

Economics of Innovation and Energy

Petra Hellegers
19 February, 2013



Today

i) Innovation

- Why Innovation?
- Economics of technological change
- Environmental policy and technological change

Break

ii) Africa Biogas Company – Bernard Wesseling

iii) Economics of Renewable Energy

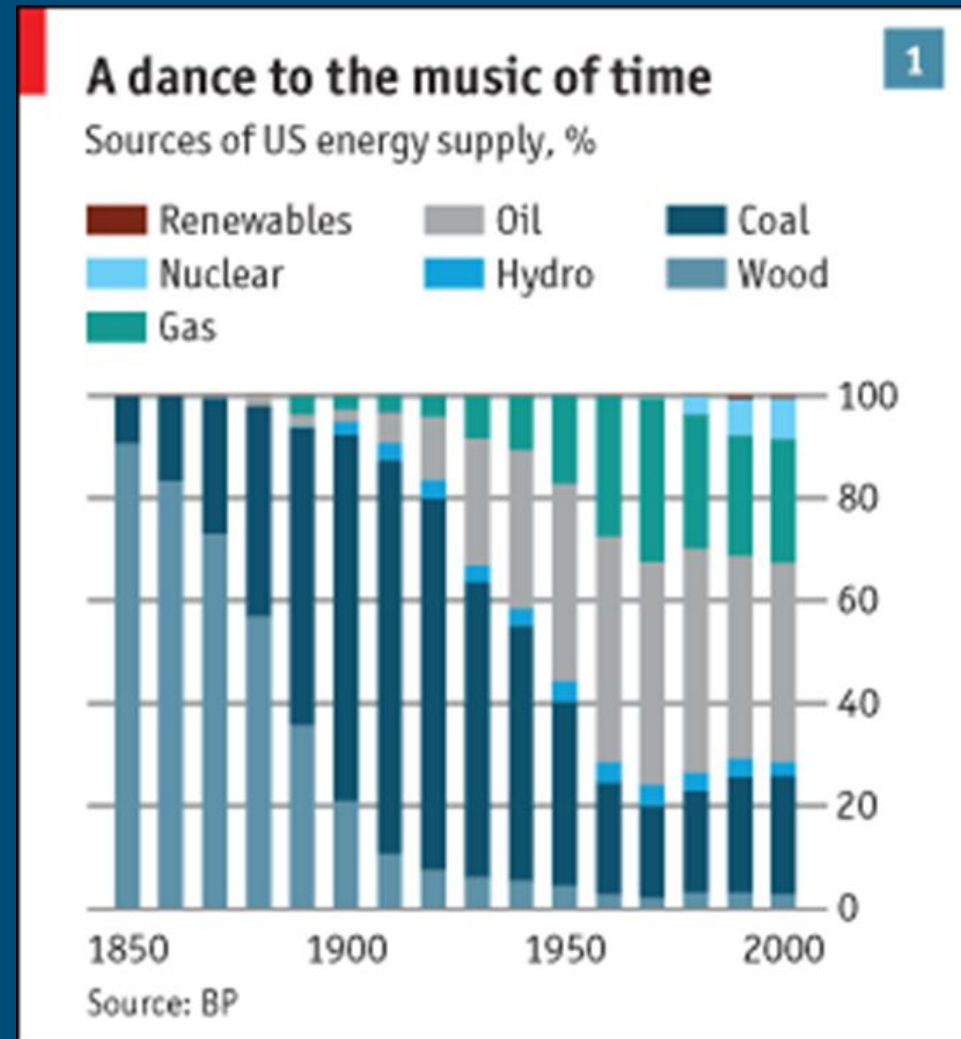
- Why renewable energy and kinds of renewable energy?
- How to determine potential availability
- Why not through markets? Justification of support schemes

1) Why innovation?

- Many current issues depend strongly on new or 'infant' technologies (such as energy and water)
- Economic growth depends on it

Energy sources have become more diverse

- Strong dependency on fossil fuels



Problems of fossil fuels

- Non-renewable
- Carbon emissions
- Geopolitics
- Collecting poses dangers

Ukraine-Russia gas dispute

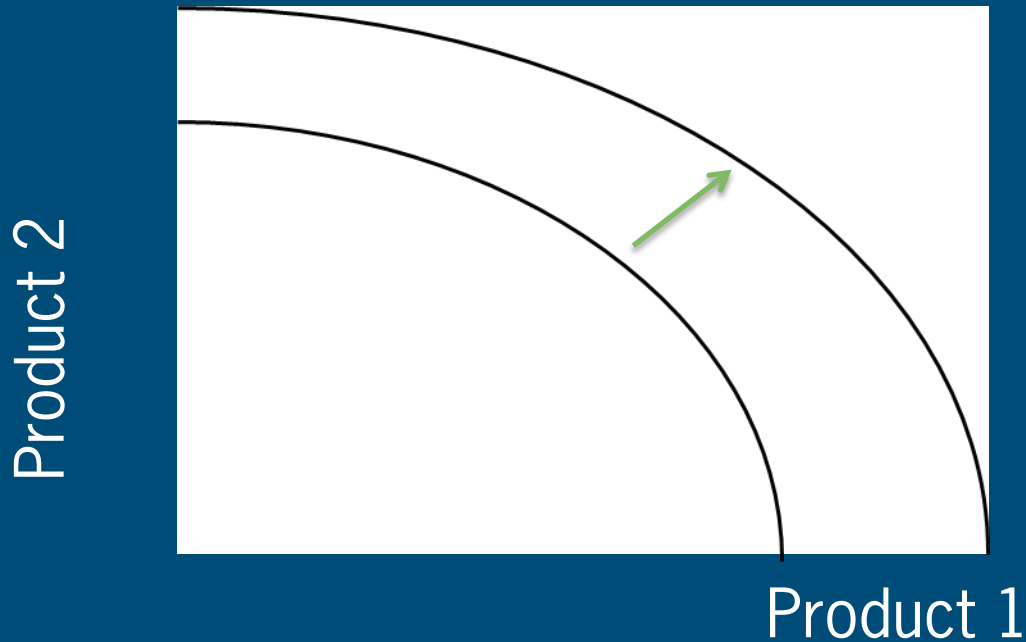


Problems of alternative energy

- Still being developed
- Irregular
- Expensive

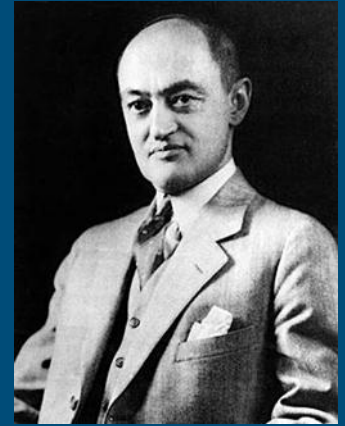
Economics of technological change

- Jaffe et al:
Technological change shifts the PPF outwards



Joseph Schumpeter (1883-1950)

- ‘Creative destruction’
 - Creation: new technologies
 - Destruction: old-fashioned ones
- Phases in the technological change process
 - Invention (an idea is born)
 - Innovation (an existing idea is being developed and commercialized, i.e. brought to the market)
 - Diffusion (a developed idea is adopted by users)



Invention and Innovation

- Ideas are uncertain
 - Outcome R&D investment unknown
 - Probability distribution also unknown

Laser

- “A solution looking for a problem” when invented



Nuclear fusion

- First patent: 1946
- Less radioactive waste than nuclear fission
- Safer than nuclear fission
- It just does not work yet



Invention and innovation

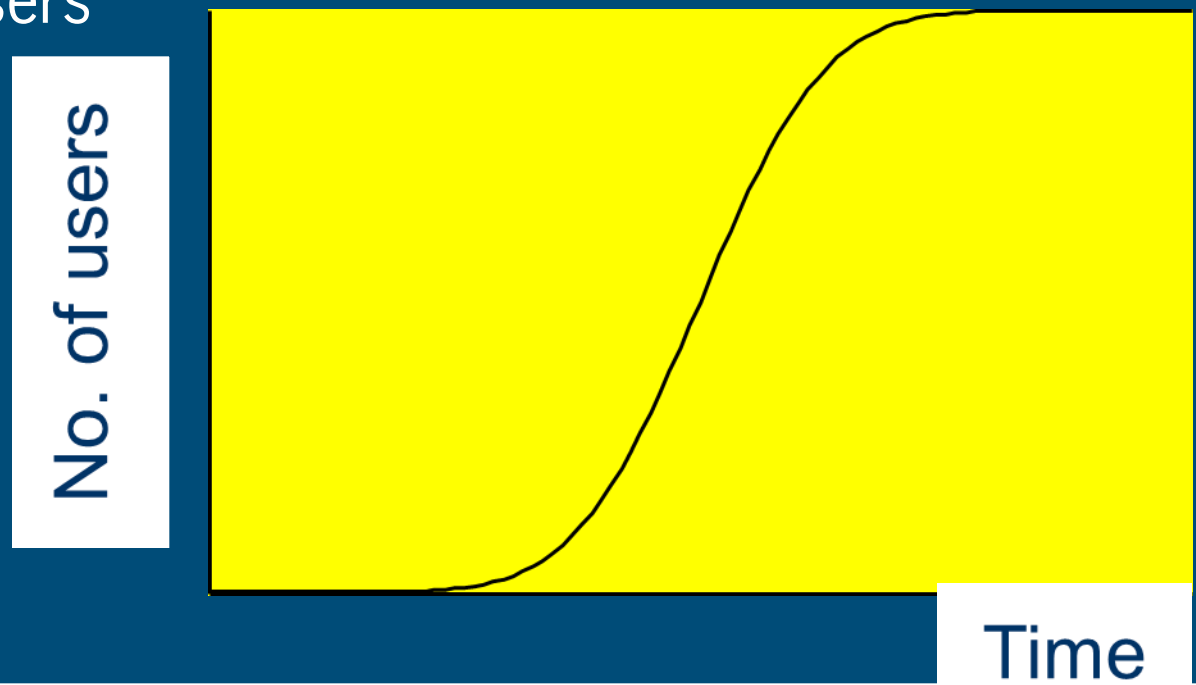
- Ideas are uncertain
 - Outcome R&D investment unknown
 - Probability distribution also unknown!
- Ideas are difficult assets
 - Specialized (only valuable in limited context)
 - Sunk (investment cannot be retrieved)
 - Intangible
- Ideas are, to some extent, public goods
 - Nonrivalrous
 - Poorly excludable

Invention and innovation

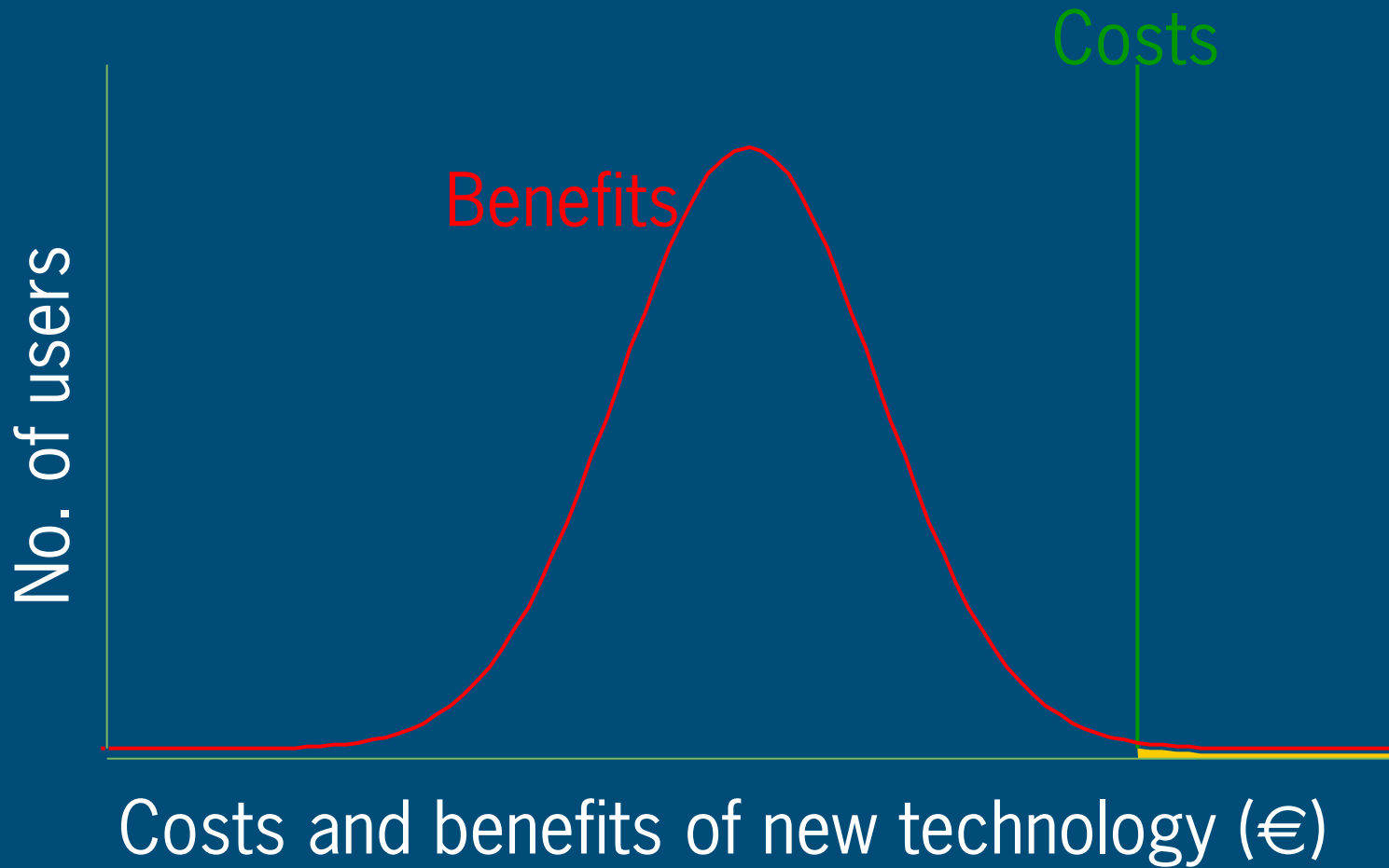
- Underinvestment is likely
 - Uncertain outcome of ideas
 - Ideas make poor collateral
 - Not all benefits accrue to inventor
- Patents may solve the problem to some extent...
 - More benefits to inventor → incentive to invent
- ...but also have a downside
 - 'Outsiders' must be able to build on existing ideas
- Therefore, patents are seldomly forever

Technology diffusion

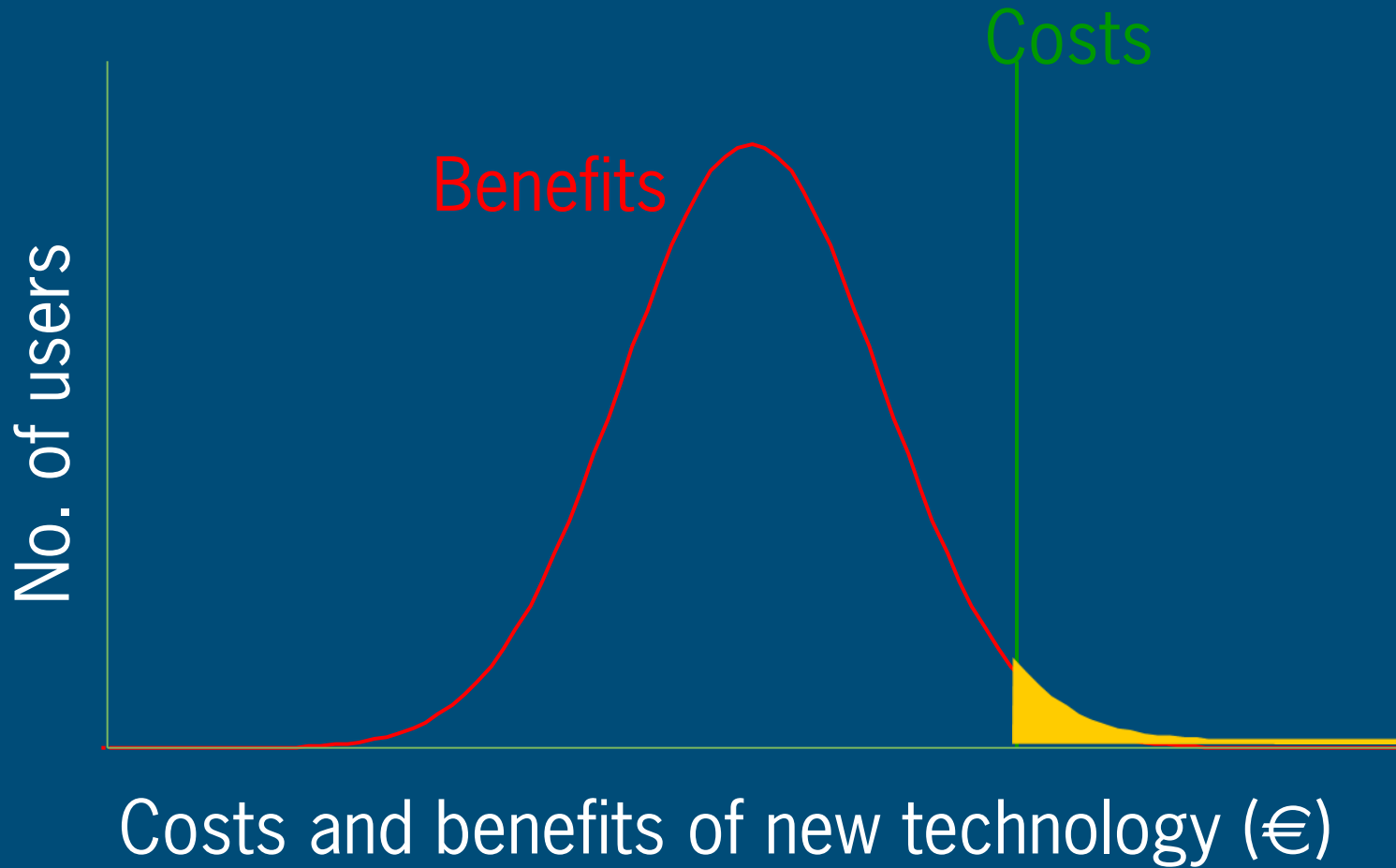
- Often S-shaped
- Alternative explanations:
 - Heterogeneity of users
 - Information



Heterogeneity of users

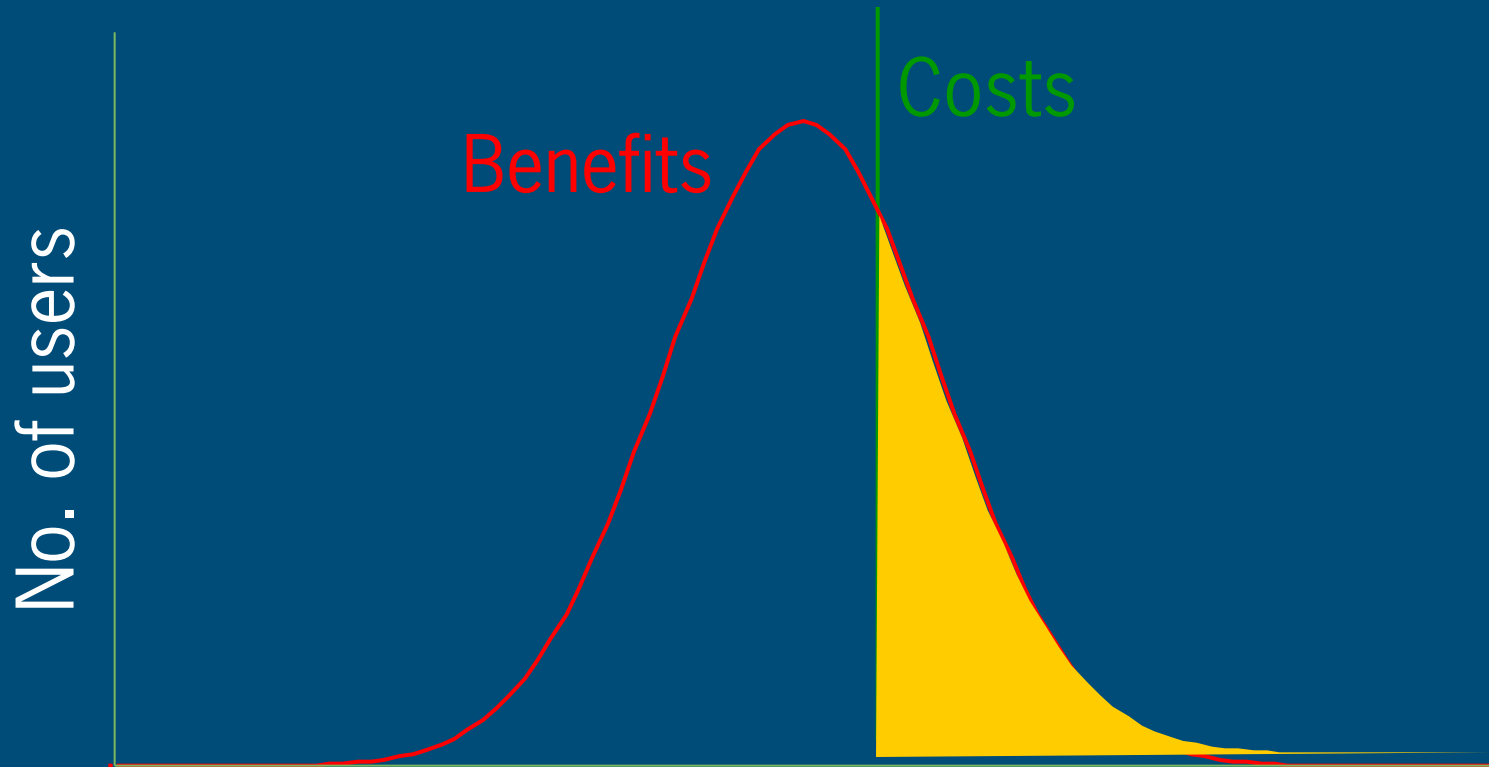


Heterogeneity of users



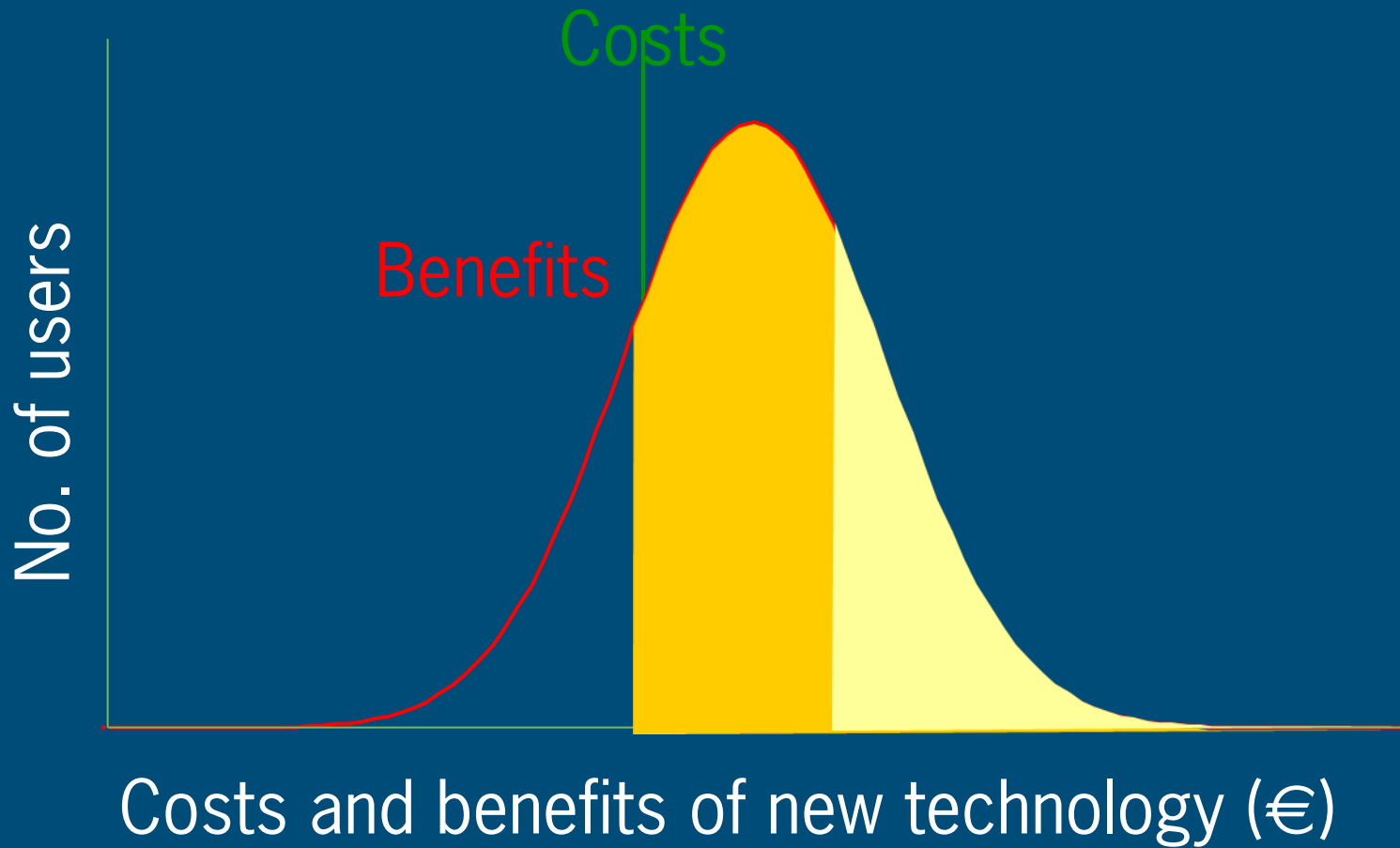
Costs and benefits of new technology (€)

Heterogeneity of users



Costs and benefits of new technology (€)

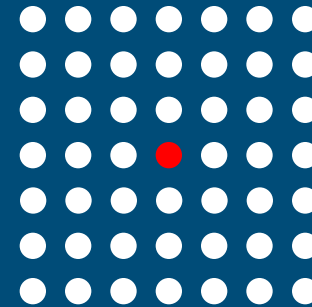
Heterogeneity of users



Information

- Comparable to epidemics
- Suppose firm adopts technology if 'neighbour' does
- Number of firms:

1.1

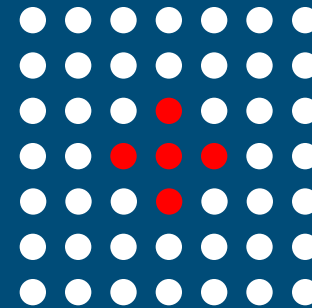


Information

- Comparable to epidemics
- Suppose firm adopts technology if 'neighbour' does
- Number of firms:

1.1

2.5 (4 more)



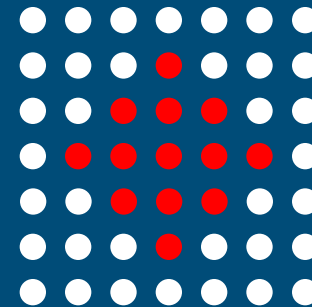
Information

- Comparable to epidemics
- Suppose firm adopts technology if 'neighbour' does
- Number of firms:

1. 1

2. 5 (4 more)

3. 13 (8 more)



Information

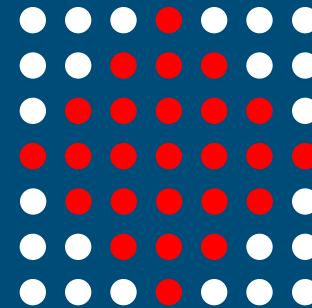
- Comparable to epidemics
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4. 25 (12 more)



Information

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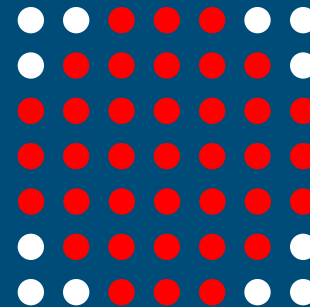
1. 1

2. 5 (4 more)

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4. 25 (12 more)

5. 37 (12 more)



Information

- Comparable to epidemics
- Suppose firm adopts technology if 'neighbour' does
- Number of firms:

1. 1

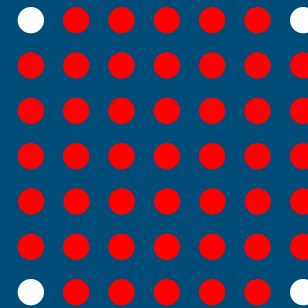
2. 5 (4 more)

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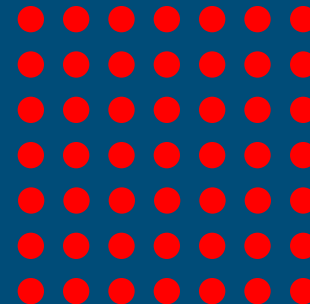
5. 37 (12 more)

6. 45 (8 more)



Information

- Comparable to epidemics
- Suppose firm adopts technology if 'neighbour' does
- Number of firms:
 - 1
 - 5 (4 more)
 - 13 (8 more)
 - 25 (12 more)
 - 37 (12 more)
 - 45 (8 more)
 - 49 (4 more)

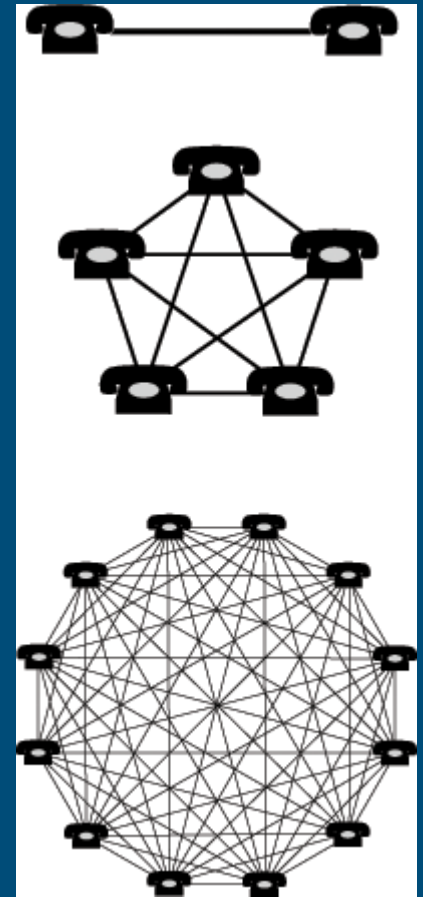


Diffusion market failures

- Information
- Uncertainty and irreversibility
 - Learning to use a new machine, or program
 - Firms may prefer to postpone the adoption decision
- Separation of 'payers' and 'deciders'
 - One person decides which technology to buy
 - Another pays the cost
- Increasing returns to scale
 - Learning
 - Network externalities

Network externalities

- More users → more benefits for each user
 - Communication devices
 - Software
 - Fuel
- Effects
 - Increasing returns to scale
 - Multiple market equilibria (lock-in effect)
 - Natural monopoly



Technological change

- Invention and innovation
 - Uncertainty
 - Irreversibility
 - Non-rivalry
 - Poor excludability
- Diffusion
 - Uncertainty
 - Principal-agent problem
 - Increasing returns to scale
- What about the environment?

Environmental policy as innovation policy

- Is environmental policy a means to enhance technological change?
- Porter hypothesis

Porter hypothesis

- Stringent environmental policy stimulates firms to invest in R&D
- R&D leads to
 - A more knowledge-intensive workforce
 - More technologies that can be used in other fields
- So stringent environmental policy
 - Enhances economic growth (through innovation)
 - Gives countries a competitive edge over their 'dirty' competitors
- ...Or that's the hypothesis

Environmental policy as innovation policy

The answer depends on what you assume firms do

- Induced innovation (R&D as a profit-motivated investment activity)
- Evolutionary approach (rules of thumb to determine how much to invest in R&D).

Effect of policy instruments

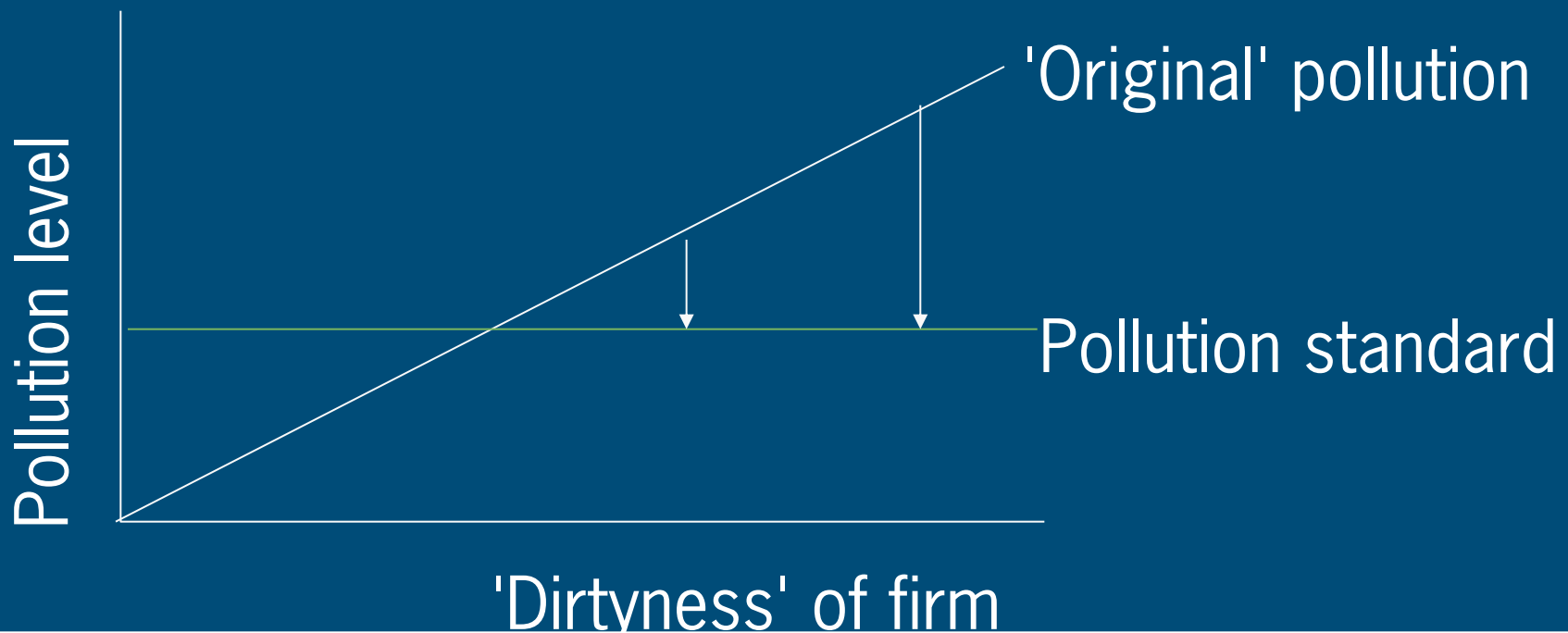
- Uniform standards
- Best Available Technology standards
- Taxation
- Tradable permits
- Subsidies

In general, the effects can go different ways

- Pollution more costly → more innovation
- Smaller product market → less innovation

Uniform standards

- May promote innovation by 'slightly dirty' firms
- Lethal to 'very dirty firms'
- No incentive for 'clean firms' to become even cleaner

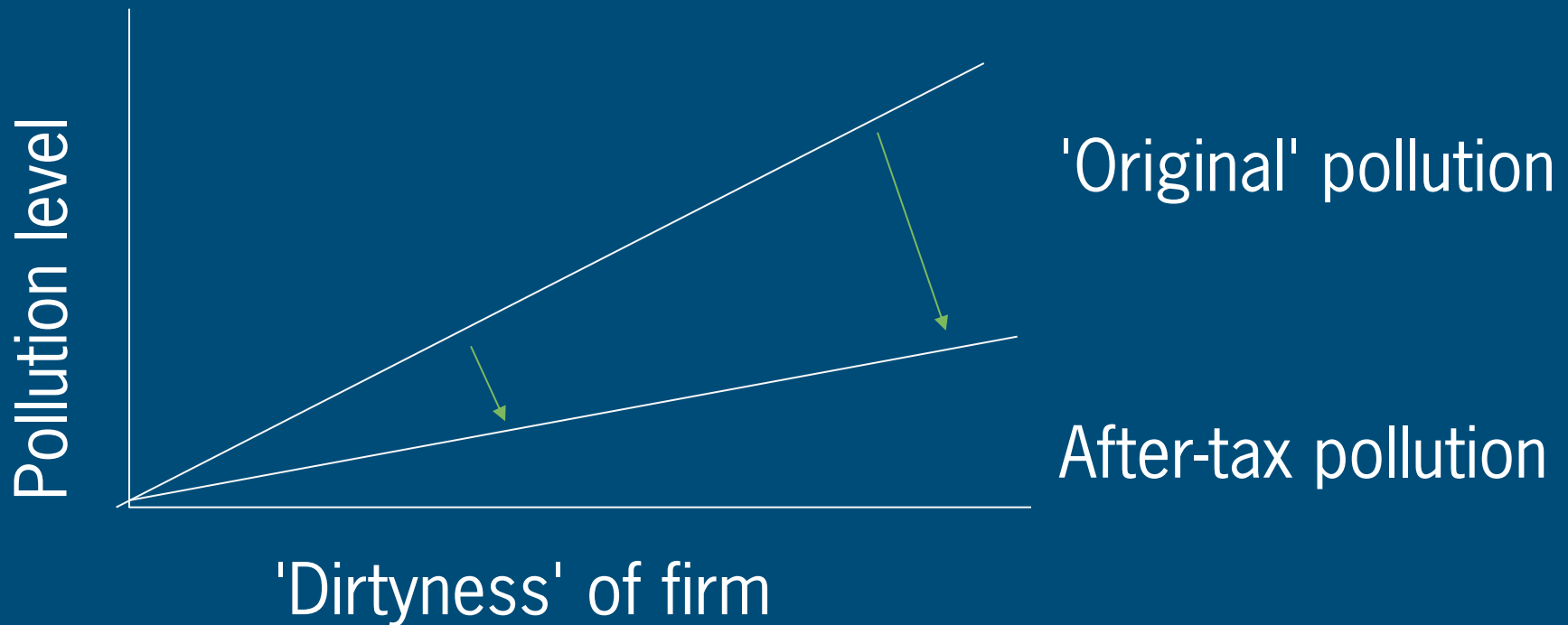


BAT standards

- On first sight 'freezes' technology
- No incentive to pollute less than standard
- Incentive to invent cleaner technology?
 - Inventors will be forced to use the new technology
 - But they will be ahead of their competitors

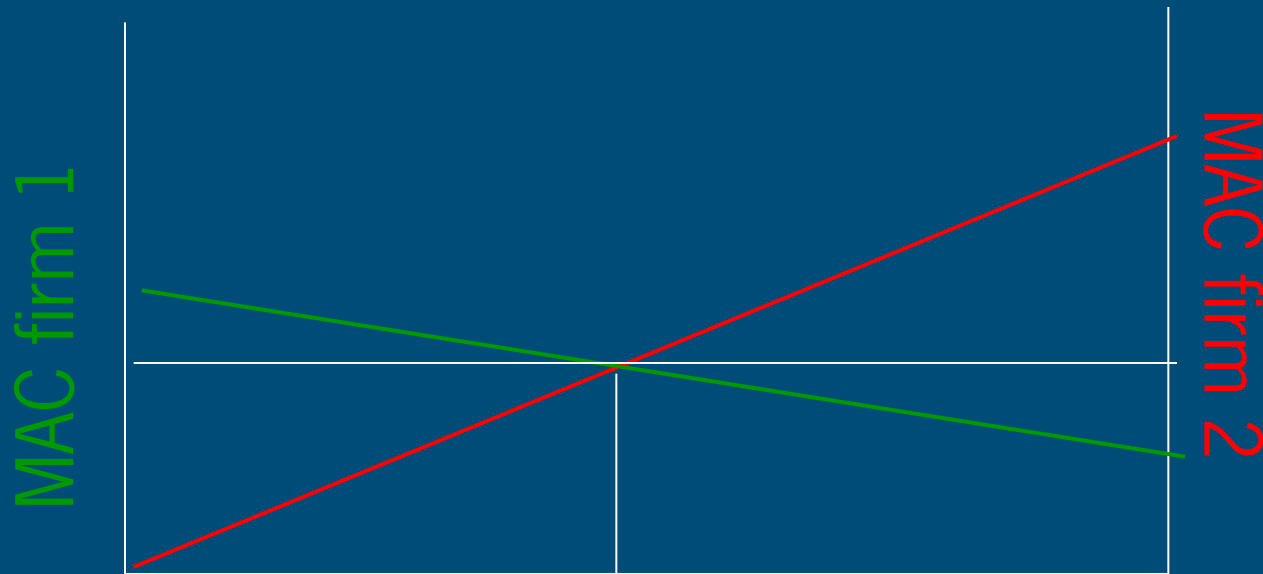
Pollution taxes

- In principle promote innovation by all firms
- Innovation reduces pollution and costs



Tradable permits

- Suppose two firms:

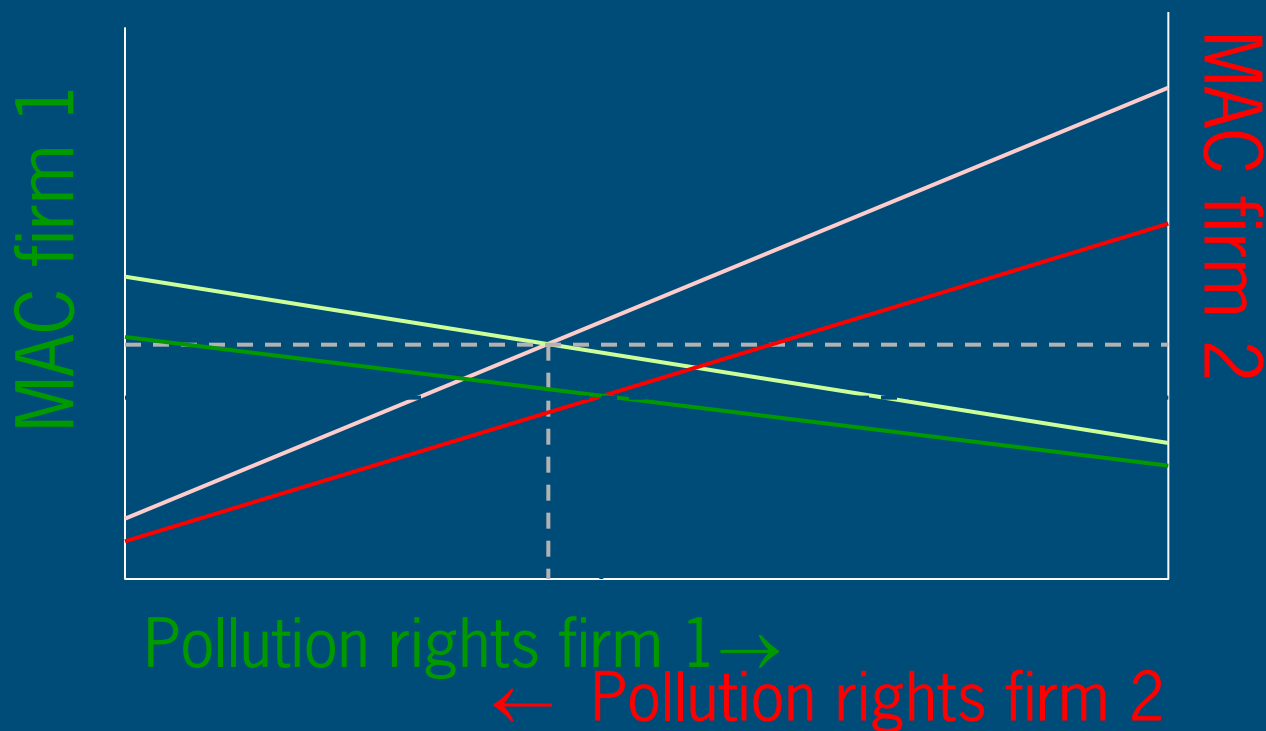


Pollution rights firm 1 →

← Pollution rights firm 2

Tradable permits

- Suppose innovation lowers marginal costs:



Tradable permits

- Incentive to innovate to all firms
- Innovation reduces costs, but not pollution
- Incentive to innovate declines after each innovation
- Allocation mechanism matters a lot
 - Auctioned: effect comparable to tax
 - Grandfathered: incentive much lower

Subsidies

- Market failures
 - Asset uncertainty, specificity, intangibility
- Invention/innovation:
 - Which technologies to subsidize?
 - Does the government know more than firms do?
- Diffusion:
 - Network externalities
 - Economies of scale
- But:
 - Polluter pays principle
 - Firms that would use the technology anyway

To summarize...

- Technological change is the main driver of growth
 - Gadgets
 - New ways to organize production
- The effect on the environment is ambiguous
- Environmental policy affects technological change
 - Cleaner technologies
 - Spillovers?
- In general, taxes and permits seem to be more effective in stimulating innovation than uniform standards

II) Africa Biogas Company – Bernard Wesseling

- III) Economics of energy

Summary

- Disadvantages of using fossil fuels, such as coal, oil and natural gas
 - They are non-renewable and limited in supply and will one day be depleted
 - Burning fossil fuels creates carbon dioxide, the number one greenhouse gas
 - Collecting them poses dangers to natural ecosystems, particularly coal and oil.
- Innovation is required for:
 - more efficient use of energy
 - the development and increased production of renewable energy technologies, such as solar energy, wind power and moving water.

Economic theory of innovations and energy policy

- Economics of renewable energy
 - Why renewable energy?
 - Kinds of renewable energy?
 - How to determine the potential availability?
- Economic incentives for promoting renewable energy
 - Why not diffusion of renewable energy by the market?
 - Justification of support schemes

Why are non-fossil fuel options important?

- Fossil fuels are non-renewable
- The risk of human-induced climate change
- The volatility of world oil markets
 - Risk of energy supply insecurity
 - Need for resource diversification
 - Cost increase of conventional oil and gas exploitation

Kinds of alternatives

- Wind
- Solar-PV
- Biomass

- Hydropower
- Geothermal power
- Tidal power

Potential availability of renewable energy varies due to

- Resource characteristics (wind/solar/soil)
- Geographical characteristics (land use/land cover)
- Techno-economic factors (scale, labour cost)
- Institutional factors (policy regime, legislation)

Uncertainties determining the potential?

- Resource base
 - Land suitability/availability factors
 - Wind speed/solar radiation/energy plantation yield
- Technology
 - Conversion efficiency
 - Management factor (biomass)
 - Average turbine size (wind) and solar-PV plant scale (solar)
- Economic
 - Specific investment cost
 - Interest rate
 - Transport cost

What will determine the realisation of the potential?

- Energy supply security
- Environmental impacts
- Socio-economic considerations
- Policy

- The Directive 2009/28/EC on renewable energy, implemented by Member States by December 2010, sets ambitious targets for all Member States, such that the EU will reach a 20% share of energy from renewable sources by 2020

- Economic incentives for promoting sustainable energy

Why not diffusion of renewable energies by the market?

- Because they contribute to the preservation of public goods: clean air and climate stability
- Private actors are not prepared to invest in something everyone can acquire free of charge
- Green electricity enables consumers to pay a higher price for a public good everyone will be able to benefit from

- Public support given to the generation of renewable energies is justified if looked upon as temporary compensation for the avoidance of negative externalities (However difficult to estimate the cost of avoided damage or the value of the public goods preserved)

Justification for support schemes

- When Renewable Energy arrives on the market, they have not reached their optimum performance in terms of cost and reliability.
- It is not because a technology is efficient that it is adopted, but rather because it is adopted it will become efficient.

Summary

Innovation

- Why Innovation?
- Economics of technological change
- Environmental policy and technological change

Economics of Renewable Energy

- Why renewable energy and kinds of renewable energy?
- How to determine potential availability
- Why not through markets? Justification of support schemes

Tomorrow Allard Castelein

Vice President of Environment for Shell

- Considerations of Shell to invest in renewable energy
- What are the most promising new technologies for cleaner energy
- Does Shell focus its R&D on specific technologies or problems
(or more explorative/fundamental line of research)
- Does environmental policy support innovations (or is it an obstacle)

Thank you very much!

Any questions?

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