ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECT: CAPACITY BUILDING AND TRAINING PROGRAMME

CARBON MARKETS

www.itpowergroup.com

CARILEC

Teaching Segment 2: Other Carbon Market Schemes for Developing Countries and Its Applicability within the Region

POSSIBILITIES FOR RE PROJECTS IN THE REGION TO EARN REVENUE FROM THE SALE OF CARBON CREDITS

Scope

- Overview on the Caribbean Islands
- RE and EE projects pipeline
- Possible revenue for the sale of carbon credits

Teaching Segment 2: Other Carbon Market Schemes for Developing Countries and Its Applicability within the Region

POSSIBILITIES FOR RE PROJECTS IN THE REGION TO EARN REVENUE FROM THE SALE OF CARBON CREDITS

Overview on the Caribbean Islands

Overview on the Caribbean Island

Characteristics of the Caribbean Region

- **The region is highly energy dependent, with limited economic growth:**
  - region imports petroleum products to meet over 90% of its energy needs, and energy prices are among the highest in the world
  - Across the region, economic growth is poor
  - High energy prices are a source of economic vulnerability and reduce competitiveness for Small and Medium Enterprises
  - 85% of the Caribbean's population already has access to electricity, energy demand is expected to double in the next 20 years – unsustainably increasing demand of energy imports

Overview on the Caribbean Island

Characteristics of the Caribbean Region

- **There is potential for RE power and EE measures to reduce demand**
  - Estimates of the WB from 2010 show potential for: 25,460 Gigawatt per year (GW/yr)) including:
    - hydropower (294 Megawatts per year (MW/yr));
    - geothermal (455 MW/yr);
    - wind (3700 MW/yr);
    - solar (5781 MW/yr),
    - wave and bio-fuels.
  - high-carbon transport and other "lifestyle" options such as air conditioning, especially in tourism, provides plenty of scope for energy efficiency measures, behavioural change and the introduction of low-carbon transport
  - recent analysis found that Barbados could achieve its Sustainable Energy Matrix in the next twenty years if it increased its renewable energy use to 29% of all electricity consumption and reduced overall energy use by 22% (against a 'business as usual' scenario) by energy efficiency measures.

Overview on the Caribbean Island

Characteristics of the Caribbean Region

- **Slow progress and limited efforts have been put towards addressing market failures**
  - Only 3% of the regional energy supply comes from RE;
  - Financial investments required to realise these opportunities are large and can not be covered by the indebted public sector alone (DFIDC Operational Plan 2011 stated *that public debt is higher than in any other region, averaging over 100% of GDP in the Eastern Caribbean and 125% in Jamaica*).
  - limited private sector investment due to lack of leadership to drive through necessary reforms and provide an appropriate enabling framework and incentives

Overview on the Caribbean Island

Characteristics of the Caribbean Region

- **Notable donor assistance to the region**
  - There has been several projects developed in the region:
    - It is estimated that between 1994 and 2008, approximately US$152 million in grants and loans have been provided to the Caribbean for the areas of energy and climate change (GEF, IDB, CBD, OAS, EU, GTZ, CIDA, UNDP)
    - Amongst donor-funded projects there is the Caribbean Renewable Energy Development Project (CREDP) and the CARICOM Sustainable Energy platform which aim at increasing the use of RE and improving EE in the region
    - A number of other programmes are also operational at national level, focusing on strengthening the policy and legal and regulatory environment - progress has been mixed and tangible results difficult to quantify
    - International initiatives such as GEF and CDM are dificult for accessing funds due to lack of capacity and the necessity to coordinate joined approaches btw relevant agencies at national level

Overview on the Caribbean Island

Similarities among the Caribbean Islands

- High dependency on fossil fuel
- Isolated systems with no or very limited possibilities for interconnection (to maintain a reliable supply they require high reserve capacity margins so that is has sufficient generation availability) – need for more capital intensive systems
- There are no economies of scale to be exploited due to the small size nature of the systems

Overview on the Caribbean Island

Differences among the Caribbean Islands

- Island size and characteristics: area, peak load, energy consumption, population, economic characteristics (GDP per capita)
- Geographical characteristics:
  - Different configuration of power systems (voltage level choice)
  - Different renewable energy sources
- Institutional differences:
  - Type of utility onership
  - Presence of regulatory bodies

Teaching Segment 2: Other Carbon Market Schemes for Developing Countries and Its Applicability within the Region

POSSIBILITIES FOR RE PROJECTS IN THE REGION TO EARN REVENUE FROM THE SALE OF CARBON CREDITS

RE and EE Project Pipeline in the Region

RE and EE Project Pipeline in the Region

- The Caribbeans has stated its intention to move to a low carbon, climate change-resilient economy as quickly as possible
- All islands have potential to develop solar, wind and hydro projects as well as to implement EE measures

RE and EE Project Pipeline in the Region

RE potentials for 7 Caribbean Countries

Renewable Energy Potential						
Nation	Hydro (MW)	Wind (MW)	Geothermal (MW)	Solar PV (MW)	Biomass (MW)	Total Potential (MW)
Antigua and Barbuda	None indicated	400	None indicated	27	Unknown	427
The Bahamas	None indicated	15	None indicated	58	1	74
Dominica	17	30	300	45	Unknown	392
Grenada	0.5	5	Unknown	Unknown	Unknown	5.5
St. Kitts and Nevis	None indicated	5	300	16	10	331
St. Lucia	0.15	40	170	36	Unknown	246.15
St. Vincent and the Grenadines	10	8	100	23	4	145
Total	**27.65**	**503**	**870**	**205**	**15**	**1620.65**

Source: CARILEC 07/11/2011

Teaching Segment 2: Other Carbon Market Schemes for Developing Countries and Its Applicability within the Region

POSSIBILITIES FOR RE PROJECTS IN THE REGION TO EARN REVENUE FROM THE SALE OF CARBON CREDITS

Possible Revenue from the Sale of Carbon Credits

Possible revenue from the sale of carbon credits

- Hydro

	HydroMW	Electricity generated (MWh)	CO2 emision (tCO2/year)	CER Revenue ($/year)	CER Total Revenue (10 years) USD$
Antigua and Barbuda					
Bahamas					
Dominica	17	102,159	81,727	817,273	899,000
Grenada	0.5	3,005	2,404	24,037	26,441
St. Kitis & Nevis		-	-	-	-
St. Lucia	0.15	901	721	7,211	7,932
St. Vincent & Grandines	10	60,094	48,075	480,749	528,824
Total	**28**	**166,159**	**132,927**	**1,329,270**	**1,462,197**

Emission factor: 0.8tCO2/MWh
CER price: 10$/tCO2e

Possible revenue from the sale of carbon credits

- Wind

	Wind MW	Electricity generated	CO2 emision (tCO2/year)	CER Revenue ($/yr)	CER Total Revenue (10 years) USD$
Antigua and Barbuda	400	858,480	686,784	6,867,840	68,678,400
Bahamas	15	32,193	25,754	257,544	2,575,440
Dominica	30	64,386	51,509	515,088	5,150,880
Grenada	5	10,731	8,585	85,848	858,480
St. Kitis & Nevis	5	10,731	8,585	85,848	858,480
St. Lucia	40	85,848	68,678	686,784	6,867,840
St. Vincent & Grandines	8	17,170	13,736	137,357	1,373,568
Total	**503**	**1,079,539**	**863,631**	**8,636,309**	**86,363,088**

Emission factor: 0.8tCO2/MWh
CER price: 10$/tCO2e

Possible revenue from the sale of carbon credits

- Wind

	Solar PV MW	Electricity generated	CO2 emision (tCO2/year)	CER Revenue ($/yr)	CER Total Revenue (10 years) USD$
Antigua and Barbuda	27	13,600	10,880	108,799	1,087,992
Bahamas	58	29,215	23,372	233,717	2,337,168
Dominica	45	22,667	18,133	181,332	1,813,320
Grenada					-
St. Kitis & Nevis	16	8,059	6,447	64,474	644,736
St. Lucia	36	18,133	14,507	145,066	1,450,656
St. Vincent & Grandines	23	11,585	9,268	92,681	926,808
Total	205	103,259	82,607	826,068	8,260,680

Emission factor: 0.8tCO2/MWh
CER price: 10$/tCO2e

Possible revenue from the sale of carbon credits

- Summary of Revenues
  - If all this capacity would be installed, CDM revenues (10 years crediting period): **96,000,000USD in 10 years**
  - With mayor contribution coming from the wind power….
- This projects due to its characteristics could be developed as regional CDM PoA project, so that transaction cost would be minimised

Possible revenue from the sale of carbon credits

- This projects (specially the smaller scale ones) could be developed as regional CDM PoA project

Contact us

London Office
Golden Cross House
8 Duncannon Street
London
WC2N 4JF

+44 (0) 203 397 0336
global@itpowergroup.com
www.itpowerglobal.com

Teaching Segment 3: Carbon Market Theory

ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECT: CAPACITY BUILDING AND TRAINING PROGRAMME

CARBON MARKETS

www.itpowergroup.com

CARILEC

Teaching Segment 3: Carbon Market Theory

BRIEF OVERVIEW ON THE CARBON MARKET THEORY

Scope

- Introduction
- Emission Trading Theory

Teaching Segment 3: Carbon Market Theory

BRIEF OVERVIEW ON THE CARBON MARKET THEORY

Indroduction

Brief Overview on the Carbon Market Theory: Introduction

- To achieve stabilized levels of atmospheric CO2 there is:
  - a need to prime the research pump behind clean energy technologies and emission reduction strategies; and
  - generate market pull from them;
- Markets for emission reductions are among the most innovative and cost-effective means society has of creating a market pull for new clean energy technologies while putting a price on pollution and thereby providing incentives for people to emit less.

Brief Overview on the Carbon Market Theory: Introduction

The Theory is that carbon markets are able to achieve this magic because they help channel resources towards the most cost-effective means of reducing GHG emission

They punish (monetarily) those who emit more than an established quota

They reward (monetarily) those who emit less

- They encourage people to emit less
- Change the economics of energy technologies – making technologies that emit less carbon more competitive vis-à-vis their carbon-intensive counterparts

Brief Overview on the Carbon Market Theory: Introduction

… there is another magic

By turning units of pollution into units of property – the systems allows two facilities, cities, countries to exchange pollution

If business managers find that reducing of its pollution is too costly They can buy excess reductions from a facility where reductions are less expensive

$$$$

Receive more allowance to pollute

Pollutes **more** than the quota

Pollutes **less** than the quota

Brief Overview on the Carbon Market Theory: Introduction

Carbon Market

- Refers to the buying and selling of emission credits that have been either distributed by a regulatory body of generated by GHG reduction project
- Six GHGs generally included: Carbon Dioxide, methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons and perfluorocarbons
- GHG ERs are traded in the form of carbon credits – represent reductions of GHG equal to 1 metric ton of CO2 (the most common GHG)

Carbon credits can be accrued by two ways

Project based transactions – carbon credits are the result of emission reductions achieved by specific carbon offset project

Allowance based transactions – trade of issued allowances (permits) created and allocated by regulators under a cap-and-trade regime

Teaching Segment 3: Carbon Market Theory

BRIEF OVERVIEW ON THE CARBON MARKET THEORY

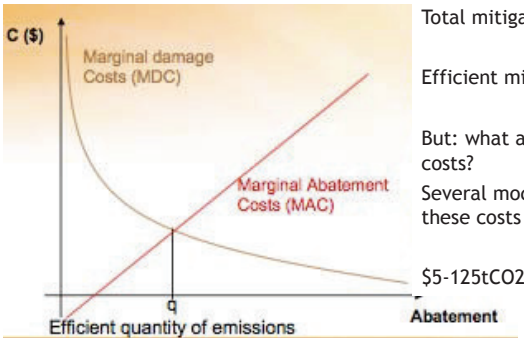
Emission Trading Theory

Emissions Trading Theory

- Governments establish a target (Total ET – budget = efficiency levels of GHG emissions) – allocates the allowances:
- For all GHG companies need to surrender allowances otherwise a penalty has to be paid
- Each company assesses its marginal abatement costs
- Trading occurs and market price will be determined by aggregated marginal abatement costs and total allowance supply

Emissions Trading Theory

Climate change: Efficiency level of GHG emissions



Total mitigation is not efficient

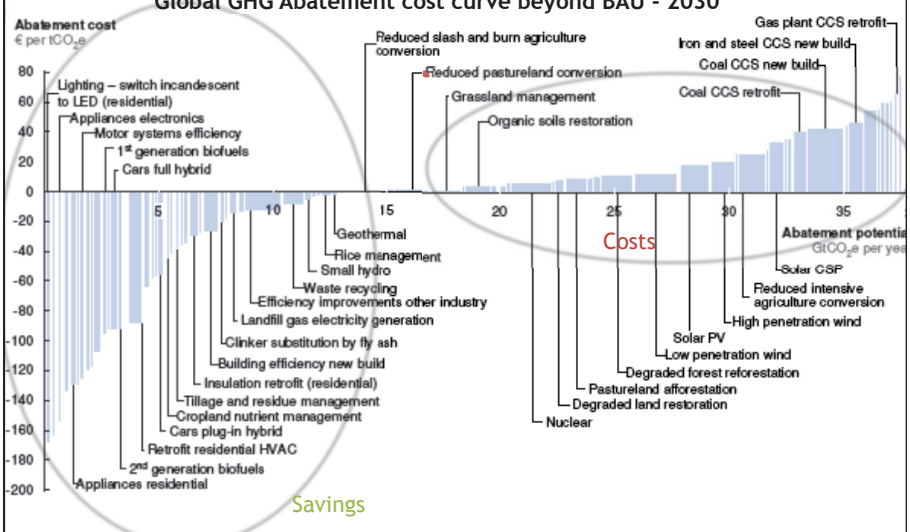
Efficient mitigation: **MAC = MDC**

But: what are the marginal damage costs?

Several models are used to estimate these costs (IPCC 2nd AR:

$5-125tCO2 * 3.667= $18 – 458 tCO2

Global GHG Abatement cost curve beyond BAU - 2030



Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €80 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.

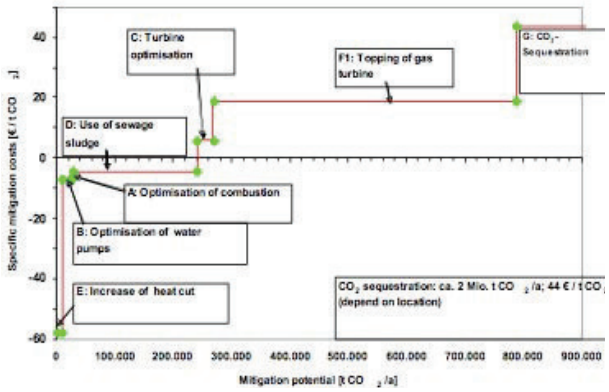
Emissions Trading Theory

Abatement Options Now

Sector	Key mitigation technologies and practices currently commercially available.
Energy Supply [4.3, 4.4]	Improved supply and distribution efficiency; fuel switching from coal to gas; nuclear power; renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of CCS (e.g. storage of removed CO_2 from natural gas)
Transport [5.4]	More fuel efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; modal shifts from road transport to rail and public transport systems; non-motorised transport (cycling, walking); land-use and transport planning
Buildings [6.5]	Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improved insulation ; passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycle of fluorinated gases
Industry [7.5]	More efficient end-use electrical equipment; heat and power recovery; material recycling and substitution; control of non-CO_2 gas emissions; and a wide array of process-specific technologies
Agriculture [8.4]	Improved crop and grazing land management to increase soil carbon storage; restoration of cultivated peaty soils and degraded lands; improved rice cultivation techniques and livestock and manure management to reduce CH_4 emissions; improved nitrogen fertilizer application techniques to reduce N_2O emissions; dedicated energy crops to replace fossil fuel use; improved energy efficiency
Forestry/forests [9.4]	Afforestation; reforestation; forest management; reduced deforestation; harvested wood product management; use of forestry products for bioenergy to replace fossil fuel use
Waste [10.4]	Landfill methane recovery; waste incineration with energy recovery; composting of organic waste; controlled waste water treatment; recycling and waste minimization

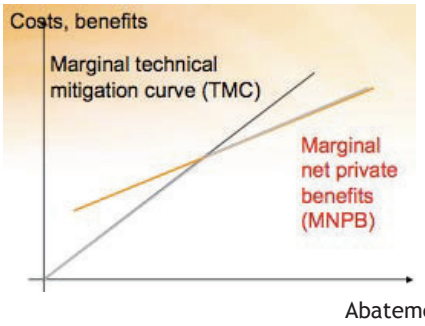
Emissions Trading Theory

Each Company assessment its marginal abatement cost



Emissions Trading Theory

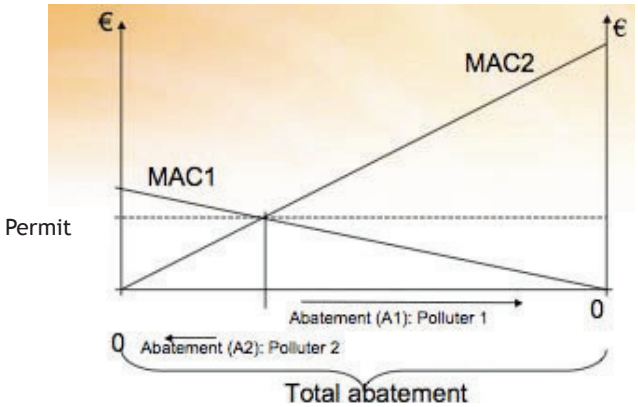
Marginal Abatement Cost



- MBPB is the abatement costs where only output reductions can be used to reduce pollution
- Usually MAC are a combination of technical mitigation costs and MNPB
- For convenience the technical mitigation curve is shown as a straight line instead of a step function

Emissions Trading Theory

How does emission trading work?



Consulting · Engineering · Implementation

Excellence in sustainable energy and climate change consulting

Contact us

London Office
Golden Cross House
8 Duncannon Street
London
WC2N 4JF

+44 (0) 203 397 0336
global@itpowergroup.com
www.itpowerglobal.com

ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECT:
CAPACITY BUILDING AND TRAINING PROGRAMME

CARBON MARKETS

www.itpowergroup.com

CARILEC

Teaching Segment 3: Carbon Market Theory

POTENTIAL ADVANTAGES AND DISADVANTAGES OF CARBON MARKETS

Advantages & Disadvantages of Carbon Markets

Advantages of carbon trading:

- **Reduction of GHG Emissions and lowering of energy consumption**
- Brings forward **financial incentives** for the reduction of GHG emissions
- Motivation that it gives for emitting lower amounts of gases. *The idea is that companies will realize that adopting greener methods of carrying out business is more gainful than paying for carbon credits*
- It is open market model that permits any company to purchase carbon credits or offer them for sale. *As a result of non intrusion from the governments such as imposition of fines or making regional legislations, this method is quite successful.*
- **Source of revenue for developing countries**: developing countries can ear revenue by selling carbon credits to countries with more fossil fuel demand

Advantages & Disadvantages of Carbon Markets

Advantages of carbon trading:

- **Supports sustainable development of developing countries**
- **Supports a free market system:** the carbon trade market is without any economic intervention and regulation by government except to regulate against force or fraud
- **Impetus for alternative sources of energy or green technologies:** threshold limits encourages industries to harness alternative sources of energy and invest in green technology globally or in indigenous research

Advantages & Disadvantages of Carbon Markets

Advantages of carbon trading:

- As companies and different industries face high costs to lower their emissions, the market based approach allows the companies to take **carbon-reducing measures that everyone can afford**
- **Long-term investment angle** - buying into the carbon market boom now suggest significant dividends later on (price of carbon credits relatively cheap – but their value will likely rise, giving companies another reason to participate)
- **The continuation of the EU ETS 2013-2020** provided a good sign for the continuity of the market
- **The definition of new financial mechanisms introduced by UNFCCC provided clear support for developing countries**

Advantages & Disadvantages of Carbon Markets

Disadvantages of carbon trading:

- **Right to pollute**: industries in the ratified nations are purchasing legal rights to pollute the atmosphere
- **Slow process**: industries are opting the easy way – purchase more allowances than implementing greener technologies
- **Lack of a centralized system or global framework**: absence of a centralised and accepted global standards/act are missing
- **No effective carbon reduction in the atmosphere** : leads to carbon reduction in one place and results in carbon emissions in some other place

Advantages & Disadvantages of Carbon Markets

Disadvantages of carbon trading:.

- some businesses are reluctant to adopt this system, as they do not want to make expenditure that cannot be passed on to their products' end buyers.
- several small companies are unable to bear the expenses necessary for acquiring new machinery and adopting new processes to decrease their emissions. As a result, the smaller companies are made to continuously purchase carbon credits in this system which leads to decreasing of their ability to compete with bigger organizations.

Advantages & Disadvantages of Carbon Markets

Disadvantages of carbon trading:.

- As any financial market, emissions traders are vulnerable to significant risk and volatility
  - the EU's trading scheme (EU-ETS), for instance, issued so many permits between 2005 and 2007 that it flooded the market. Supply soared and carbon prices bottomed out, removing incentives for companies to trade
- Carbon offsets have their drawbacks, which reflect a fast growing and unregulated market
  - some offset firms in the United States and abroad have been caught selling offsets for normal operations that do not actually take any additional C02 out of the atmosphere, such as pumping C02 into oil wells to force out the remaining crude

Advantages & Disadvantages of Carbon Markets

Disadvantages of carbon trading:.

- The lack of offset regulations has also made marketing problematic Recently, companies have taken to declaring themselves "carbon neutral." But until the there is a global framework that determines the guidelines for such terms, it's unclear which companies actually merit the distinction.

Advantages & Disadvantages of Carbon Markets

Conclusions:

- Carbon trading brings forth financial incentives to reduce GHG emissions and implement eco-friendly/green technologies
- The introduction of new financial mechanisms (NAMAS, green fund) are supposed to boost the adoption of clean energy technologies in developing countries
- Assignment of caps or other upper threshold limits over the years can ameliorate the GHG emission problem
- The alternative/renewable sources of energy like hydro, wind and solar are supposed to get financial boost to substitute fossil fuels

Advantages & Disadvantages of Carbon Markets

Conclusions:

- Absence of standard measuring technique in carbon sequestration or storage questions the feasibility of Carbon Offsetting techniques
- Presently the market is primarily driven by financial interest or gains by investment farms as opposed to seeking environmental remedy
- The lack of a centralized system or global framework prevents the regional participation

Consulting · Engineering · Implementation

Excellence in sustainable energy and climate change consulting

Contact us

London Office
Golden Cross House
8 Duncannon Street
London
WC2N 4JF

+44 (0) 203 397 0336
global@itpowergroup.com
www.itpowerglobal.com

ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECT:
CAPACITY BUILDING AND TRAINING PROGRAMME

CARBON MARKETS

www.itpowergroup.com

CARILEC

Teaching Segment 3: Carbon Market Theory

ENVIRONMENTAL EXTERNALITIES

Environmental Externalities

The concept of Externalities is central to environmental economics.

in general, markets do not exist where the victims and beneficiaries of pollution can trade to achieve an efficient level of pollution abatement.

Environmental Externalities

The Environment (Protection) Act, 1986 defines **environment to include 'water, air and land and the interrelationship which exists among and between water, air and land, and human beings, other living creatures, plants, microorganisms and property'.**

- Environmental resources such as groundwater, water in lakes and rivers, clean air in many places have become scarce due to population growth and rapid industrialization.
- Industrial discharge of untreated effluents into water bodies and emissions into air have deteriorated the quality of water and air
- Negative inter-temporal externalities occur when exhaustible resources are depleted and when renewable resources are harvested at rates greater than the regeneration rates.

Environmental Externalities

Environment is economically important

- The environment plays an absolutely essential role in shaping our economic and social welfare. The environment
  - **Provides services to consumers** in the form of living and recreational spaces and the opportunity to enjoy utility from experiencing natural landscapes and habitats
  - It provides us with the **natural resources necessary to sustain production and consumption** including the basis for renewable and non-renewable sources of energy
  - **It is a dumping ground for the waste products of our society** - be it waste from producers in different industries or from households and consumers
- The link between economic activity and our environment is fundamental. We hear constantly about the need for **sustainable economic welfare,** for growth to take into account the direct and indirect effects on our resources. And increasingly we, as producers and consumers, are affected by many government policies and strategies designed to promote environmental protection and improvement.

Environmental Externalities

Externalities:

- Arise when certain actions of producers or consumers have unintended external (indirect) effects on other producers or/and consumers
- Externalities can be:

Positive	**Negative**
arises when an action by an individual or a group confers ***benefits*** to others	arise when an action by an individual or group produces ***harmful*** effects on others.
E.g. A technological spillover is a positive externality and it occurs when a firm's invention not only benefits the firm but also enters into the society's pool of technological knowledge and benefits the society as a whole	E.g. Pollution is a negative externality. When a factory discharges its untreated effluents in a river, the river is polluted and consumers of the river water bear costs in the form of health costs or/and water purification costs

Environmental Externalities

- GHG emissions, depletion of the ozone layer and reduction of biodiversity are global public bads. These are mainly caused by pollution that represents an external cost because damages associated with it are borne by society as a whole and are not reflected in market transactions

Environmental Externalities

- In the presence of externalities, social benefits (costs) and private benefits (costs) differ:
  - In an activity generating positive externality, social benefit is higher than private benefit; and
  - in an activity generating negative externality, social cost is higher than private cost.

Environmental Externalities

- Environmental externalities generally arise for three reasons:
  - **Common resources** (not privately owned - e.g. ocean fisheries) – commonly owned resources may lack the protection of property rights and are susceptible to over-exploitation because the marginal cost of extracting the resource for a private economic agent is close to zero. This is known as the **"tragedy of the commons"**
  - **Public goods** (indivisible common resources - e.g. the air)
  - **Future generations** (sources of externality including carbon emissions – greenhouse effects – contributions to global warming which threatens future sustainability)

Environmental Externalities

- In these cases, the **private equilibrium of supply and demand** is not the same as the social equilibrium which includes all costs.

Environmental Externalities

- The value of global environmental externalities is high and increasing. Environmental costs are caused by greenhouse gas emissions, overuse of water, pollution and unsustainable natural resource use.

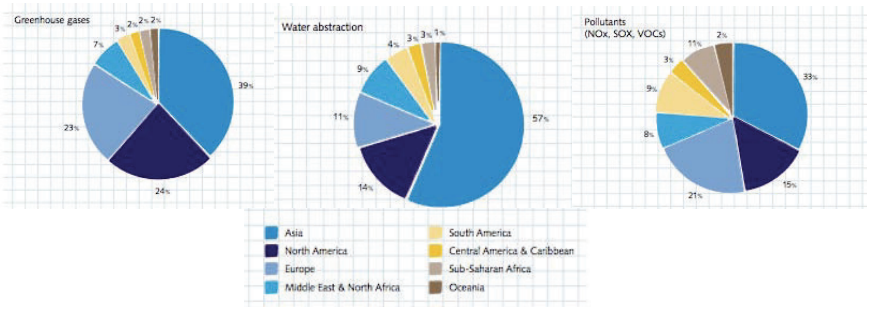
Environmental impact	External costs in 2008 (US$ billions)	External cost relative to global GDP in 2008	Projected external costs in 2050 (US$ billions)	Projected external cost relative to global GDP in 2050
Greenhouse gas (GHG) emissions	4,530	7.54%	20,809	12.93%
Water abstraction	1,226	2.04%	4,702	2.92%
Pollution (SOx, NOx, PM, VOCs, mercury)	546	0.91%	1,926	1.20%
General waste	197	0.33%	635	0.39%
Natural resources				
Fish	54	0.09%	287	0.18%
Timber	42	0.07%	256	0.16%
Other ecosystem services, pollutants and waste	Not available (NA)	NA	NA	NA
Total	**6,596**	**10.97%**	**28,615**	**17.78%**

Source: PRI, 2009

Environmental Externalities

- Carbon, water and air pollution have costs

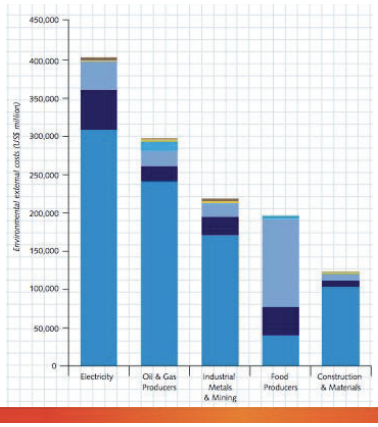
Breakdown of carbon, water and air pollution costs by region



Source: PRI, 2009

Environmental Externalities

- 5 sectors account for around 60% of all externalities



Sector	Electricity	Oil & Gas Producers	Industrial Metals & Mining	Food Producers	Construction & Materials
Heavy metals	4,207	1,668	3,954	377	915
General waste	814	2,431	2,043	547	1,917
VOCs	532	12,527	747	4,084	1,308
Water abstraction	36,692	20,081	17,154	114,880	7,399
Air pollution	53,133	24,580	24,440	37,151	8,487
Greenhouse gases	309,188	242,047	170,783	40,113	103,258
Total	**404,566**	**303,334**	**219,121**	**197,152**	**123,285**

Source: PRI, 2009

Environmental Externalities

- Environmental externalities are the basis of the economic theory on the environment
- Environmental externalities, such as GHG, pollution (air, water, soils) and reduction of biodiversity are negative externalities with high social costs
- The costs of environmental externalities are increasing and will increase even further in the next decades
- The main sectors responsible for environmental external costs are the electricity sector, oil and gas and industry.

Externalities need to be taken into account when dealing with environmental issues and their costs need to be internalized by the governments and society in general

Consulting · Engineering · Implementation

Excellence in sustainable energy and climate change consulting

Contact us

London Office
Golden Cross House
8 Duncannon Street
London
WC2N 4JF

+44 (0) 203 397 0336
global@itpowergroup.com
www.itpowerglobal.com

ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECT: CAPACITY BUILDING AND TRAINING PROGRAMME

CARBON MARKETS

www.itpowergroup.com

CARILEC

Teaching Segment 3: Carbon Market Theory

THEORY OF EXTERNALITIES AND MARKET FAILURE

Theory of Externalities & Market Failure

- Environmental economics is for a large part about market failures: goods (or bads!)
- 2007 Nicholas Stern (and co-authors) to British government):
  "Climate change is the biggest market failure the world has ever seen."
- GHG emissions are due to an externality
- Low level of international co-operation is due to emission reductions being a (global) public good

Theory of Externalities & Market Failure

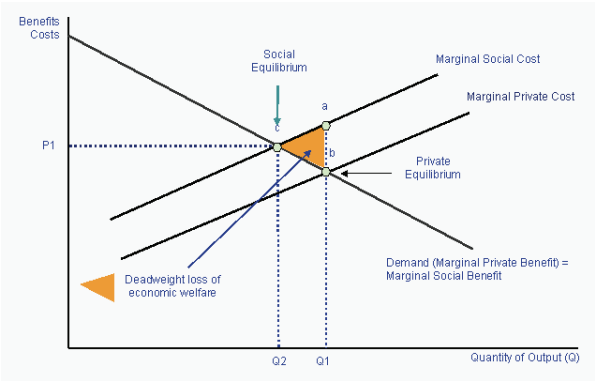
- For environmental economics, one of the most important market failures is caused by **negative externalities** arising from either production or consumption of goods and services.
- A negative externality occurs where a transaction imposes external costs on a third party (not the buyer or seller) **who is not compensated by the market**. The result is a loss of allocative efficiency and shown by a reduction in economic welfare

Theory of Externalities & Market Failure

- Externalities arise from common sources, public goods and future generations
- In these cases, the **private equilibrium of supply and demand** is not the same as the **social equilibrium which includes all costs.**
- In a completely free market, a producer will have no incentive to control pollution because it is external –*the producer only considers his/her own private costs and benefits.*

Theory of Externalities & Market Failure

- The market failure arising from negative externalities :



Economists argue that **market failures provide a rationale for policy intervention** to improve economic efficiency. But since market failures are pervasive, **intervention is only justified if the benefits exceed the costs**

Theory of Externalities & Market Failure

Strategies for including Environmental Costs of Doing Business

1) The problem with Common Property Resources Garrett Hardin (1868) "The Tragedy of the Common" Science 162: 1243-1248.

- Over use of lumber resources on publicly held land.
- Extraction of mineral resources on publicly held land.
- Pollution of Air and Water by individuals and industry

- Social Costs: The cost of producing and delivering goods or service, including traditional economic cost and externalities.

Theory of Externalities & Market Failure

Strategies for including Environmental Costs of Doing Business (Cont)

2) **Models for recovering social costs.**

- a) Society Pays: Federal and state taxes assessed on public for problems created by residuals. Such a tax could be charged in the form of a general sales tax. The problem with this model is it is anti-free market. The real cost of using natural resources is not apparent to the consumer and it does not encourage the consumer to alter behavior.
- b) Polluter Pays Principle: Covers the cost of negative residuals released during refining and manufacturing. Does not cover the cost associated with negative residuals produced on consumption.

Theory of Externalities & Market Failure

Strategies for including Environmental Costs of Doing Business (Cont)

2) **Models for recovering social costs.**

- C) through Tax: Charge placed on producer of products which include cost of all residuals including residual cost of consumption of product or service.

- E.g. Disposal Charge
  Many "button batteries" contain significant amounts of Mercury (Mercuric oxide batteries typically contain 35 to 50% Mercury by weight). A throughput tax which could be practically recoverable through a deposit program could be used to reduce pollution

Theory of Externalities & Market Failure

Strategies for including Environmental Costs of Doing Business (Cont)

2) **Models for recovering social costs.**

- d) Consumer Pays Model: Tax placed on sale of product which will cover cost pollution caused by use of product or disposal of any residual remaining after its use.

  e.g. Pollution tax on gasoline: except for a fraction of a penny used for LUST site cleanup there is no pollution tax on Gasoline in Wisconsin. Wisconsin has the 2nd highest gas tax in the country, 32.1¢/gallon plus 18.4¢ federal tax. In Wisconsin state gasoline tax is a dedicated to the DOT for highway construction and maintenance. Gasoline tax currenly covers about 90% of the state highway cost.
  ?

Theory of Externalities & Market Failure

Strategies for including Environmental Costs of Doing Business (Cont)

2) **Models for recovering social costs.**

- e) Incentive-based regulation uses the economic behavior of firms and households to attain desired environmental goals. Incentive-based programs involve taxes on emissions or tradable emission permits. The primary strength of incentive-based regulation is the flexibility it provides the polluter to find the least-cost way to reduce emissions.

Theory of Externalities & Market Failure

Strategies for including Environmental Costs of Doing Business (Cont)

3) **Models for environmental planning**

a) Cost effectiveness Analysis:
Summing all the cost and monetary returns involved in implementing a single plan in order to determine the return on the investment.

b) Benefit-Cost Analysis (or B:C ratio):
Compares the costs and benefits of several competing plans at the same time.
Shopper in the supermarket analogy.

Theory of Externalities & Market Failure

Strategies for including Environmental Costs of Doing Business (Cont)

4) **Quantifying Externalities: Putting price on Incommensurables**

a) Shadow Pricing (creating a fudge factor) included in B:C ratio analysis

b) Willingness to Pay:
Ask consumers what they are willing to pay for incommensurables. Contingent valuation method (CVM): questionnaire including competing scenarios

c) Proxy Value
E.g. The value of deer hunting to an individual is equal to the cost of his equipment, hunting license, time off work, travel expenses, etc.

Theory of Externalities & Market Failure

Strategies for including Environmental Costs of Doing Business (Cont)

4) **Quantifying Externalities: Putting price on Incommensurables**

d) Replacement Cost: The Cost of replacing the resource.
e.g: If an oil spill fouls a beach, what is the cost of replacing the polluted sand with clean sand.

e) Avoidance Cost:
If an individual or industry is legally exploiting a resource that is of value to society, ask society how much it will pay an individual not to use a resource.
e.g: Farmers abusing ground water in Texas

Consulting · Engineering · Implementation

Excellence in sustainable energy and climate change consulting

ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECT:
CAPACITY BUILDING AND TRAINING PROGRAMME

CARBON MARKETS

www.itpowergroup.com

CARILEC

Teaching Segment 3: Carbon Market Theory

POLICY OPTIONS FOR DEALING WITH ENVIRONMENTAL EXTERNALITIES

Scope

- Objectives of Environmental Policy
- Policy options for Internalizing Negative Externalities

Teaching Segment 3: Carbon Market Theory

POLICY OPTIONS FOR DEALING WITH ENVIRONMENTAL EXTERNALITIES

Objectives of the Environmental Policy

Objectives of the Environmental Policy

- The United Nations Conference on Environment and Development (UNCED) held at Rio de Janeiro in 1992 specifies the following objectives of environmental policy:
  - To incorporate **environmental costs in the decisions of producers and consumers**, to reverse the tendency to treat environment as a "free good" and to pass these costs on to other parts of society, other countries or to future generations.
  - To move more fully towards the **integration of social and environmental costs into economic activities**, so that prices will appropriately reflect the relative scarcity and total value of resources and contribute towards the prevention of environment degradation.
  - To include, wherever appropriate, the **use of market principles** in the framing of economic instruments and policies to pursue sustainable development (UNCED: *Agenda 21,* Chapter 8, p.85)

Objectives of the Environmental Policy

- Also Agenda 21 adopted at the Conference represents a global consensus and political commitment at the highest level on socio-economic development and environmental cooperation.
- The Rio Declaration advocates the principles of intergenerational equity, the **polluter pays principle** and the **precautionary approach** in framing environmental policies.

Teaching Segment 3: Carbon Market Theory

POLICY OPTIONS FOR DEALING WITH ENVIRONMENTAL EXTERNALITIES

Policy Options for Internalising Negative Externalities

Policy Options for Internalizing Negative Externalities

Potential Policy Instruments

Direct Regulation	command and control methods (e.g., requiring firms to generate electricity from renewable energy resources)
Direct Government-Sponsored R&D	government funding for scientists and engineers working on improving different renewable energy technologies, support for national laboratories, funding research prizes such as "X prizes"
R&D Tax Incentives	subsidies for private renewable energy technology R&D
Instruments to Correct Market Prices - excise taxes - cap-and-trade - subsidies	"get prices right" by adding to the cost of goods (e.g., through a tax or a permit price) or reducing the cost of goods (e.g., through a subsidy)
Feed-In Tariffs	require electric utilities to purchase electricity from other generators (often small renewable energy generators) at a specified price
Information Programs	education campaigns and required labels

Policy Options for Internalizing Negative Externalities

Potential Policy Instruments (Cont)

Product Standards	require firms to improve their product characteristics to meet a specified goal (e.g., efficiency of solar PV cell or energy efficiency of lighting)
Marketable Market-Wide Standards - renewable portfolio standards - low carbon fuel standards - corporate average fuel economy standards	require firms (e.g., utilities) to meet a specified standard (e.g., produce a specified amount of electricity from renewables) or purchase permits or certificates from other firms who over-comply with the standard
Transparency Rules	require firms to provide more information about their current conditions to investors
Macroeconomic Policy	fiscal or monetary policies to stabilize the economy and provide liquidity to markets to reduce credit constraints
Corporate Taxation Reform	adjusting the corporate income tax to improve corporate incentives
Competition Policy/Laws	reduce the exercise of market power through anti-trust action
Restructured Regulation	reduce regulatory failures and loopholes in regulations that allow for market power
Intellectual Property Law	laws to encourage innovation by allowing innovators to appropriate the benefits of their work

Policy Options for Internalizing Negative Externalities

a) Pollution from stationary and point sources
- Regulatory mechanism: standards and regulation
- Pollution charges based on volume of effluents/emissions and concentrations of pollutants (above the prescribed limits) in effluents/ emissions
- Assignment of tradable pollution permits and creation of markets to determine their prices
- Liability insurance, environmental bonds, bank guarantees
- Taxes on outputs/inputs of polluting units
- Fiscal incentives for pollution abatement and introduction of clean technologies
- Use of market signals for environmental compliance: eco-labelling, green rating, public disclosures.

Policy Options for Internalizing Negative Externalities

b) Pollution from non-stationary and non-point sources
- Deposit refund system
- Technology standards e.g. vehicle standards, pesticide content in food
- Taxes on observable, measurable items which serve as proxies for pollution tax base e.g weight of car, type of fuel.

Choice among instruments of pollution control depends on factors such as information intensity, political feasibility, institutional capacity, cost effectiveness and environmental effectiveness.

Policy Options for Internalizing Negative Externalities

c) Natural Resources
- Natural and environmental resources are vital for sustainable development. As inputs into production, they are private goods but problems of depletion and degradation do arise.
- As waste disposal services, quantities of disposals should be related to the environment's assimilative capacity.
- Common property/common pool resource problems and use of nature as a sink, a free good, arise. As life support and asthetic services, they provide non-marketed/non-use values. Hence government intervention is needed to correct market failures.

Policy Options for Internalizing Negative Externalities

c) Natural Resources (cont.)

- For private goods like coal, petroleum and other exhaustible resources there is a need of prices to reflect marginal social costs including depletion costs
- For renewable natural resources, prices/user charges should be fixed in such a manner the harvesting rates do not exceed the regeneration rates. Subsidies which encourage unsustainable use should be phased out
- For resources having use and non-use values an incentive package consisting of prices based on long-run marginal costs for goods/services having use values, and subsidies for production of non-use values yielding ecosystem benefits
- Where there are threats of serious or irreversible danger to a natural habitat, the precautionary approach be applied by designating such an area a protected area.

Consulting · Engineering · Implementation

Excellence in sustainable energy and climate change consulting

ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECT:
CAPACITY BUILDING AND TRAINING PROGRAMME

CARBON MARKETS

www.itpowergroup.com

CARILEC

Teaching Segment 3: Carbon Market Theory

ESTABLISHMENT OF CARBON PRICES FROM ITS SUPPLY AND DEMAND CURVES

Scope

- Supply and Demand Curves
- Supply and Demand Curves in the Power Market
- Abatement Cost Curves

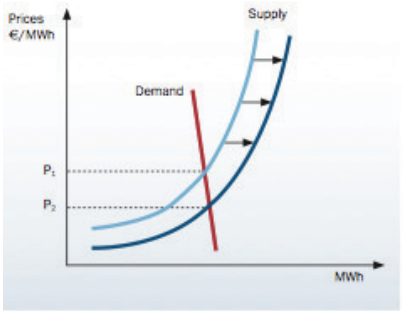
Teaching Segment 3: Carbon Market Theory

ESTABLISHMENT OF CARBON PRICES FROM ITS SUPPLY AND DEMAND CURVES

Supply and Demand Curves

Supply and Demand Curves

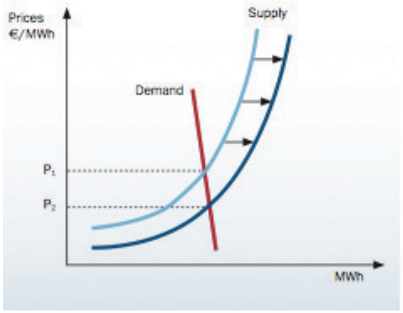
- The basic concept of determining the price in a market is though supply and demand curves
  - The point where the demand and supply curve meet, determines the price
  - The demand curve is relatively steep – it is very inelastic (remains unchanged in spite of change in price)



Source: EWEA

Supply and Demand Curves

- Inelastic demand is characteristic of goods that are a necessity – the substitutes of these goods are few and difficult to obtain
- e.g. Power and electricity fall into this category as they are essential and vital goods
- As demand is inelastic, minor changes in the supply curve can result to major price changes
- e.g addition of wind power into the generation mix affects the supply curve determines a new price (P2)



Source: EWEA

Teaching Segment 3: Carbon Market Theory

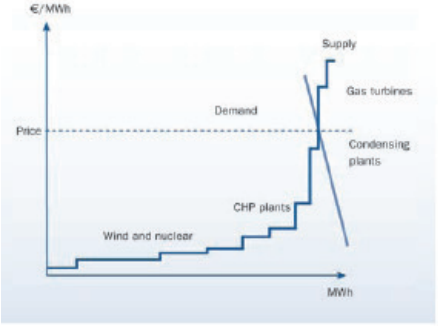
ESTABLISHMENT OF CARBON PRICES FROM ITS SUPPLY AND DEMAND CURVES

Supply and Demand Curves in the Power Market

Supply and Demand Curves In the Power Market

- Typically power portfolios are made up of a range of technologies
- the amount of power supplier's can supply and the cost of the power – determines de ordering or each player
- supply curve is called the 'merit order curve'.

Annual Supply and Demand Curve in the Power Market



Source: EWEA Economics of Wind

Teaching Segment 3: Carbon Market Theory

ESTABLISHMENT OF CARBON PRICES FROM ITS SUPPLY AND DEMAND CURVES

Abatement Cost Curves

Carbon Abatement Cost Curves

Why are they important?

- powerful decision making tool when assessing a business' carbon exposure and opportunities to reduce carbon emissions
- In a budget-constrained environment with uncertainties such as technology, regulation, energy and carbon pricing risk, making informed decisions about the sequence and timing of greenhouse abatement investments is difficult, but critical

Development of abatement cost curves assists to evaluate the mitigation measures that could be adopted, where to prioritise resources and the timing of projects

Carbon Abatement Cost Curves

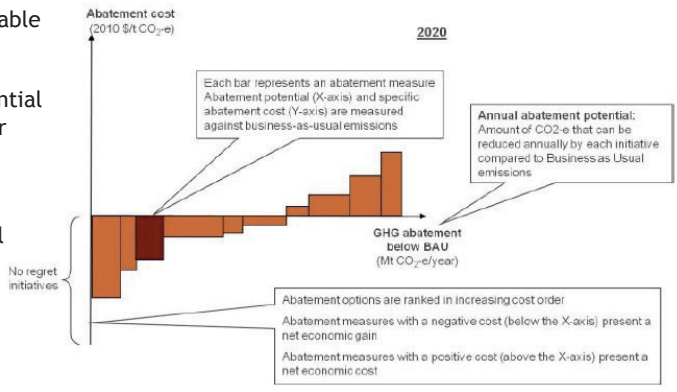
How to development Abatement Cost Curves?

- Abatement cost ranking is done accordingly to: its effectiveness using a common investment appraisal procedure based on discounted cash flow valuation which considers life cycle costs, benefits and emissions reduction potential
- In evaluating the portfolio of possible emissions-reduction projects and its implementation schedule, greenhouse gas abatement cost curves are plotted at selected time horizons.
- They can have an important role in policy decision making – central decision making tool

Carbon Abatement Cost Curves

Key abatement cost curve dimensions

reflect the available mitigation measures, their abatement potential in a specific year and their cost effectiveness, relative to a business as usual scenario.



Carbon Abatement Cost Curves

Steps for developing a robust abatement cost curve

1. Frame the abatement cost assessment in terms of time horizon(s), scope of emissions and system boundaries.
2. Develop a greenhouse gas emissions baseline and reference baseline projections for all the assets and emissions sources within the system boundaries.
3. Identify all abatement opportunities available, now and over the timeframe being considered, and develop initial abatement potential and cost estimates.
4. Build initial greenhouse gas abatement cost curve(s) using a structured bottom-up engineering approach with clear assumptions and screen all options based on your business risk criteria.

Carbon Abatement Cost Curves

Steps for developing a robust abatement cost curve (cont)

5. Refine estimates for abatement potential, cost and lead time.
6. Firm up opportunities with constraints by removing mutually exclusive abatement measures and considering inter-relationships between abatement measures.
7. Construct the final cost curve(s) and perform a sensitivity analysis.
8. Communicate findings and recommendations.

Carbon Abatement Cost Curves

Strategic Benefits of GHG abatement cost curves

- Understand the overall GHG abatement potential within a specific time horizon - realistic carbon abatement target(s) can be set and sensitivity to internal growth can be tested.
- Assessment of the cost effectiveness of greenhouse gas abatement measures on a common platform and measures are evaluated and ranked, enabling prioritisation.
- Informed capital expenditure decisions can be made about the sequence and timing of abatement investments.
- Different strategic options can be considered such as site expansion, power supply options, product mix changes and an organisation's Research Development and Demonstration program can be structured.

Carbon Abatement Cost Curves

Factors to consider when developing and analysing GHG abatement Cost Curves

- Not all the costs are the same!!
- **Barriers to the take up** of individual projects can be underestimated. This is particularly the case with projects regarded as "no regret" initiatives that are assessed as relatively low cost, and high yield in terms of emissions reductions or cost savings, but might face barriers to their implementation
- Cost curves need to consider **inter-dependencies** - The portfolio of abatement options also needs to be screened for projects/investments that are mutually exclusive.
- **timing of a project's implementation** can be varied to the organisation's advantage
- abatement cost assessment should be viewed as a **dynamic process** that takes into account information available, with various levels of confidence, such as abatement cost, the potential of abatement measures or energy and carbon price forecasts – What if scenarios

Carbon Abatement Cost Curves

Modeling the GHG mitigation policies

- This curves can be used to assess the impact of policy instruments at a sectoral, more macro-economic level.
- It can model the long-term energy system transformations that are necessary to address climate change and provide a range of insightful outputs. For that:
  - establishing baseline projections taking into account foreseeable economic technological and regulatory changes
  - With the incorporation of sector-specific market penetration models, the approach provides estimates of the plausible take up of technical measures driven by policy programs and quantifies the likely costs of implementing each program
  - cost curve(s) can then provide valuable inputs that are fundamental to the construction of a policy when selecting and defining the best portfolio of abatement programs that present the most attractive return

Carbon Abatement Cost Curves

Collaborative approach should be followed to develop the Cost Abatement Curves

- Collaboration is key!!!
- The process should draw together:
  - Expert projections for energy prices and greenhouse gas emissions factors
  - Assessment of management plans, site expansion plans and their impacts on abatement potential
  - Insights into emerging technologies and their price paths over time
  - Considerations of project risk and uncertainty in the basis of estimates
  - Developing an assessment tool that can be used to regularly review an organisation's range of abatement actions taking into account additional information and changes in the regulatory and market environment

itp

Consulting · Engineering · Implementation

Excellence in sustainable energy and climate change consulting

ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECT: CAPACITY BUILDING AND TRAINING PROGRAMME

CARBON MARKETS

www.itpowergroup.com

CARILEC

Teaching Segment 3: Carbon Market Theory

ISSUES AFFECTING THE SUPPLY AND DEMAND OF CARBON

Issues Affecting the Supply and Demand of Carbon

- National and International Policy decisions
- World economic crisis
- Natural Disasters
- Lack of finance

Issues Affecting the Supply and Demand of Carbon

- National and International Policy decisions
  - Regulatory measures and standards provide some certainly of emission levels
  - Taxes and charges are generally cost-effective, but they cannot guarantee a particular level of emissions and they can be politically difficult to implement
  - Tradable permits are important to establish a carbon price – the volume of allowed emissions, determines the carbon price and the environmental effectiveness of this instrument
  - Distribution of allowance can affect cost-effectiveness and competitiveness
  - Uncertainty on the price of carbon markets makes it difficult to estimate the total cost of meeting emission reduction credits

Issues Affecting the Supply and Demand of Carbon

- Voluntary agreements
  - Voluntary agreements between industry and governments have played a role in the evolution of many national policies:
    - They have accelerated the application of he best available technologies and led to measurable emission reductions
- Successful programmes all include clear targets, baseline scenario, third party involvement in the design and review and formal provision for monitoring

Issues Affecting the Supply and Demand of Carbon

- International Financial Mechanism
  - International financial mechanism (NAMAS, CDM, PCDM) have an impact on the supply of carbon credits
  - Financial mechanism to develop GHG abatement projects have great influence in supply of carbon credits;
  - The establishment of the new financial instruments and the continuation of the KP2 is meant to boost both supply and demand of carbon credits

Issues Affecting the Supply and Demand of Carbon

- Impacts of natural disaster
  - The carbon markets are struggling to understand the implications of the deadly earthquake and tsunami that stuck Japan, followed by the nuclear accident
  - This natural disaster may lead Japan to use more carbon intensive fossil fuels to compensate for the loss of nuclear capacity. As a result, it is expected that carbon- and energy-intensive reconstruction activities will increase the carbon-intensity of output in Japan – thus an increase in demand of carbon offset is expected from japan
  - Safety concerns around the globe may also result in a substantial reduction in nuclear power generation, increasing carbon emissions in other countries and consequently an increase in carbon demand

Issues Affecting the Supply and Demand of Carbon

- Lack of finance
- Financing needs for green growth and implementing low-emission development strategies are huge, in the hundreds of billions annually for developing countries
- The green climate fund and the mobilization of $100 billion per year from 2020, in conformity with the pledges under the Copenhagen Accord are a green light for the development of carbon projects in developing countries – thus assuring a supply of carbon credits

Issues Affecting the Supply and Demand of Carbon

Predictability and ambition, ingenuity and reforms, capacity—all are needed to scale up carbon markets and maximize their transformational impact

Consulting · Engineering · Implementation

Excellence in sustainable energy and climate change consulting

Useful Links and Reports

CD4CDM, http://cd4cdm.org/

Riso Centre, CDM Pipeline and PoA Pipeline, http://uneprisoe.org/

UNFCCC website, http://unfccc.int/2860.php

UNEP, ACPMEAS, CDM Information and Guidebook, Third Edition, http://cd4cdm.org/Publications/cdm_guideline_3rd_edition.pdf

Caribbean Renewable Energy Development Programme (CREDP) website, http://www.credp-gtz.org

Bloomberg, Back to the Future State of the Voluntary Carbon Markets 2011, http://www.forest-trends.org/documents/files/doc_2828.pdf

Bueno Ramon et all, The Caribbean and Climate Change – Costs of Inaction, May 2008, http://ase.tufts.edu/gdae/Pubs/rp/Caribbean-full-Eng-lowres.pdf

Inter-American Development Bank, Climate Change's Impacts on the Caribbean Ability to Sustain Tourism, Natural Assets and Livelihood, http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=35769833

Smith School of Enterprise and the Environment University of Oxford; International climate change negotiations: Key lessons and next steps, July 2011, http://www.smithschool.ox.ac.uk/wp-content/uploads/2011/03/Climate-Negotiations-report_Final.pdf

Raúl I. Alfaro-Pelico, Small Island Developing States and Climate Change: Effects, Responses and Positions: beyond Durban (WP), http://www.realinstitutoelcano.org/

André Aasrud, Richard Baron (IEA) and Katia Karousakis (OECD), MARKET READINESS: BUILDING BLOCKS FOR MARKET APPROACHES, November 2010, http://www.oecd.org/dataoecd/30/14/46563135.pdf

Peter Wooders and Jean Nolet, State of the Carbon Market: How the future market can encourage developing participation, March 2009, http://www.iisd.org/pdf/2009/state_carbon_future_market.pdf

IGES, CDM in Charts, February 2012, http://enviroscope.iges.or.jp/modules/envirolib/upload/835/attach/charts.pdf

UNEP, CDM PDD Guidebook: Navigating the Pitfalls, http://cd4cdm.org/Publications/UNEP-DNV_PDD%20Pitfalls%20Guidebook.pdf

KfW, PoA Blueprint Book, Guidebook for PoA Coordinadion under CDM/JI, http://www.jiko-bmu.de/files/inc/application/pdf/poa_blueprintbook_2edition.pdf

Southpole, PoA Developing CDM Programmes of Activities: Guidebook, http://www.southpolecarbon.com/_downloads/PoA_Guidebook_SouthPole.pdf

A Primer on CDM Programme of Activities, http://cd4cdm.org/Publications/PrimerCMDPoA.pdf

CCB Standards, Climate, Community and Biodiversity Project Design Standards, http://www.climate-standards.org/standards/pdf/ccb_standards_second_edition_december_2008.pdf

Gold Standard, http://www.cdmgoldstandard.org/

Verified Carbon Standard, http://www.v-c-s.org/

Plan Vivo, http://www.planvivo.org/