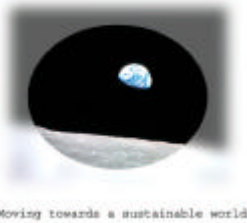


# Successful Policies for the Advancement of Renewable Energy Sources Experiences and Outlook

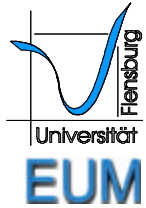
Prof. Dr. Olav Hohmeyer  
Universität Flensburg

European Energy Venture Fair  
Rüschlikon

October 28<sup>th</sup> 2003

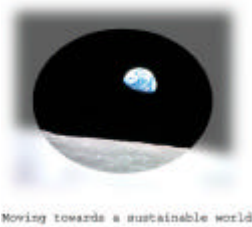


# Structure of the Presentation

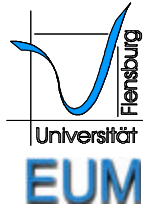


- Structure of the presentation
- Sustainable development and renewables?
  - Management rules
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

- Sustainable development and renewables
  - Management rules for sustainable development
  - Environmental damages
  - Backstop technologies for the long term energy supply
- The role of external costs
- Policies for internalisation of external costs
  - Theoretical considerations
  - Practical approaches
- Successes and failures of the past
  - NFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission certificate trading
  - Intelligent quantity regimes



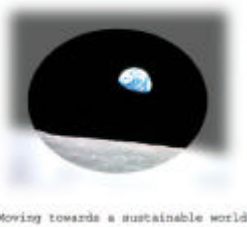
# Sustainable Development and Renewables



- Structure of the presentation
- Sustainable development and renewables?
  - Management rules
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

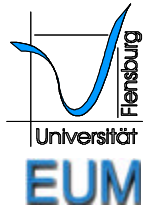
## Management rules for sustainable development

- Don't exceed the assimilative capacity of the major ecosystems
- Don't exceed the regenerative capacity of renewable resources
- Keep the stock of resource capital functionally constant



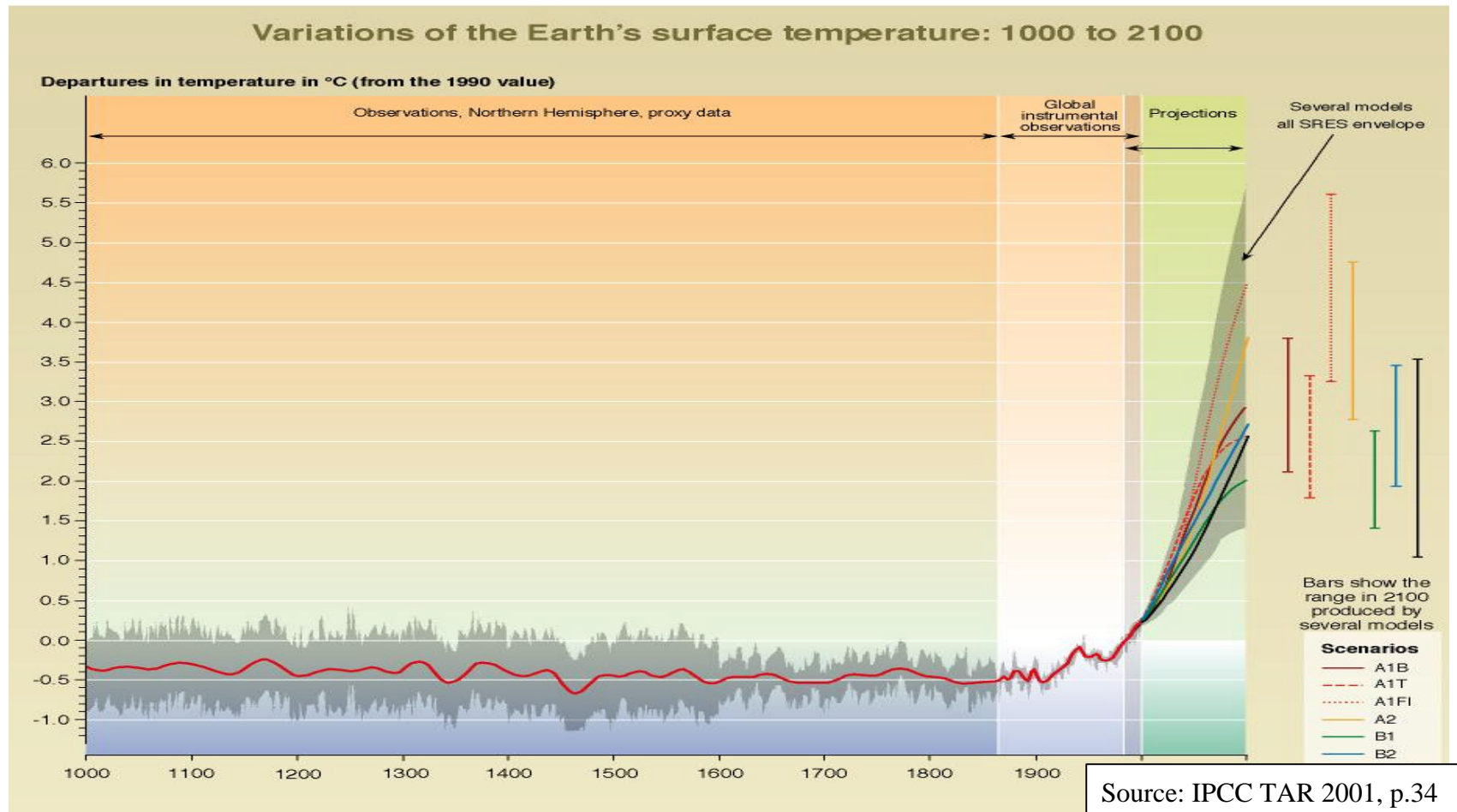
# Sustainable Development and Renewables

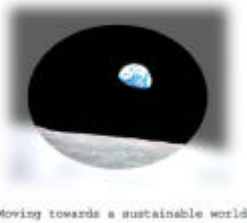
## Environmental Damages – Climate Change



Projected Temperatures During the 21<sup>st</sup> Century Are Significantly Higher Than at Any Time During the Last 1000 Years

- Structure of the presentation
- Sustainable development and renewables?
  - Management rules
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

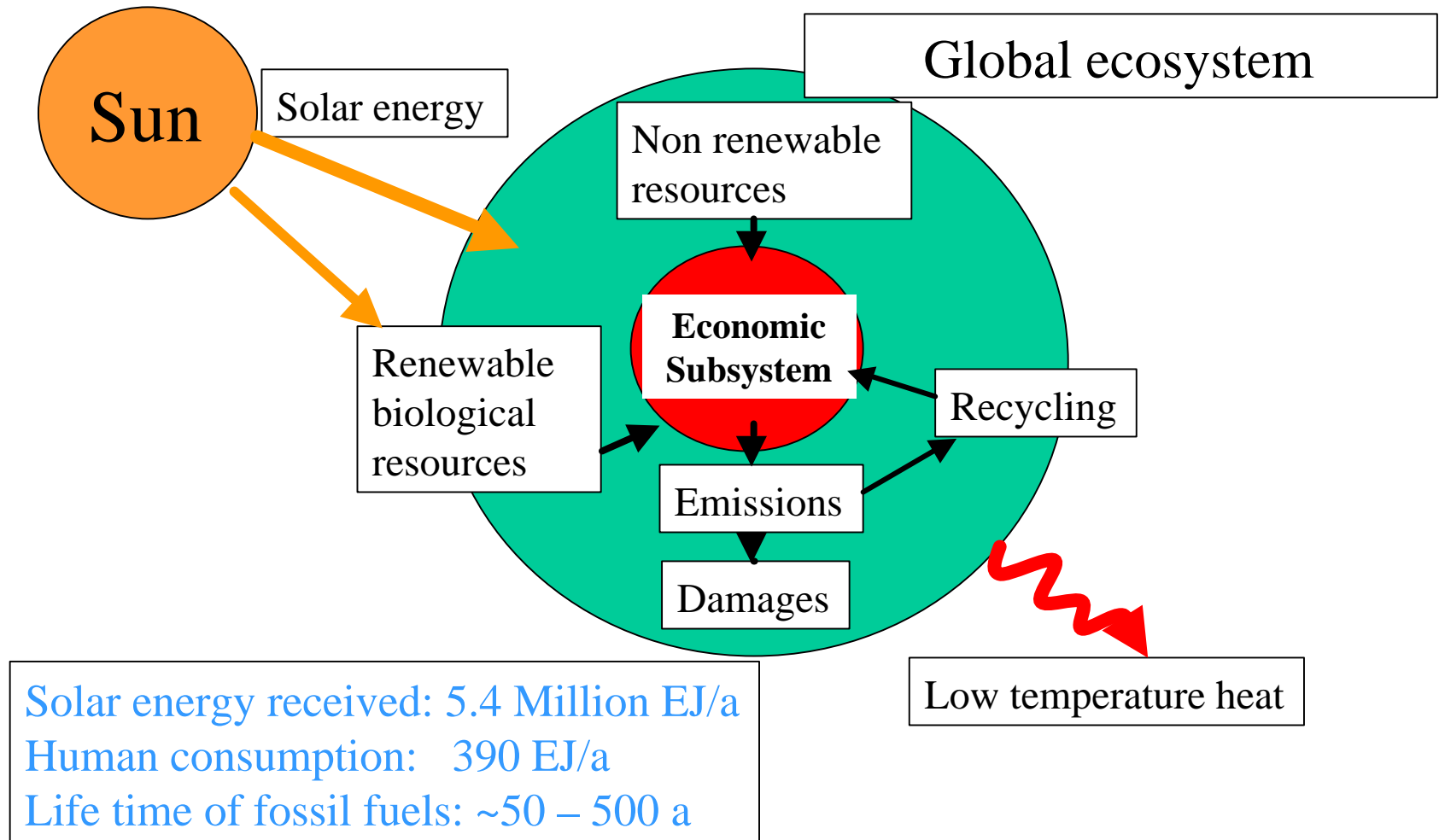




# Sustainable Development and Renewables

## Solar Energy – The Backstop Option

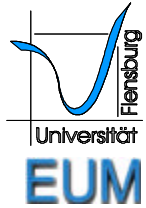
- Structure of the presentation
- Sustainable development and renewables?
  - Management rules
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes





Moving towards a sustainable world

# The Role of External Costs of Energy



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes
- The use of fossil fuels is not sustainable
  - Violation of management rules:
    - Rule 1: assimilative capacity (climate change)
    - Rule 3: functionally constant resource capital stock
- Violation of sustainability is not reflected by prices and not recognised by markets
- Costs not reflected by prices are called ‘external costs’
- Examples of external costs are:
  - Damages due to anthropogenic climate change
  - Damages of air pollution (human health, forests,..)
  - Long term damages of nuclear accidents



Moving towards a sustainable world

# The Role of External Costs of Energy

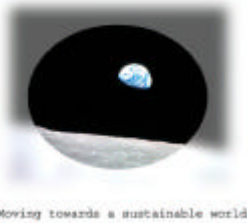
## The Impacts of External Costs



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

### What external costs lead to:

- Not including external costs in market prices leads to misallocation of resources
- The relative price of a good (e.g. fossil fuel) is too low – the good will be over consumed
- Alternative goods are crowded out
- Wrong resource allocation may lead to substantial costs to society

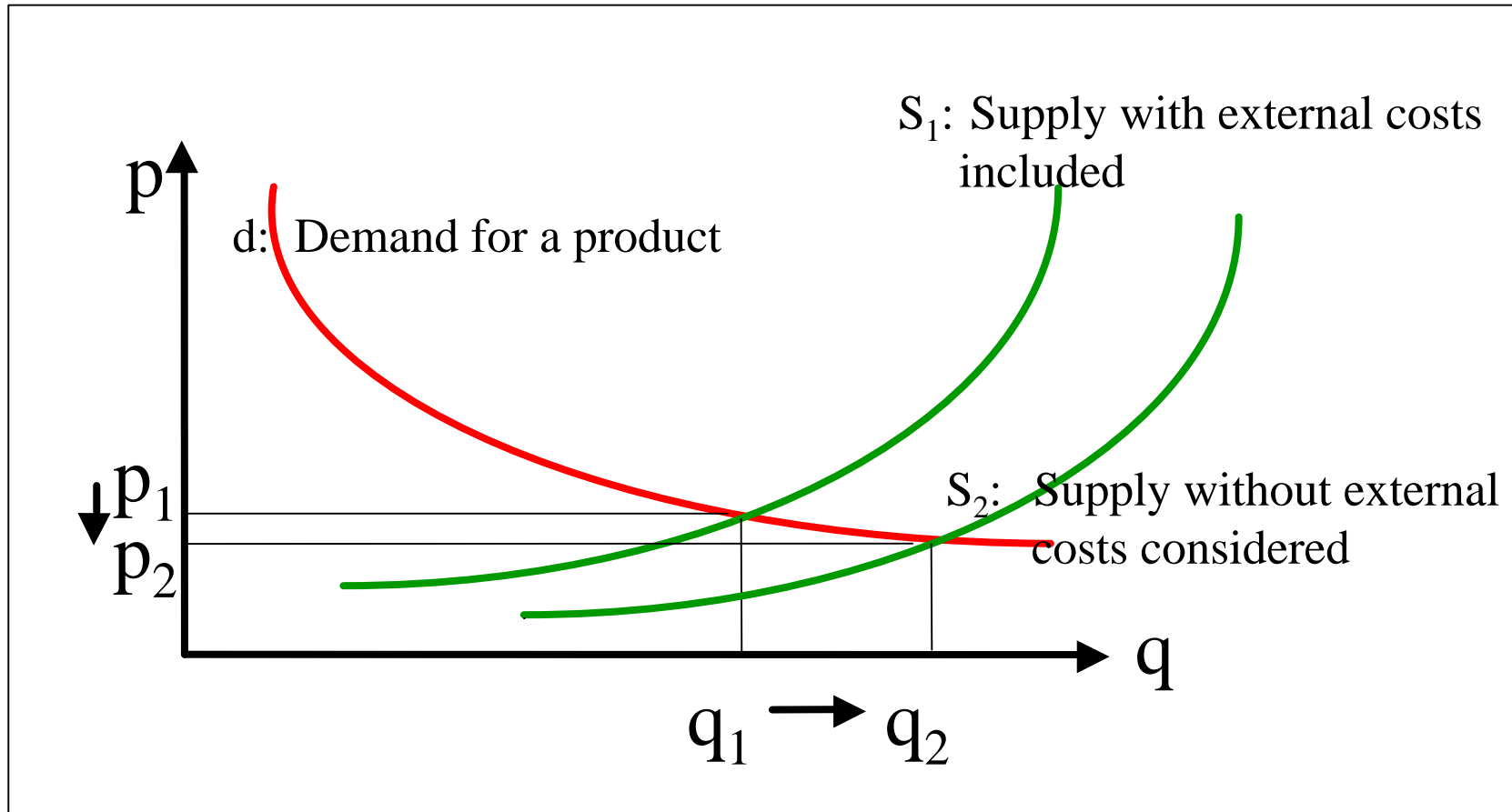


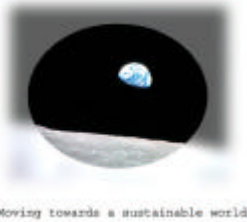
# The Role of External Costs of Energy Misallocation



Optimal demand  $q_1$  resulting from correct prices and over consumption  $q_2$  due to externalisation

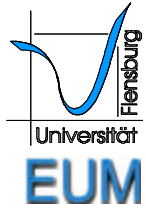
- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes





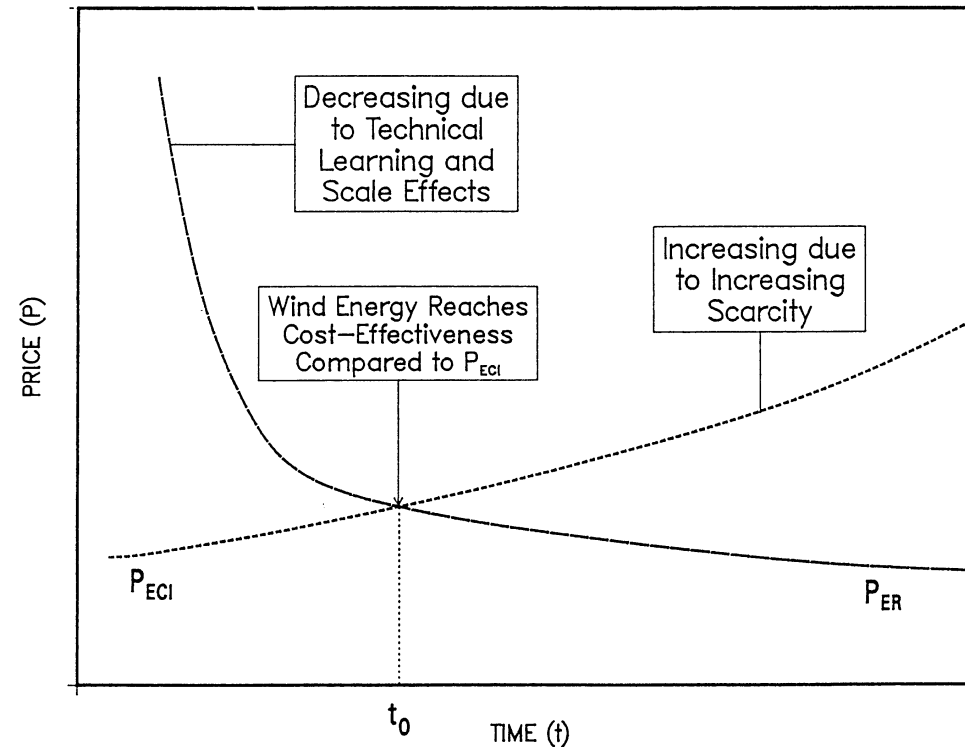
# The Role of External Costs of Energy

## Impact on Competing Technologies

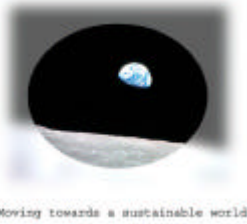


- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

### Relative price and competition without external costs

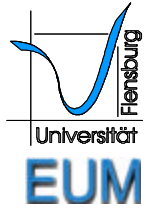


- I. Cost Development of Electricity Generation Over Time
  - $P_{ER}$ : Wind Energy
  - $P_{ECI}$ : Conventional Electricity, Only Internal Costs



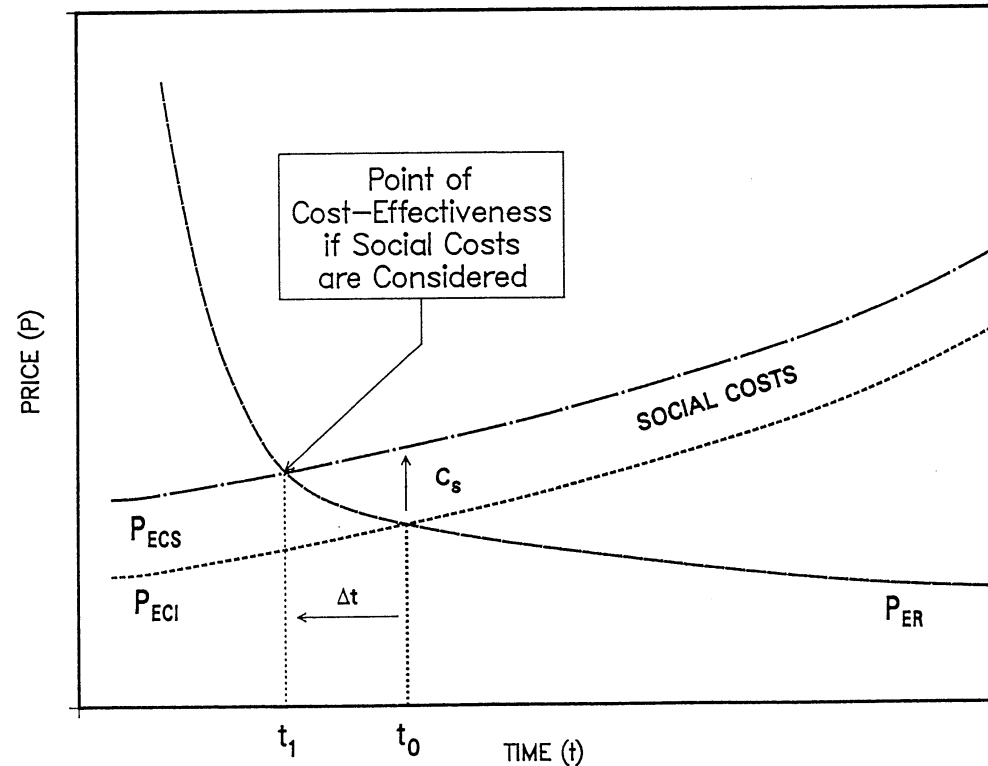
# The Role of External Costs of Energy

## Impact on Competing Technologies

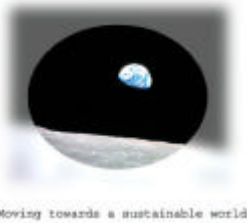


### Relative price and competition including external costs

- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

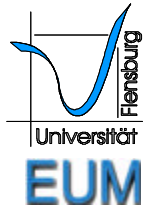


II. Cost Development of Electricity Generation Over Time  
 $P_{ER}$  : Wind Energy  
 $P_{ECS}$  : Conventional Electricity Including Social Costs



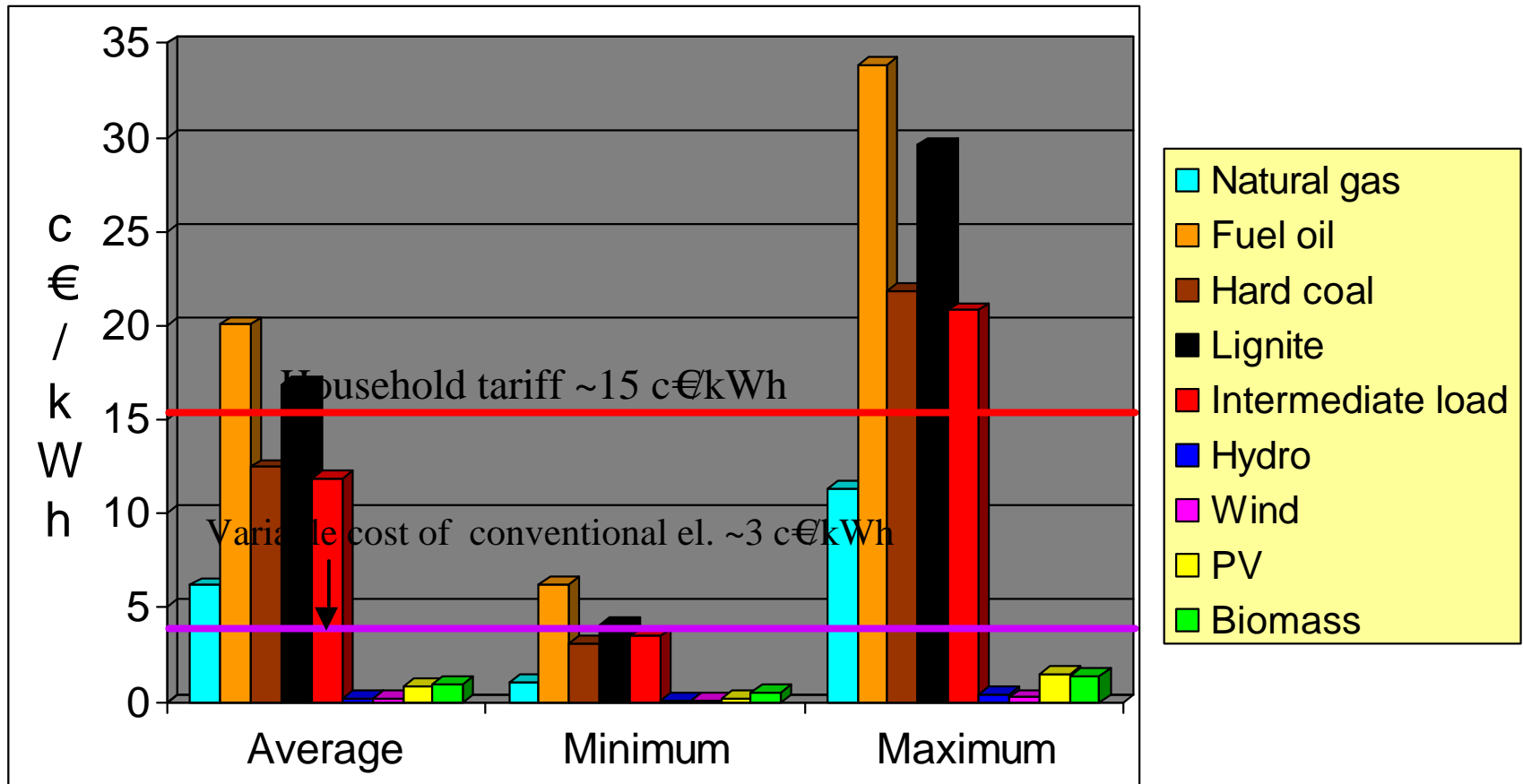
# The Role of External Costs of Energy

## External Costs of Electricity in Germany 1998



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

### The order of magnitude of external costs of electricity





Moving towards a sustainable world

# The Role of External Costs of Energy

## External Costs of Electricity in Germany 1998

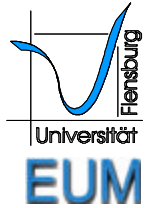


- Structure of the presentation
  - Sustainable development and renewables?
    - Environmental damages
    - Backstop technologies
  - **Role of external costs**
  - Policies for internalisation
    - Theory
    - Practice
  - Successes and failures of the past
    - NAFFO
    - RPS
    - EEG
  - Outlook
    - EEG and emission trading
    - Quantity regimes
- |                                                           |                          |
|-----------------------------------------------------------|--------------------------|
| • <b>External costs of intermediate load:</b>             | <b>2,9 - 20,8 c€/kWh</b> |
| • Hydro power:                                            | 0,04 - 0,38 c€/kWh       |
| • Wind energy:                                            | 0,04 - 0,23 c€/kWh       |
| • Photovoltaic solar energy:                              | 0,15 - 1,45 c€/kWh       |
| • Biomass (Power plant/residual wood):                    | 0,47 - 1,40 c€/kWh       |
| • Avoided internal costs (conv el.):                      | 3,04 c€/kWh              |
| • Household tariff (ex tax):                              | ~15,0 c€/kWh             |
| • Correcting electricity prices is a must!                |                          |
| • How can we achieve a correction of the relative prices? |                          |



Moving towards a sustainable world

# Policies for Internalisation Theory



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

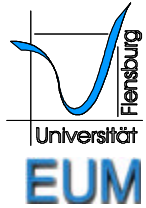
## Price or Quantity Regimes

- Precondition: Substantial environmental impacts of economic activities (external effects)
- Goal: Reduction of negative impacts / internalisation
- If external costs are known price regulation is feasible (tax or levy)
  - Relative prices are corrected (Pigou tax)
  - In the case of strong political resistance against a tax on conventional electricity an isolated correction may be used (reducing the cost of the clean alternative – e.g. EEG)
- If the external costs are unknown, quantity regimes can be applied (certificates or auctioned rights)
  - Targeted volumes of installed capacity are mandated (e.g. RPS)



Moving towards a sustainable world

# Policies for Internalisation Practice



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

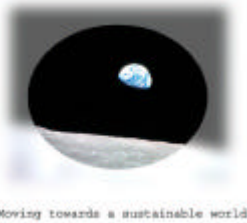
## Examples for internalisation policies:

### – Price regimes

- Eco taxes (electricity, gas, fuel oil, coal)
- SO<sub>2</sub> tax
- **StEG/EEG**

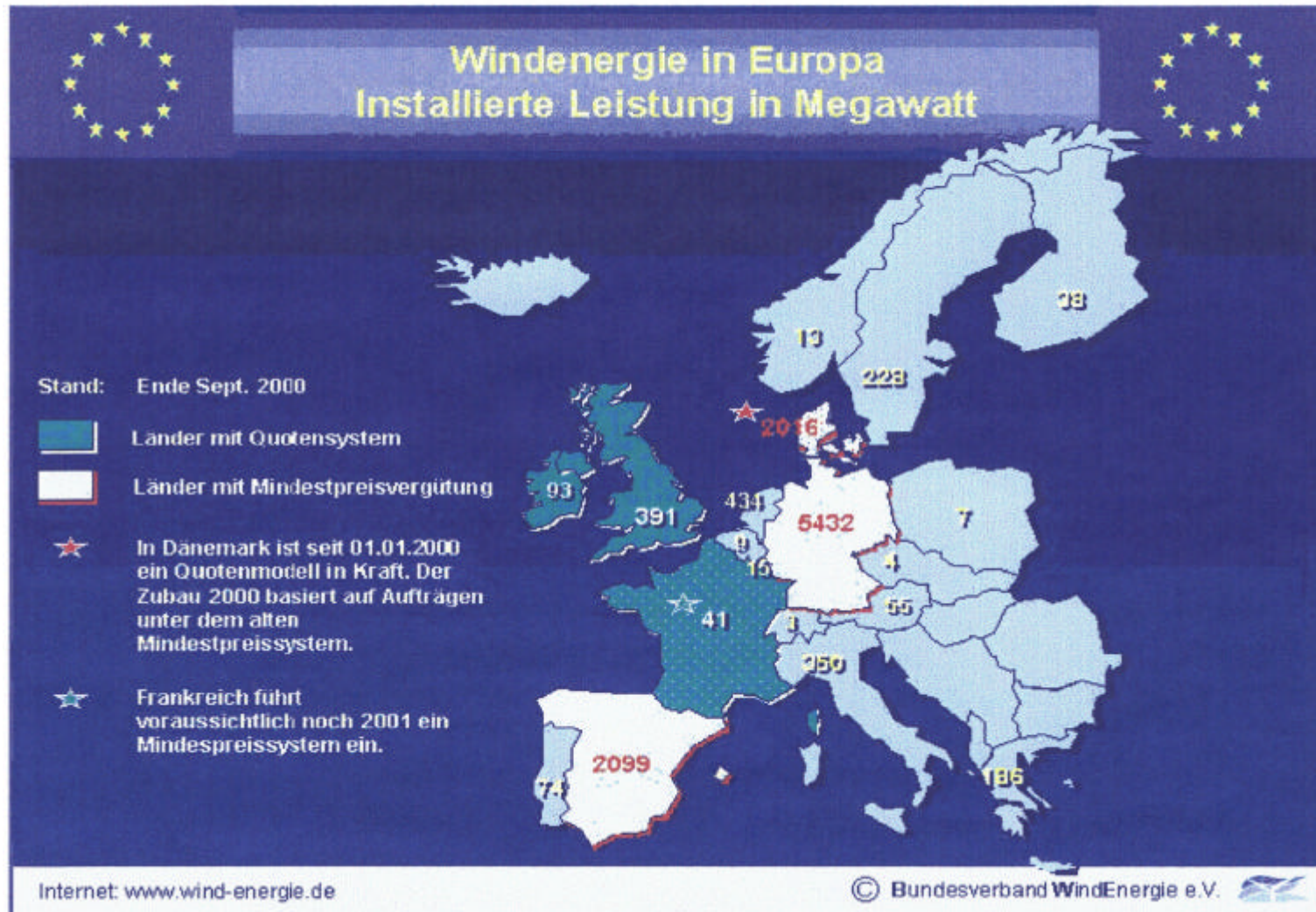
### – Quantity regimes

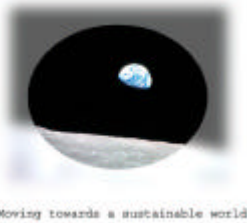
- Auctioned quantities (**NFFO**)/UK
- Renewable portfolio standards (**RPS**) /US
- Renewable options certificates (**ROC**)/UK
- CO<sub>2</sub> emission certificates (climate change)/EU



# Successes and Failures of the Past Wind Energy in Europe 2000

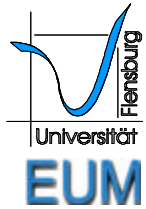
- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes





# Successes and Failures of the Past

## Wind Energy in Europe 2000



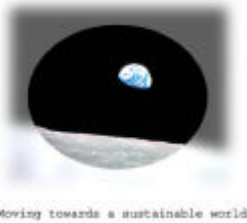
- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

| Windenergie in Europa<br>Mindestpreissystem versus Quotensystem        |                |                                               |                                            |                                                         |                                                                |
|------------------------------------------------------------------------|----------------|-----------------------------------------------|--------------------------------------------|---------------------------------------------------------|----------------------------------------------------------------|
|                                                                        | Land           | installierte Leistung Ende 9/2000 in Megawatt | Zubau in 2000 Stand Ende Sept. in Megawatt | Installierte Leistung pro Einwohner, in Watt/ Einwohner | Installierte Leistung pro Fläche, in Kilowatt/ km <sup>2</sup> |
| Länder mit Preisregulierungssystemen (Einspeisegesetze)                | Deutschland    | 5.432                                         | 989                                        | 66,19                                                   | 15,21                                                          |
|                                                                        | Spanien        | 2.099                                         | 557                                        | 53,38                                                   | 4,16                                                           |
|                                                                        | Dänemark *     | 2.016                                         | 245                                        | 381,53                                                  | 46,78                                                          |
|                                                                        | <b>Summe</b>   | <b>9.547</b>                                  | <b>1.791</b>                               | <b>75,36</b>                                            | <b>10,55</b>                                                   |
| Länder mit Mengenregulierungssystemen (Quoten-/ Ausschreibungssysteme) | Großbritannien | 391                                           | 38                                         | 6,63                                                    | 1,61                                                           |
|                                                                        | Irland         | 93                                            | 20                                         | 25,40                                                   | 1,32                                                           |
|                                                                        | Frankreich *   | 41                                            | 19                                         | 0,70                                                    | 0,08                                                           |
|                                                                        | <b>Summe</b>   | <b>525</b>                                    | <b>77</b>                                  | <b>4,33</b>                                             | <b>0,61</b>                                                    |

★ In Dänemark ist seit 01.01.2000 ein Quotenmodell in Kraft. Der Zubau 2000 basiert auf Aufträgen unter dem alten Mindestpreissystem.

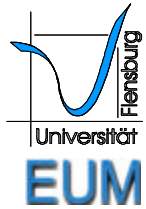
★ Frankreich führt voraussichtlich noch 2001 ein Mindestpreissystem ein.

Internet: [www.wind-energie.de](http://www.wind-energie.de) © Bundesverband WindEnergie e.V.



# Successes and Failures of the Past

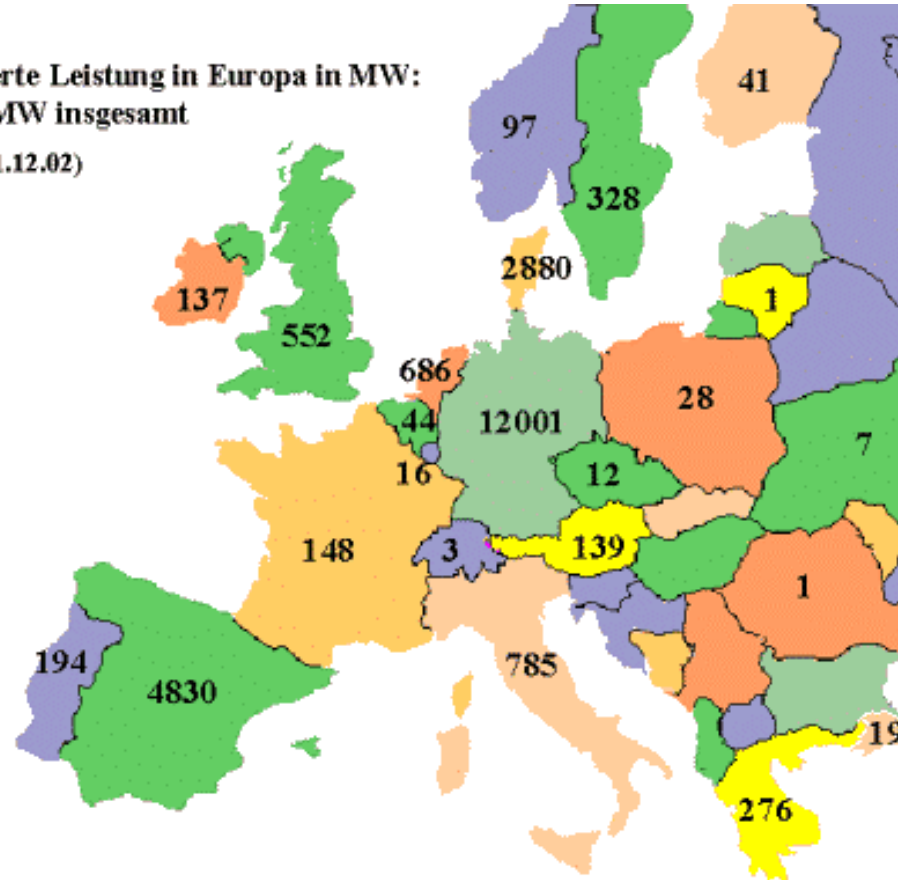
## Wind Energy in Europe 2000



### Installed wind capacity in MW (31.12.2002)

- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- **Successes and failures of the past**
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

Installierte Leistung in Europa in MW:  
23.225 MW insgesamt  
(Stand 31.12.02)



Change 99 - 2002:

**FRG: + 7.560 MW**  
**Spain: + 3.600 MW**

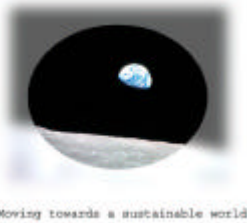
DK: +1.120 MW  
UK: + 199 MW

In 2003 (1.-6.03)

**FRG: + 835 MW**  
**Spain: + 230 MW**

DK: + 36 MW  
UK: + 34 MW

Source: BWE 2003  
and EWEA 2003



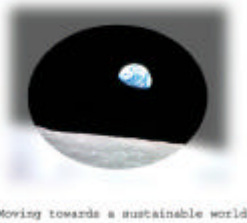
# Successes and Failures of the Past Renewable Energy Law in Germany since 1991



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

## Special rates (2001) for renewable under the EEG

| <b>Energy source</b> | <b>Small inst. c€/kWh</b> | <b>Intermediate size inst. c€/kWh</b> | <b>Large inst. c€/kWh</b> | <b>Maxium size</b>                  | <b>Reduction per year in %</b> |
|----------------------|---------------------------|---------------------------------------|---------------------------|-------------------------------------|--------------------------------|
| Small hydro          | 7,67                      |                                       | 6,65                      | sm. 500 KW<br>lar. 20 MW            | 0 %                            |
| Biomass              | 10,23                     | 9,21                                  | 8,70                      | sm. 500 KW<br>m. 5 MW<br>lar. 20 MW | 1 %                            |
| Geothermal energy    | 8,95                      |                                       | 7,16                      | sm. 20 MW<br>no limit               | 0 %                            |
| Wind                 | 9,10                      |                                       | 6,19                      | Quality of location                 | 1,5 %                          |
| PV                   | 50,62                     |                                       |                           | frei 1,1 MW<br>5 MW                 | 5 %                            |

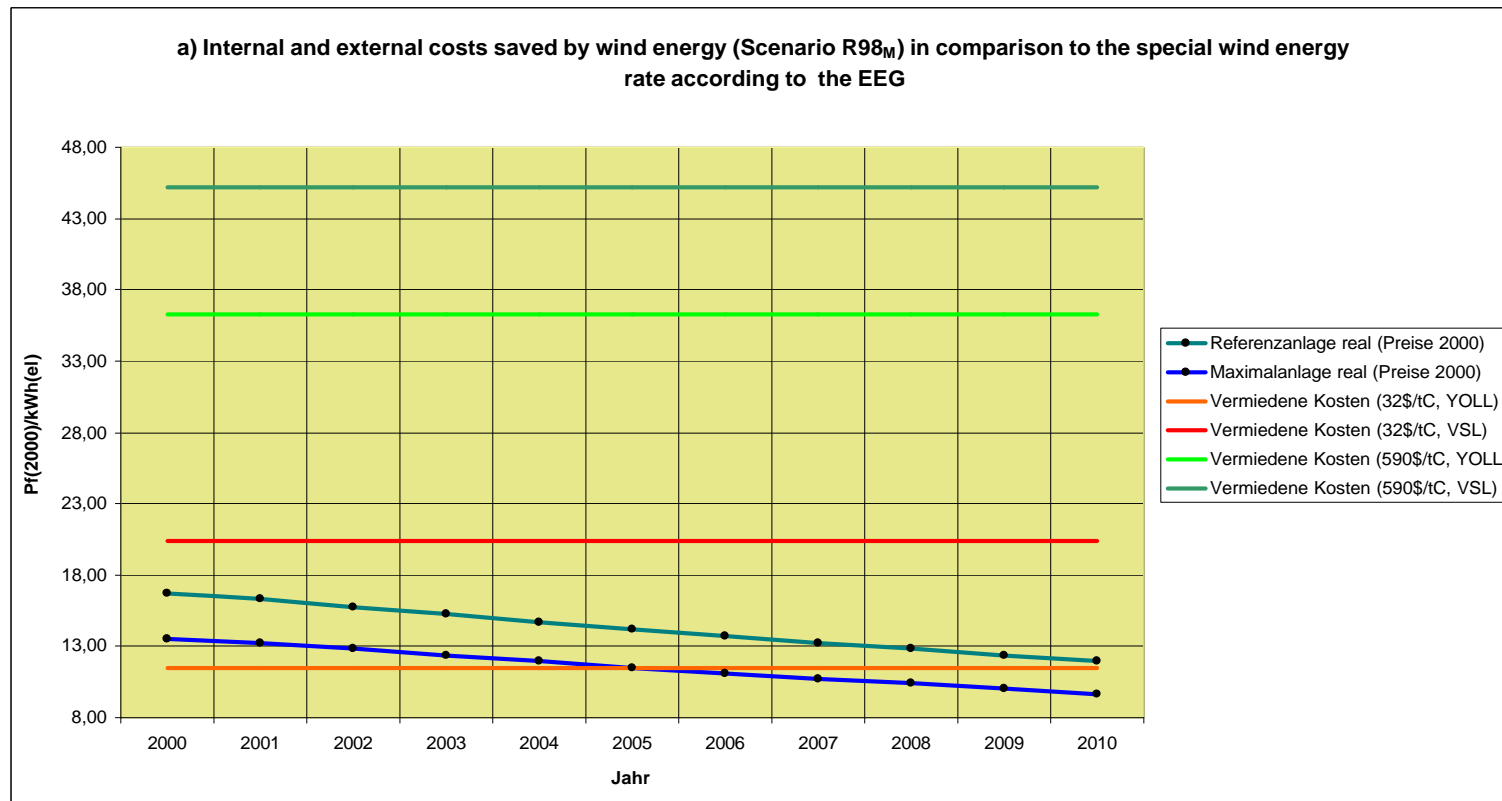


# Successes and Failures of the Past Renewable Energy Law in Germany since 2000

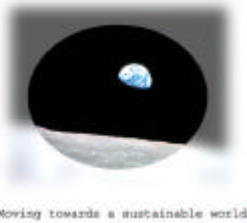


- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

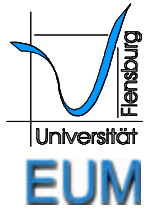
## EEG and wind energy 1998 – 2010



Source: Hohmeyer 2002, S. 95)

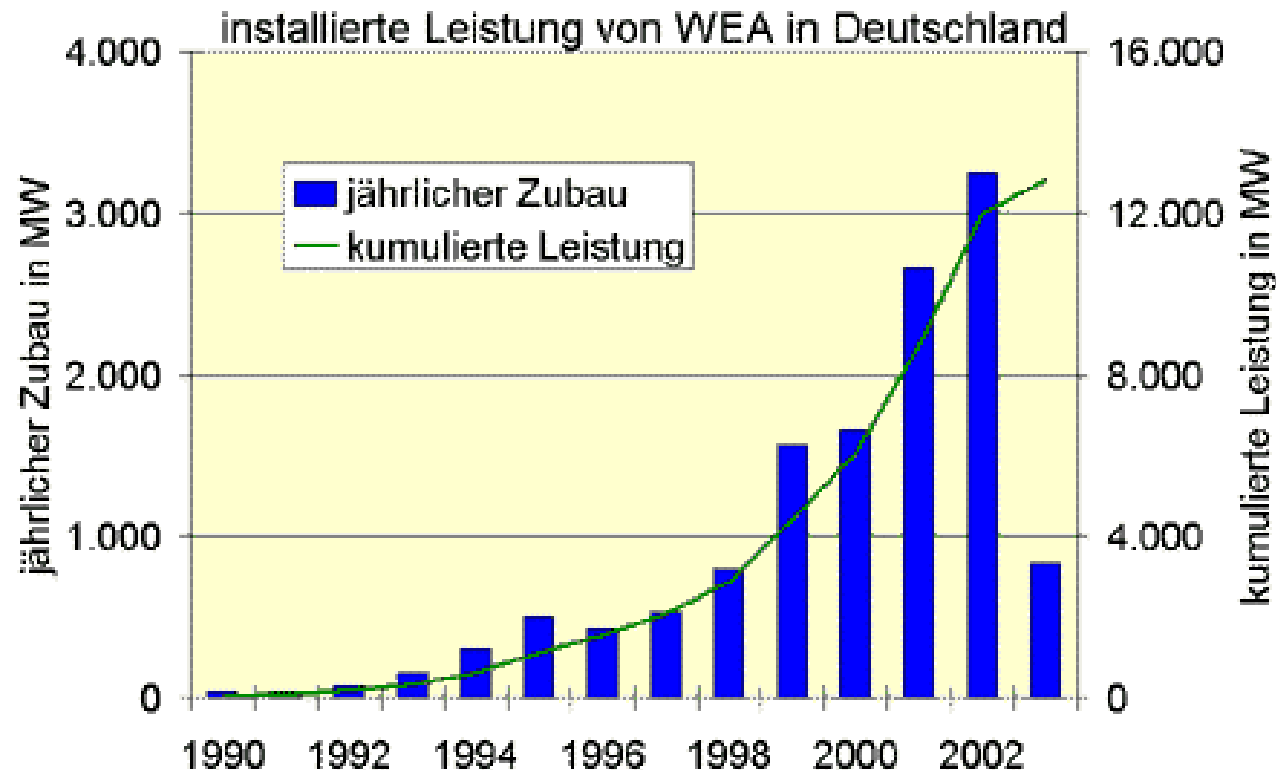


# Successes and Failures of the Past Renewable Energy Law in Germany since 1991

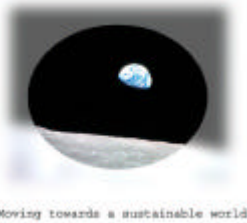


- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

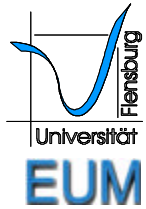
## Annual and cumulative wind capacity in Germany



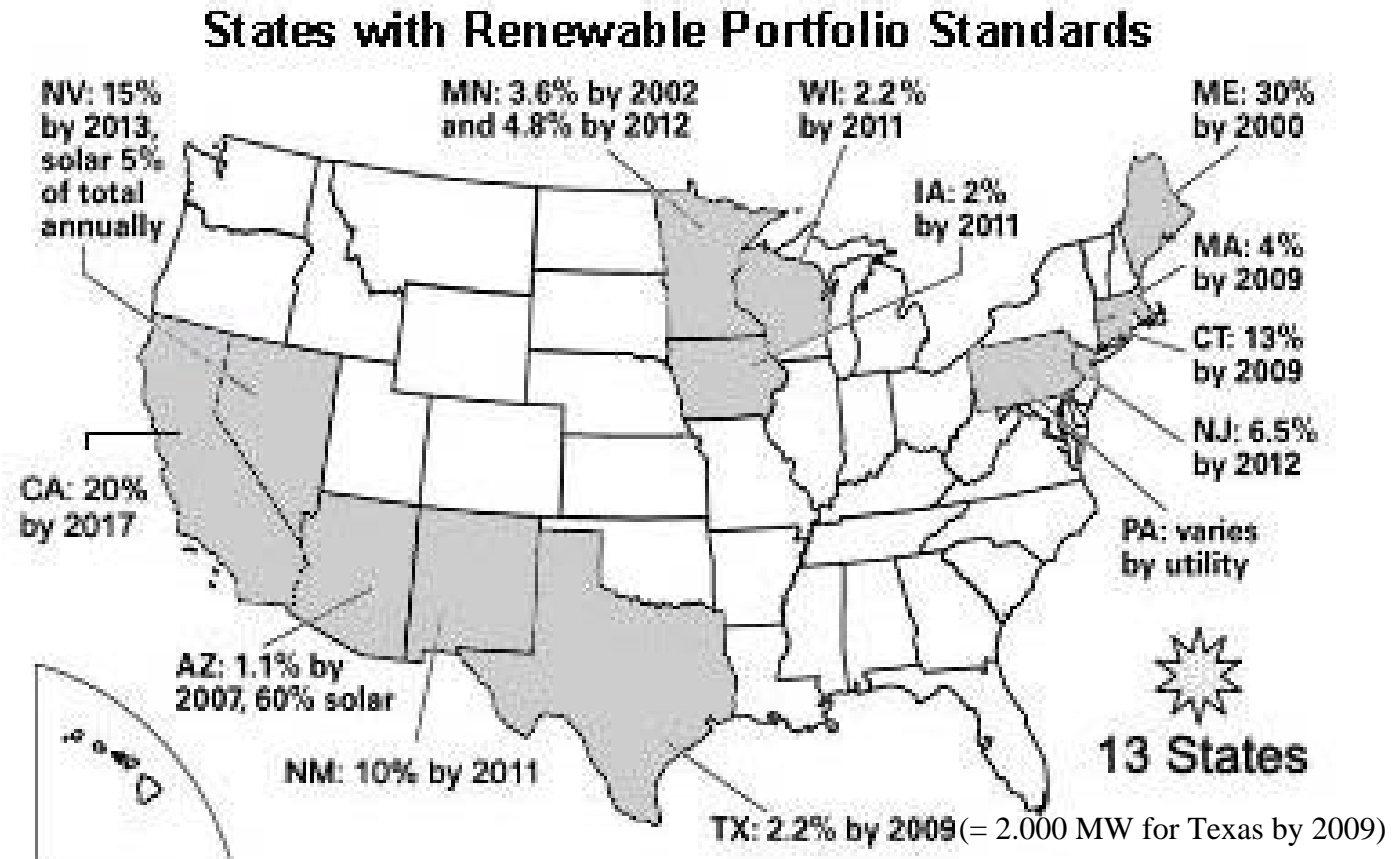
Source: BWE 2003



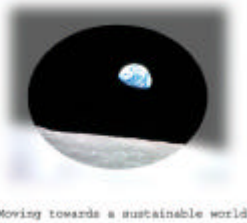
# Successes and Failures of the Past Renewable energy policy in the USA



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- **Successes and failures of the past**
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes



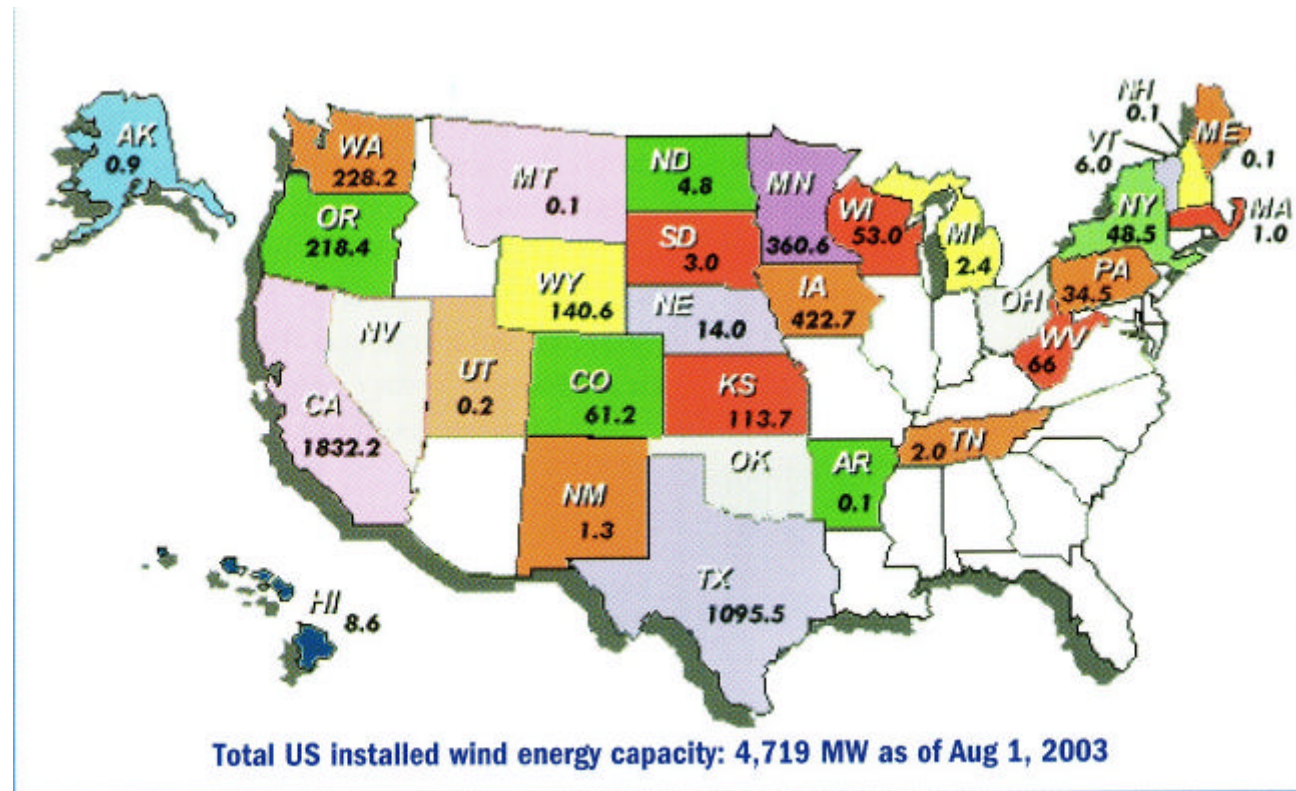
Source: Union of concerned scientists 2003



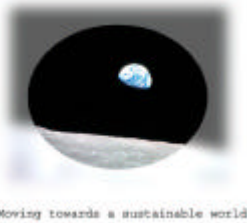
# Successes and Failures of the Past Renewable energy policy in the USA

- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- **Successes and failures of the past**
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

## Installed wind capacity in the USA (8/2003)

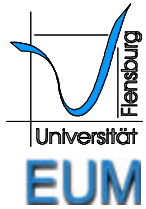


Source: EWEA 2003, p. 6



# Successes and Failures of the Past

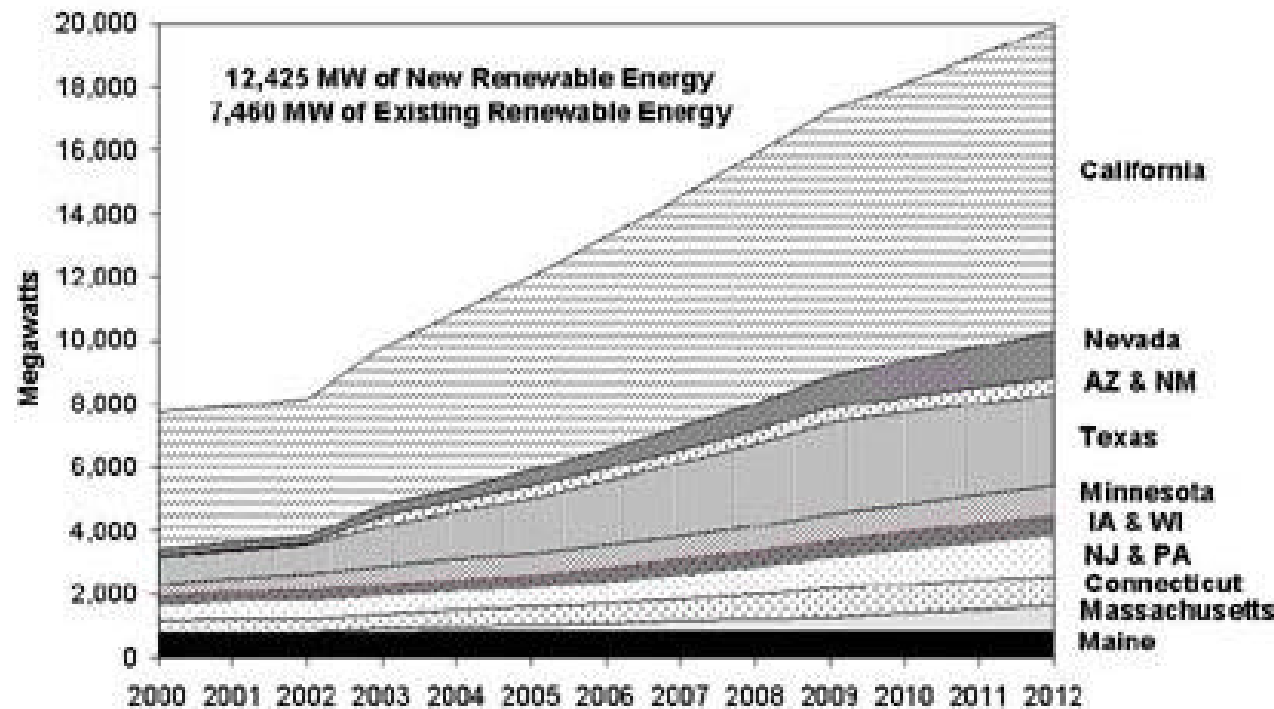
## Renewable energy plans in the USA



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- **Successes and failures of the past**
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

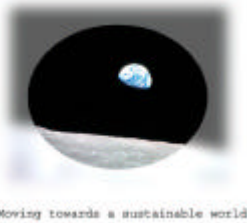
## Projected impacts of RPS in the USA (about 1.200 MW renewables ex hydro power by 1997)

**Renewable Energy Expected From State Standards\***



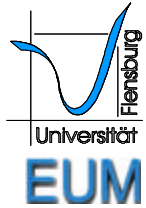
\* Projected development assuming states achieve annual RPS targets.

Source: Union of concerned scientists 2003



# Successes and Failures of the Past

## NFFO in the UK



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO/ROC
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

### Extremely limited success of auctioning regime

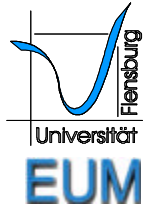
| Capacity in MW             | NFFO1<br>1990 | NFFO2<br>1991 | NFFO3<br>1994 | NFFO4<br>96/97 | NFFO5<br>1998 | Total |
|----------------------------|---------------|---------------|---------------|----------------|---------------|-------|
| Wind power contracts       | 12            | 84            | 146           | 330            | 340           | 912   |
| Wind power realised        | 8             | 52            | 41            | 11             | 0             | 113   |
| Total renewables contracts | 152           | 472           | 626           | 843            | 1 177         | 3 270 |
| Total renewables realised  | 141           | 172           | 300           | 169            | 105           | 888   |



Moving towards a sustainable world

# Successes and Failures of the Past

## ROCs in the UK



- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- **Successes and failures of the past**
  - NAFFO/ROC
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes

## Renewable obligation certificates in the UK

- Introduced in 4/2001
- Target 10% renewables in electricity by 2010
- Buy out penalty 4.3 c€/kWh
- Penalty money recycled as a bonus to compliers
- Present certificate price at 6.9 c€/kWh
- In the first year only 50% of targeted quantity was achieved (4.4 out of 8.8 TWh/a)
- Only 30 MW wind capacity commissioned in first year
- Unclear future price and bonus payment



Moving towards a sustainable world

# Successes and Failures of the Past

## Why Does the Inferior Systems Succeed?

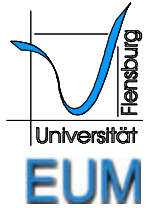
- Structure of the presentation
  - Sustainable development and renewables?
    - Environmental damages
    - Backstop technologies
  - Role of external costs
  - Policies for internalisation
    - Theory
    - Practice
  - Successes and failures of the past
    - NAFFO
    - RPS
    - EEG
  - Outlook
    - EEG and emission trading
    - Quantity regimes
- Investors find reliable conditions for planning, financing and insurance (fixed price system)
  - Small local investors can easily participate
  - Local communities receive considerable part of the income generated
  - Local actors support the development
  - Projects are developed with local communities and little resistance
  - The economics of an installation increases with increasing operating performance
  - National industry develops well



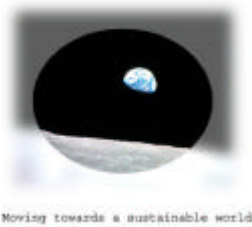
Moving towards a sustainable world

# Successes and Failures of the Past

## Why do the Theoretically Better Systems Fail?

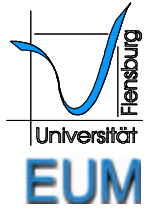


- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes
- Small local investors can hardly compete
- Local communities doubt whether they will receive a part of the income generated
- Local actors oppose the development
- Projects are developed without local community participation
- Investors don't find reliable conditions for planning, financing and insurance (ROC)
- Operators are at the mercy of large utilities (RPS)
- National production doesn't develop

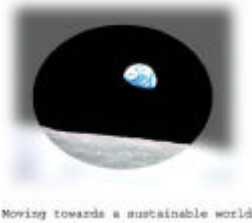


# Outlook

## Price Regimes and GHG Emission Trading

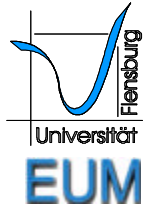


- Structure of the presentation
  - Sustainable development and renewables?
    - Environmental damages
    - Backstop technologies
  - Role of external costs
  - Policies for internalisation
    - Theory
    - Practice
  - Successes and failures of the past
    - NAFFO
    - RPS
    - EEG
  - Outlook
    - EEG and emission trading
    - Quantity regimes
- Successful systems will either rely on price regimes or on very ambitious (and intelligent) quantity regimes
  - Price regimes like the EEG have to be reconciled with GHG emissions trading
    - A possible approach is the splitting of the external costs covered into:
      - damages due to conventional pollution and
      - damages due to climate change
    - If an investor opts for emission reduction credits (GHG emission rights) he opts out of the GHG part of the EEG



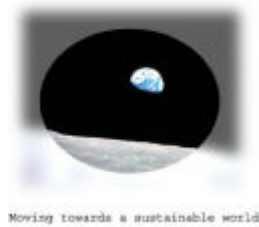
# Outlook

## Quantity Regimes and GHG Emission Trading

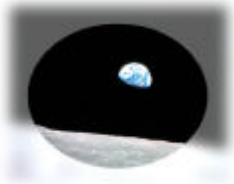


- Structure of the presentation
- Sustainable development and renewables?
  - Environmental damages
  - Backstop technologies
- Role of external costs
- Policies for internalisation
  - Theory
  - Practice
- Successes and failures of the past
  - NAFFO
  - RPS
  - EEG
- Outlook
  - EEG and emission trading
  - Quantity regimes
- Successful quantity regimes will need to secure local involvement and support
- Quantity regimes:
  - may come into play for large scale installations like offshore wind parks
  - will compete with GHG emission trading (opt in solutions could be considered)
  - will need to introduce long term quantity schedules
  - make sure to reach targets
- Only ambitious quantity regimes may replace present successful price regimes
- Quantity regimes can deliberately be used against renewables, if very low goals and bad conditions (like NFFO) are introduced

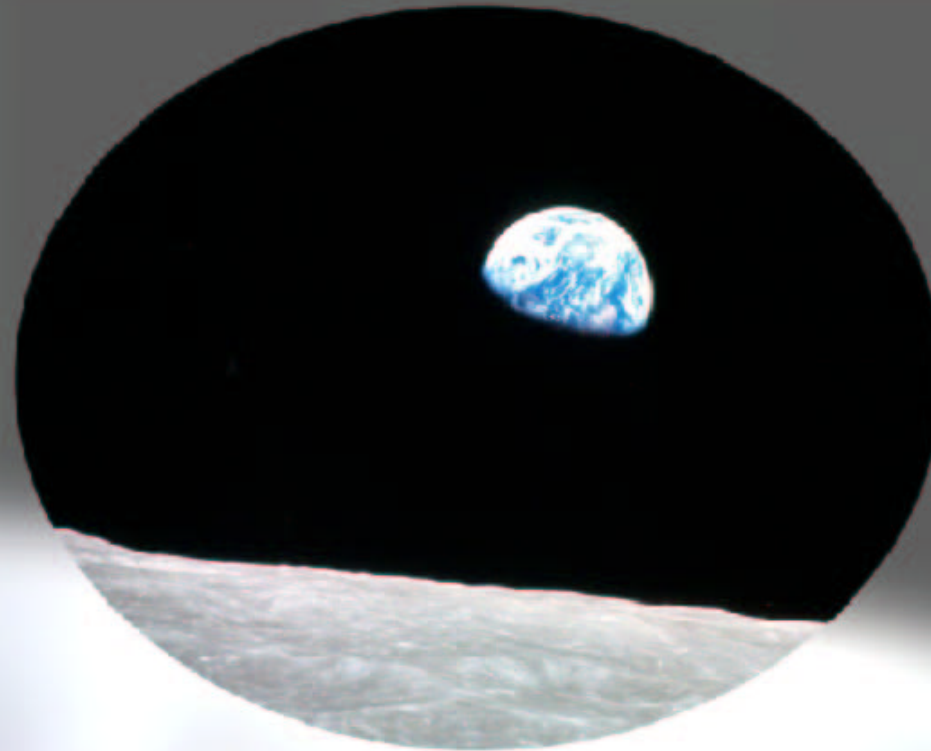
# Conclusions



- Structure of the presentation
  - Sustainable development and renewables?
    - Environmental damages
    - Backstop technologies
  - Role of external costs
  - Policies for internalisation
    - Theory
    - Practice
  - Successes and failures of the past
    - NAFFO
    - RPS
    - EEG
  - Outlook
    - EEG and emission trading
    - Quantity regimes
- Price regimes based on external costs can be quite successful
  - Price regimes will drive the major part of developments of REG in the future
  - Quantity regimes can be very interesting, if external costs are difficult to measure (climate change)
  - A combination of price regimes for renewables and GHG emission rights trading is a likely future
  - REN markets will be policy driven for the foreseeable future!



Moving towards a sustainable world



Moving towards a sustainable world