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Emission trading and Energy Systems Integration effects

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Overview

- CO_2 emissions and climate change
- International agreement?
- Current EU Policies
  - EU ETS
  - Targets for renewables
- EU policies towards 2030
- Reflections

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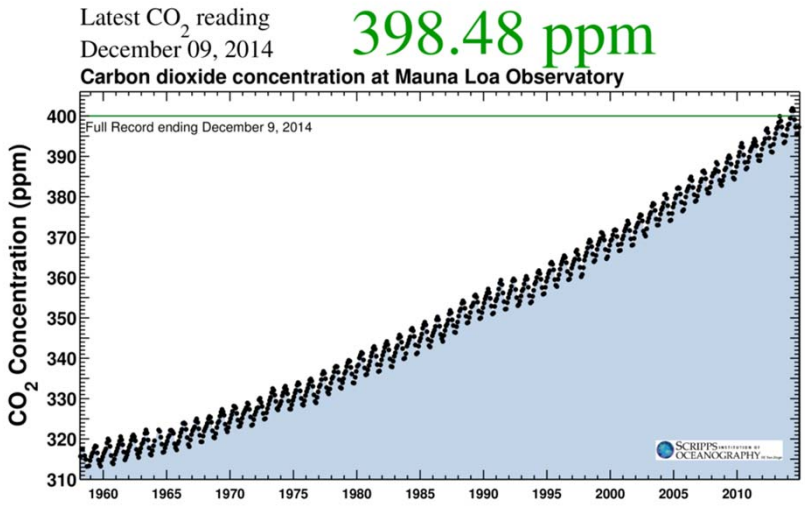
CO_2 emissions and climate change



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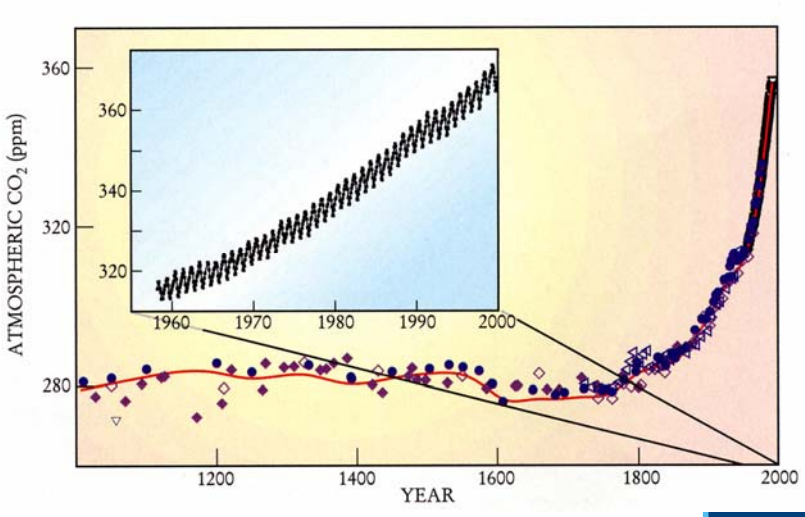
CO_2 emissions and climate change



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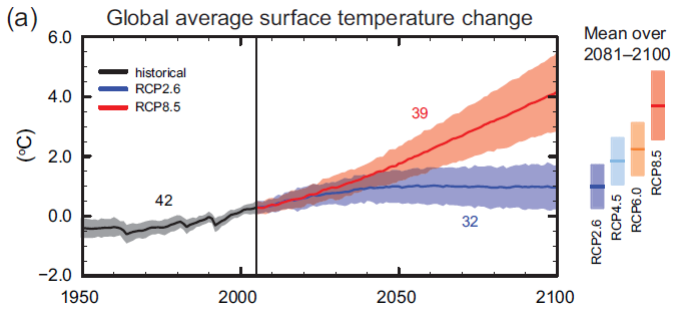
CO_2 emissions and climate change



IPCC AR5 The physical science basis, SPM

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International agreement?

- United Nations Framework Convention on Climate Change: UNFCCC
- Agreed at Earth Summit in Rio De Janeiro in 1992
- Follow-up meetings: “Conference of Parties” to fill in the details – COPs
- COP Nr 3, Dec 1997 Kyoto

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International agreement?

- COP #3 December 1997
  - "Initialed" in Kyoto
  - Later "signed" in New York
  - But to be valid; must be "ratified" by parliaments!
  - Entered into force on February 16, 2005 (55 & 55%)
    - w/o the USA, since never submitted to Congress, and hence not ratified!
    - Withdrawal of Canada in 2012
    - But including Russian Federation

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International agreement?

- Copenhagen 2009
  - Hype - Extraordinary expectations
  - High hopes
    - EU from 20% to 30%
      - EU push for binding targets for US and China
    - US president Obama
      - Clinton did not ratify Kyoto protocol!

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International agreement?

- Copenhagen Accord
  - US and China, Brazil, India and South Africa
    - Europe and conference could only take note
  - Ambition to limit global warming to 2°C
  - Countries could submit emission reduction pledges – not binding
- Copenhagen has not lived up to the promises
  - Only “intentional declaration” to keep T at max 2°C above pre-industrial levels

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International agreement?

- Durban 2011
  - Again EU push for binding targets
    - US and China could hide behind each other
  - Japan (Fukushima), Canada (unconventional oil and gas) and Russia (new reserves in Arctic due to warming) less willing participants
  - Increasingly just EU venture
  - Agreement to keep trying to reach an agreement
    - No target for emissions, but target for reaching an agreement
    - To be achieved in **2015**, apply from 2020

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International agreement?

- Conference of the parties
  - COP15, Copenhagen, 2009
  - COP16, Cancun, 2010
  - COP17, Durban, 2011
  - COP18, Doha, 2012
  - COP19, Warsaw, 2013
  - COP20, Lima, 2014
  - **COP21, Paris, 2015**

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International agreement?

- International agreement?
  - Hopes not translated in happy outcome
  - "Path to what seems like endless summits where NGOs gather with government ministers and make profound statements, but typically achieve little relative to the scale of the challenge"
  - Prisoner's dilemma, tragedy of the commons, free-riding
    - Sub-optimal outcome if pursuing self-interest
    - US and China
    - Impact varies considerably
      - Some might gain, e.g., Russia, access to oil and gas in Arctic

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International agreement?

- US and China
  - Deal in November 2014

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International agreement?

"No challenge poses a greater threat to future generations than climate change"

US President Barack Obama in his State of the Union speech January 21, 2015

His statement was met with scattered, muted applause

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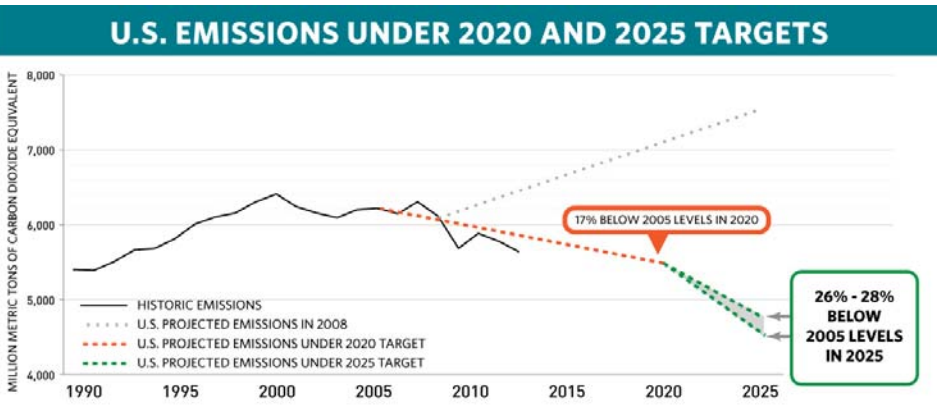
International agreement?



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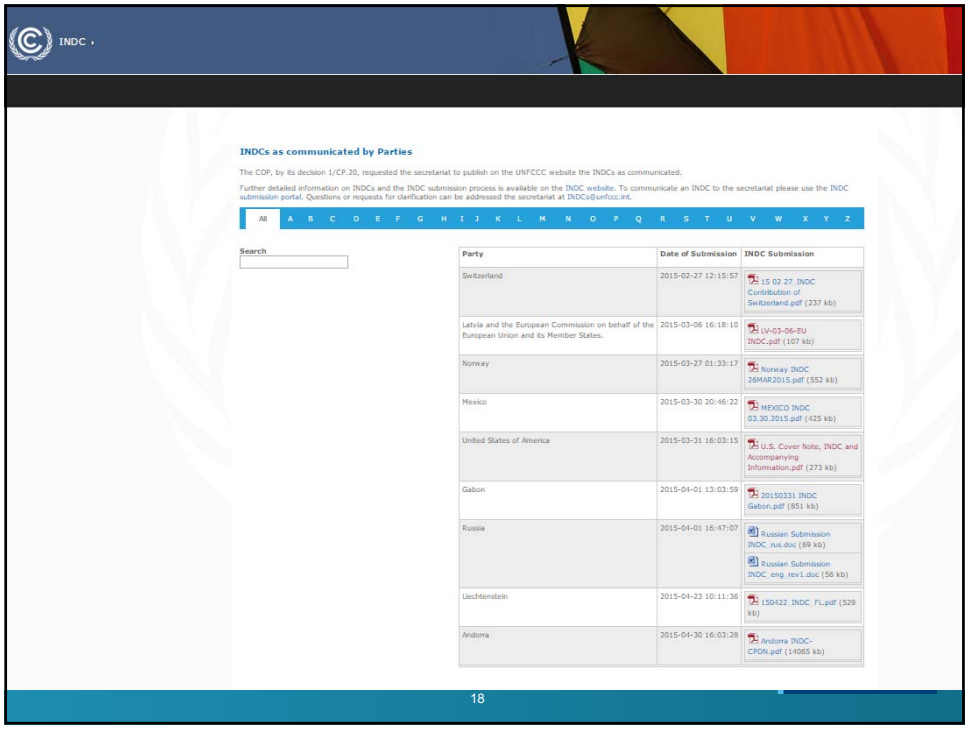

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Current EU energy policy

- Energy Sector
- 20-20-20 targets by 2020
  - EU ETS
  - RES targets

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Current EU energy policy
Energy Sector

- Electric power sector
  - The electricity generated by power plants and consumed at home, office, industry, etc.
- Heating & cooling
  - Heating our houses, hot water, heat for industry, etc.
- Transport
  - Passenger vehicles, freight transport, aviation, trains, navigation, etc.

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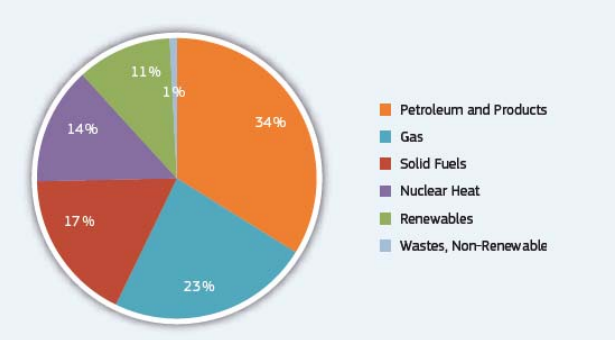
Current EU energy policy
Energy Sector

- Overall EU Energy
  - EU-28 inland consumption – primary sources
    - Total: 1682 Mtoe (2012)

Source: EC, 2014



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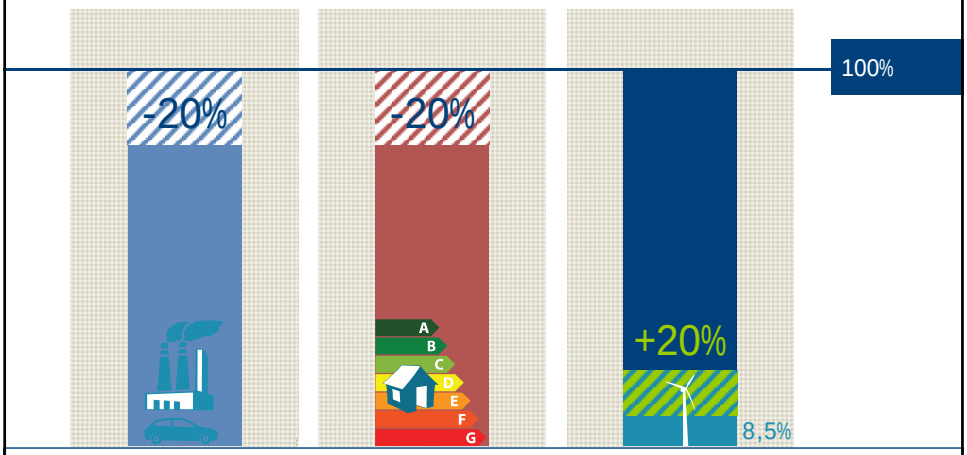
Current EU energy policy
EU 20-20-20 targets by 2020



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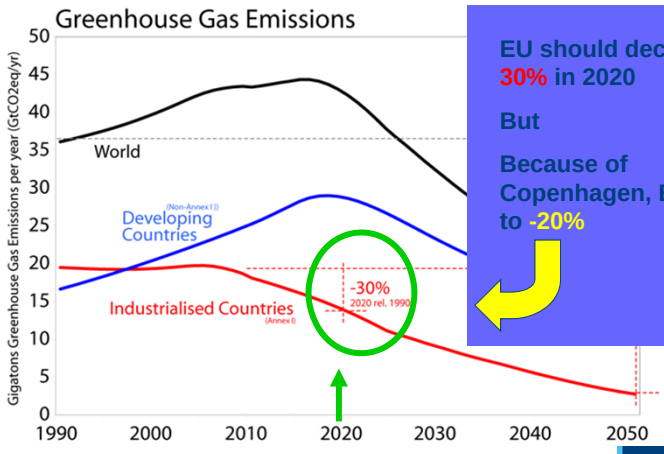
European Energy Policy
EU ETS

To limit temperature increase to 2°C above pre-industrial level



EU should decrease by 30% in 2020

But

Because of Copenhagen, EU sticks to -20%

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EU: A shared effort between sectors and MS

GHG Target:

-20% compared to 1990

-14% compared to 2005

EU ETS
-21% compared to 2005

Non ETS sectors
-10% compared to 2005

27 Member State targets, stretching from -20% to +20%

European Energy Policy
EU ETS

-20% GHG wrt 1990 = -14% GHG wrt 2005

Emission Trading Scheme (ETS)	Effort Sharing Decision

• -21% GHG compared to 2005
• ~45% GHG, ~50% CO_2
• one EU-wide system for heavy industries
  o power and heat sector
  o energy intensive industrial sectors
  o aviation (from 2012, within ETS)
• cap-and-trade system
	• -10% GHG compared to 2005
	• ~55% GHG, ~50% CO_2
	• Member State targets for small emitters
	 

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European Energy Policy
EU ETS

- As of January 1st 2005, EU has started **EU Emission Trading Scheme (EU ETS)**
- For each ton of CO_2 emission, allowance must be submitted
  - Can be traded on a market
- So-called "Cap and Trade" system: Amounts emitted limited but price varies

  ↔ CO_2 tax fixes price, but emissions unknown
- Not between countries but between companies!

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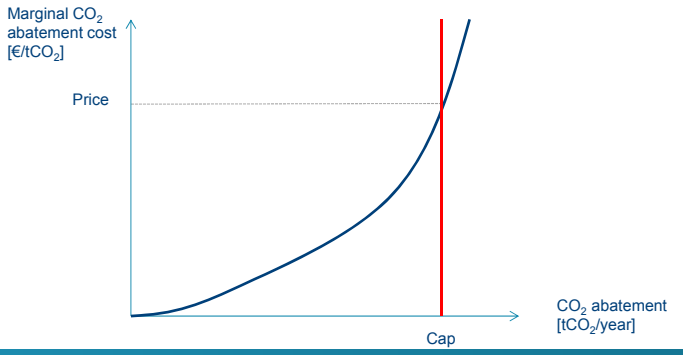
European Energy Policy
EU ETS

1. The emitter must submit a EU **emission allowance** (EUA) for each ton CO_2.
2. The EU sets a **cap** on the GHG emissions within the EU ETS.
3. Emitters **trade** emissions allowances on the market.



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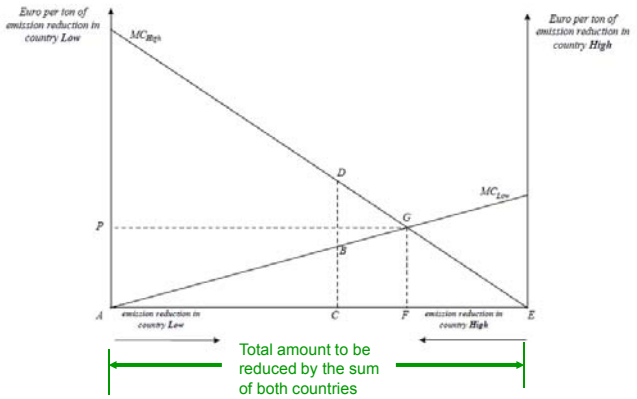
European Energy Policy
EU ETS



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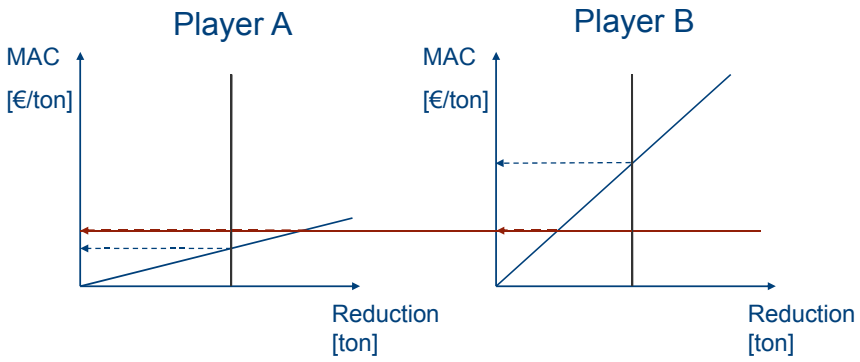
European Energy Policy
EU ETS



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European Energy Policy
EU ETS

- Cap decreases each year by 1.74% of the average total quantity of allowances issued annually in 2008-2012
  - To reach 21% reduction in 2020 compared to 2005 levels

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European Energy Policy
EU ETS

- Sector covered responsible for 45% GHG emissions EU
  - Power and heat sector
  - Energy intensive industrial sectors
    - Oil refineries, steel works and production of iron, aluminum, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals
  - Aviation (from 2012, within EU ETS countries)
- > 11 000 heavy energy-using installations
- Installations > 25 MW
- CO_2, N_2O and perfluorocarbons (PFCs)
- EU 28 plus Iceland, Liechtenstein and Norway

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European Energy Policy
EU ETS

- Different Phases
  - First Phase 2005-2007 = test/pilot phase
  - Second Phase 2008-2012 = Kyoto period
  - Third Phase 2013-2020
  - Fourth period 2021-2028
- Banking
  - Transferring allowances from one period to the next
  - Not allowed in first period
  - Allowed as from second period
- Borrowing
  - Using future allowances to cover current emissions
  - Only borrowing from the next year is possible

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European Energy Policy
EU ETS

- Allocation of allowances (≤ 2012)
  - Allocation through National Allocation Plans (NAPs)
  - Grandfathering, i.e., distributed for free
- Allocation of allowances (≥ 2013)
  - General rule for power sector is auctioning, exceptions for East European MS until 2019
  - Energy intensive industry major share grandfathered (80% in 2013), moving to more auctioning (70% in 2020)
  - > 40% auctioned as from 2013, full implementation by 2027

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European Energy Policy
EU ETS

- Cost pass through?
  - Allowances have opportunity cost, i.e., cost of not selling them on the market at the market price
  - CO_2 price is (should be) taken into account in (dispatch) decisions
  - Cost pass-through to consumers
    - In power sector

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European Energy Policy
EU ETS

- International credits

System	Emission permit	
Emission Trading Scheme (ETS)	European Union allowances (EUA)	European Union
Clean Development Mechanisms (CDM)	Certified Emission Reductions (CER)	Kyoto Protocol
Joint Implementation (JI)	Emission Reduction Units (ERU)	Kyoto Protocol

  - CER and ERU can also be used to cover portion of ETS emissions
  - Significant share allowed in period 2008-2020 (~50% of envisaged reduction)
  - After 2020, focus on domestic reduction

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European Energy Policy
EU ETS

- Carbon leakage
  - Transferring production to other countries with less stringent (or no) constraints on greenhouse gas emissions
    - For reasons of costs related to EU climate policies
  - Official list every five years

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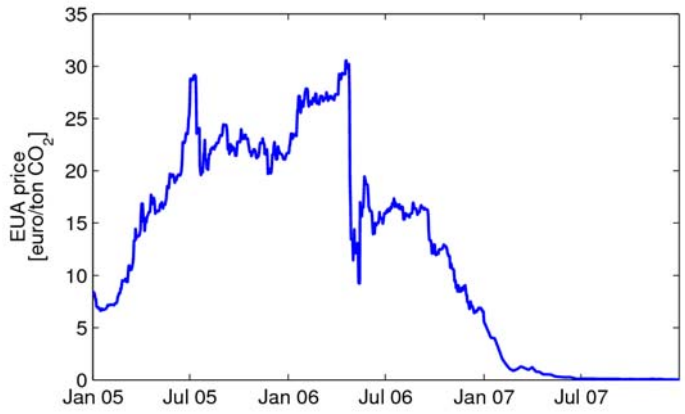
European Energy Policy
EU ETS

- EU ETS price - First Phase (2005 - 2007)



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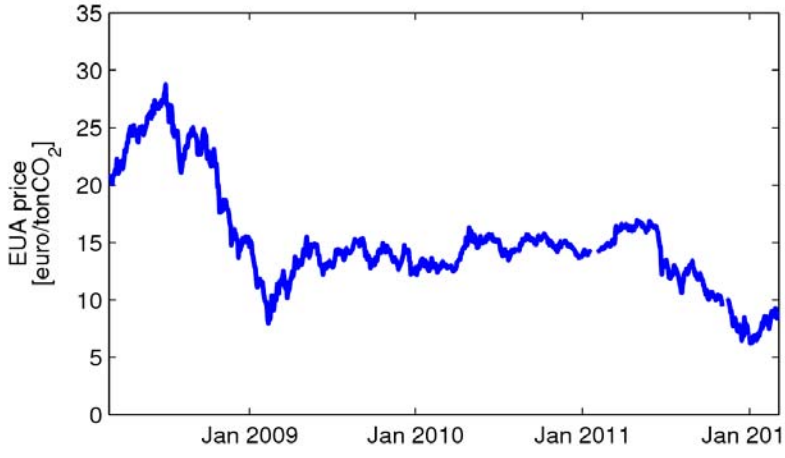
European Energy Policy
EU ETS

- EU ETS price – Second Phase (2008 - 2012)



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European Energy Policy
EU ETS

- EU ETS price – Second and Third

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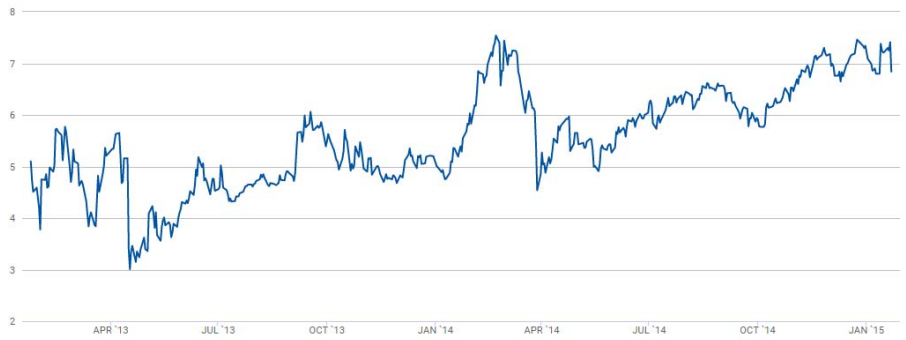
European Energy Policy
EU ETS

- EU ETS price – Third Phase (2013 till early 2015)



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European Energy Policy
EU ETS

- EU ETS considered as main instrument to reduce CO_2 emissions
- Cap respected, but price too low to serve as incentive for low-carbon investment
- Low prices because of
  - Economic recession
  - Inflow of international credits
  - Separate policies
    - E.g., RES targets
  - Banking

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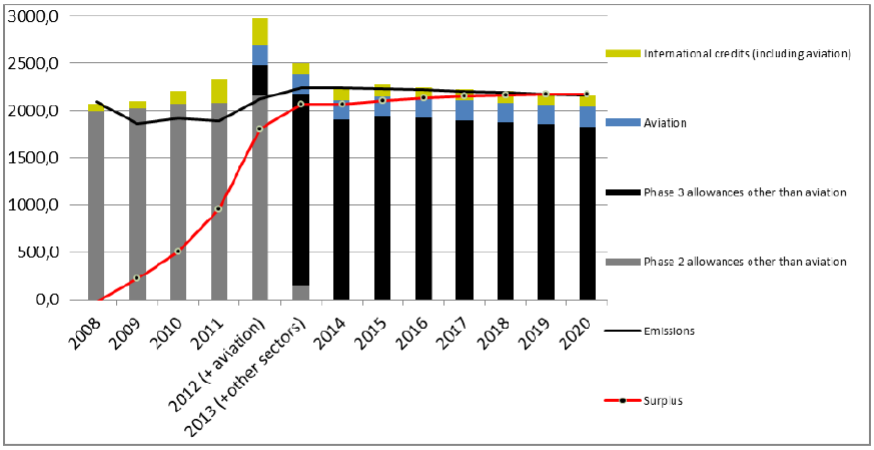
European Energy Policy
EU ETS

Figure 2: Historic and likely future profile up to 2020 of supply and demand



Source: SWD(2012) 234 final

European Energy Policy
EU ETS

Reform options

- Increase demand for allowances
  - Extend scope of ETS to other sectors
- Decrease supply for allowances
  - Increase EU target to 30% in 2020
  - Retire number of allowances
  - Revise linear reduction factor
  - Limit access to international credits
- Discretionary price management
- Discretionary quantity management

Reform plans

1. **Backloading**: temporary withdrawal of number of allowances in the short term (phase 3)
2. **Market stability reserve**: quantity management to stabilize ETS price in the long term (phase 4)

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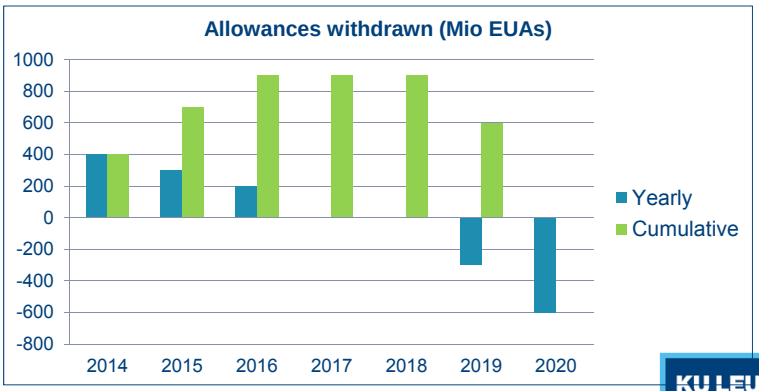
European Energy Policy
EU ETS

- Back-loading in third phase
  - Short-term, temporal measure (2014-2020)
  - Final approval December 2013



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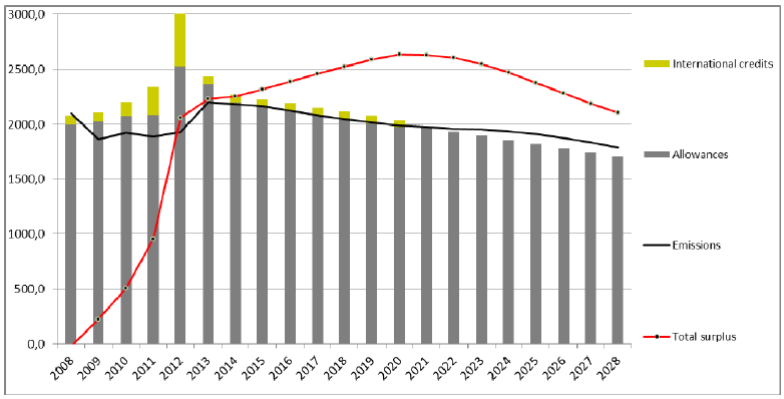
European Energy Policy
EU ETS

- Historical and projected future profile of supply and demand up to 2028



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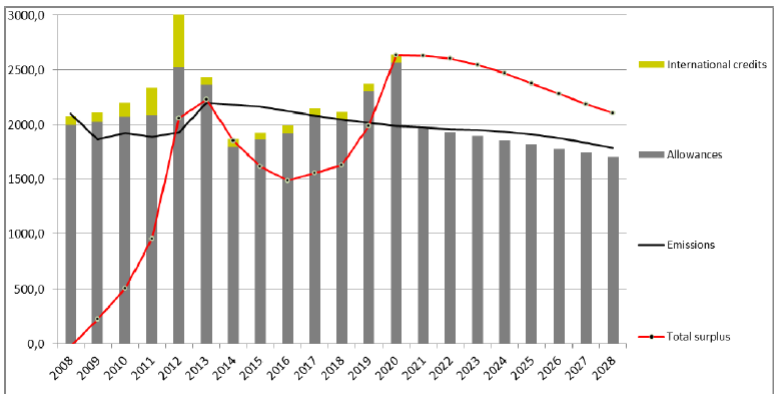
European Energy Policy
EU ETS

- Historical and projected future profile of supply and demand up to 2028 with back-loading



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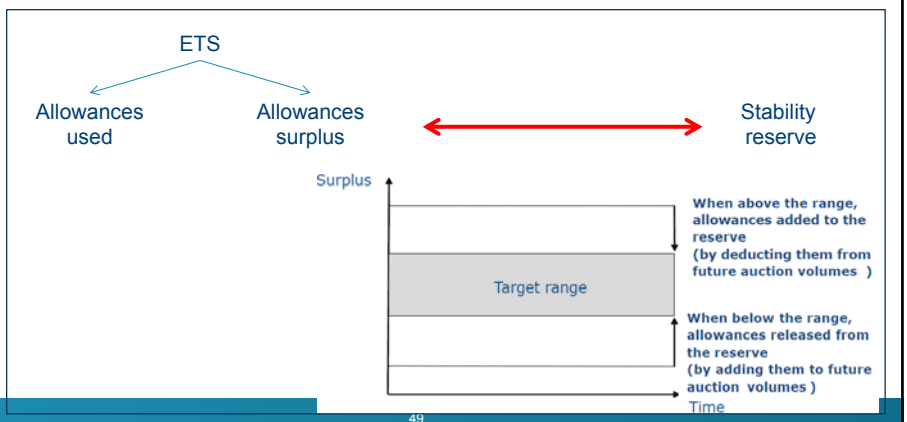
European Energy Policy
EU ETS

Market stability reserve in phase 4

- Long term, structural measure (as of 2021 – or 2019?)
- Legislation proposed by Commission, to be approved by Parliament and Council



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European Energy Policy
EU ETS

- Abatement options
  - In industry
    - Different processes
    - Using different fuels
    - Energy efficiency
    - Reducing output?
    - Carbon Capture and storage?

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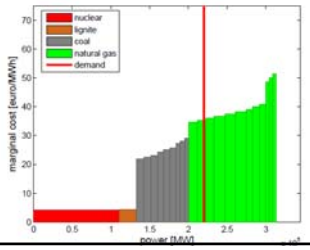
European Energy Policy
EU ETS

- Abatement options
  - In electricity sector

Conventional portfolio	Residual load	Generation costs
• Fuel mix, age, technical parameters, etc. • Might change in the long term (years)	• Electricity demand minus renewables generation • Might change in the medium term (months)	• Marginal generation costs of conventional units • Might change in the short term (days)



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European Energy Policy
EU ETS

	Conventional portfolio	Residual load	Generation costs
General influences/policies	Cost, legislation, etc.	Economic growth/ downturn, energy efficiency, electrification, RES obligation, etc.	Fuel prices.
CO_2 cost	Changes levelized cost of electricity, making low-carbon technology more interesting	Electricity price increase, reducing demand, renewables investments	Marginal costs and ranking in merit order

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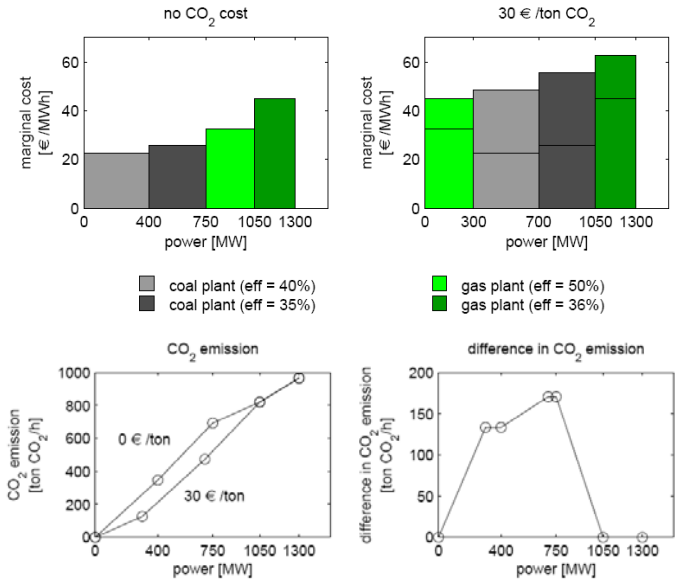
European Energy Policy
EU ETS



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European Energy Policy
EU ETS

- CO_2 price where MC_{coal} = MC_{gas} is switch price

$$ACs = \frac{\eta_c \cdot FC_g - \eta_g \cdot FC_c}{\eta_g \cdot EC_c - \eta_c \cdot EC_g}$$

- Dependent on power plant efficiencies, fuel prices and carbon content of fuels

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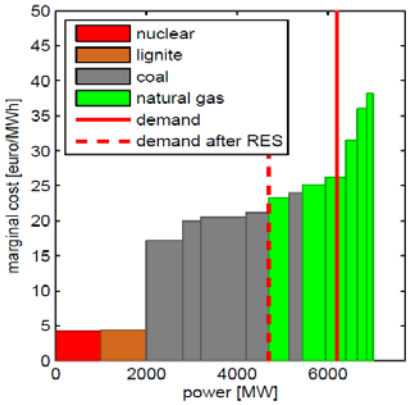
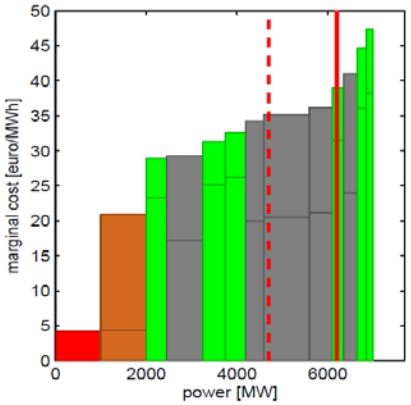
European Energy Policy
EU ETS

- Impact of renewables

0 €/ton



15 €/ton



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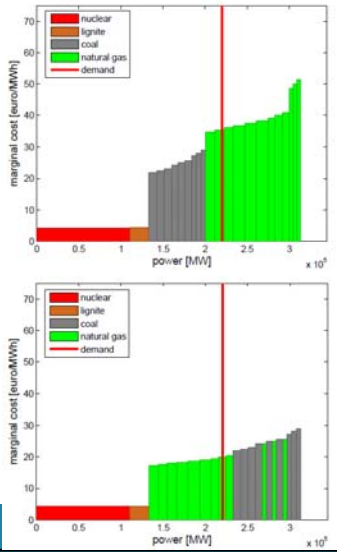
European Energy Policy
EU ETS

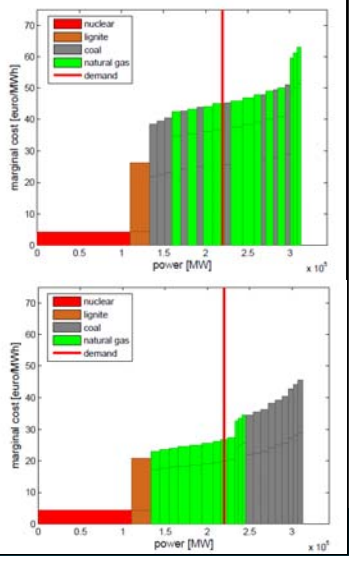
- Impact of gas price

E.g., shale gas in the US

0 €/ton



20 €/ton



European Energy Policy
EU ETS

- CO_2 emissions in Germany
  - 7 NPPs closed
    - More import nuclear from France
    - More old coal & lignite plants operating
  - Influence USA on DE
    - shale gas very cheap
    - gas pushes coal out of merit order → coal prices down
    - In DE, coal cheaper than gas...
  - Renewables counteract
- But CO_2 emissions in EU will not rise
  - Cap in ETS system
  - Impact on ETS price

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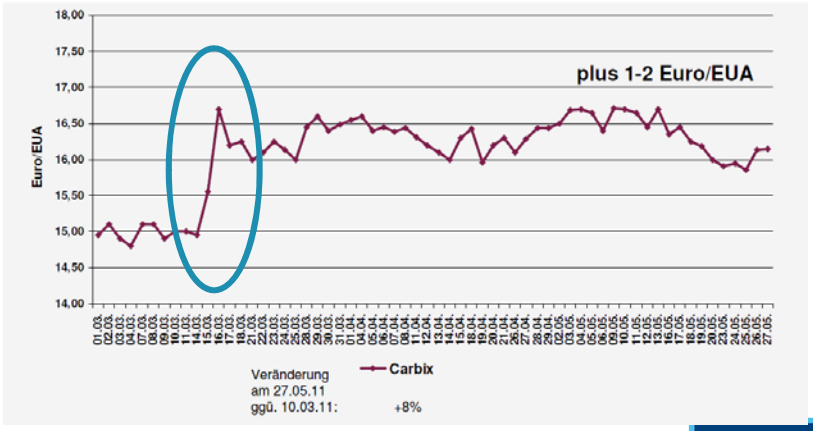
European Energy Policy
EU ETS

CO_2-Preise an der EEX:
EEX Carbix Index (Carbix)

bdew
Energie. Wasser. Leben.



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European Energy Policy
Renewables

- 20 % target for the overall share of energy from renewable sources
  - 10 % target for energy from renewable sources in transport
- Renewable energy obligation:
  - Not potential related!
  - Based on flat amount of 5.5%, and amount ~ GDP of MS
  - Correction for early starters
  - No EU-wide support scheme – only possibility for selling/buying at the end on a MS level

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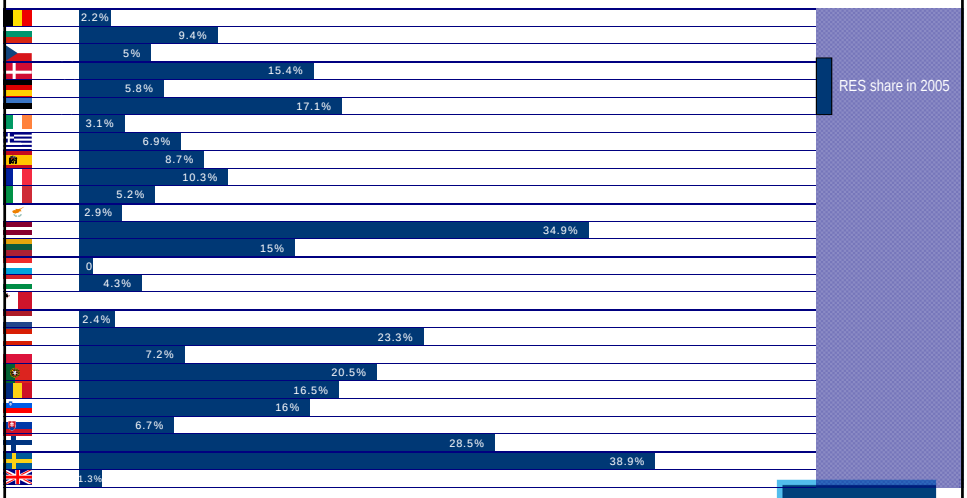
European Energy Policy
Renewables



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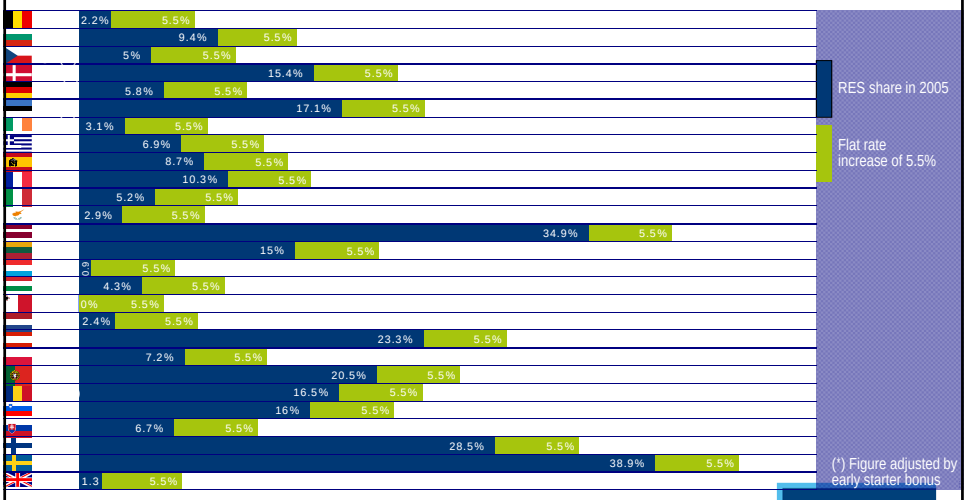
European Energy Policy
Renewables



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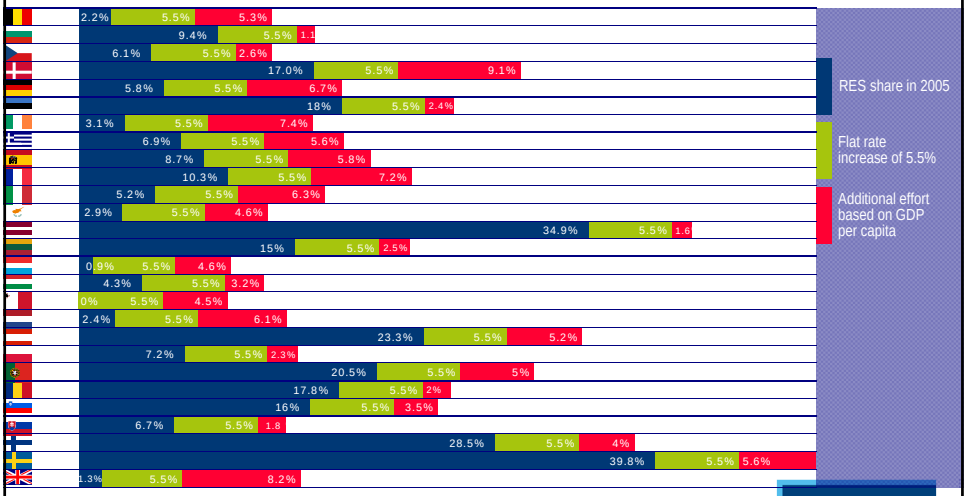
European Energy Policy
Renewables



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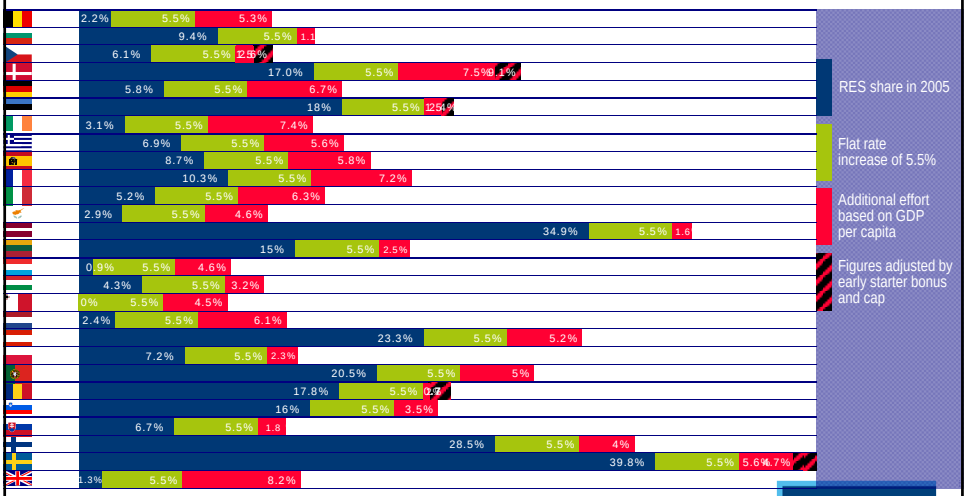
European Energy Policy
Renewables



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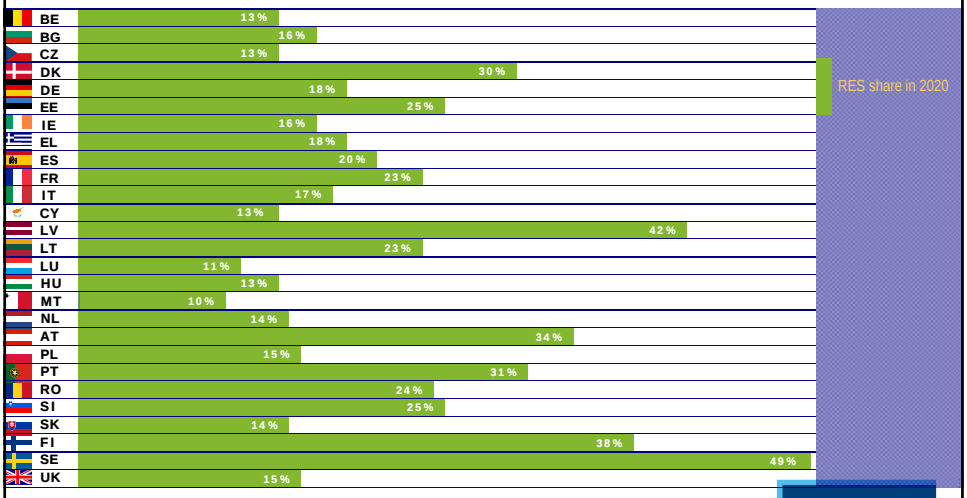
European Energy Policy
Renewables



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European Energy Policy
Renewables

- 20% RES in energy consumption
  - Transport
    - Specific 10% target
  - Heating & cooling
  - Electricity
- Member States have developed National renewable energy action plans (NREAP)
- No uniform EU-wide approach
  - Member States are free to chose adequate support systems to reach targets

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European Energy Policy
Renewables

- Options in transport and heating & cooling limited
  - Bio energy
  - Solar thermal

→ ~ 33 % renewable electric energy

  - Because of low load factor, high level of installed capacity required
    - Often serious over production / too much electricity
  - Highly intermittent & non-controllable / need thermal plant back up!
    - Thermal plants must balance very quickly

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European Energy Policy
Renewables

- RES in electricity sector
- Several support mechanisms
  - Quantity based instruments
    - Quota system → Green certificates
  - Price based instruments
    - Premium, feed-in tariff
  - Hybrid approaches
  - Tax incentives
  - …

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European Energy Policy
Renewables

Source: EWEA, 2014

- EU situation, *Installed capacity*

FIGURE 2.3: EU POWER MIX 2000

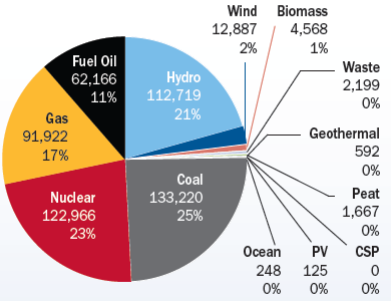
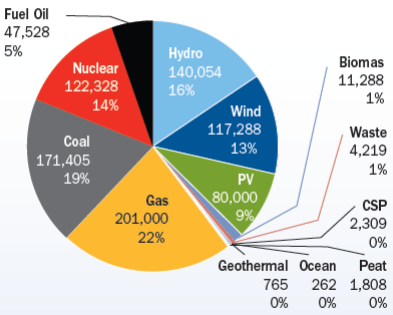


FIGURE 2.4: EU POWER MIX 2013



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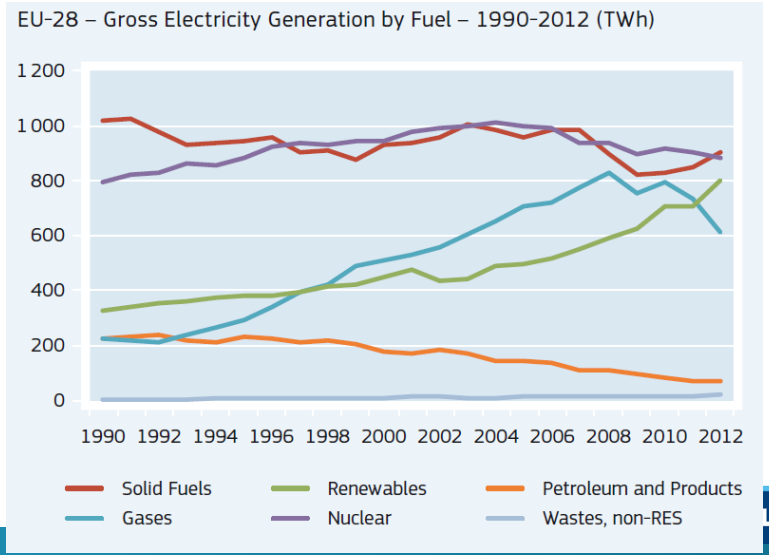
European Energy Policy
Renewables

Source: EC, 2014



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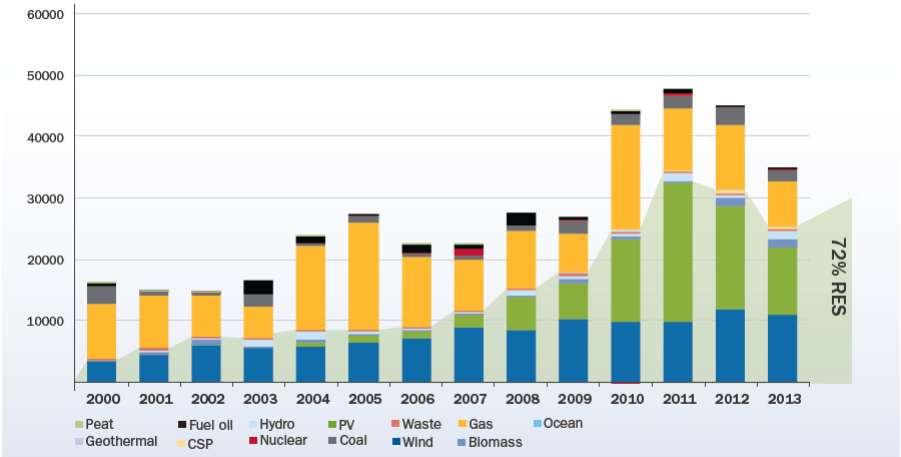
European Energy Policy
Renewables

Source: EWEA, 2014

- New capacity in EU



European Energy Policy
Renewables

Source: EWEA, 2014

FIGURE 1.1: EU MEMBER STATE MARKET SHARES FOR NEW CAPACITY INSTALLED DURING 2013 IN MW. TOTAL 11,159 MW

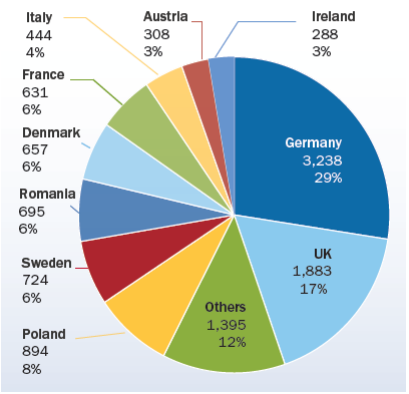
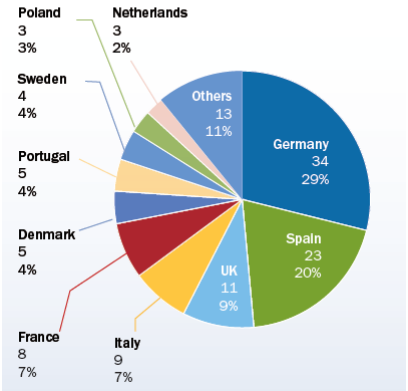


FIGURE 3.5: EU MEMBER STATE MARKET SHARES FOR TOTAL INSTALLED CAPACITY (TOTAL 118 GW)



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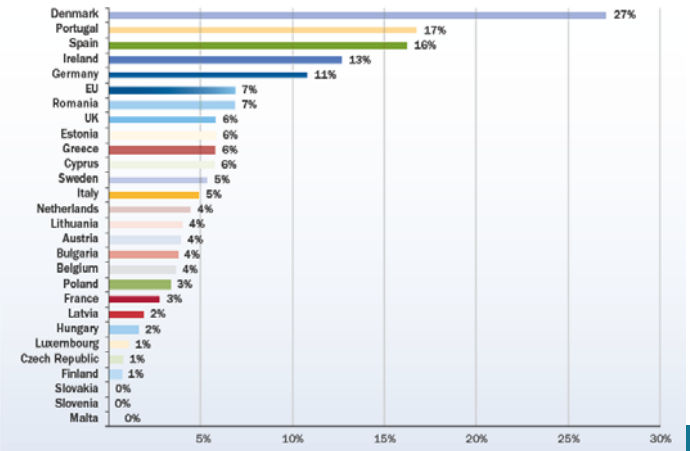
European Energy Policy
Renewables

Source: EWEA, 2013

- Fraction of energy consumption (2012)

FIGURE 3.6 WIND POWER SHARE OF TOTAL ELECTRICITY CONSUMPTION IN EU (7%) AND IN MEMBER STATES



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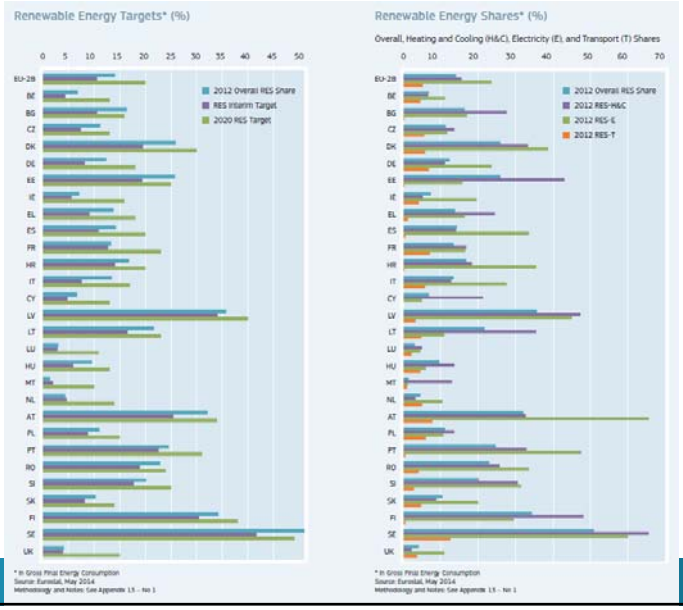
European Energy Policy
Renewables



Source:
EC, 2014

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Overview

- CO_2 emissions and climate change
- International agreement?
- Current EU Policies
  - EU ETS
  - Targets for renewables
- **EU policies towards 2030**
- Reflections

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EU implementation & vision
Europe's Energy and Climate goals for 2030

- Key elements of the 2030 policy framework set out by the EC
  - A binding greenhouse gas reduction target
  - An EU-wide (binding?) renewable energy target
  - Energy efficiency (non-binding)
  - Reform of EU ETS
  - Indicators for competitive, affordable and secure energy provision
  - New governance system

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EU implementation & vision
Europe's Energy and Climate goals for 2030

- Why climate and energy framework up to 2030?
  - Longer term 2050
  - Economic and financial crisis
  - Security of EU energy supplies
  - Predictability and reduced regulatory risk
  - Paris 2015

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EU implementation & vision
Europe's Energy and Climate goals for 2030

- Current status and outlook 2020
  - 18% GHG reduction between 1990 and 2012
    - On track to meet 2020 goal of 20%
    - ETS sectors -21% compared to 2005
    - Non ETS sector have MS specific level
      - Aggregated about -10% compared to 2005

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EU implementation & vision
Europe's Energy and Climate goals for 2030

- A binding greenhouse gas reduction target
  - 40% emissions reduction below the 1990 level
  - Domestic measures alone
    - No more import from international credits after 2020
  - EU ETS sectors
    - Annual reduction in the 'cap' on emissions increased from 1.74% now to 2.2% after 2020
  - Non-ETS sectors
    - These emissions would need to be cut by 30% below the 2005 level

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EU implementation & vision
Europe's Energy and Climate goals for 2030

- Reform of EU ETS
  - Establish a market stability reserve at beginning of the next ETS trading period in 2021
    - In addition to current backloading
    - Reserve would operate entirely according to pre-defined rules

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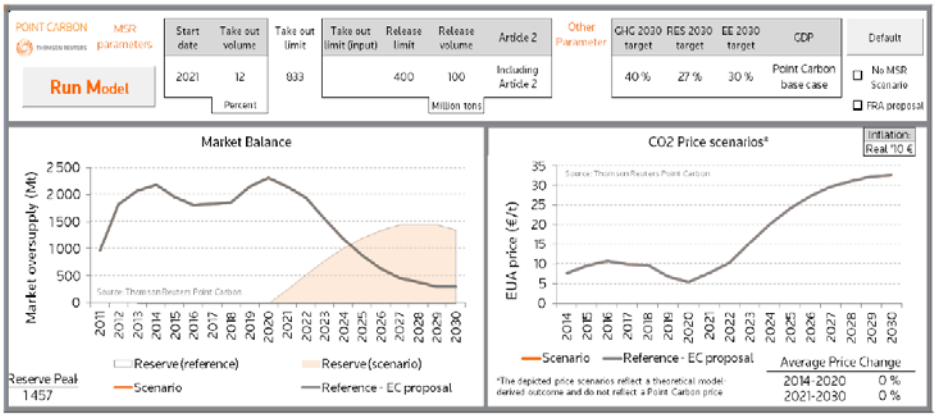
EU implementation & vision
Europe's Energy and Climate goals for 2030

- Market Stability Reserve (MSR)



Source: Point Carbon

EU implementation & vision
Europe's Energy and Climate goals for 2030

- Current status and outlook 2020
  - For RES, interim targets met, but more effort required to achieve 2020 goal of 20%
    - In 2014, ~14% of gross final energy consumption from RES (compared to 8.5% in 2005)
    - About 23% in electricity sector (2014)

EU implementation & vision
Europe's Energy and Climate goals for 2030

- An EU-wide (binding?) renewable energy target
  - RES to play a key role in the transition towards a competitive, secure and sustainable energy system
  - More market-oriented approach
  - EU-wide binding target for renewable energy of at least 27% in 2030

→ In electricity sector a share of RES of at least 45% in 2030 (23% today)

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Overview

- CO_2 emissions and climate change
- International agreement?
- Current EU Policies
  - EU ETS
  - Targets for renewables
- EU policies towards 2030
- **Reflections**

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EU implementation & vision
Reflections

- Issues
  - EU CO_2 emissions OK because of
    - De-industrialization
      → services society & to cheaper countries – carbon leakage
      → Often less efficient + transport → more carbon!
    - Economic crisis (cfr Kyoto period 2008-2012)
  - Carbon *production* versus carbon *consumption*
  - Global CO_2 emissions have gone up tremendously

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EU implementation & vision
Reflections

- Options?
  - Stable, sufficiently high carbon price
    - Carbon tax (+border tax)?
  - Gas as transitional fuel?
    - Shale gas? Avoid coal?
  - Subsidizing (expensive) renewables?
    - Picking winners is typically not good idea

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