spillover problem, info. asymmetry.
- Regulation, if carefully designed, is still a useful tool to complement non-regulatory measures and catalyze the adoption of TEI.

# New Environment Regulatory Approach (NERA)

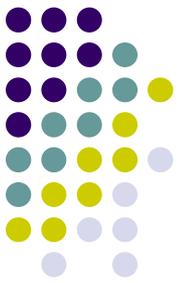


- capitalizes on the regulatory pressure of environmental regulation to stimulate TEIs
- accommodates non-regulatory instruments to enhance the capability of the business
- replace traditional environmental regulations with new environmental regulations that are innovation-oriented, and are properly-designed and implemented
  - To reduce the negative impacts of traditional C&C REG
- policy characteristics
  - goal-setting, stringency, flexibility, certainty, consistency, innovation-oriented, participatory, capability-enhanced,



# TEI Conditions

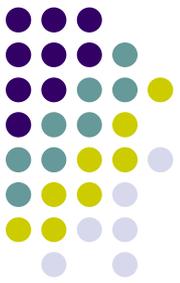
- The adoption/diffusion of TEI is determined by *economic*, *firm-internal* and *contextual* factors.
- Apart from costs, many other factors prevent the adoption/diffusion of TEI
  - market failures and barriers, such as negative externality, information asymmetry, and technological lock-in (Jaffe, Newell and Stavins, 2000)
  - bounded rationality, firm capability and stakeholder pressure



# Economic Condition

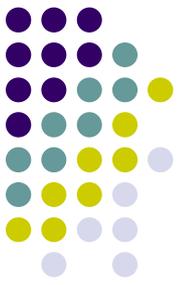
- Do economic benefits outweigh the expected costs of a TEI investment?
- Short term high costs are usually repaid after a long period of time.
- Benefits
  - Direct: may reduce costs
  - Indirect: improved resource productivity, increased competitive advantage, improved customer satisfactions, public relations, staff commitment, corporate reputation, ... (Porter & Van der Linde 1995a, 1995b, Gouldson & Murphy 1998, Jaffe, Newell & Stavins 2004)

# Firm Internal Conditions: Innovation Capability

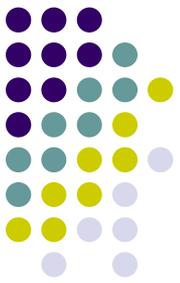


- organizational and technological capabilities, strategic alliances and networks of collaboration are critical to the willingness of adopting TEI
  - Corral (2002, 2003), Gouldson and Murphy (1998), Kemp (1997)
- Organizational capabilities
  - the ability for firms to learn quickly and reshape organizational structures and routines to enable the integration of TEI in the company
- Technological capabilities
  - the extent that the existing production processes are able to adapt to and prepare for transitions towards new technological pathways

# Contextual Conditions: Attitudes, Norms & Behaviours



- Stakeholder attitudes, norms and behaviours of individuals are considered to be critical determinants in explaining the TEI behavior
  - Klemmer, Lehr & Lobbe (1999)
- e.g. Firm managers need to attend to attitudes and norms of societal stakeholders such as customers or regulators.

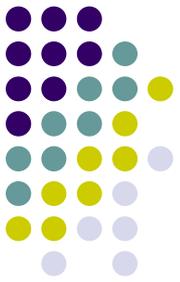


# Role of Env. Regulation

- The Traditional Env. Regulatory Approach (TERA) is dominated by command-and-control regulation (C&C REG), characterized by rules, hierarchy, control, deterrence and specialization. (Fiorino, 2006).
  - impedes innovation, inflexible, legalistic, fragmented, ...
- Firms are not encouraged to go beyond the prescribed level even if they have the capacity as no benefits can be reaped from such efforts.

# Question

- What kind of env. regulation should we promote?



# Properly-designed Env. Regulation



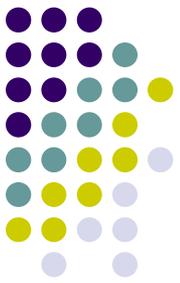
- Porter & van der Linde (1995) argue that properly-designed environmental regulation (PD REG) may not only benefit the environment but also the regulated industries by forcing industry to innovate and thus increase productivity and resource efficiency.
- “win-win” hypothesis
- To avoid the negative consequence of C&C REG in the past, they note that good env. regulations that foster TEI should be designed in such a way that
  - should create maximum opportunity for industries to innovate,
  - should be technology-forcing instead of technology-setting, and
  - should leave little rooms for uncertainty at every stage during the regulatory process.

# Characteristics of PD REG (I)



- Goal-setting
  - focus on long-term goals to steer regulated firms towards the most innovative solution, instead of forcing them to adopt particular technologies (technology-setting) or environmental standards (standard-setting).
- Stringency
  - provide impetus for regulated firms to strive for higher environmental performance.
- Flexibility
  - increase the flexibility for regulated firms in terms of how they achieve the regulatory target.

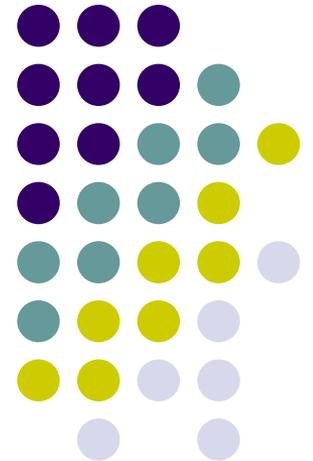
# Characteristics of PD REG (II)



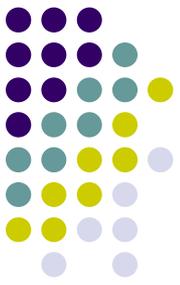
- Incentive-driven
  - couples environmental regulations with other incentive-based instruments, e.g. pollution charges, tradeable permits, or credit system
- Participatory
  - encourage industrial participation in the design of phase-in periods, the content of regulations, trust-building, and self-regulatory behaviours, such as information disclosure.
- Capability-enhanced
  - enhance managerial competence and receptivity, by introducing voluntary programmes in the form of technical assistance, demonstration projects and training programmes and technological consulting services
- Consistency, Certainty, ...

# Case Study

Zero Emission Bus in California



# Zero Emission Bus Regulation Background (CARB 2009)



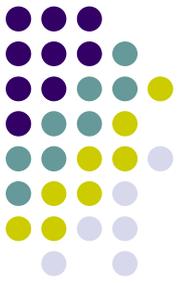
- Adopted in Feb 2000 & modified in Jun 2004
- Goal - Encourage a fleet dominated by zero emission vehicles
- Fuel Cell Buses had demonstrated ability to meet performance needs
- Fuel cell manufacturers anticipated bus cost to be roughly equivalent to overhead trolley by 2004

# ZEBus Purchase Requirements



- Diesel Path
  - Based on number of buses Jan 2007
  - Agencies with > 200 buses
  - 15% 2008-2015
- Alternative Fuel Path
  - Based on number of buses Jan 2009
  - Agencies with > 200 buses
  - 15% 2010-2015

# ZBus Regulation & NERA (I)



- Goal-setting & Certainty
  - well defined phase-in periods and deadlines for ZBus demonstration, purchase requirements and other targets
- Stringency
  - a certain percentage of buses purchased or leased should be ZBuses by certain deadlines
  - transit bus operators should commit to the ZBus demonstrations on street
- Consistency
  - broadly consistent with other regulations by CARB, e.g. the ZEV Mandate or ZEV Regulation.

# ZBus Regulation & NERA (II)



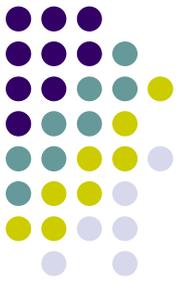
- Flexibility
  - a grace period to implement ZBus demonstration programmes
  - options for joint implementation of demonstration and purchase/leasing agreements of ZBuses
- Incentive-driven
  - Credit award systems encourage early adoption of advanced ZBus technologies.
- Participatory
  - extensive consultation with the transit agencies and other stakeholders, through regular meetings and consultations

# ZBus Regulation & NERA (III)

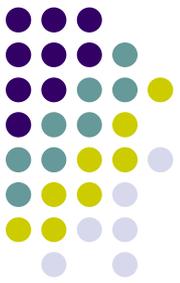


- Capability-enhanced
  - joint participation between transit agencies creates opportunities for inter-organizational learning and sharing of funding resources.
  - CaFCP
    - provides opportunities for transit agencies to team up auto manufacturers, energy companies, fuel cell technology companies and government agencies at the local, state and federal levels in fuel cell demonstration.

# Current Technology Costs

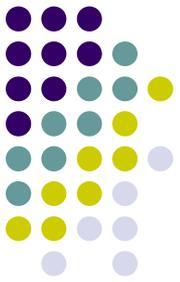


<i>Technology</i>	<i>Cost</i>
2010 compliant diesel	\$380,000
CNG	\$490,000
Diesel Hybrid Electric	\$560,000
CNG Hybrid Electric	\$1,000,000
Battery Electric	\$1,200,000
Fuel Cell Electric	\$2,200,000



# US Efforts

- Sunline Transit – 1 fuel cell bus
- South Carolina – 1 battery dominant fuel cell bus
- Connecticut – 3 fuel cell buses
- City of Burbank – 1 battery dominant fuel cell bus (fall 2009)
- Foothill Transit – 3 battery buses (2010)
- AC Transit – 12 fuel cell buses (all delivered by June 2010)



# Worldwide Efforts

## Ongoing

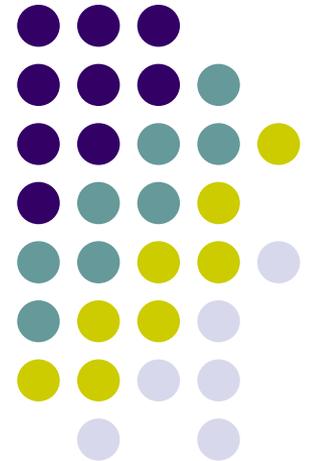
- Brazil – 2 fuel cell buses
- China – 6 fuel cell buses
- Hamburg – 9 fuel cell buses
- Amsterdam – 2 articulated fuel cell buses
- Brussels – 1 fuel cell bus

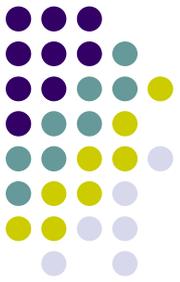
## Planned

- London – 10 fuel cell buses (under construction 2010)
- Vancouver – 20 fuel cell buses (under construction 2010 Olympics)
- Hamburg – 30 fuel cell buses (2011 in planning)

# THANK YOU!

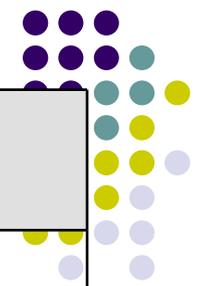
Questions and comments are  
welcomed.



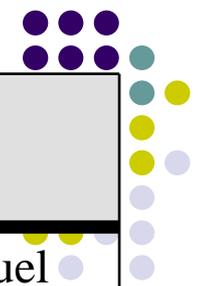


# Case Study II: LPG Taxis

- Hong Kong government made two legislation attempts
- Diesel to Petrol Conversion (1995)
  - Failure
- Diesel to LPG Conversion (2000)
  - Success



<b><i>Replacement Scheme</i></b>	<b><i>Diesel-to-Petrol Scheme</i></b>	<b><i>Diesel-to-LPG Scheme</i></b>
<b>Rationale</b>	Traditional C&C	Re-regulation (C&C + Facilitative)
<b>Goal</b>	Vehicle emission control	Vehicle emission control + encourage continuous environmental innovation (cleaner fuel alternatives)
<b>Implementation Progression</b>	Abrupt and immediate, no early goal announcement, drawing oppositions from the taxi trades No attention paid to amendments afterwards	Gradual, early announcement with progressive tightening without giving a feeling of C&C Fuel and emission standards will be amended to keep in line with the most stringent fuel and emission standards in the world.
<b>Integration with other economic and voluntary instruments</b>	Low / barely integrated	High / tightly integrated



<b><i>Replacement Scheme</i></b>	<b><i>Diesel-to-Petrol Scheme</i></b>	<b><i>Diesel-to-LPG Scheme</i></b>
<b>Technology-forcing</b>	Yes, tightened emission standards to force all diesel taxis to convert to petrol engines.	Yes, tightened emission and fuel standards to force all diesel taxis to convert to LPG or unleaded petrol compatible engines.
<b>Flexibility</b>	Low, rigid, same requirement for all taxis and PLBs	High, different requirements tailored-made for taxis and PLBs
<b>Cooperative nature</b>	Low – no consultation or partnership between the government and stakeholders at all, unilateral decisions from the government	High – consultation and partnership during LPG trial programs between the trades, the government, academics, fuel suppliers, vehicle suppliers, etc.
<b>Stringency</b>	High	High, in tandem with the most stringent standards.
<b>Time frame</b>	Very short announcement, short phase-in period	Early announcement with extended enforcement period.



<b><i>Replacement Scheme</i></b>	<b><i>Diesel-to-Petrol Scheme</i></b>	<b><i>Diesel-to-LPG Scheme</i></b>
<b>Consensus seeking</b>	Low – short period of consultation with trades and other stakeholders	High – thorough consultation with the trades and other stakeholders
<b>Capability enhancing</b>	No support given	Yes, trial programs, seminars and trainings, and infrastructure support
<b>Incentive Inducement</b>	Acceptable but relatively smaller than that offered by the diesel-to-LPG switch scheme, including exemption of tax, licensing fee, fuel differential, but no subsidy was given.	High – LPG fuel tax exemption and attractive government subsidies for taxi diesel-to-LPG conversions to attract voluntary replacement before mandatory implementation.