Economics of Sustainable Development

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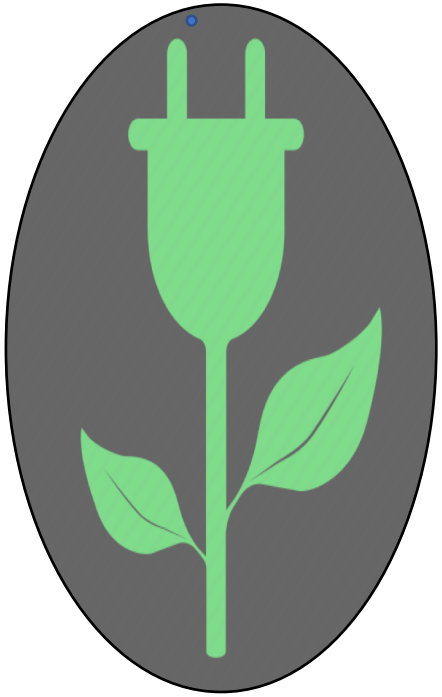
Overview

- The components of sustainable development (SD)
- How does the study of economics help with SD?
- The economics toolkit to assess SD:
  - Market failures and externalities
  - Policy instrument design
  - Benefit-cost analysis
- Research topics for economists

Sustainable development is "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report, 1987)

Three pillars of Sustainable development

Economic



Environmental

Social

Economic, environmental and social sustainability are all connected. One cannot trump the other two.

Economics and Sustainable development

What is the connection?

- Economics is about:
  - Maximising societal welfare
  - Markets
  - Scarcity
  - Decision-making
  - Wellbeing
- Sustainable development is about:
  - Development that enhances future welfare
  - Ecology
  - Social justice
  - Economic sustainability

Economics gives us the tools to understand and assess sustainable development

What do we mean by economic sustainability?

- "**Economic sustainability** is the ability to support a defined level of economic production indefinitely" (Muneeb, 2018).
- Distinguish between Economic Growth vs. Economic Development
- **Economic growth:** an increase in the capacity [illegible] economy to produce goods and services, compared f[illegible] period of time to another. Could reduce poverty but [illegible]pense of depletion of natural resources, pollution [illegible] & disease.
- **Economic developm[illegible]**erned with economic sustainability which means taking ca[illegible] issues such as the alleviating the rise of poverty, congestion, disease as well as environmental issues and, overall, meeting the needs of the present without compromising future needs.

Needs long-term thinking!

Measuring sustainable development

- Need to consider a range of environmental, economic and societal indices
- Several organisations have developed lists of recommended indicators UN
- Global indicator framework for SDG (sustainable development goals) published by UN - 231 unique **indicators!**
  https://unstats.un.org/sdgs/

Which elements of the economics toolbox can we use in sustainable development research?

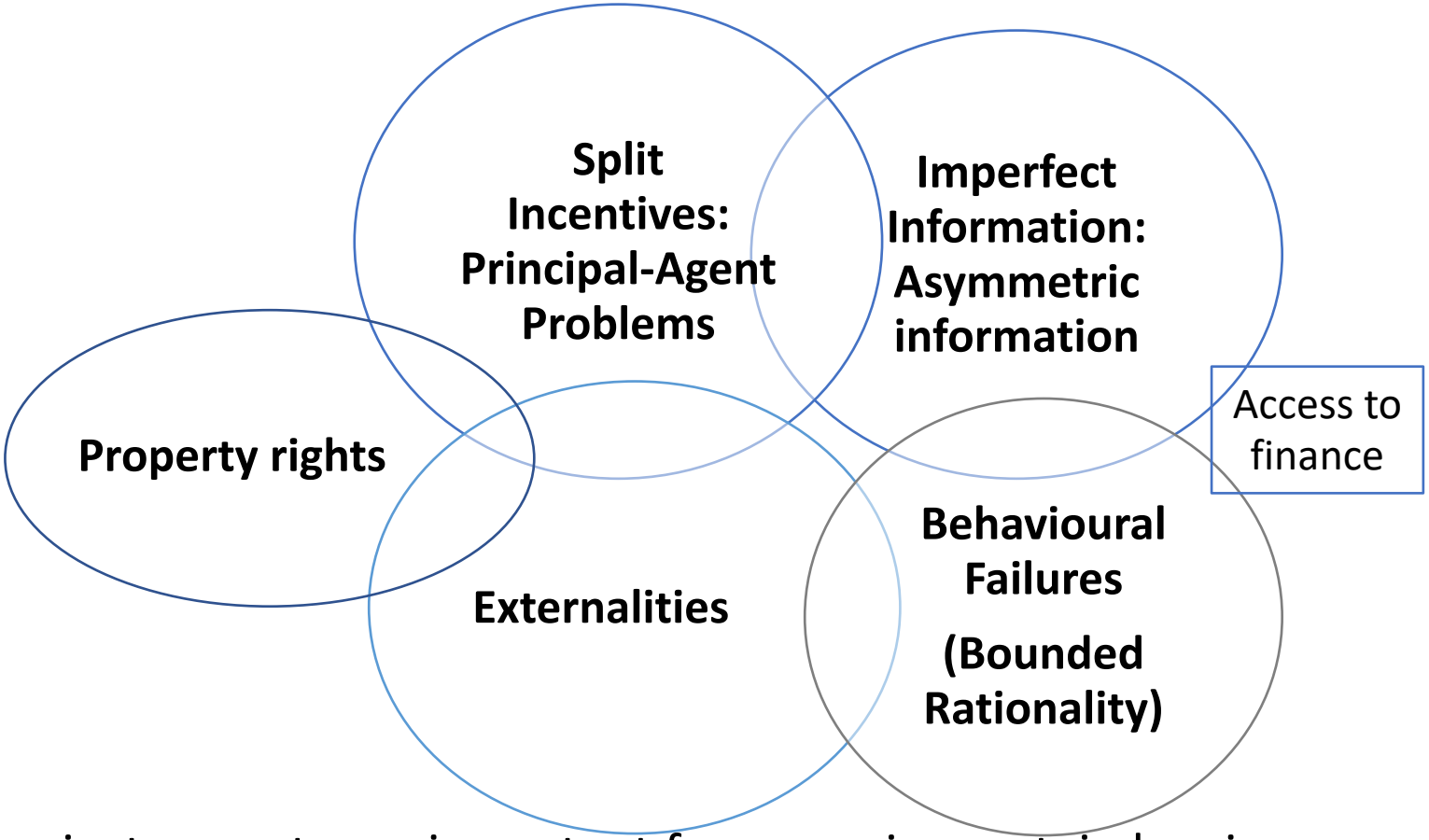
- Cost benefit analysis (1.2),
- Incentives (1.2, 2.2, 2.3, 2.4),
- Price mechanism (2.1),
- Externalities and market failure (3.3),
- Taxation (2.4, 3.2, 3.3, 4.2) and
- Regulation (2.4, 3.3)

Market failures and externalities

Externalities and market failure (3.3)

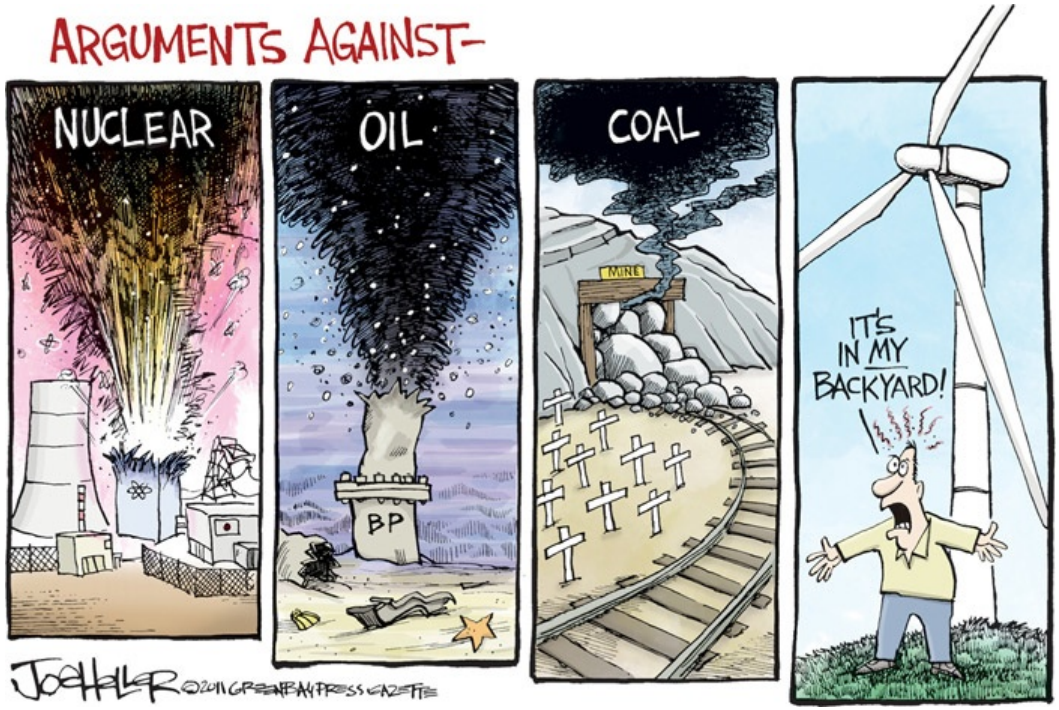
- The concept of market failures is a key framework to explain environmental problems and how markets can be used to find solutions
- In economics we assume competitive markets with a range of conditions:
  - ✓ Markets exist for all goods and services produced and consumed
  - ✓ No externalities exist
  - ✓ All markets perfectly competitive
  - ✓ All transactors have perfect information
  - ✓ All goods and services are private goods (there are no public goods)
  - ✓ All agents are maximisers
- Almost NEVER in real life!

Market failures in the energy sector



- Price instruments are important for removing certain barriers, e.g. "internalize" negative externalities by increasing prices with taxes
- Lack of property rights causes lack of/incorrect pricing
- Informational failures and principal-agent problems can prevent price signals from reaching consumers

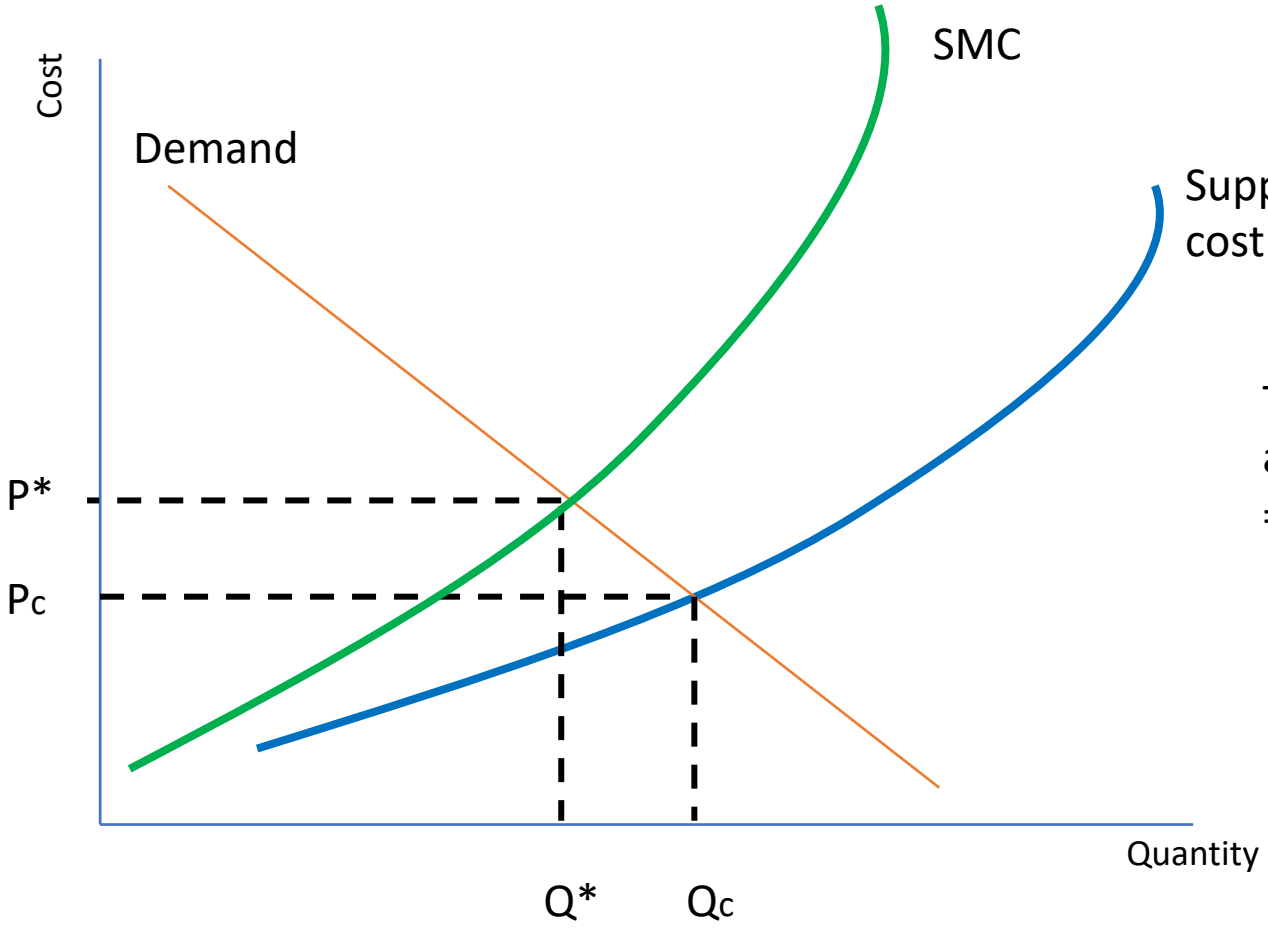
Externalities in the Energy Sector



Source: C. Aravena

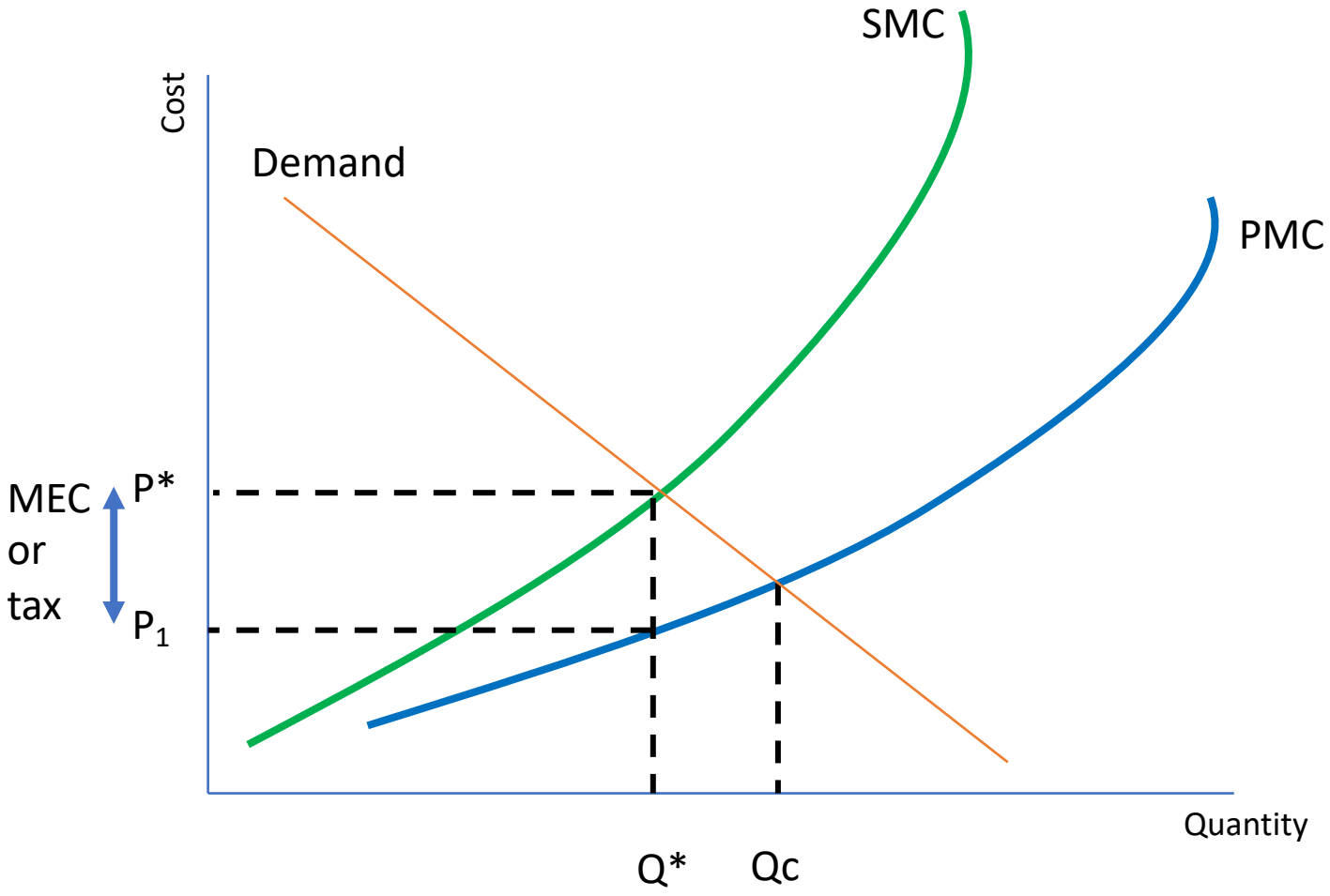
In the presence of market failures…

The presence of market failures means that the true cost of emissions is illustrated by the marginal social cost (MSC) of emissions.



The efficient equilibrium is at P* and Q*:
=> SMC = SMB (or demand)

Correcting externalities with taxes



The cost of the externality can be added as a (carbon) tax on the firm. This shifts the marginal cost curve to the left to reflect the social marginal cost of emissions

Policy instrument design

Policy Instruments: categories

- Command and control – standards and mandates
- Information measures
- Economic instruments – price-based policies

Book by Bemelmans-Videc et al. (2003)

Command-and-control

- Market failure addressed: split incentives and imperfect information
- Characteristics: regulatory target set specifying environmental performance, e.g. emissions limits, technical characteristics, e.g. minimum performance standard
- Strengths: relatively easy to understand and administer, no subsidy from public budget
- Weaknesses: often inefficient, i.e. not least cost, enforcement needed, risk of regulatory capture, policymaker technical capability important.
- Examples: building codes, EU car CO2 emissions regulation, EU energy efficiency regulations on electric appliances

2009 EU CO_2 Emissions Legislation for Passenger cars

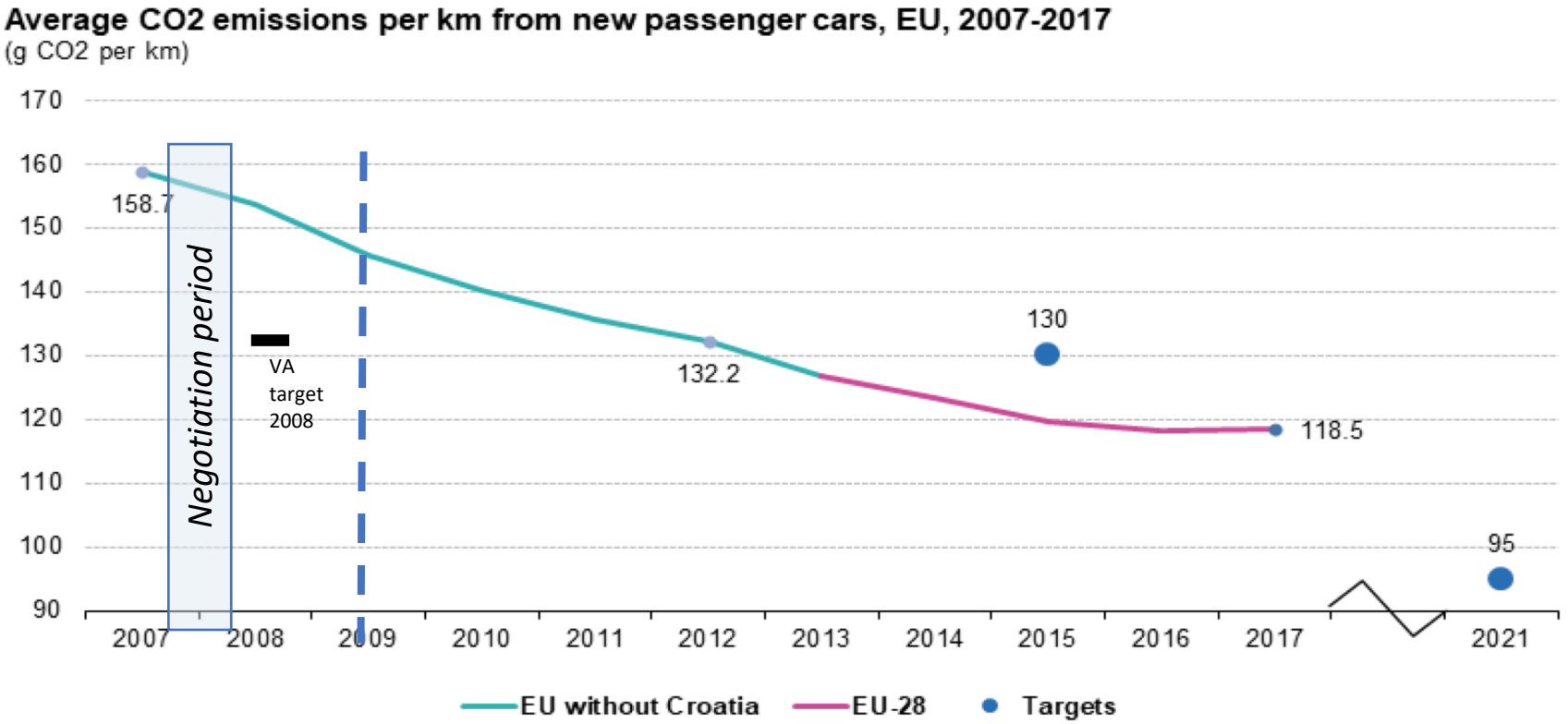
- Since 2000 voluntary agreements to reduce CO2 emissions with auto industry (140g/km by 2008)
- By 2007, clear that emissions target would not be achieved (~160g/km)
- 2009: New regulation:
- 130 CO2 g/km average new car emissions by 2015, phase-in from 2012
  - Individual manufacturer targets based on vehicle weight
  - Penalty payment for excess emissions
  - Eco-innovations
  - Super-credits
  - Pools acting jointly
  - 25% reduction target for smaller manufacturers

- Longer-term target 95 g/km by 2021
- 2030: (still under negotiation) 37.5% lower than 2021

http://ec.europa.eu/clima/policies/transport/vehicles/cars/

https://multimedia.europarl.europa.eu/en/emission-performance-standards-new-passenger-cars_I161029-V_v

Average CO2 emissions: historical trends and targets EU-28



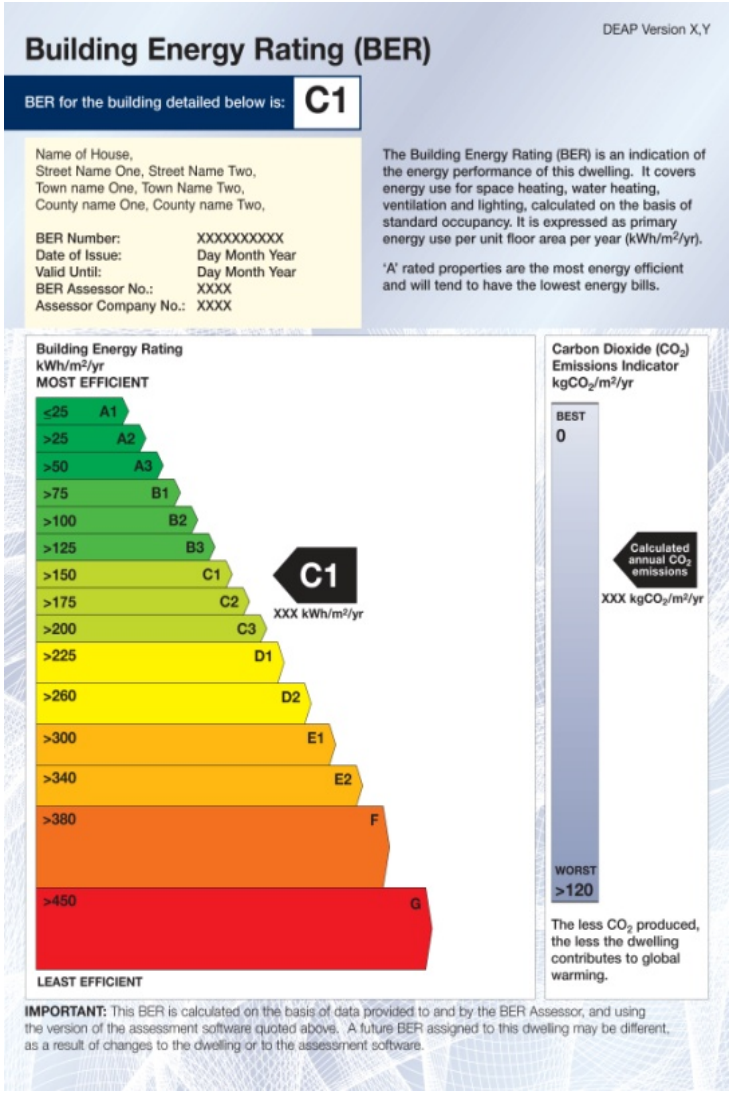
Source: Eurostat (online data code: sdg_12_30)

eurostat

Information measures

- Overcome market failures relating to imperfect information
- Can be combined with other policy instruments such as incentives and regulation
- Design of labels important – endorsement vs rating vs information
- Allow sufficient time in advance of implementation to ensure trained professionals where certification is needed
- Need to raise awareness among public and relevant sector
- Regular checking of assessors and enforcement needed to ensure credibility

Information measures: buildings rating labelling Ireland and Portugal



DEAP Version X,Y

Building Energy Rating (BER)

BER for the building detailed below is: **C1**

Name of House,
Street Name One, Street Name Two,
Town name One, Town Name Two,
County name One, County name Two,

BER Number:	XXXXXXXXX
Date of Issue:	Day Month Year
Valid Until:	Day Month Year
BER Assessor No.:	XXXX
Assessor Company No.:	XXXX

The Building Energy Rating (BER) is an indication of the energy performance of this dwelling. It covers energy use for space heating, water heating, ventilation and lighting, calculated on the basis of standard occupancy. It is expressed as primary energy use per unit floor area per year (kWh/m²/yr).

'A' rated properties are the most energy efficient and will tend to have the lowest energy bills.

Building Energy Rating
kWh/m²/yr
MOST EFFICIENT

≤25	A1
>25	A2
>50	A3
>75	B1
>100	B2
>125	B3
>150	C1
>175	C2
>200	C3
>225	D1
>260	D2
>300	E1
>340	E2
>380	F
>450	G

C1
XXX kWh/m²/yr

LEAST EFFICIENT

Carbon Dioxide (CO_2) Emissions Indicator
kgCO_2/m²/yr

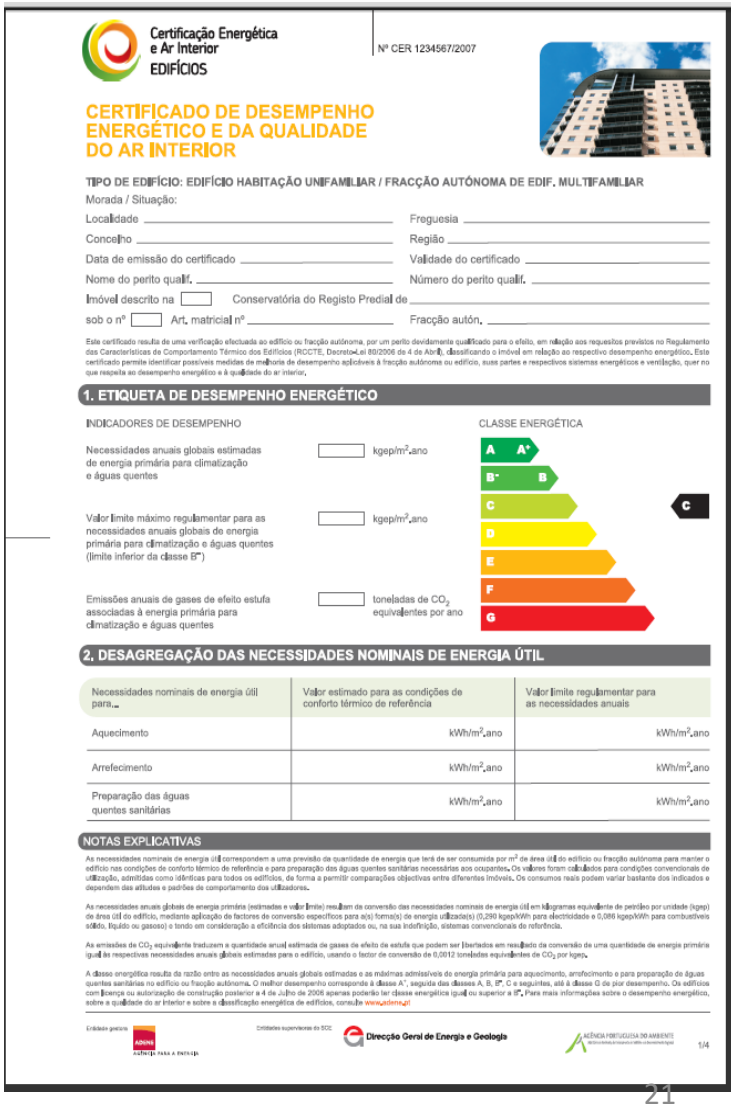
BEST
0

Calculated annual CO_2 emissions
XXX kgCO_2/m²/yr

WORST
>120

The less CO_2 produced, the less the dwelling contributes to global warming.

IMPORTANT: This BER is calculated on the basis of data provided to and by the BER Assessor, and using the version of the assessment software quoted above. A future BER assigned to this dwelling may be different, as a result of changes to the dwelling or to the assessment software.



Certificação Energética e Ar Interior
EDIFÍCIOS

Nº CER 1234567/2007

CERTIFICADO DE DESEMPENHO ENERGÉTICO E DA QUALIDADE DO AR INTERIOR

TIPO DE EDIFÍCIO: EDIFÍCIO HABITAÇÃO UNIFAMILIAR / FRACÇÃO AUTÓNOMA DE EDIF. MULTIFAMILIAR

Morada / Situação:

Localidade _____ Freguesia _____

Concelho _____ Região _____

Data de emissão do certificado _____ Validade do certificado _____

Nome do perito qualif. _____ Número do perito qualif. _____

Imóvel descrito na ☐ Conservatória do Registo Predial de _____

sob o nº ☐ Art. matricial nº _____ Fracção autón. _____

Este certificado resulta de uma verificação efectuada ao edifício ou fracção autónoma, por um perito devidamente qualificado para o efeito, em relação aos requesitos previstos no Regulamento das Características de Comportamento Térmico dos Edifícios (RCCTE, Decreto-Lei 80/2006 de 4 de Abril), classificando o imóvel em relação ao respectivo desempenho energético. Este certificado permite identificar possíveis medidas de melhoria de desempenho aplicáveis à fracção autónoma ou edifício, suas partes e respectivos sistemas energéticos e ventilação, quer no que respeita ao desempenho energético e à qualidade do ar interior.

1. ETIQUETA DE DESEMPENHO ENERGÉTICO

INDICADORES DE DESEMPENHO		CLASSE ENERGÉTICA
Necessidades anuais globais estimadas de energia primária para climatização e águas quentes	☐ kgep/m².ano	A A+ / B- B / C / D / E / F / G — C
Valor limite máximo regulamentar para as necessidades anuais globais de energia primária para climatização e águas quentes (limite inferior da classe B-)	☐ kgep/m².ano	
Emissões anuais de gases de efeito estufa associadas à energia primária para climatização e águas quentes	☐ toneladas de CO_2 equivalentes por ano	

2. DESAGREGAÇÃO DAS NECESSIDADES NOMINAIS DE ENERGIA ÚTIL

Necessidades nominais de energia útil para...	Valor estimado para as condições de conforto térmico de referência	Valor limite regulamentar para as necessidades anuais
Aquecimento	kWh/m².ano	kWh/m².ano
Arrefecimento	kWh/m².ano	kWh/m².ano
Preparação das águas quentes sanitárias	kWh/m².ano	kWh/m².ano

NOTAS EXPLICATIVAS

As necessidades nominais de energia útil correspondem a uma previsão da quantidade de energia que terá de ser consumida por m² de área útil do edifício ou fracção autónoma para manter o edifício nas condições de conforto térmico de referência e para preparação das águas quentes sanitárias necessárias aos ocupantes. Os valores foram calculados para condições convencionais de utilização, admitidas como idênticas para todos os edifícios, de forma a permitir comparações objectivas entre diferentes imóveis. Os consumos reais podem variar bastante dos indicados e dependem das atitudes e padrões de comportamento dos utilizadores.

As necessidades anuais globais de energia primária (estimadas e valor limite) resultam da conversão das necessidades nominais de energia útil em kilogramas equivalente de petróleo por unidade (kgep) de área útil do edifício, mediante aplicação de factores de conversão específicos para as(s) forma(s) de energia utilizada(s) (0,290 kgep/kWh para electricidade e 0,086 kgep/kWh para combustíveis sólido, líquido ou gasoso) e tendo em consideração a eficiência dos sistemas adoptados ou, na sua indefinição, sistemas convencionais de referência.

As emissões de CO_2 equivalente traduzem a quantidade anual estimada de gases de efeito de estufa que podem ser libertados em resultado da conversão de uma quantidade de energia primária igual às respectivas necessidades anuais globais estimadas para o edifício, usando o factor de conversão de 0,0012 toneladas equivalentes de CO_2 por kgep.

A classe energética resulta da razão entre as necessidades anuais globais estimadas e as máximas admissíveis de energia primária para aquecimento, arrefecimento e para preparação de águas quentes sanitárias no edifício ou fracção autónoma. O melhor desempenho corresponde à classe A+, seguida das classes A, B, B-, C e seguintes, até à classe G de pior desempenho. Os edifícios com licença ou autorização de construção posterior a 4 de Julho de 2006 apenas poderão ter classe energética igual ou superior a B-. Para mais informações sobre o desempenho energético, sobre a qualidade do ar interior e sobre a classificação energética de edifícios, consulte www.adene.pt

Entidades gestoras: ADENE — Agência para a Energia

Entidades supervisoras do SCE: Direcção Geral de Energia e Geologia; Agência Portuguesa do Ambiente

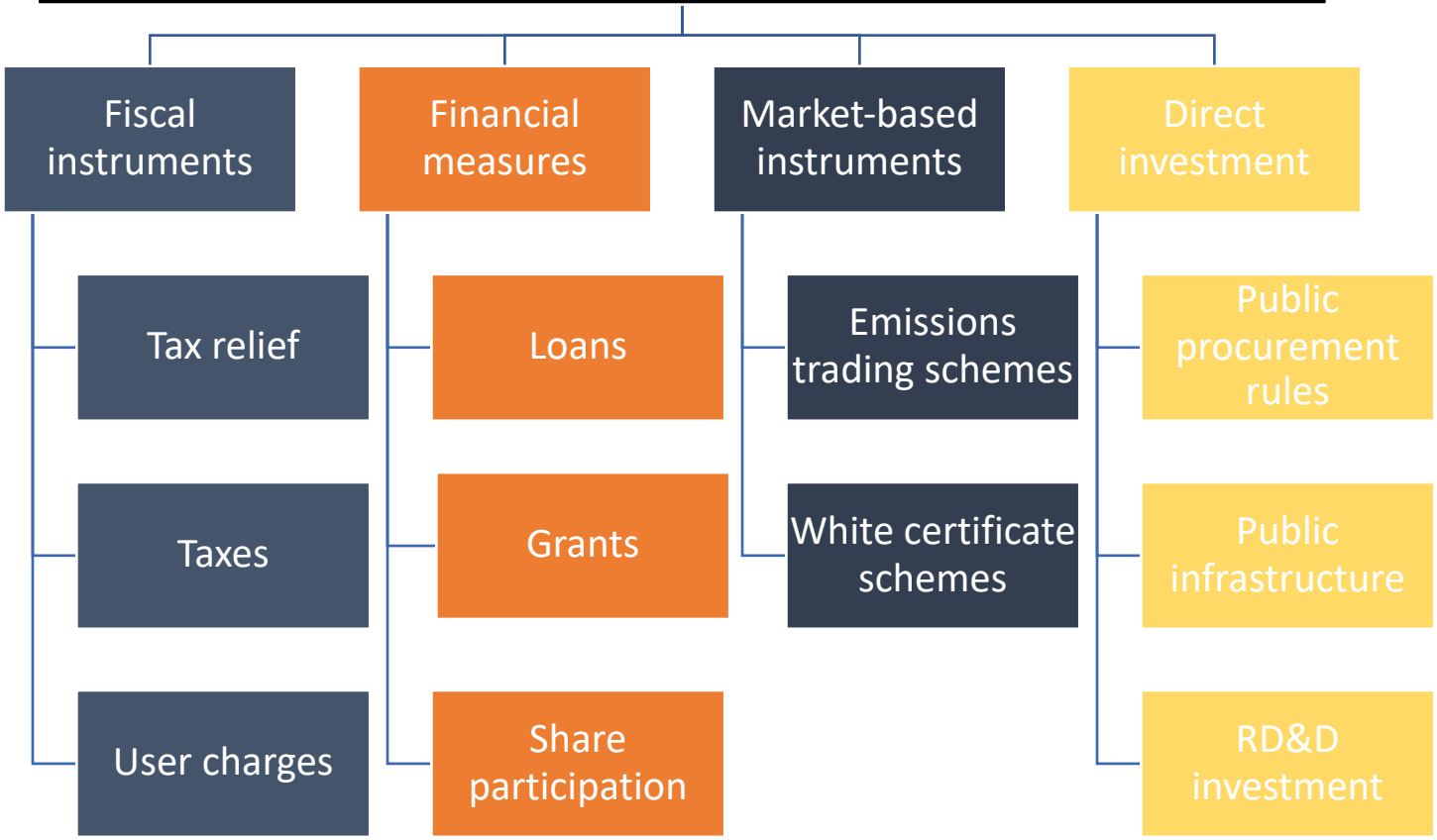
1/4

Economic policy instruments

- Economic instruments address externalities
- Improve the market efficiency of the environment by imposing a price on such goods equal to the marginal cost of their use (marginal environmental damage cost)
- This may imply a subsidy for products that are public goods or environmental goods
- Once costs associated with damage can be calculated, then environmental taxation is efficient way to rectify market failure
- Strengths of economic instruments:
  - Cover cost of environmental damage
  - Provide incentive effects
  - Raise revenue
- Weaknesses:
  - Uncertainty in damage costs and abatement costs means that prices can be difficult to set
  - Asymmetric information

"***A sufficiently high carbon price also promotes investment in clean, low-carbon technologies***." European Commission. **Discuss!**

Economic or market-based policy instruments



Examples of economic instruments for clean energy in sectors

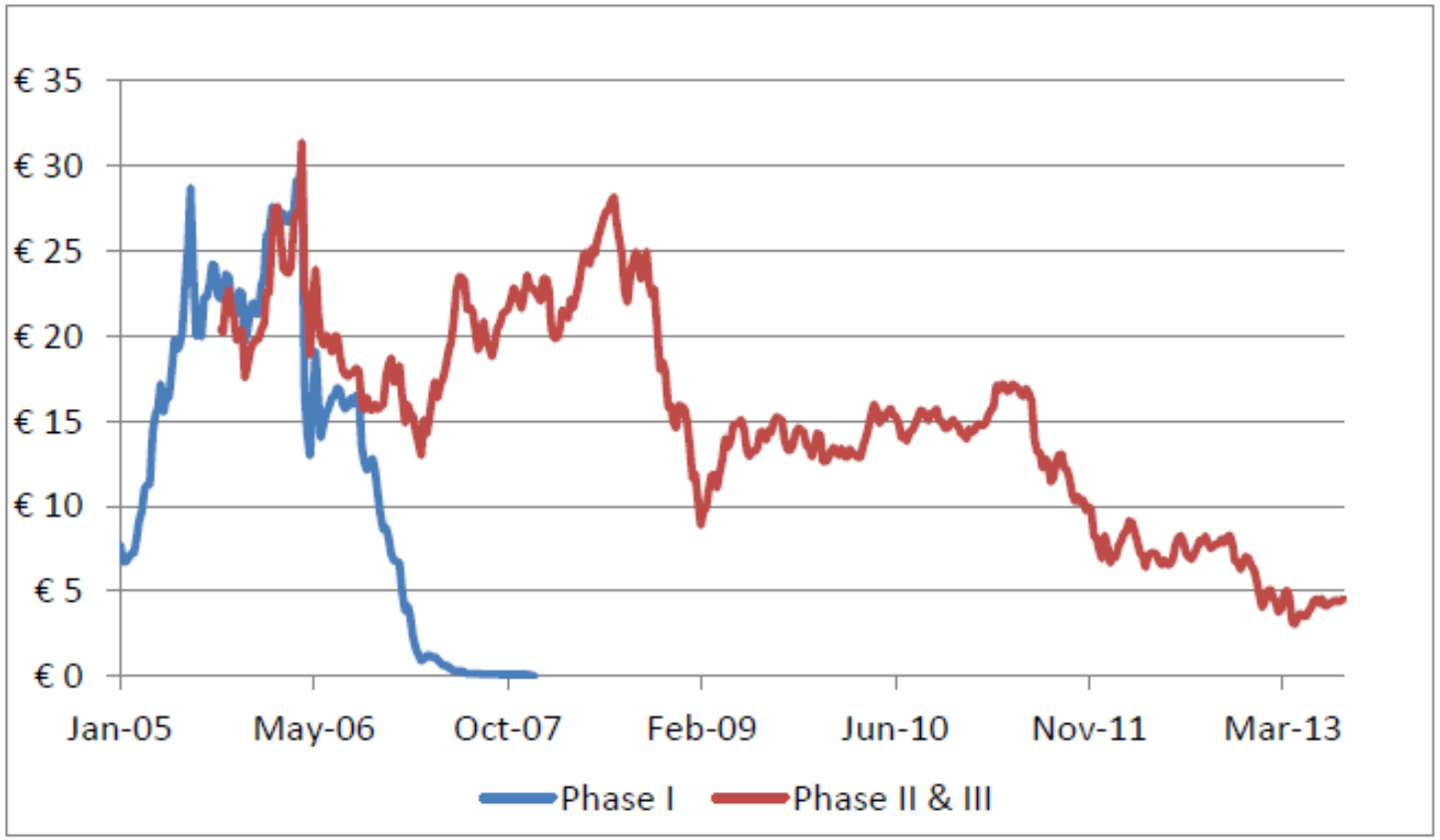
Power sector	Industry	Transport	Buildings
• Emissions trading • Subsidies for renewables • Fuel taxes	• Tax relief • Audit support • CO_2 emissions trading • Energy management support • R&D incentives • Energy prices • Carbon taxes • 3rd party finance and ESCOs	• Vehicle tax incentives • Advanced vehicle subsidies • Fuel taxes • User charges • Infrastructure investment • CO_2 emissions trading • Carbon taxes	• Grants for EE equipment • Loans and grants for refurbishment • Direct investment in social housing • Tax relief • Energy prices • Carbon taxes • 3rd party finance and ESCOs

Economic instruments (1)
Emissions Trading Schemes

- Instead of setting the charge, we set the quantity of emissions and allow the market to determine the price.
- All sources are allocated allowances to emit either on the basis of some criterion or by auctioning. The allowances are freely transferable.
- The equilibrium price will be the price at which the marginal control costs are equal for both (or across all) firms.
- The market equilibrium for an emission allowance system is the cost-effective allocation, but it is easier said than done.

EU ETS: largest ETS in the world
Historical trend in permit prices

Figure 4: Prompt-future Prices for EUA in Phase I and Phase II & III.

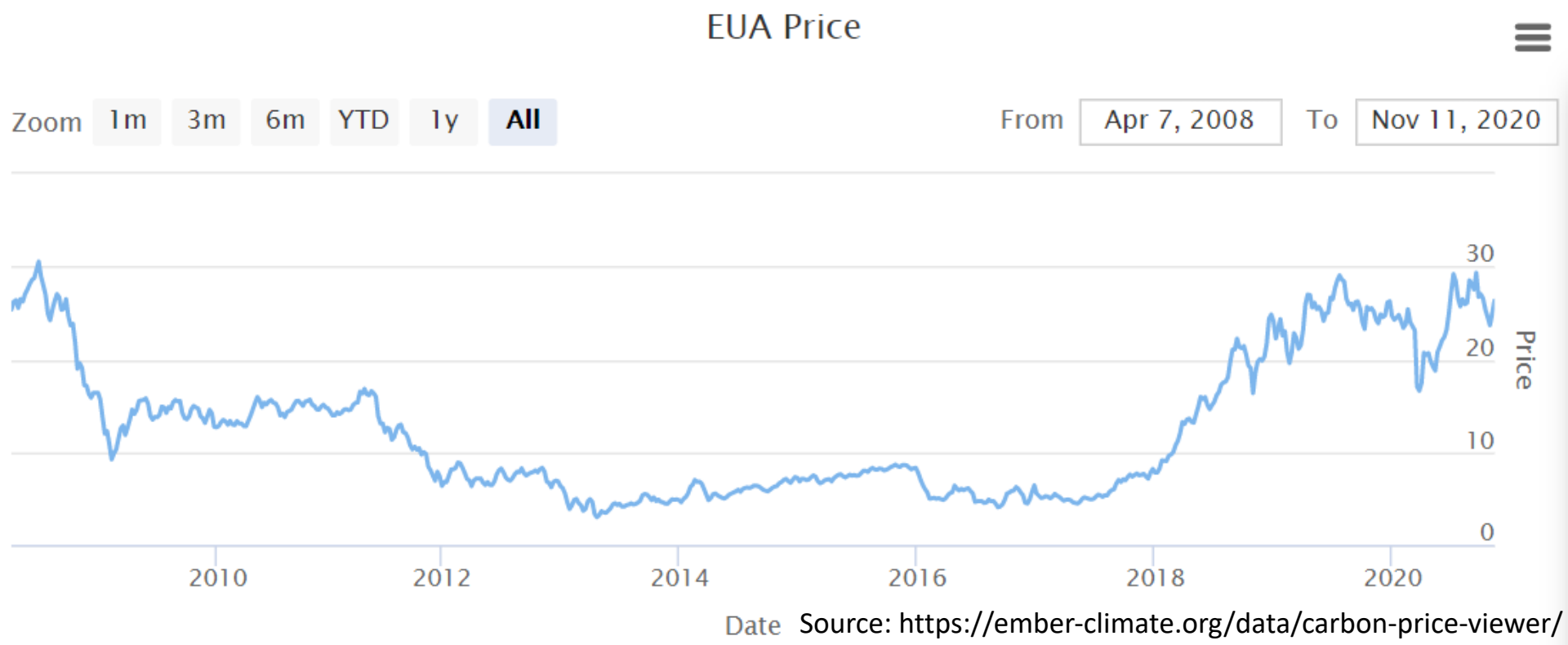


Source: Point Carbon.

Source: Ellerman et al. (2014)

Price on February 18th, 2016: 5.25€/ton(CO_2)

Progression since 2016….



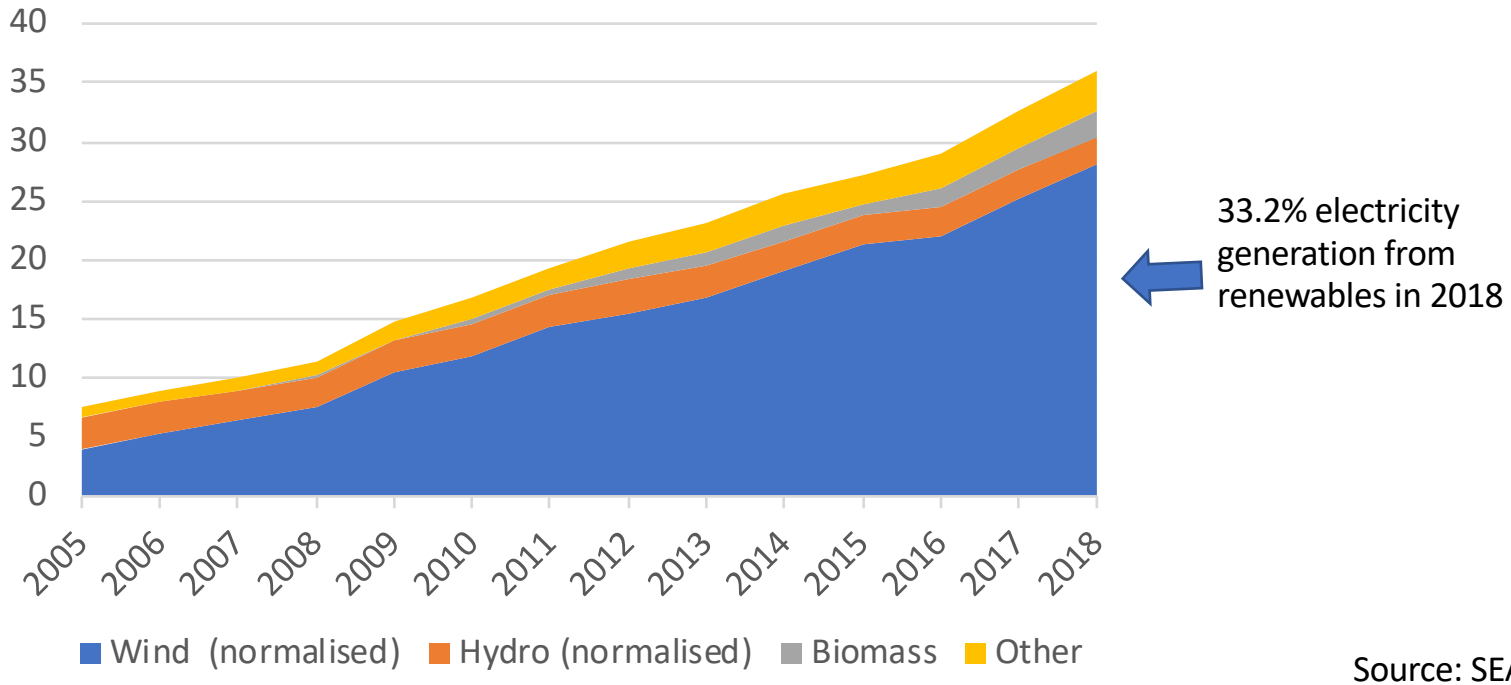
Why price rise? Scarcity introduced to the market.

Fewer permits => higher prices

Economic instruments (2)
Subsidies for environmental 'goods'

Used to correct for externality and other market failures by providing <u>subsidy</u> to cleaner competitor

Example: REFIT = 'Renewable Energy Feed in Tariff' = subsidy to encourage the development of new renewable generation - primary means through which electricity from renewable sources was supported in Europe.



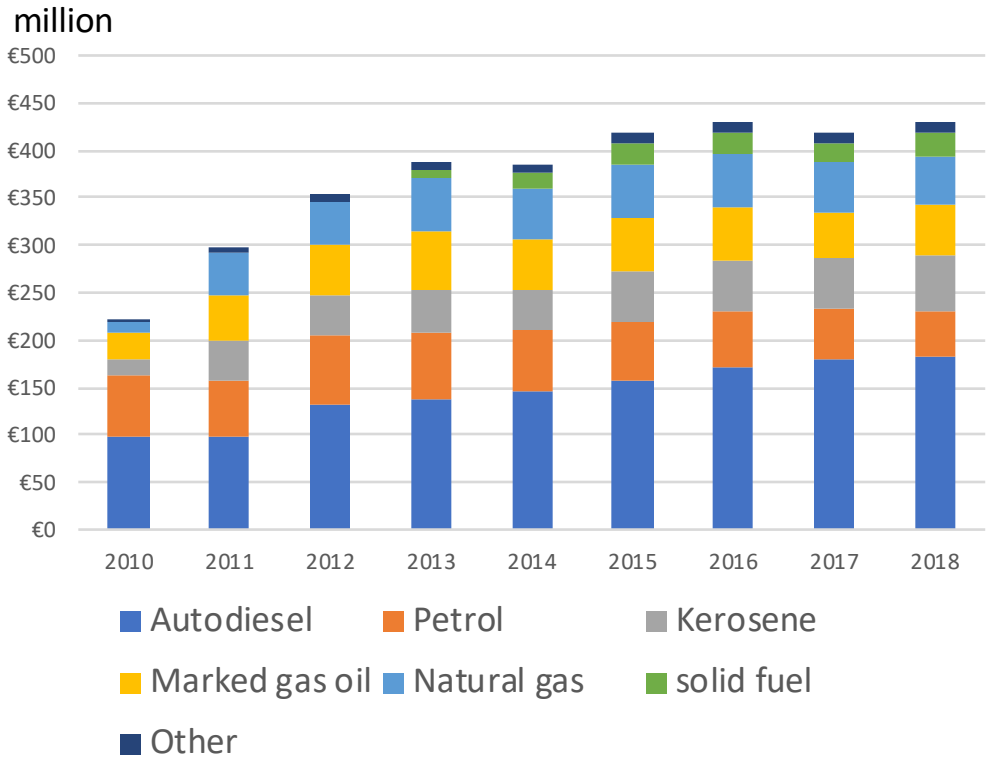
Source: SEAI 2020

Economic Instruments (3) Environmental Taxes

- ***Definition of carbon taxes***: a tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific negative impact on the environment, here carbon. Value added tax (VAT) is normally excluded (Eurostat, 2014).
- Basic rationale for environmental taxes and charges is the use of fiscal instruments to correct *environmental* **externalities**
- Primary function of environmental taxes is to create a financial incentive for reducing pollution e.g. carbon tax
- Video of Leonardo di Caprio interviewing Greg Mankiw (and Elon Musk) on carbon taxes: https://www.youtube.com/watch?v=2JNs6bC4NbY

Irish carbon tax

- Irish carbon tax introduced in 2009
- Coverage: Only non-ETS sectors and only CO2 emissions (no agriculture)
- Rate: initially €15 per tCO2, rising to €20, now €26 per tCO2
- Revenue: 52% businesses, 48% households
- Not ring-fenced/ hypothecated
- Rising to €100/tCO2 by 2030



Department of Finance, 2019

Summary on policy instruments

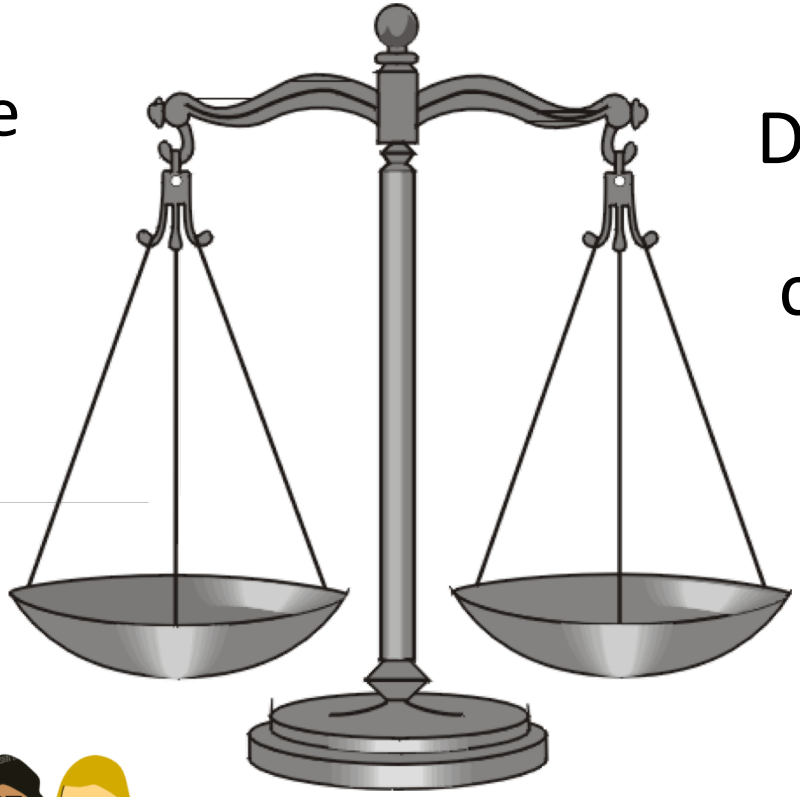
- Market failures causing GHG emissions: Externalities and property rights
- Policy instruments -> 3 categories of policy
  - Command and control
  - Information measures
  - Economic instruments
    - Emissions trading
    - Subsidies
    - Taxes
- Criteria for efficient policy instruments

Benefit-cost analysis

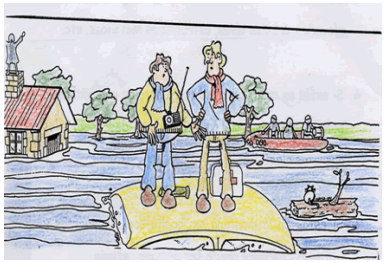
- Key tool in economic analysis of policies
- Introduces other elements: discounting, net present value, valuation of non-market goods

Benefit-cost analysis of Climate Change Policy

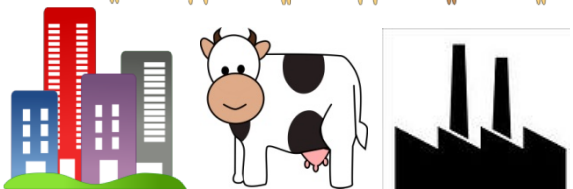
Cost of climate change mitigation



Damage costs of more rapid climate change



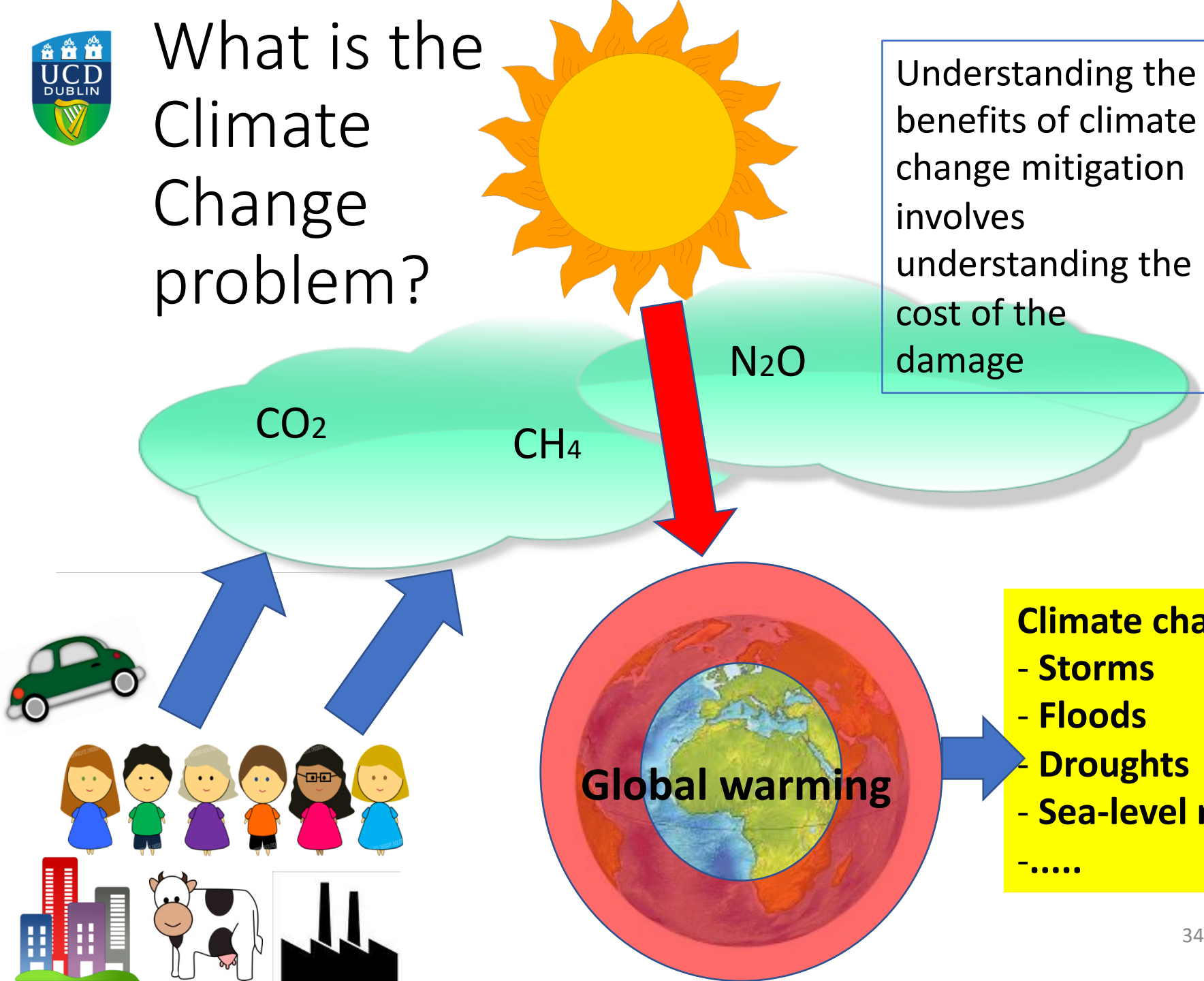
Reduction of GHG emissions



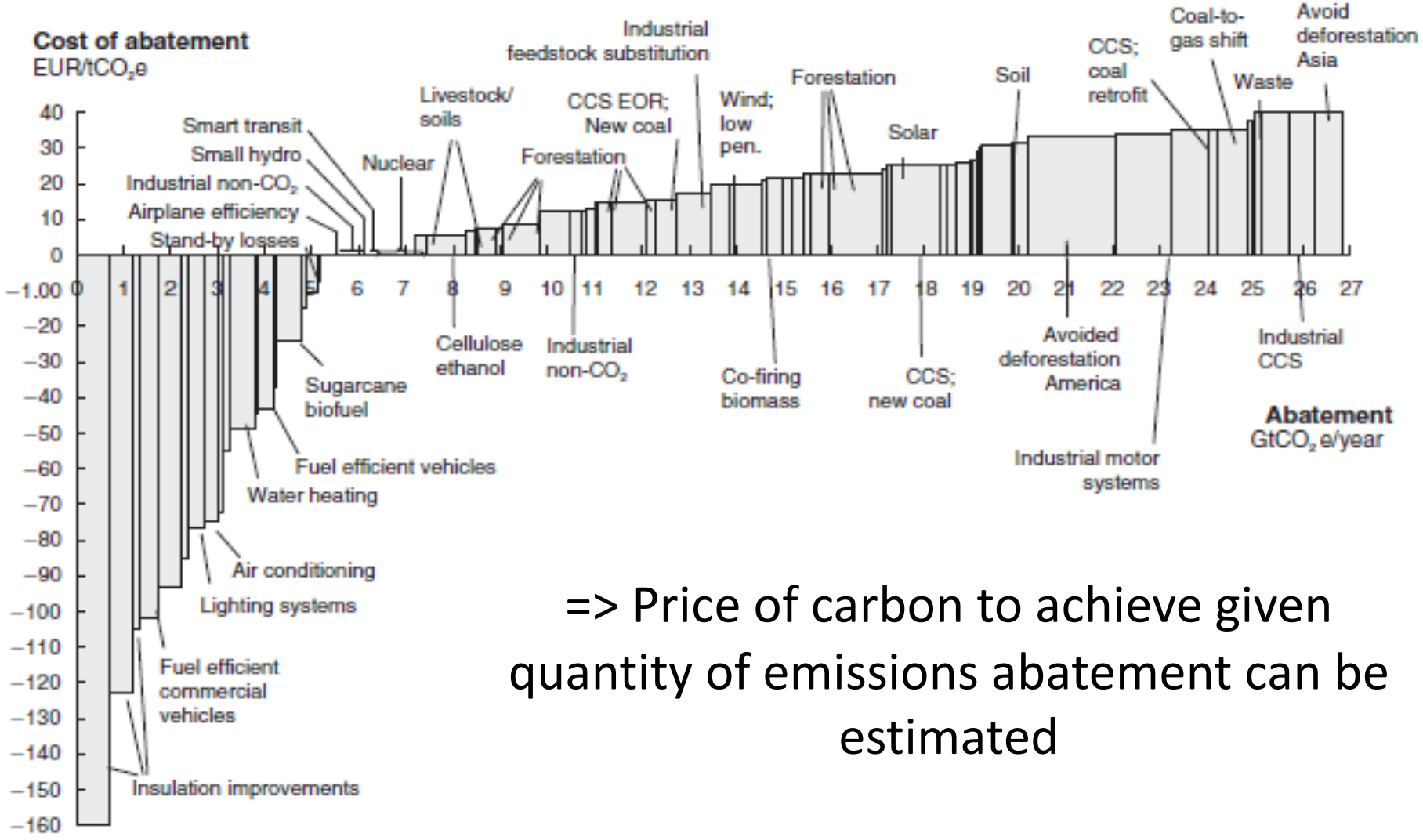
Aravena, 2015

What is the Climate Change problem?

Understanding the benefits of climate change mitigation involves understanding the cost of the damage



Costs of mitigation



=> Price of carbon to achieve given quantity of emissions abatement can be estimated

Source: Enkvist et al., (2007), cited in Stern (2008)

Policy benefits: Avoided damages
Observed climate change impacts

- Physical systems
  - Glaciers, snow ice and permafrost
  - Rivers, lakes, floods, and drought
  - Coastal erosion and sea level effects
- Biological systems
  - Terrestrial ecosystems
  - Wildlife
  - Marine ecosystems
- Human and managed systems
  - Food protection
  - Livelihoods, health, and/or economics

Estimates of the Damage Costs of Climate Change

Table V. Number of additional deaths (1000s) per °C increase in global mean temperature.

	Malaria	Schisto[a]	Dengue	C-Heat[b]	C-Cold[c]	Resp.[d]	Total
OECD-A	0 (0)	0 (0)	0 (0)	11.4 (5.9)	−64.4 (4.4)	3.0 (9.7)	−50.0
OECD-E	0 (0)	0 (0)	0 (0)	11.7 (4.0)	−99.8 (2.6)	−2.8 (5.7)	−90.9
OECD-P	0 (0)	0 (0)	0 (0)	3.5 (2.8)	−13.1 (2.2)	1.0 (4.8)	−8.6
CEE&fSU	0 (0)	0 (0)	0 (0)	10.7 (4.4)	−87.5 (5.2)	4.5 (11.)	−72.3
ME	0.2 (0.1)	−0.1 (0.0)	0 (0)	2.5 (0.4)	−8.9 (1.3)	9.9 (2.6)	3.6
LA	1.1 (0.8)	−0.1 (0.0)	0 (0)	8.1 (1.8)	−20.0 (3.5)	11.1 (7.0)	0.2
S&SEA	8.2 (5.9)	−0.1 (0.0)	6.7 (1.2)	17.5 (2.9)	−63.8 (16.9)	141.2 (34.1)	109.7
CPA	0 (0)	−0.1 (0.0)	0.4 (0.1)	24.3 (4.6)	−103.4 (21.7)	62.8 (44.4)	−16.0
AFR	56.5 (40.9)	−0.5 (0.1)	0.3 (0.1)	4.7 (0.5)	−18.2 (6.0)	24.8 (6.0)	68.3

[a]Schistosomiasis.
[b]Heat-related, cardiovascular mortality.
[c]Cold-related, cardiovascular mortality.
[d]Heat-related, respiratory mortality.
Source: Own calculations, after Martens (1997), Martin and Lefebvre (1995), and Morita et al. (1994).

With the changes in temperature some diseases that were not present in some places can start to appear and spread.

Estimates of the Damage Costs of Climate Change

Table VIII. Annual impact of a 1 °C increase in global mean temperatures on the world for three different rules of aggregation.

	Billion dollar	Percent of income
Simple sum	448 (197)	2.3 (1.0)
Average value	−522 (150)	−2.7 (0.8)
Equity-weighted sum	40 (257)	0.2 (1.3)

Source: Own calculations.

The aggregation of estimated impacts across regions leads to a positive impact or benefit of $488 billion per year, equal to 2.3% of the total world income.
If non-market goods are included: Negative world impact of $522 billion or 2.7% of income. Huge different. Main reason: mortality.

Aravena, 2015

Benefit-Cost Estimation

- Bring the benefits and costs together in BCA
- One problem with climate change policy evaluation – the costs of mitigation occur now but the benefits extend into the future
- Want dynamic efficiency = efficiency across time
- Estimate the net benefits (= total (private and social) benefits – total (private and social) costs) over time in the present value

Topics for economists on SD

Major research questions for economists on SD

- Climate change
- Biodiversity
- Social justice
- Poverty and the environment
- Water scarcity
- Waste recycling
- Renewable energy development
- Ex-post policy analysis of any recent policy

Covid and Sustainable Development
Some research questions for economists

- How have economic drivers been affected by Covid?
- What indicators are relevant?
  - GDP
  - Travel
  - Unemployment
  - Energy use
  - Social welfare
- How is the environment affected?
- Are the effects unequal across society?
- Webinars on Covid and public policy themes from UCD Geary Institute available here: http://publicpolicy.ie/papers/irelands-covid19-crisis-response-perspectives-from-social-science-videos-and-slides-from-all-17-panels/
- Other research relating to Covid in UCD: https://www.ucd.ie/research/covid19response/expertcommentary/

Other great topics for economics projects relating to sustainable development

- Climate change:
  - European Green Deal is a great topic for examining sustainable development research, as policy makers have tried to include economic, environmental and social sustainability objectives. There are many pieces to it so students could pick one aspect, ie CO2 targets, or investing in a green economy
  - Examine Ireland's Climate Action Plan 2019.
    - Are the policy measures proposed (for a particular sector) sustainable, ie economic, social and environmental?
    - What market failures are being addressed?
    - Pick a policy measure and carry out a benefit-cost analysis
  - Carbon tax: at what level should it be set? Why? How are low income groups affected?
  - Emissions trading: compare the Eu scheme with another (perhaps US RGGI for example)
  - Look at international agreements and consider from game theoretical point of view
- Biodiversity:
  - What are the existing market failures that lead to overexploitation?
  - Can we value/monetise the ecoservices provided?
- The future of energy:
  - Look at the external costs associated with fossil fuels, i.e. climate change, air quality, mining
  - Examine fossil fuel subsidies globally and the countries where they are highest
  - Examine renewable energy subsidies across a region; how are they designed differently?
  - What is the role of consumer? Investing in clean technologies, consumer behaviour, generating electricity at home, renovating their home to consume less.
  - How do energy prices influence investment in clean energy?
  - Energy poverty in Ireland: a combination of eergy prices, income and poor buildings quality
- Transport: how can transport be more sustainable (across the 3 dimensions)? Connect access to clean transport with social justice? How can EVs provide a solution in urban and rural areas?
- Water: who should pay? How can water charges be fairly designed?
- Waste: Look at a benefit-cost analysis of an incinerator. Compare the cost of recycling vs landfill vs waste-to-energy. Assess proposed new waste plan.

Source material suggestions

- Policy:
  - EU Green Deal: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
  - Irish Climate Action Plan: https://www.dccae.ie/en-ie/climate-action/topics/climate-action-plan/Pages/climate-action.aspx
  - EU policy: https://ec.europa.eu/info/energy-climate-change-environment_en
  - The EU Commission Climate Action Policy: https://ec.europa.eu/clima/policies/strategies_en
  - Global Paris Climate Plan: https://ec.europa.eu/clima/policies/international/negotiations/paris_en

  - Irish waste action plan: https://www.dccae.ie/en-ie/environment/publications/Pages/Waste-Action-Plan-for-a-Circular-Economy.aspx
- US ETS: epa.gov/emissions-trading-resources
- Data:
  - SEAI has ha range of energy data:
  - EPA has Irish emissions data:
  - International emissions data can be obtained from a number of international organisations' websites:
    - https://unfccc.int/
    - https://www.ipcc.ch/
    - https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data
    - http:/www.iea.org
    - http://www.eia.gov
    - https://ccafs.cgiar.org/
  - OECD has lots of databases relating to the environment, social and economic indicators for OECD countries. See in environment statistics, for example https://www.oecd-ilibrary.org/environment/data/environmental-policy/renewable-energy-feed-in-tariffs_f68de84b-en
  - World Bank has similar global but less details https://data.worldbank.org/
  - Transport
    - https://www.sustainabletransport.org/
    - https://www.oecd-ilibrary.org/transport/international-transport-forum-policy-papers_24108871
  - Agriculture
    - https://climatefocus.com/
    - www.teagasc.ie
    -
  - Electricity
    - www.iea.org
    - www.irena.org

Thank-you

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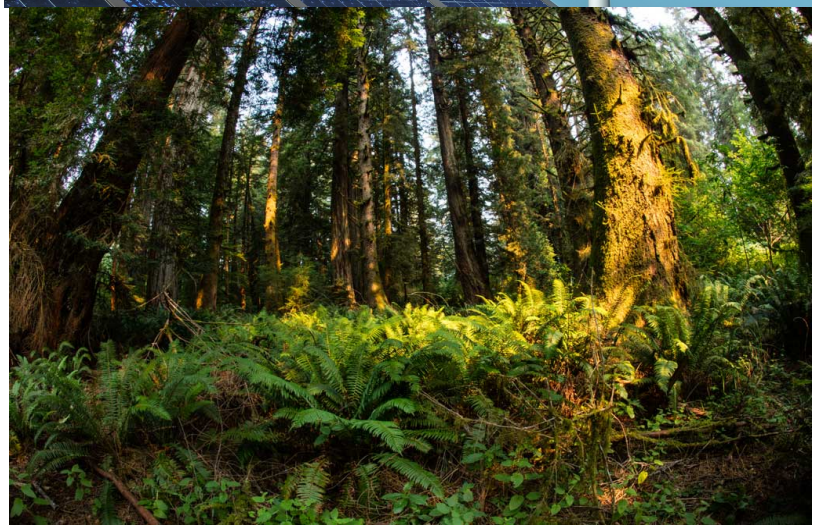

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