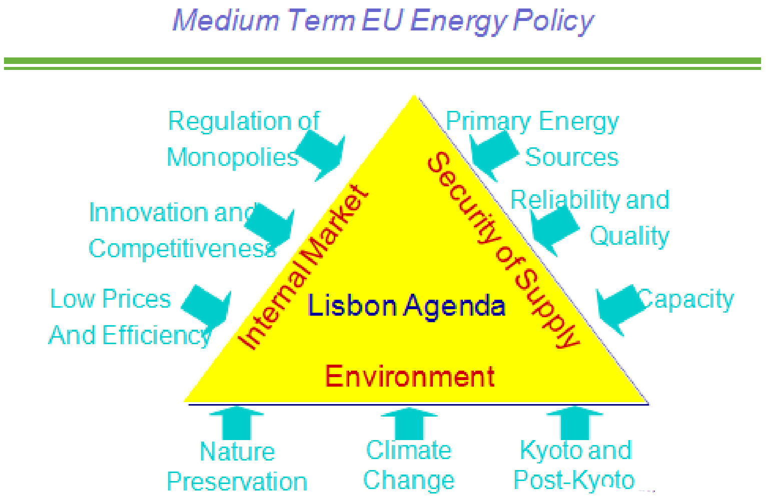
What Difference Energy Policy Makes for Future Energy Systems

UVIG Spring 2018 mtg, Tucson AZ
Closing Plenary Session

William D'haeseleer
KU Leuven / EnergyVille/ iiESI

EU's Implementation Energy & Climate



Major challenge to satisfy all three simultaneously

EU's **trilemma** !

- Objectives
  - 2020 targets (20-20-20)
    - By EU considered as "given" / "decided" / to be implemented
  - 2030 as intermediate step
    - Long enough to do something; close enough to say meaningful things
  - 2050 vision (reduction CO_2 by > 85%)
    - Need **energy revolution / paradigm shift**

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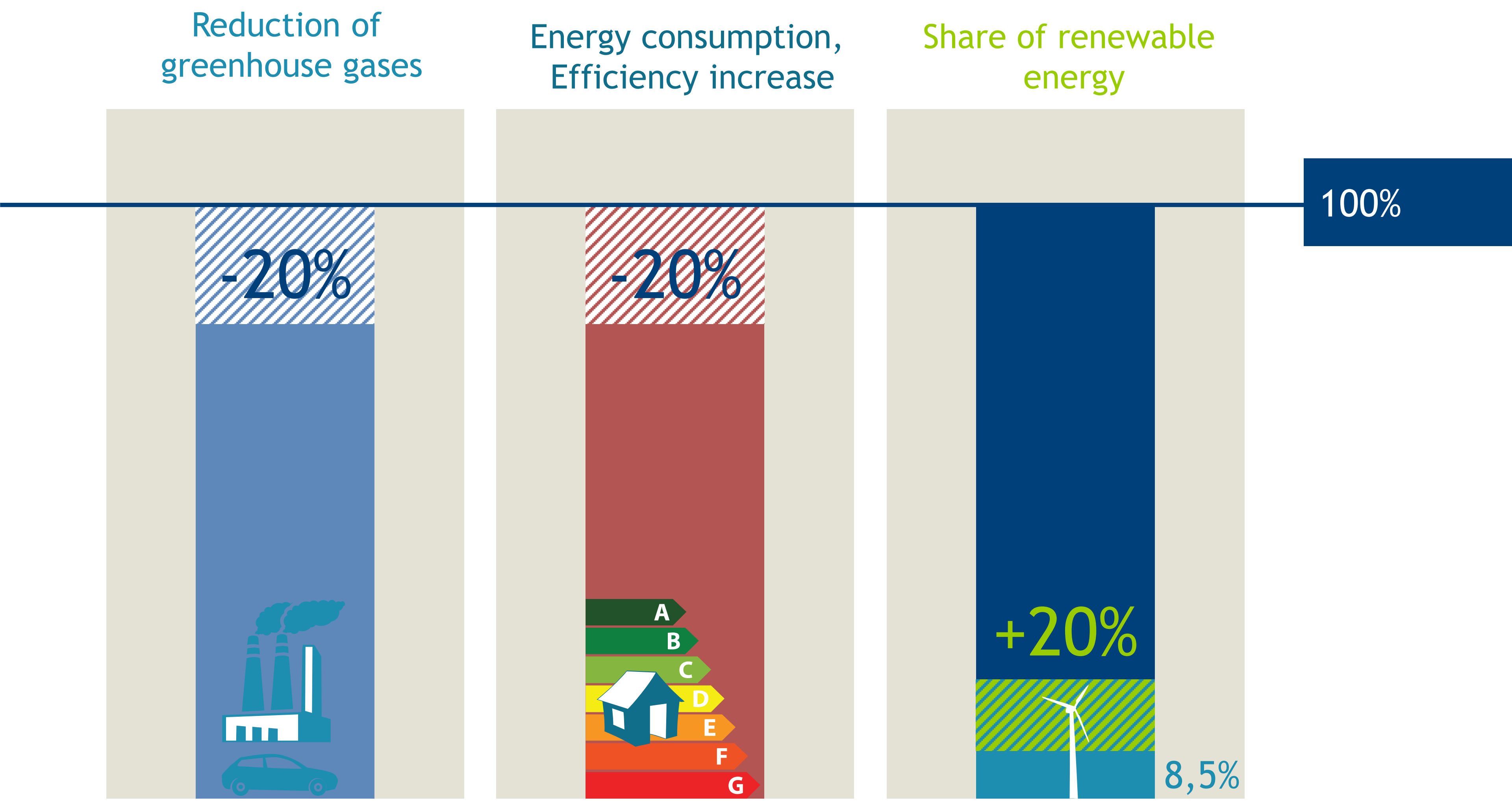
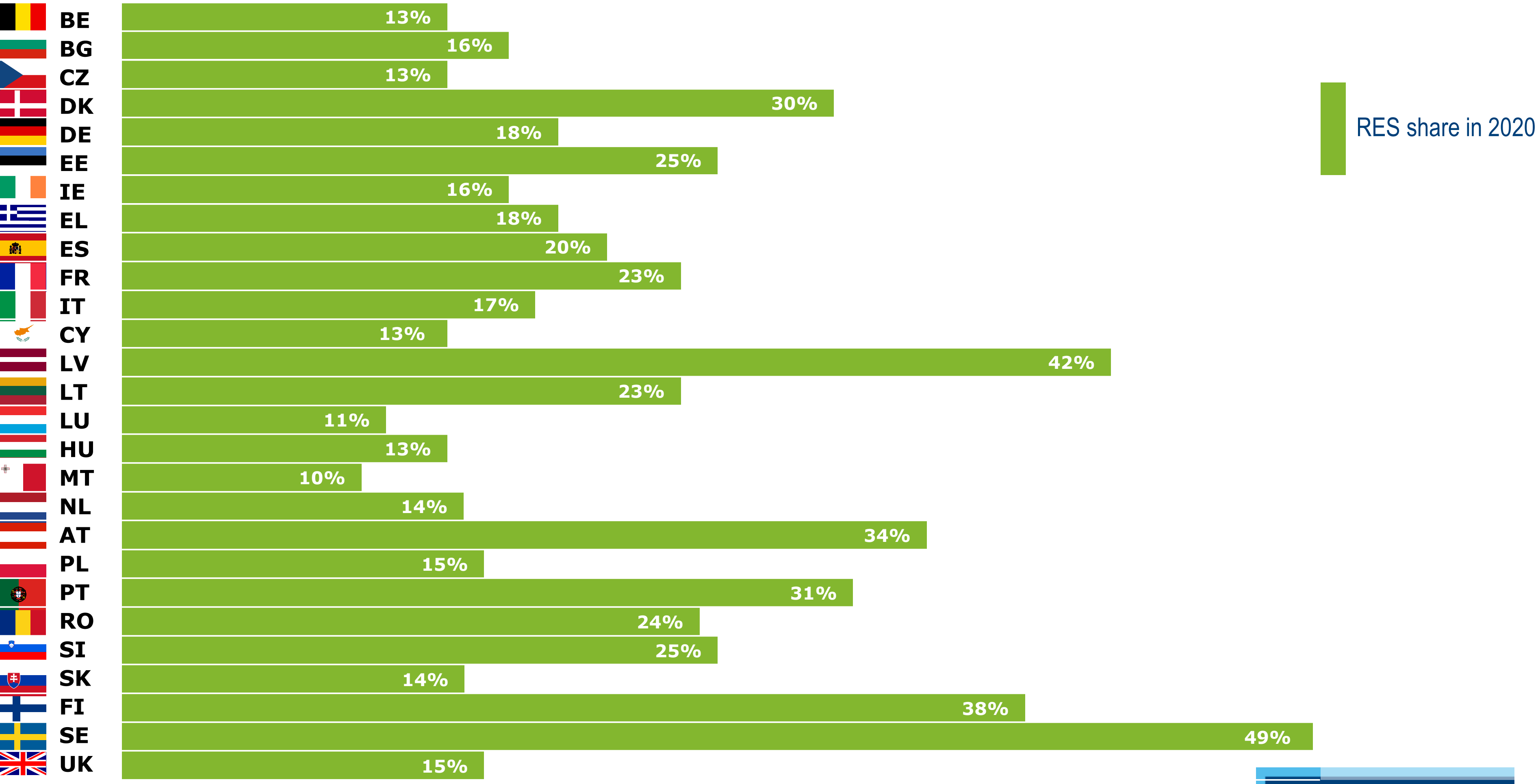
EU 20-20-20 targets by 2020



EU-27 efforts in Renewables



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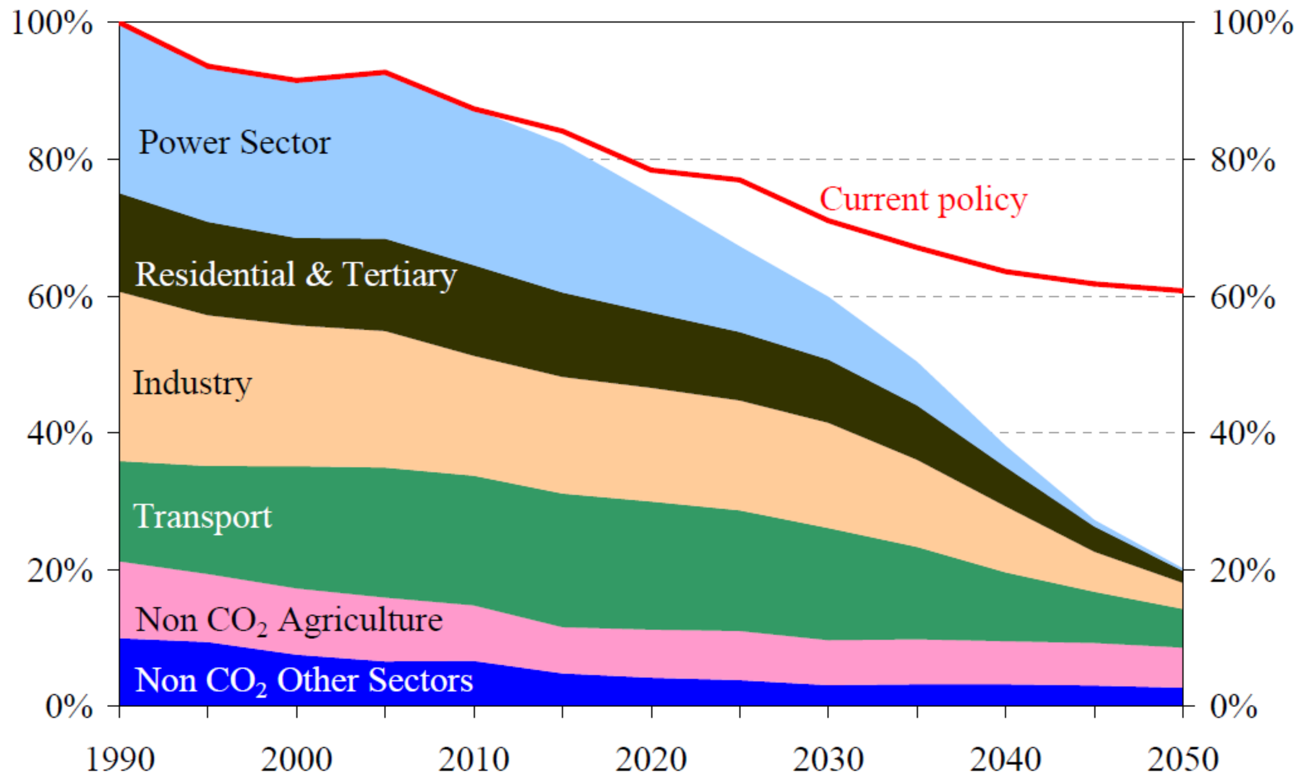
EU's long-term CO_2 reduction targets

Climate Change Roadmap - 2050

Figure 1: EU GHG emissions towards an 80% domestic reduction (100% =1990)



Reference: European Commission COM(2011) 112/4

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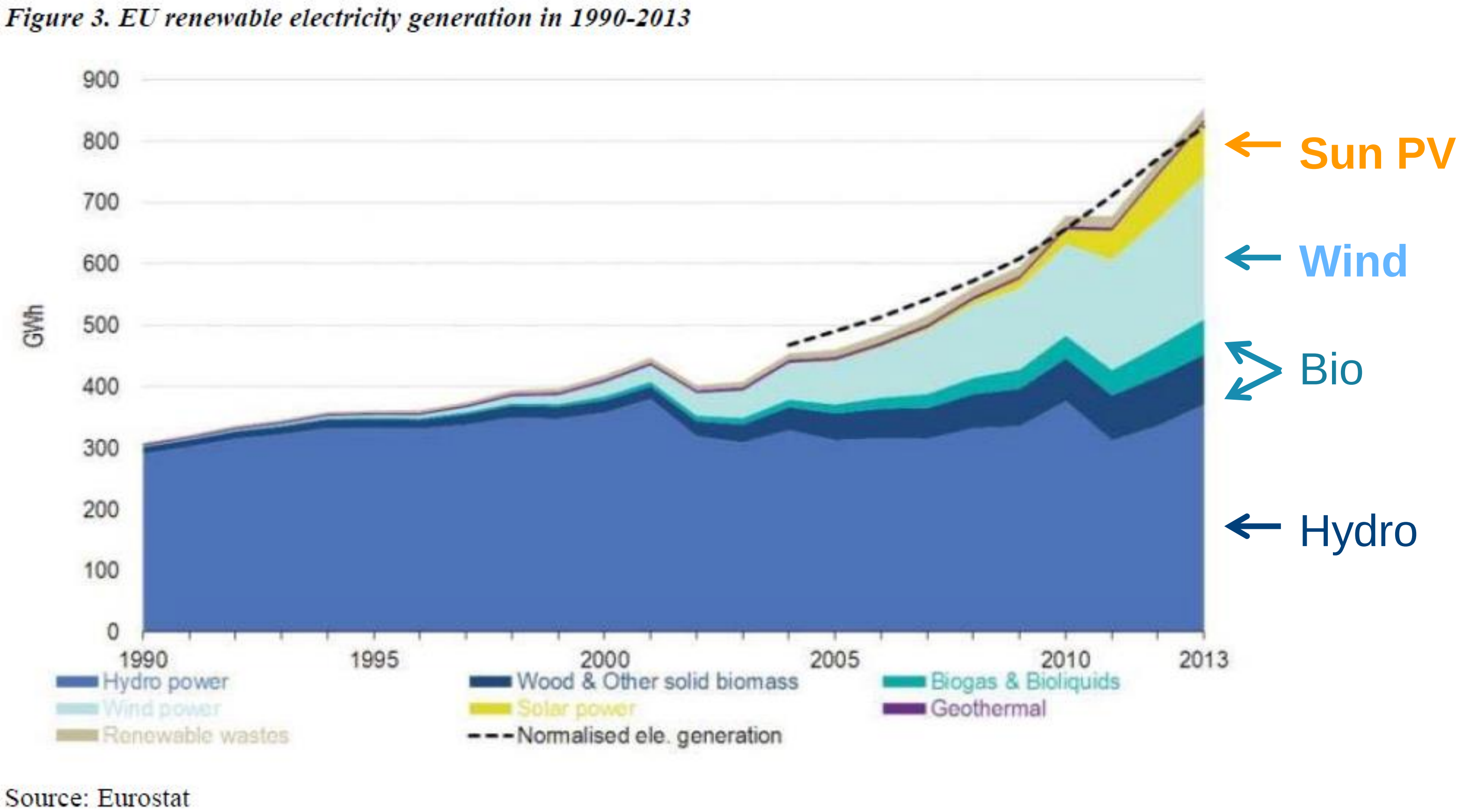
EU's implementation - currently



Ref: EU RES Progress report, 2015

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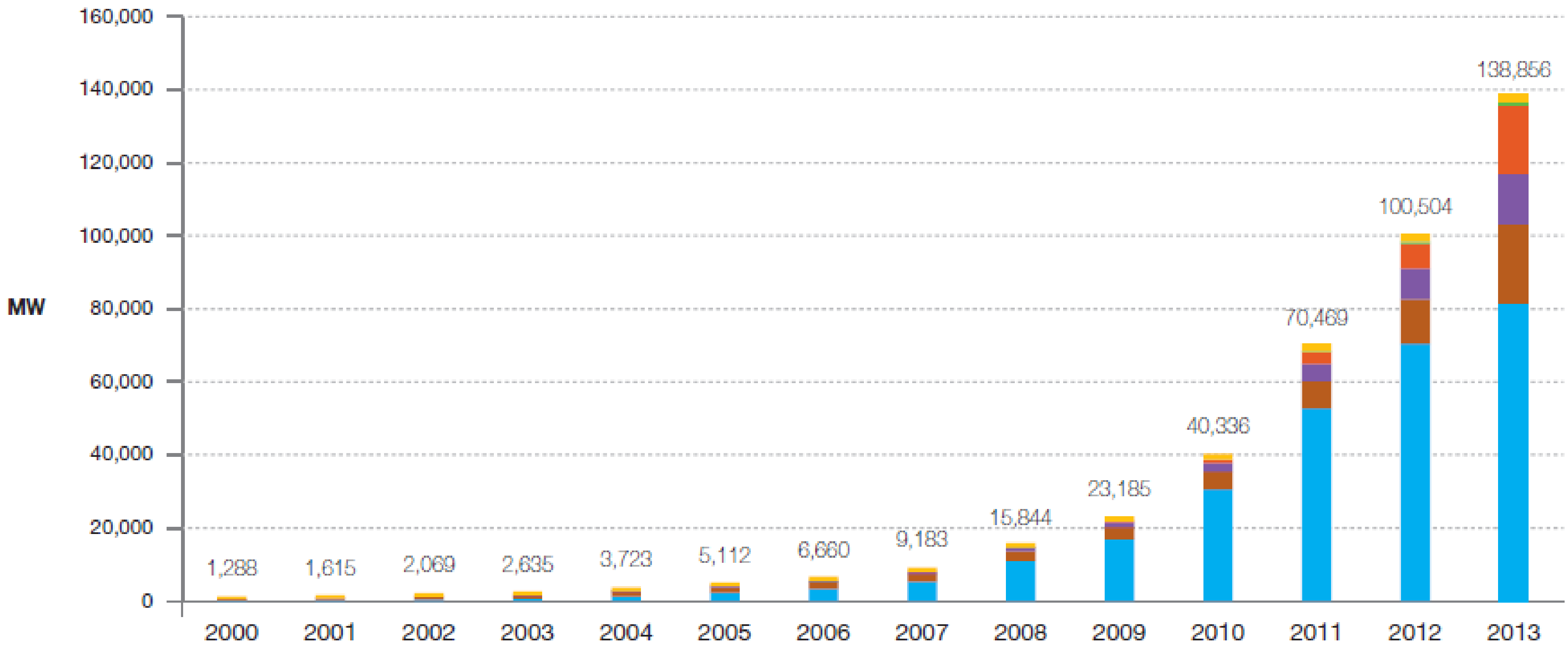
EU's implementation - currently

PV evolution worldwide

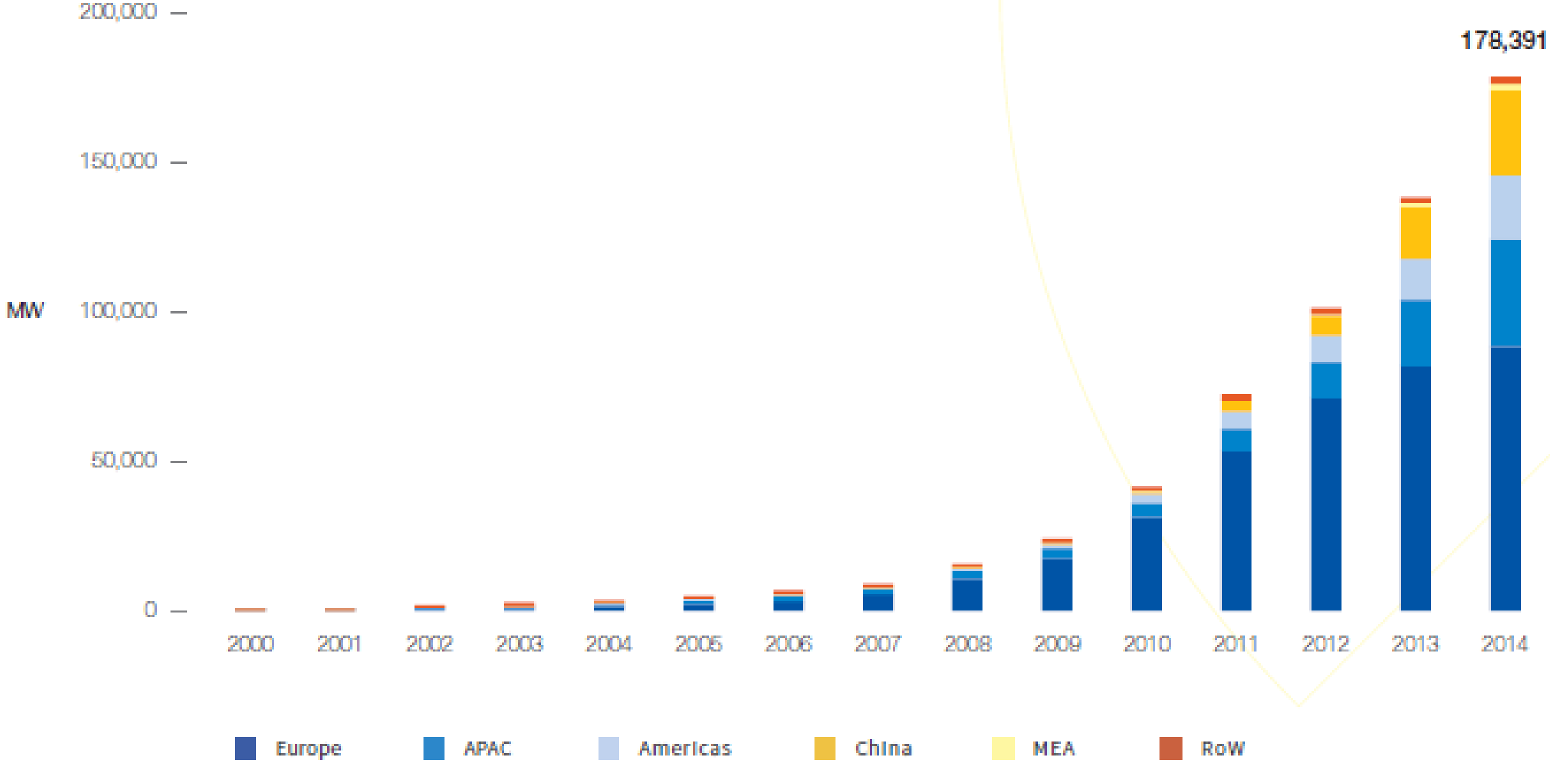


Ref: EPIA 2014

EU's implementation - currently

PV evolution worldwide

FIGURE 3 EVOLUTION OF GLOBAL SOLAR PV CUMULATIVE INSTALLED CAPACITY 2000-2014

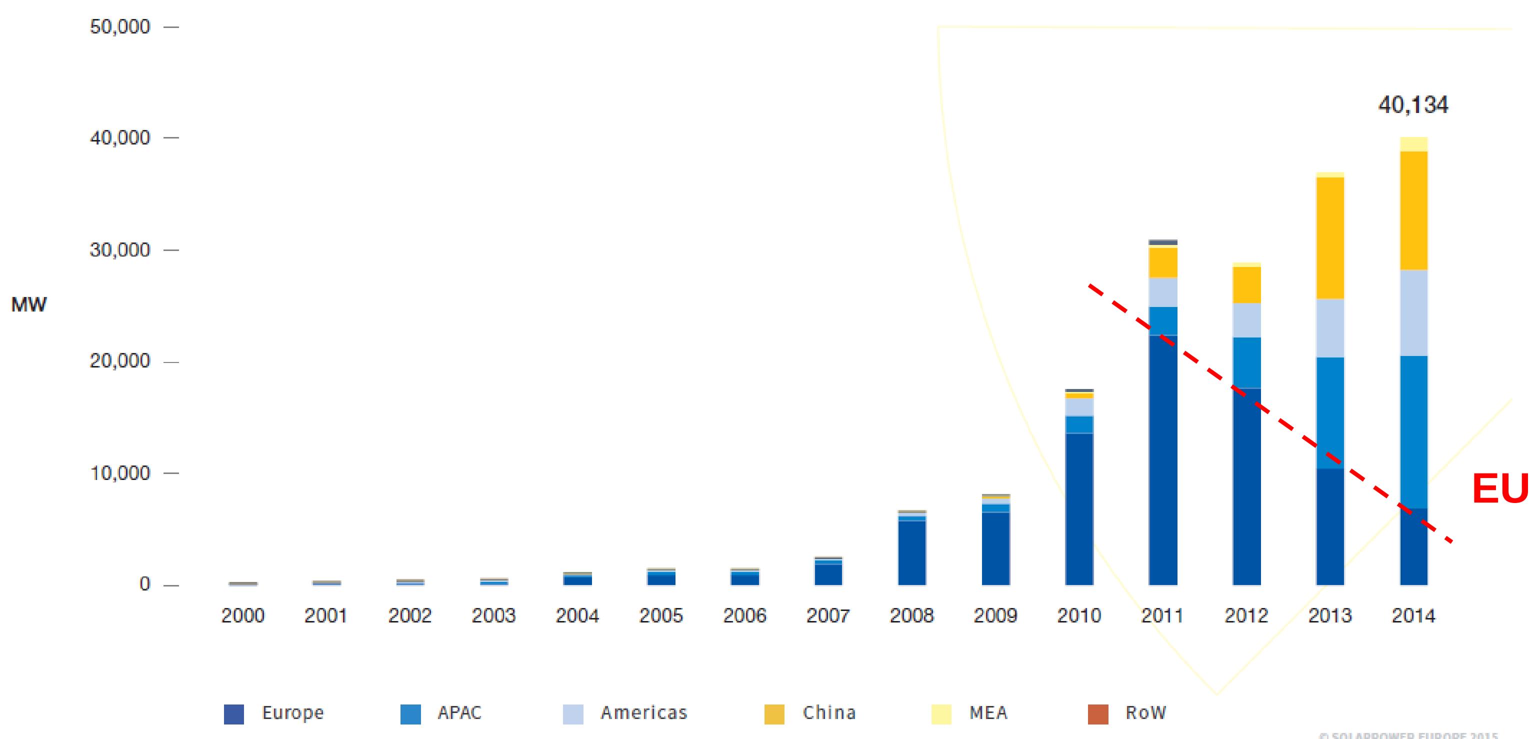


Ref: EPIA 2015

EU's implementation - currently

PV evolution worldwide

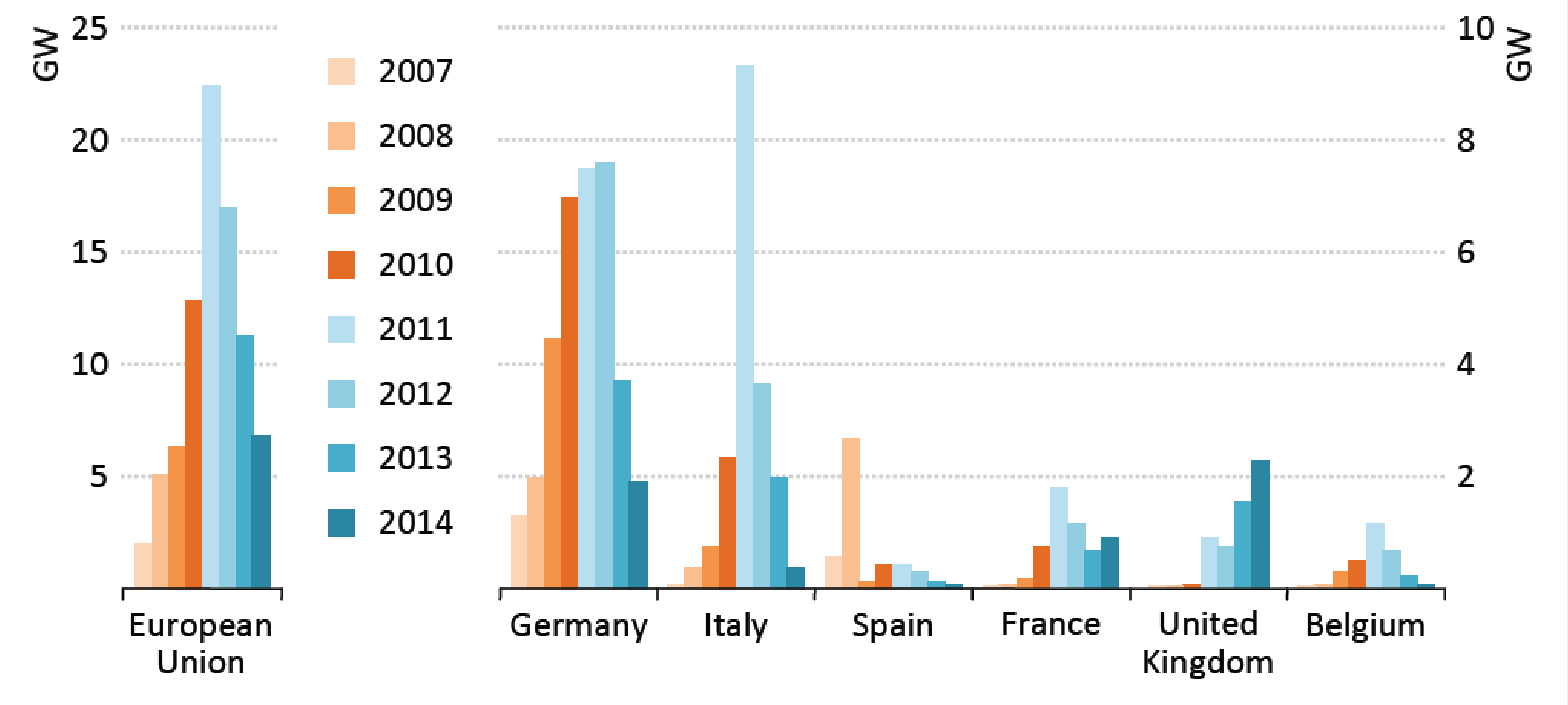
FIGURE 2 EVOLUTION OF GLOBAL SOLAR PV ANNUAL INSTALLED CAPACITY 2000-2014



Ref: EPIA 2015

EU's implementation - currently

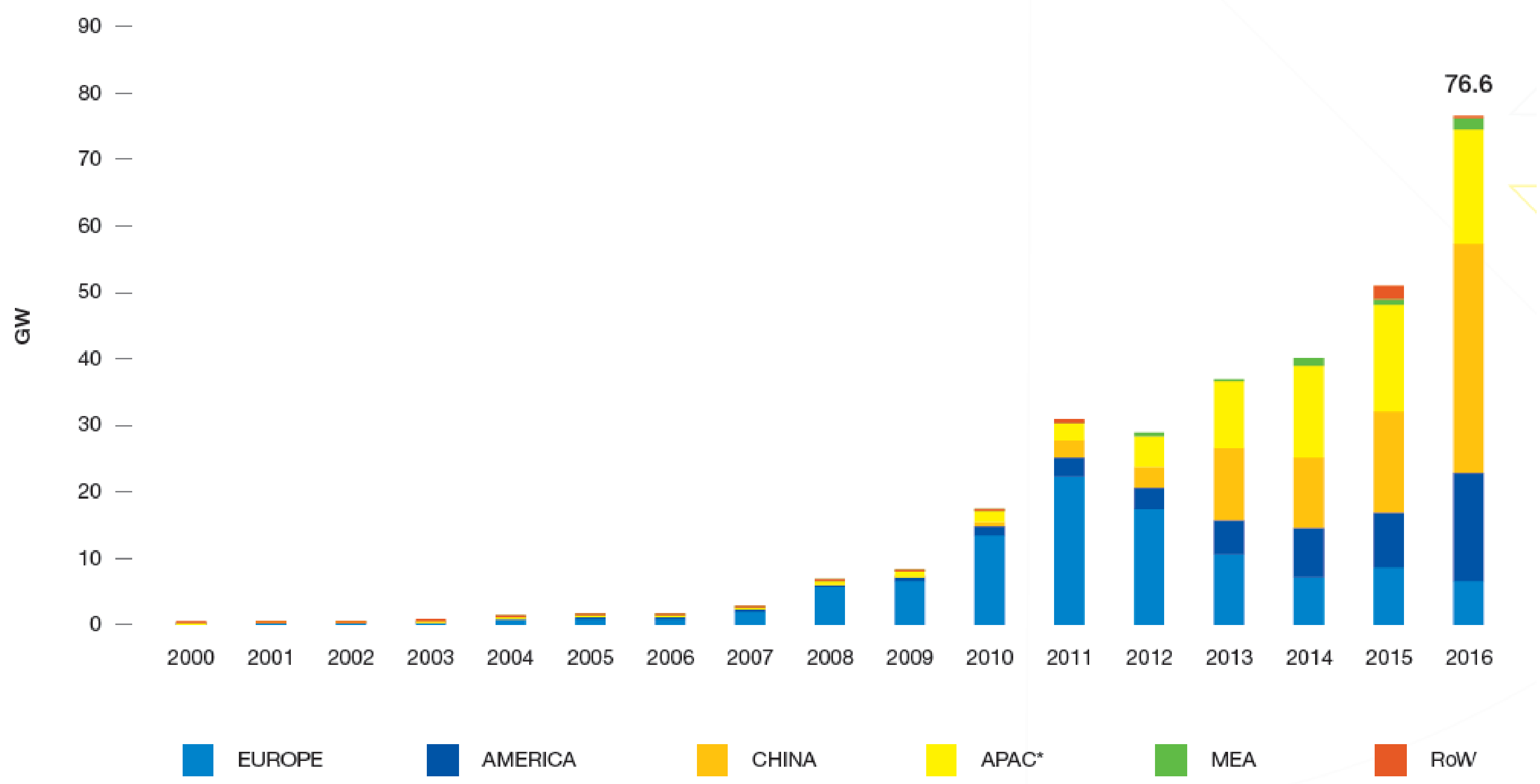
Figure 9.9 ▷ **Solar PV capacity additions in European Union and selected countries, 2007-2014**



Has the PV market in the EU peaked?

EU's implementation - currently

FIGURE 3 EVOLUTION OF GLOBAL ANNUAL SOLAR PV INSTALLED CAPACITY 2000-2016



Ref: Solar Power Europe; GMO 2017

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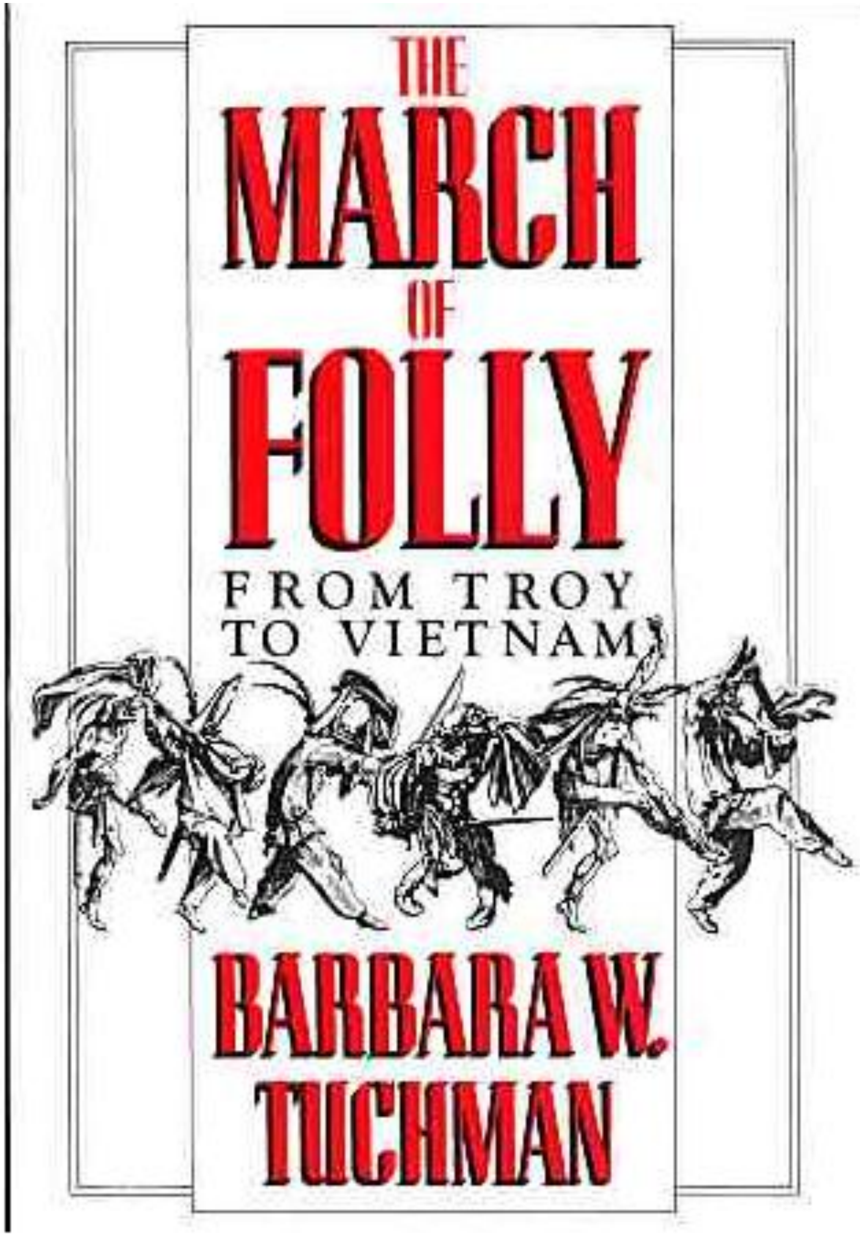
EU's implementation - currently

- All this progress seems to be too nice to be true...
  And it is...

- There are major *system effects* that have been neglected and that may jeopardize further success of RES deployment!

- One has gone too rapidly recently, with *danger of losing support of population!*



THE MARCH
OF FOLLY

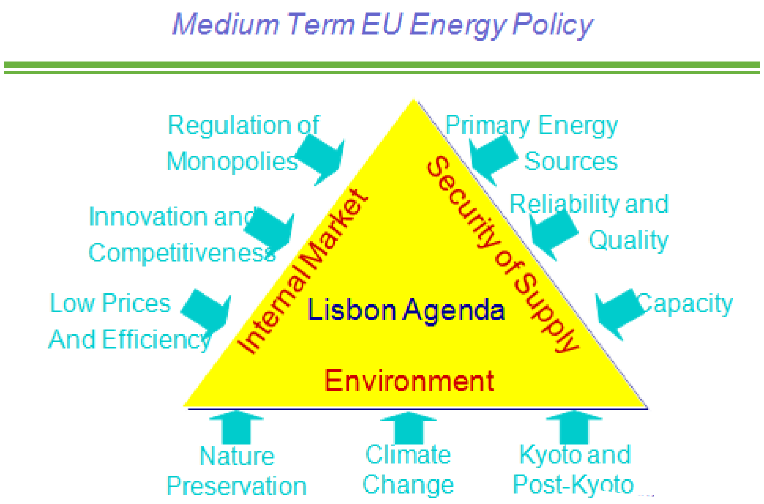
Pursuit of policy

contrary to self-interest

EU's implementation

Major challenge to satisfy
all three simultaneously

EU's **trilemma** !



Textbook example of
"well intended measures"
but ...

because *lack of system thinking*
serious issues / problems

→ EU electricity market in cirisis !!

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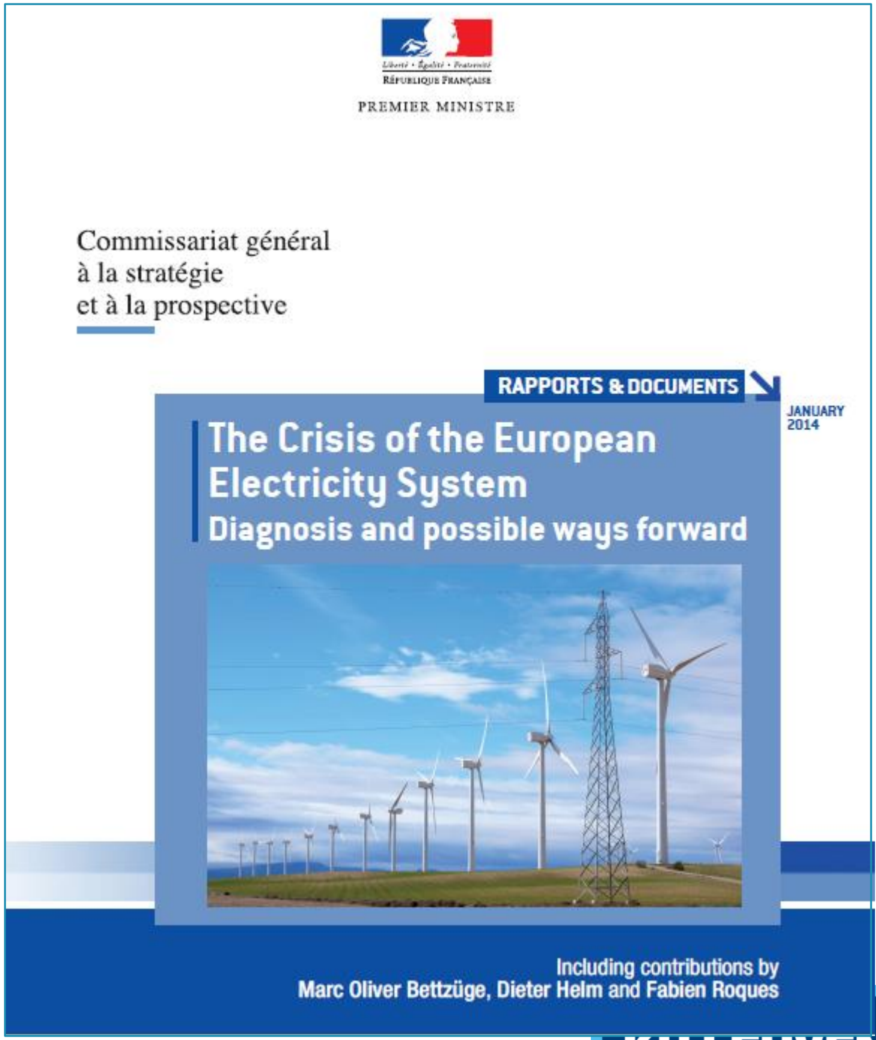
French Report January 2014



EU's implementation

Issues / challenges / problems in the EU market

- Technical challenges
- Market-integration problems
- Consequences for the CO_2 emissions
- End-electricity prices for end consumers

EU's implementation

Consequences of renewables quota in end-energy terms (1)

- Total end energy = electric energy + fuel for heat + fuel for transportation
- EU requirement by 2020: 20% of end energy from RES
- For transportation only 10% ... → for electric sector ~ 34%
- Expectations / outcome ("steered" by differentiated *subsidies*):
  - Hydro ~ only small increase possible
  - Biomass ~ moderated increase (protests against co-combustion, imported biomass pellets, sustainability questions)
  - Wind onshore + offshore / ENOH onsh ~ 2200h/a offsh ~ 3500 h/a
  - Solar photovoltaics (PV) / ENOH Belgium ~ 800 h/y
- Total: 8760 h/a → low capacity factors of these intermittent sources

EU's implementation

Consequences of renewables quota in end-energy terms (2)

- Capacity factors intermittent sources (wind + PV):
    - Wind onshore + offshore / CF ~ 25% - 30%
    - Solar photovoltaics (PV) / CF ~ 10%
- To produce 34% electric energy with something that operates only 10% or 25-30% of the time, you must install a large amount of installed power (called "capacity") → leads to massive overcapacity
- If there is a lot of wind and sun, and low demand (e.g., weekends), then too much electricity produced
- But sometimes in case of cold spell (cfr winter Feb 2012) – with temp inversion... little wind and 'dark' (hence no PV) at 17.00h-18.00h, when peak demand arises in NW-Europe! → very little RES electricity produced

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EU's implementation

Consequences of renewables quota in end-energy terms (3)

- *Intermittency*: defined as "variable" and "partly unpredictable"
- How deal with massive "intermittency" in electricity system?

  Six major 'flexibility'-enabling elements:
  - **Back up reserves from *flexible dispachable thermal plants* (+ & -)**
  - **Electric *storage* (large scale electric storage not available)**
  - **Expansion of *transmission grid***
  - **Encourage *active demand response* (ADR)**
  - ***Curtailing* of superfluous RES production / review priority access**
  - ***Interaction* with other carriers/sectors**

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EU's implementation

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EU's implementation – technical issues

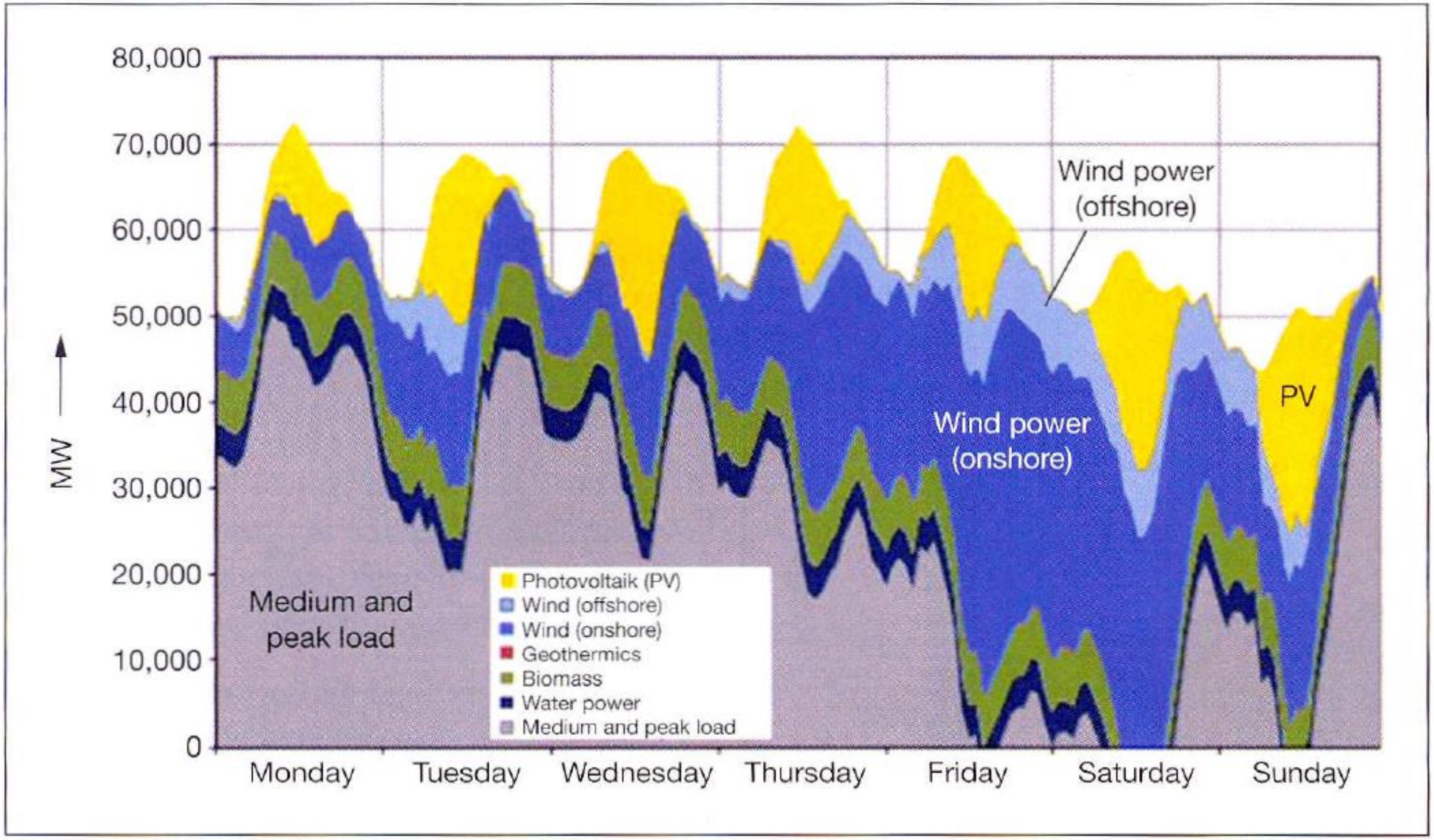


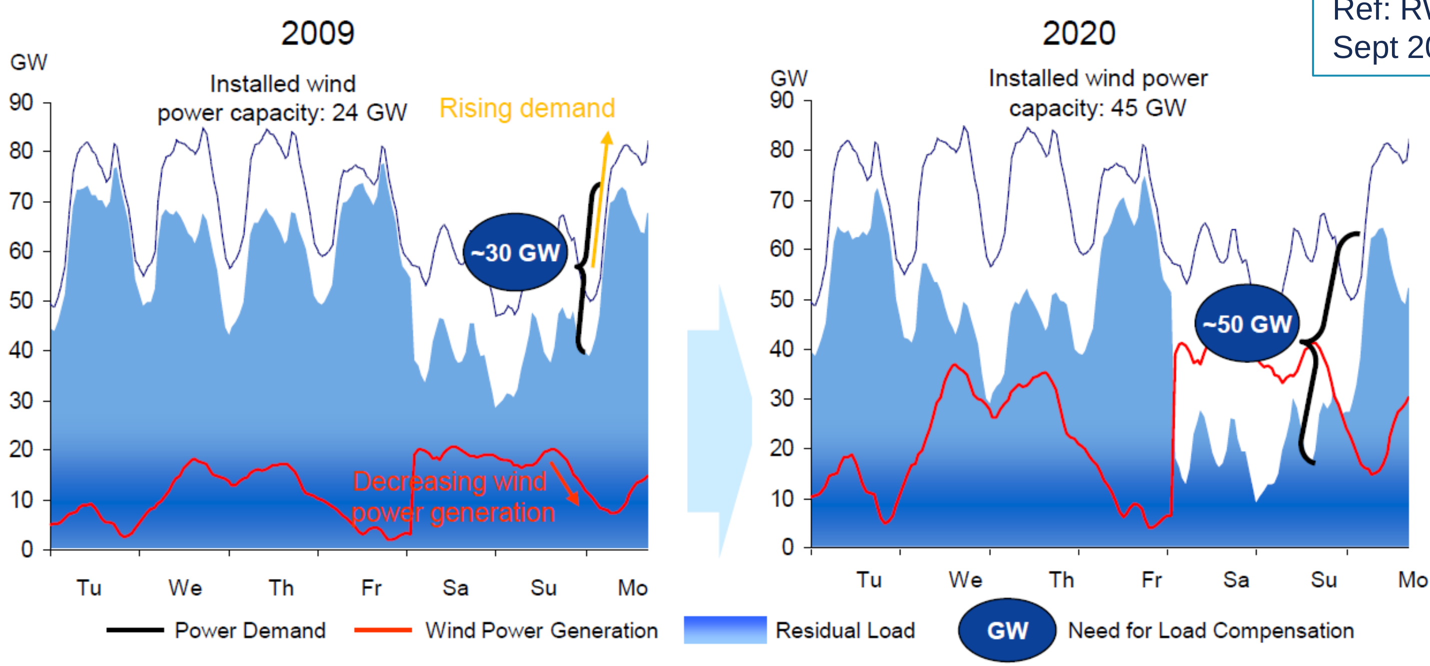
Figure 1. Power generation across one week in July 2020, BEE scenario [6].

Ref: Lehner & Schlipf, VGB Powertech, 8/2011

EU's implementation – technical issues

Residual power demand in Germany February 2009 and projection to 2020

Ref: RWE – ALSTOM
Sept 2011

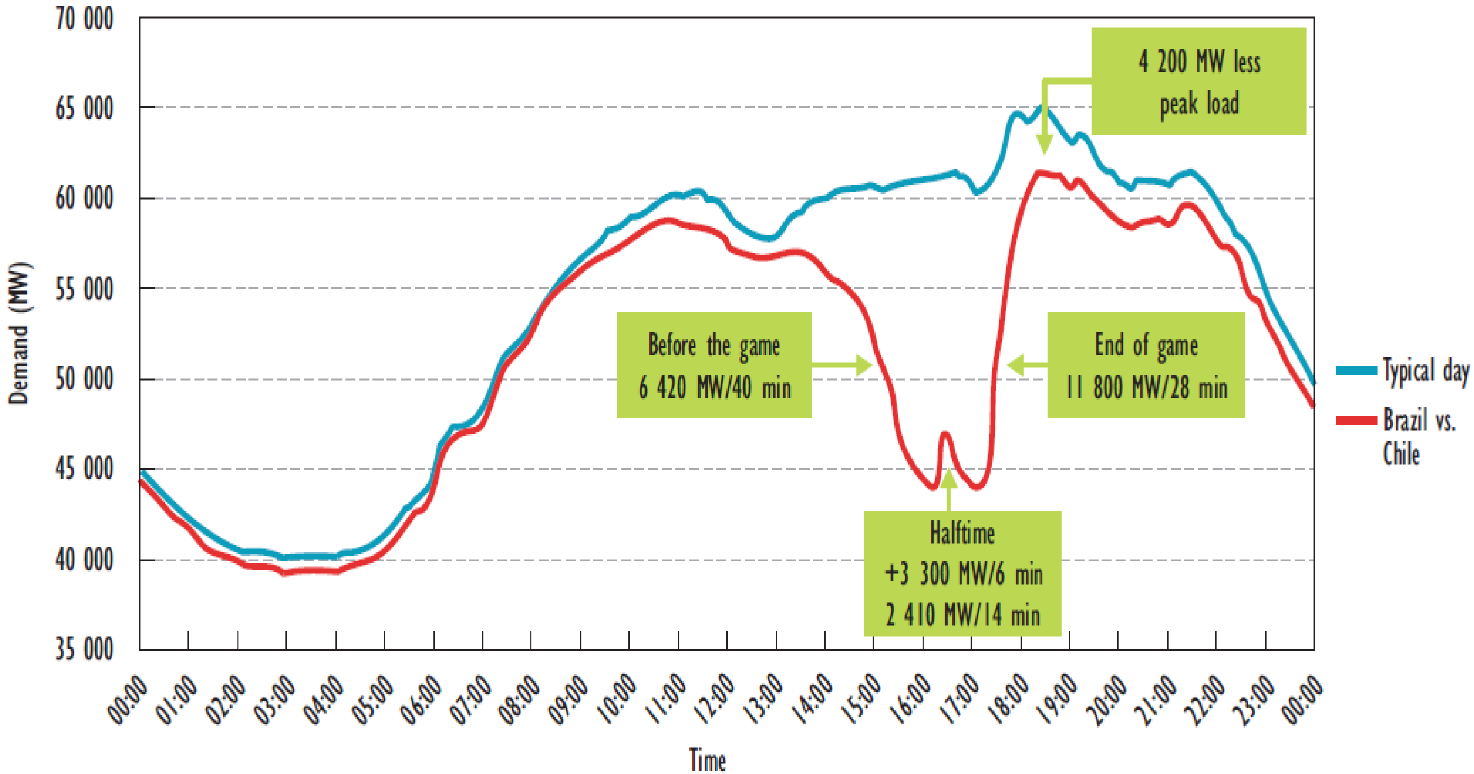


→ thermal plants must balance very quickly

→ **challenging requirements for thermal power plants!**

EU's implementation – technical issues

- Ectually not totally new (football game in Brazil 2010)



Notes: during the game of Brazil (3) vs. Chile (0) on 24 June 2010.

Ref: IEA, 2010

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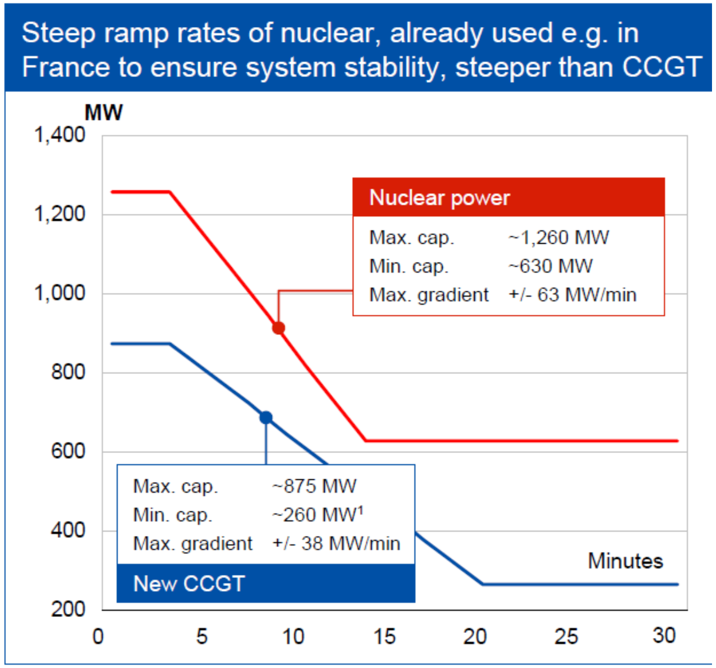
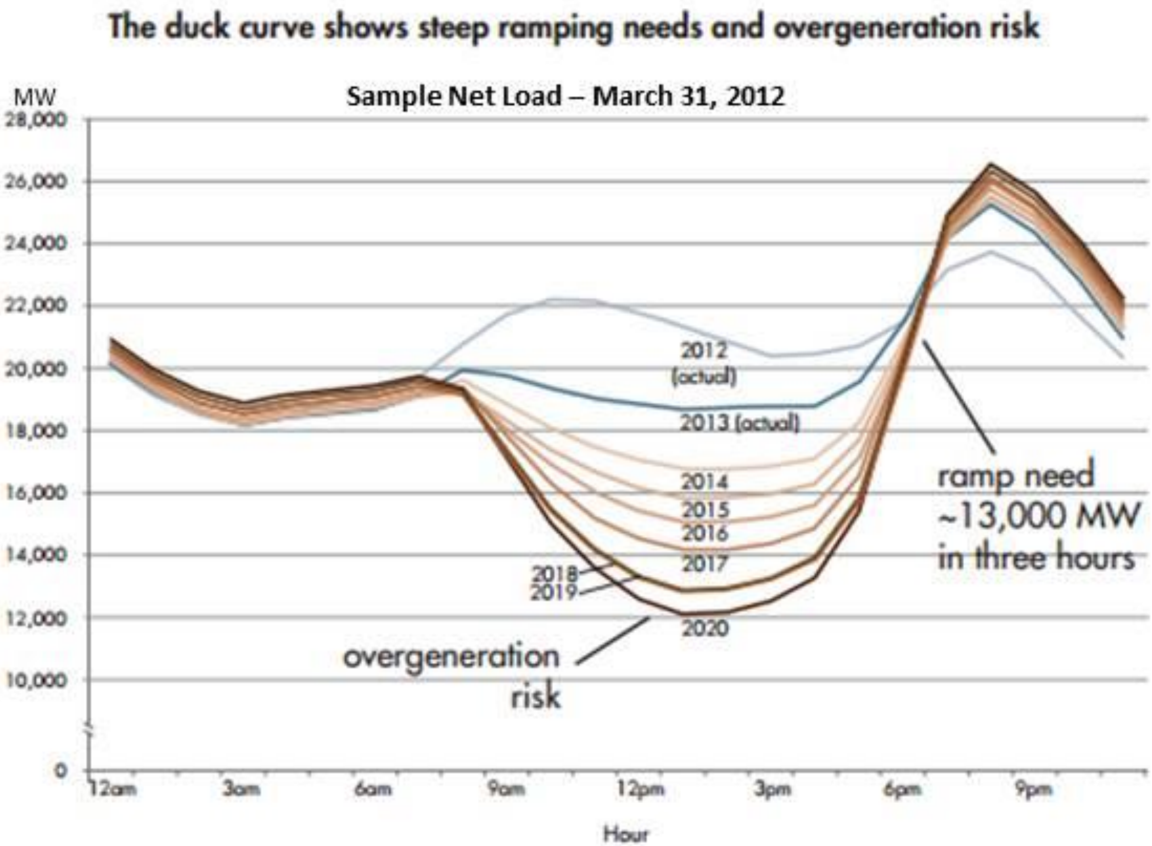
EU's implementation – technical issues

- What are critical generation-technology parameters?
  - Ramp rates compatible with technology
  - Overall dynamic behavior



US implementation – technical issues



(from the California Independent System Operator)

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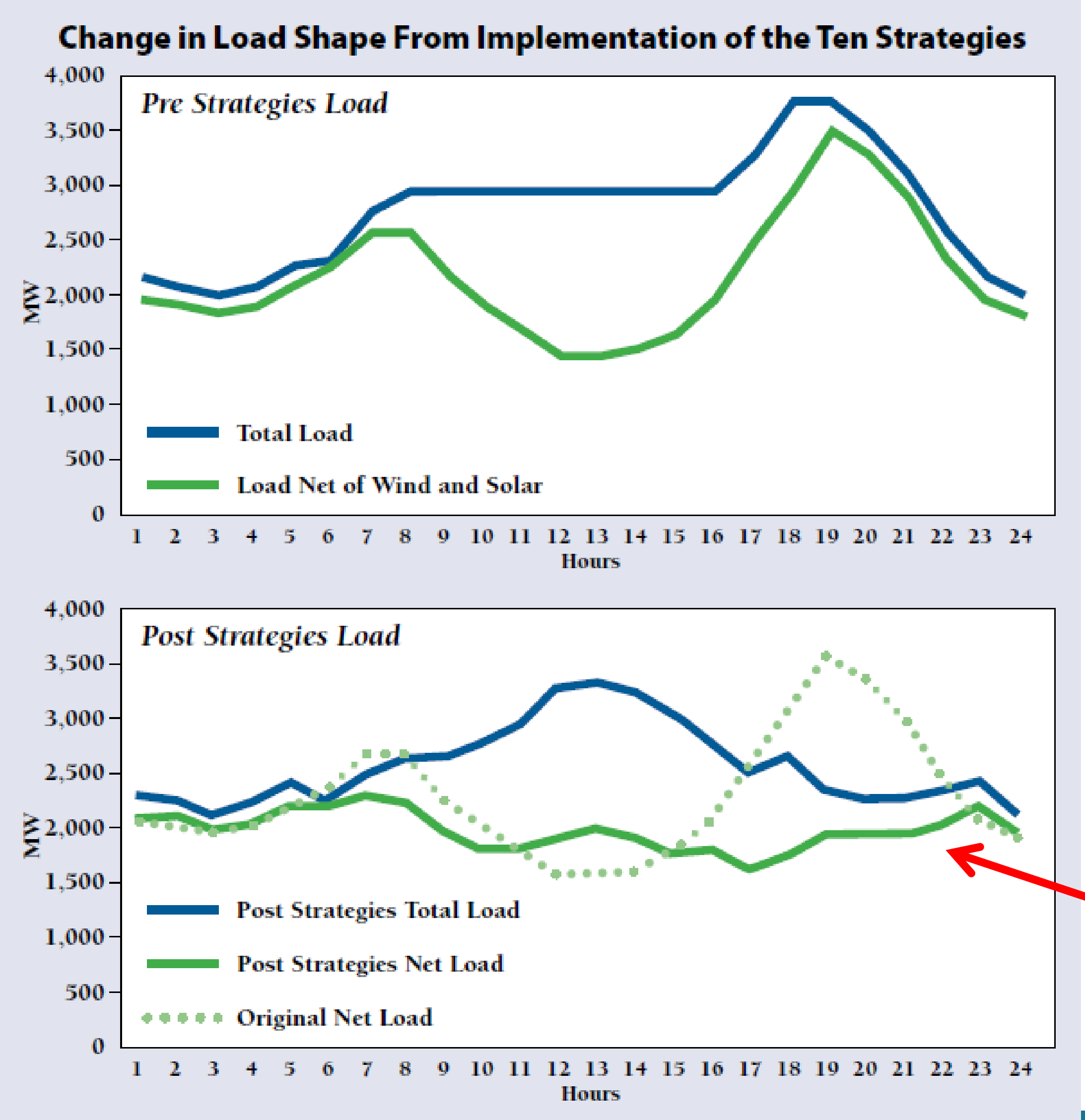
Ref: Paul Denholm, NREL, London, 2015

US implementation – technical issues

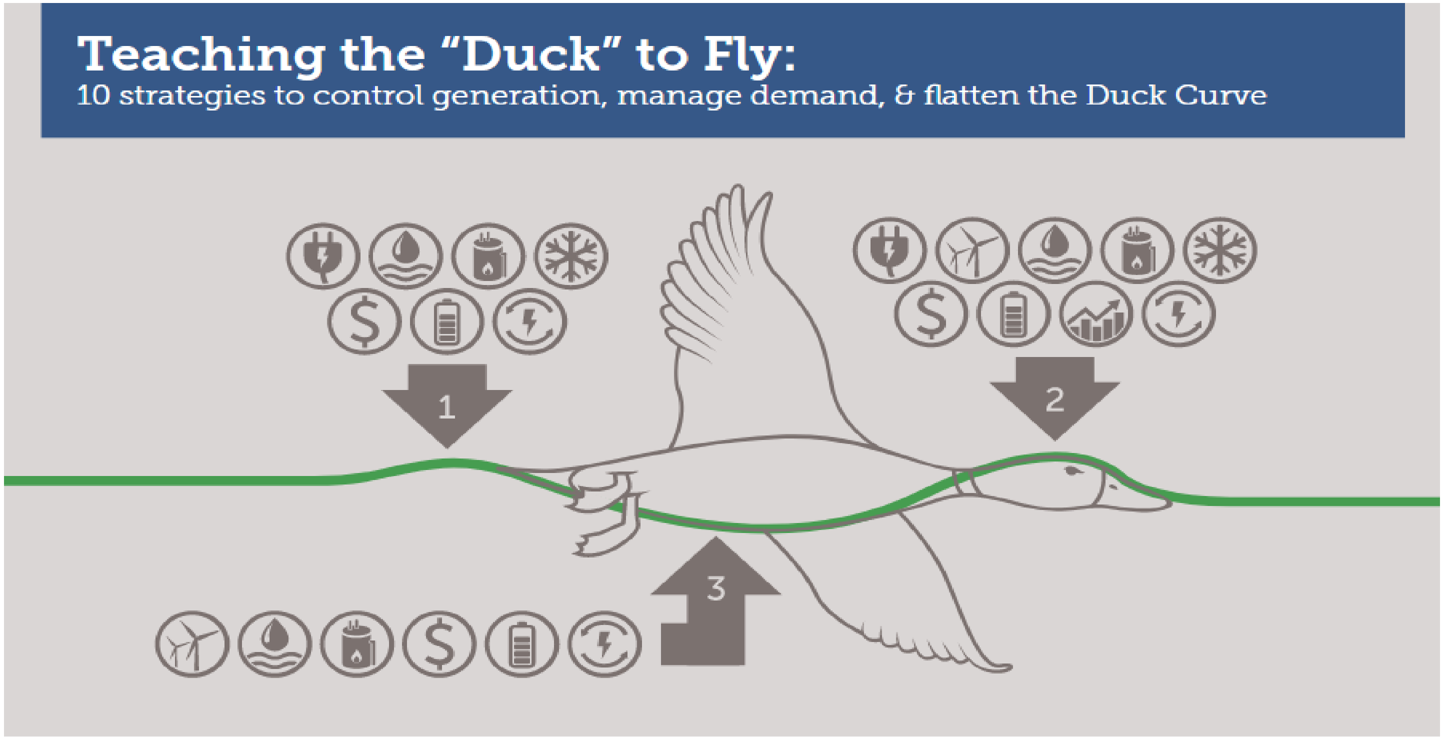


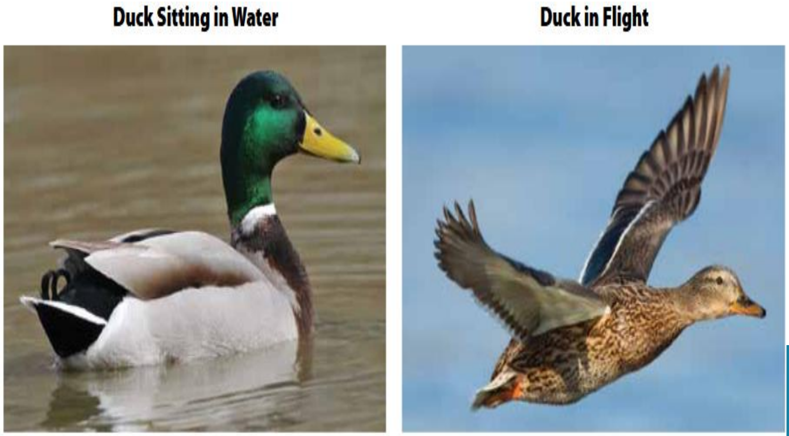
With appropriate flexibility strategies:

Teaching the duck to fly!

Reference: Lazar, 2016, RAP

US implementation – technical issues





Message:
with careful system integration approach and 'allowing' the flexibility to act, solutions are possible!

Ref: Lazar, 2016, RAP

EU's implementation

Issues / challenges / problems in the EU market

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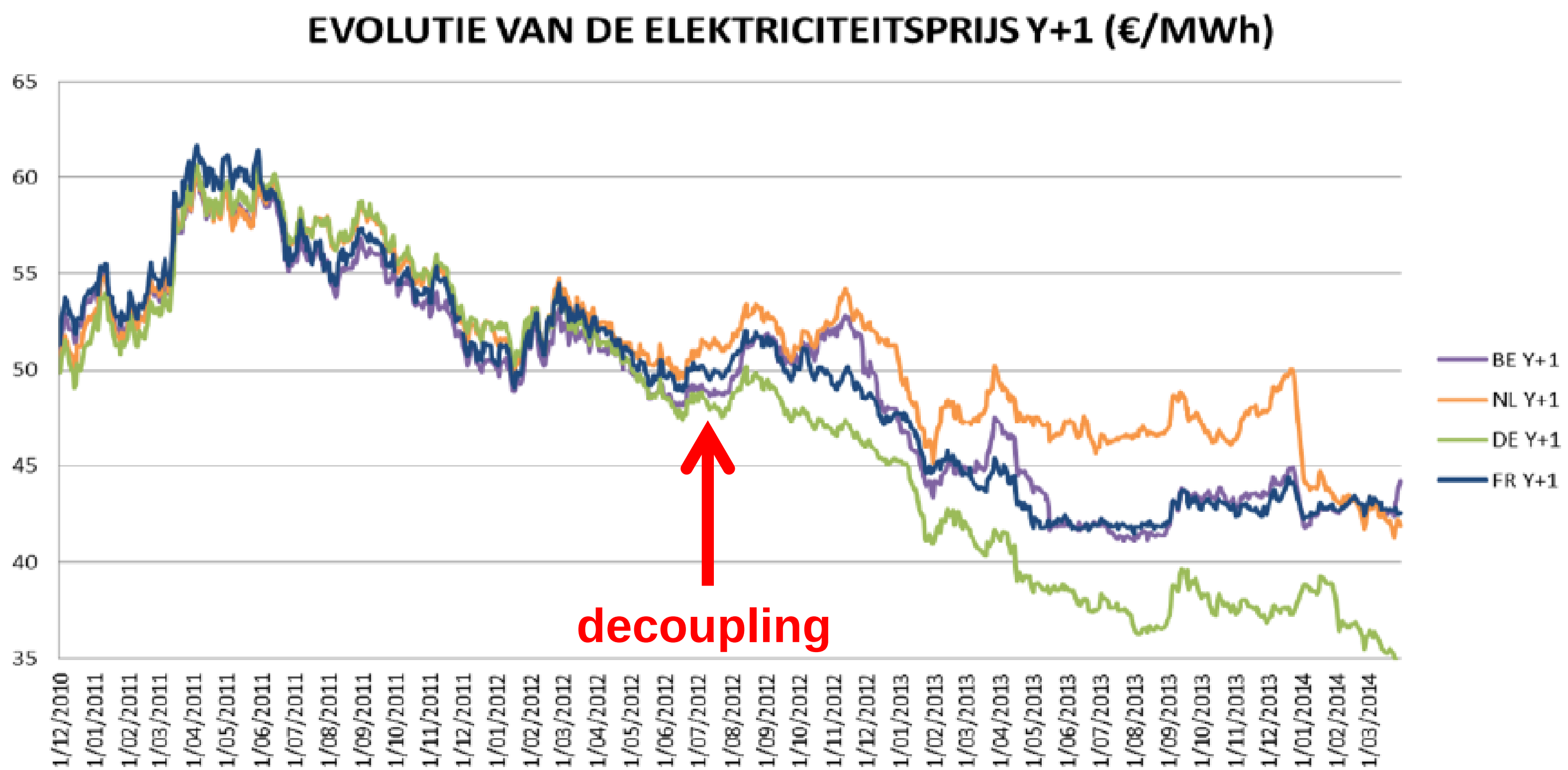
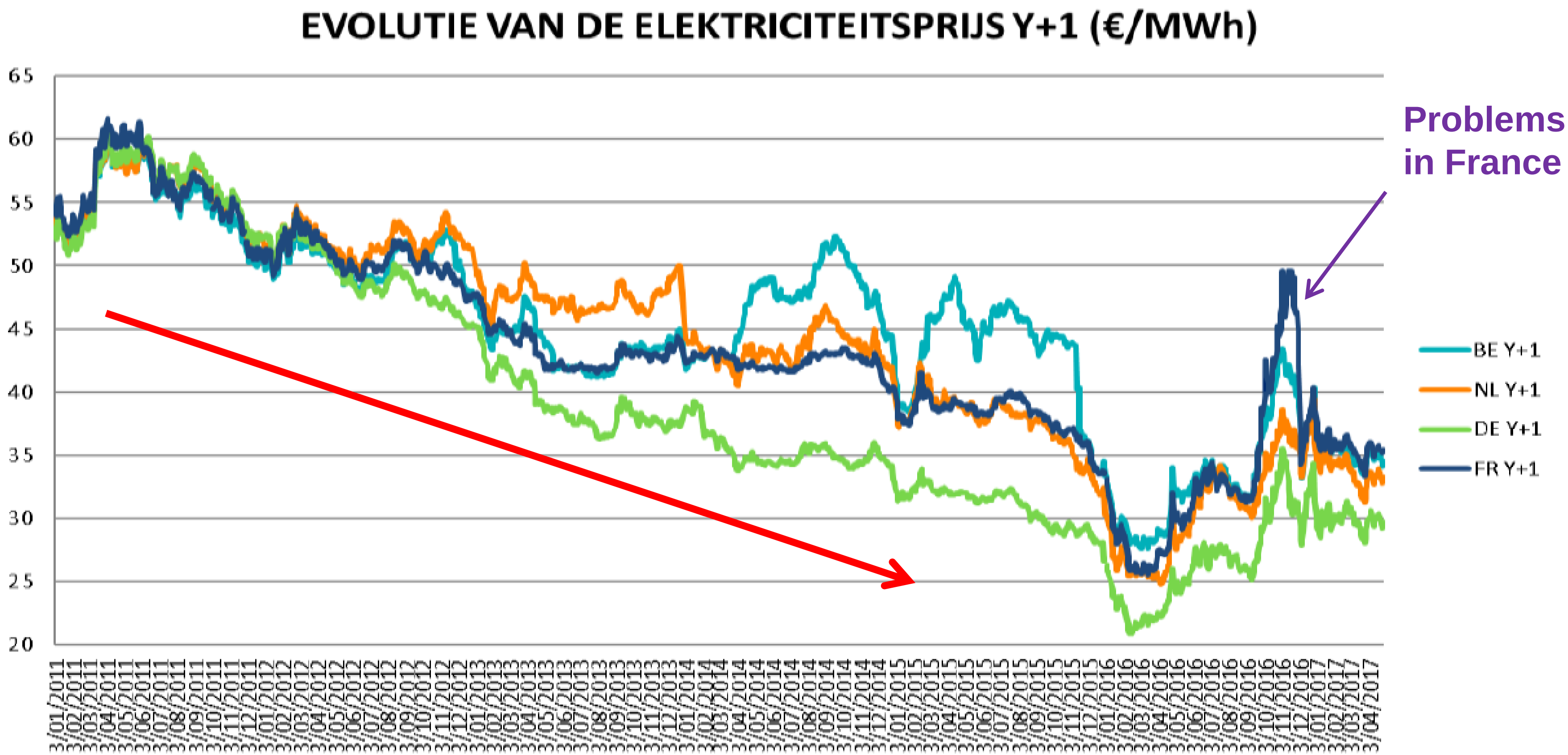
EU's implementation – market issues

But ... Recent developments... !!!



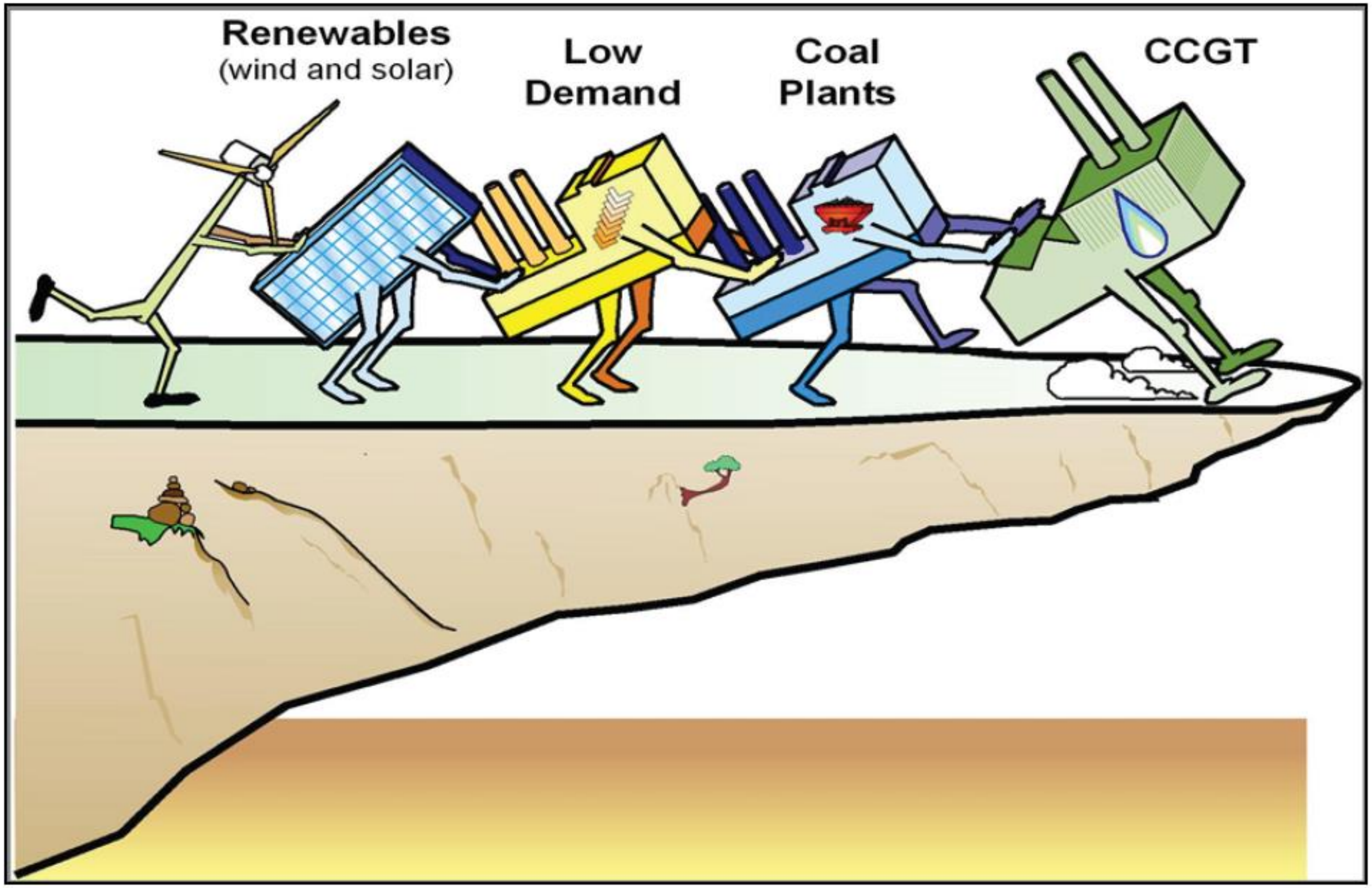
Ref: CREG 2014

EU's implementation – market issues



Ref: CREG May 2017

EU's implementation – market issues



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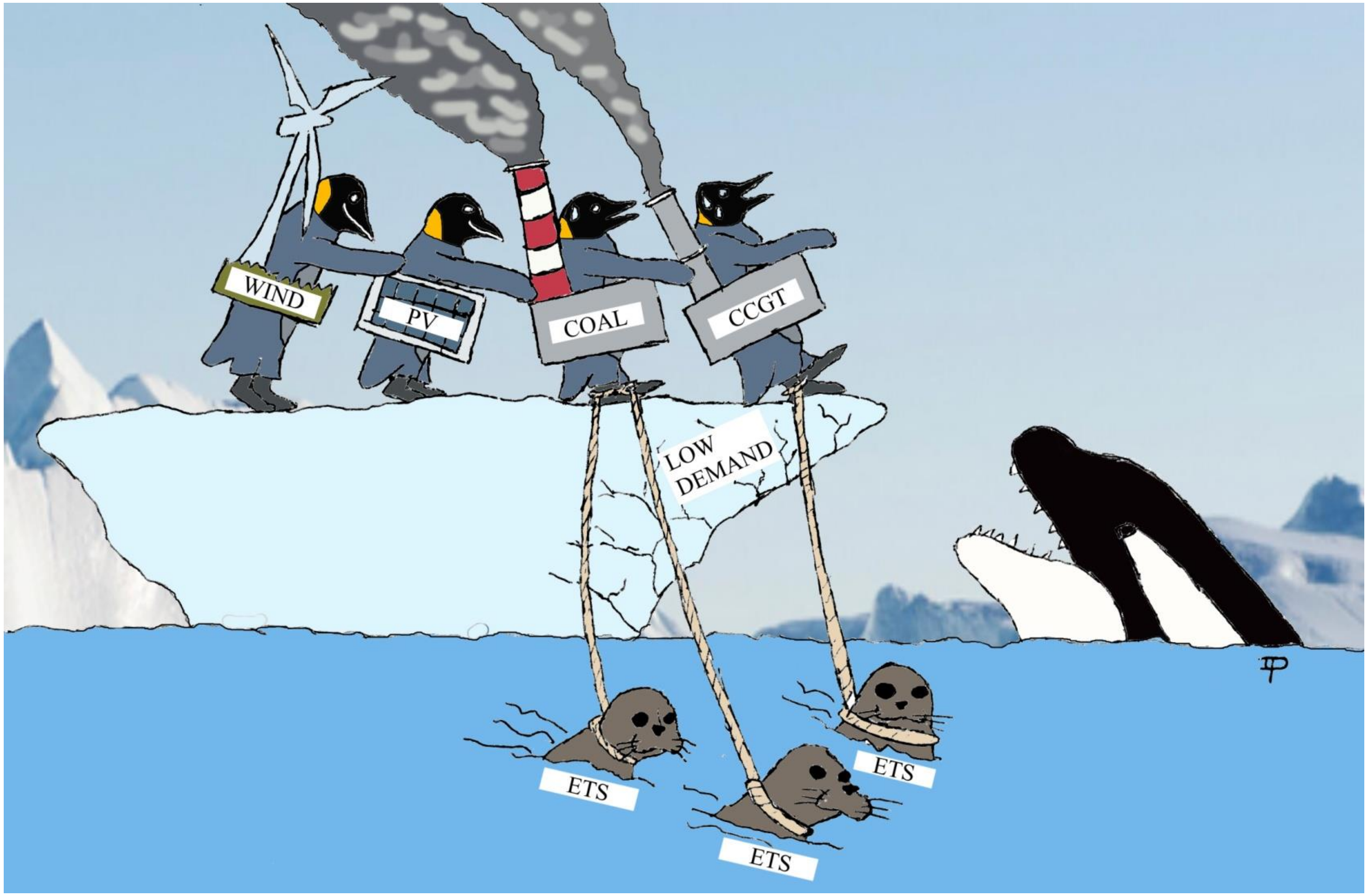
EU's implementation – market issues



Courtesy Dieter Patteeuw KULv

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EU's implementation

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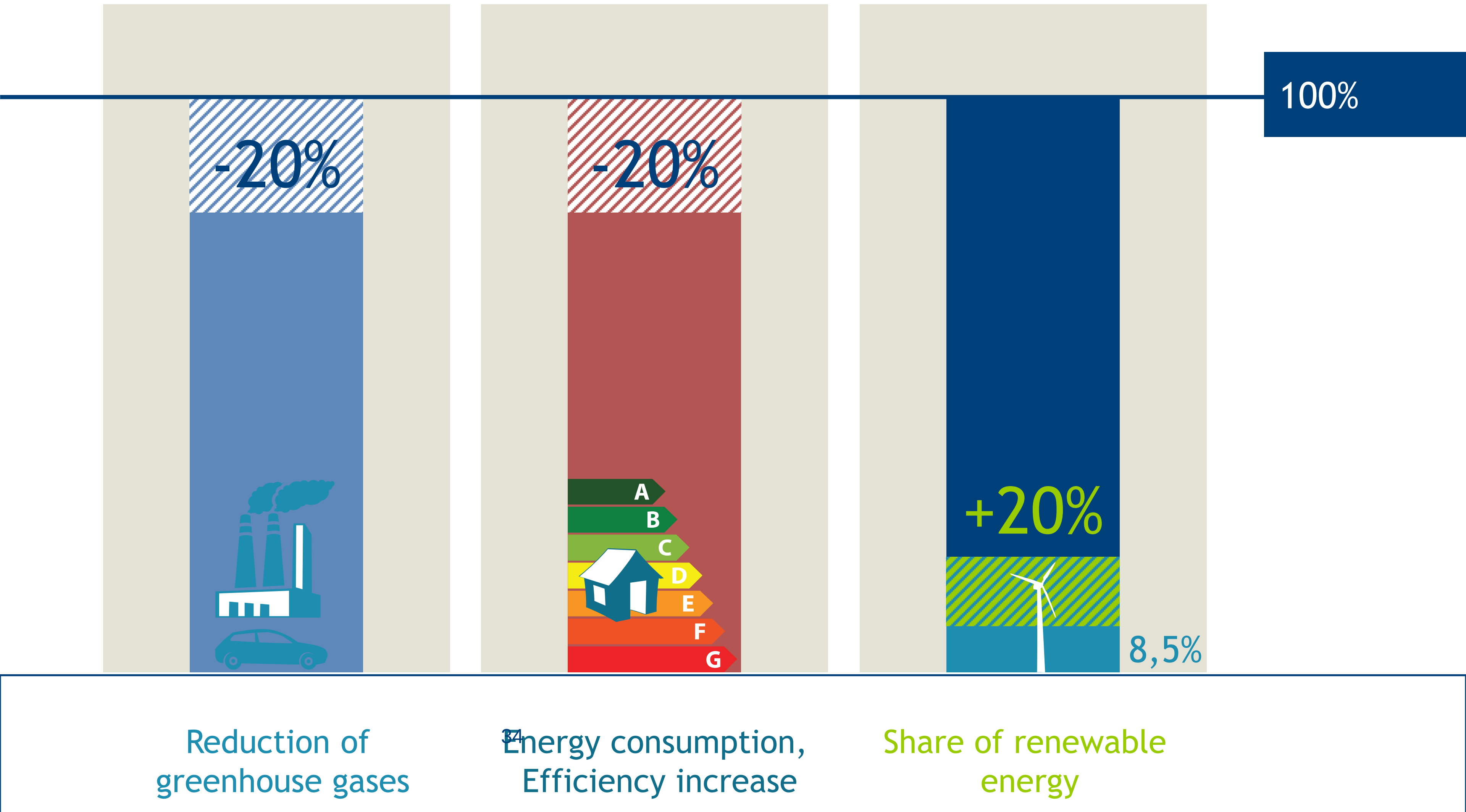
EU energy and climate policy

- EU 20-20-20 targets by 2020



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%

EU energy and climate policy

EU ETS

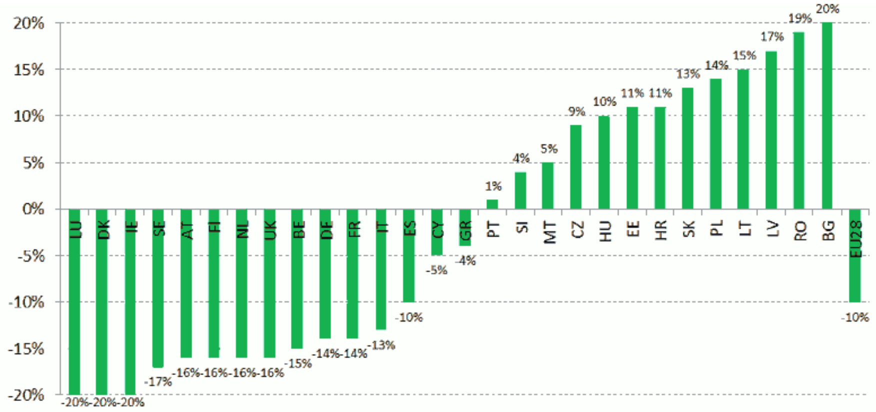
-20% GHG wrt 1990 = -14% GHG wrt 2005

Emission Trading Scheme (ETS)

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

Effort Sharing Decision

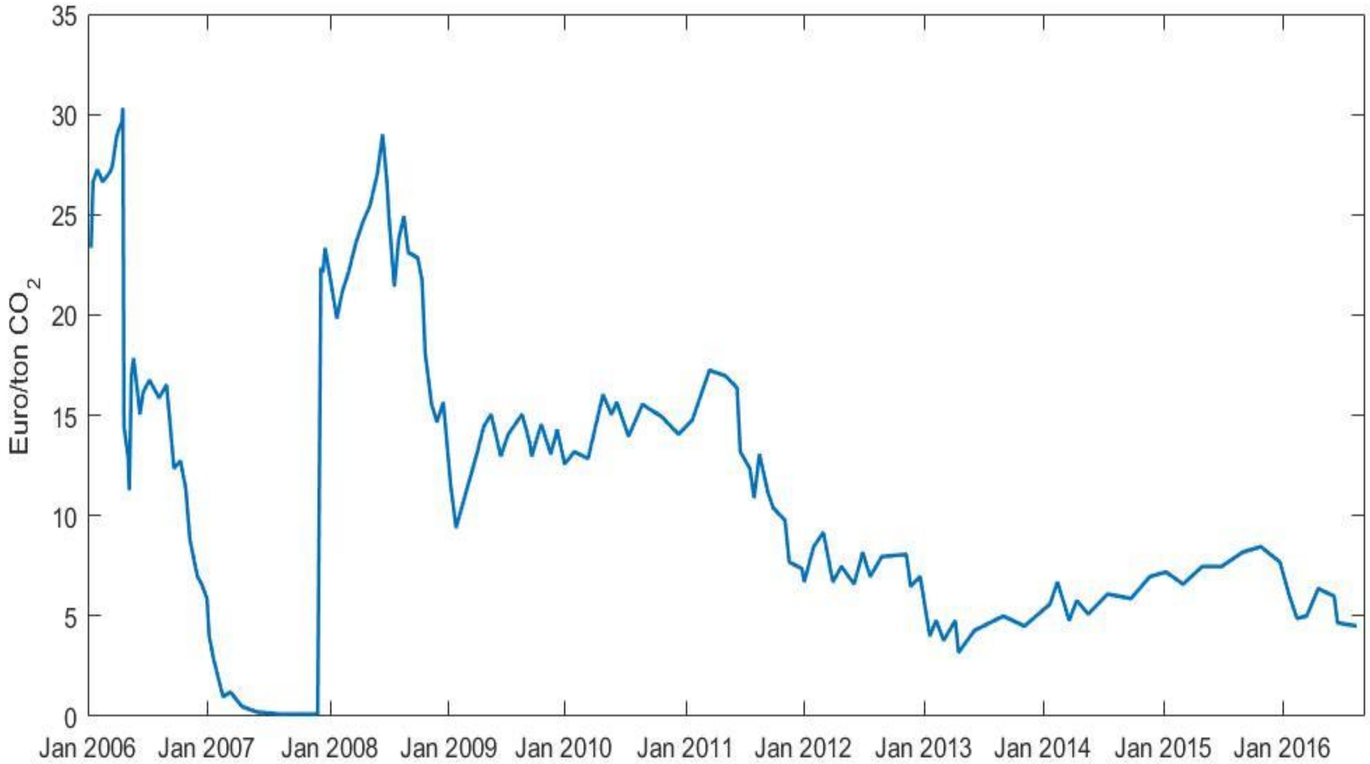
- -10% GHG compared to 2005
- ~55% GHG, ~50% CO_2
- Member State targets for small emitters



EU energy and climate policy

EU ETS

- EU ETS price:



Current price on March 09 2018 = **11 €/ton**

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EU's implementation – Climate change

Consequences for the CO_2 emissions

- Very low prices for CO_2 emission permits ("allowances")
- Due to
  - **economic crisis** (less CO_2 emissions) in 2008-2014
  - **"banking"** of allowances from phase 2
  - massive injection **RES** with priority access → reduces demand for fossil generation → reduces demand for CO_2 allowances → **lower CO_2 prices**

    i.e., highly subsidized RES effectively ***subsidize cheap coal*** *by keeping the CO_2 penalties low !!*

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EU's implementation – Climate change

Interaction between targets

- Provocative observations:
  - All RES injected into electric power system in EU has not avoided one ton of CO_2 in EU!
  - Premature closure of coal plants in DE has no consequence for CO_2 in EU!
  - Same applies to phase out of nuclear plants in DE or BE.
  - Promotion large scale CHP does not make a difference for EU CO_2!
  - ***Because of the cap for ETS*** *!!*

    Less CO_2 here allows more CO_2 elsewhere!
  - Coal units to be closed because of air pollution!

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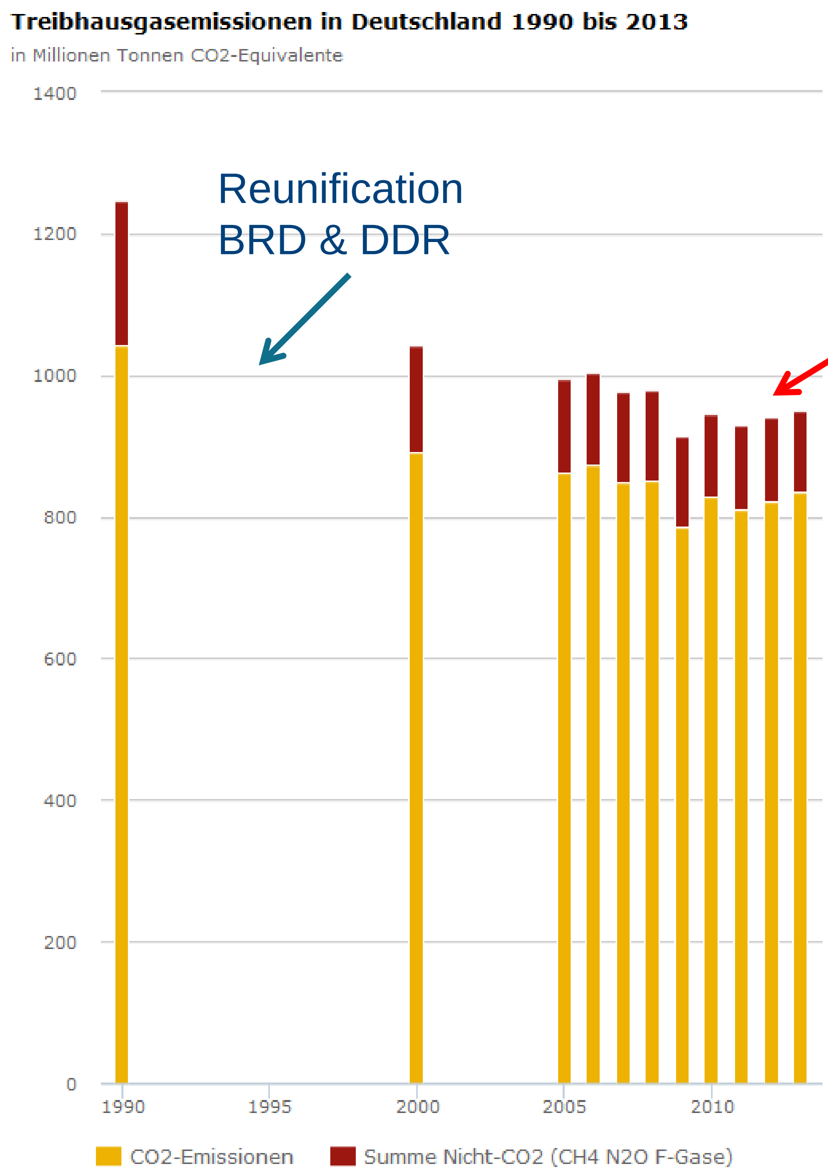
EU’s implementation – Climate change



CO_2 emissions Germany

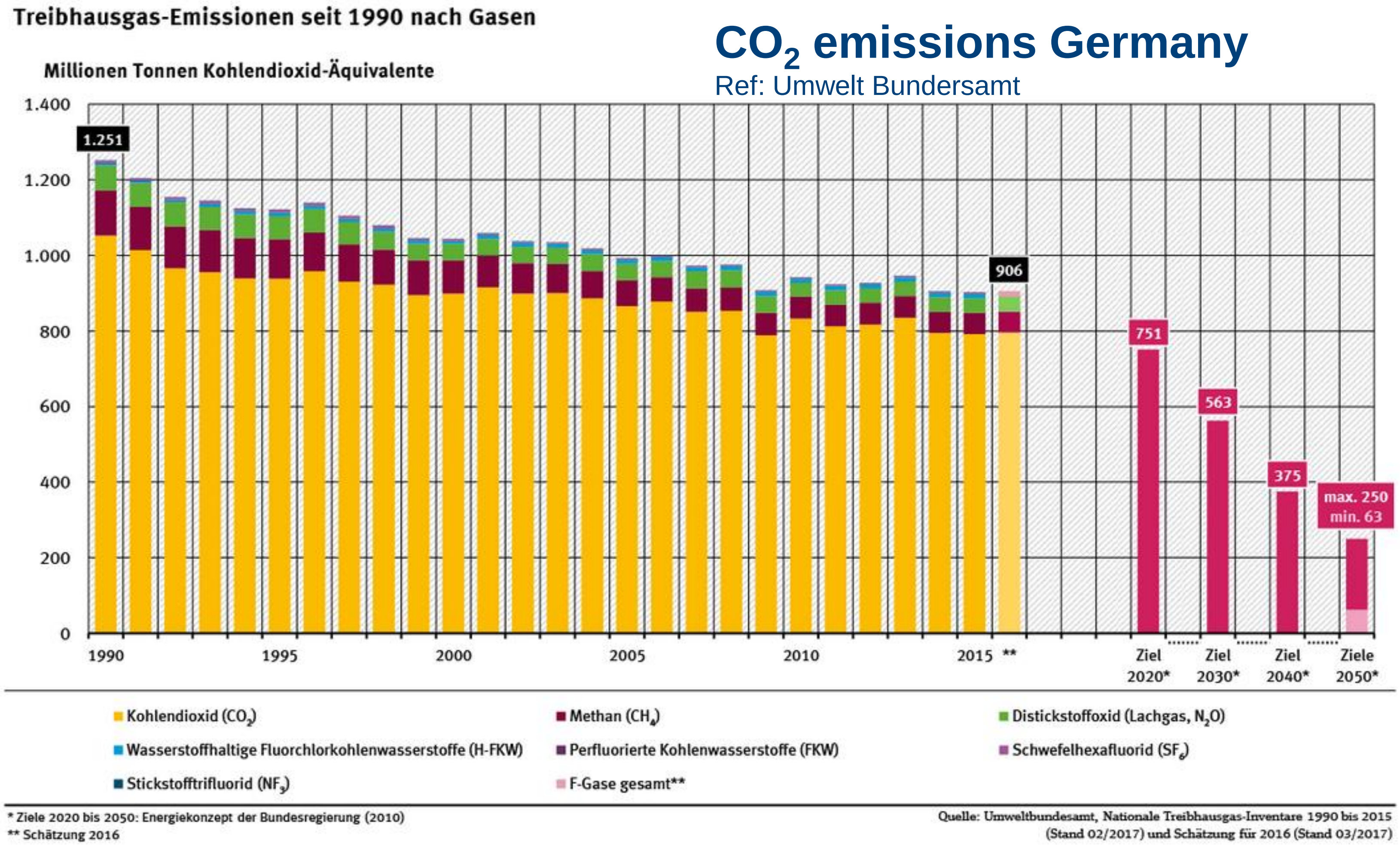
(Ref. Der Speigel Energiewende)

Increase CO_2 emissions in DE !!

EU’s implementation – Climate change

CO_2 emissions Germany

Ref: Umwelt Bundersamt



EU energy and climate policy towards 2030

2020 targets	-20% GHG	20% RES	+20% EE
Status	-23% GHG	14% RES	?
2030 targets	-40% GHG	27% RES	+27% EE
2050 objective	-80% to -95% GHG		

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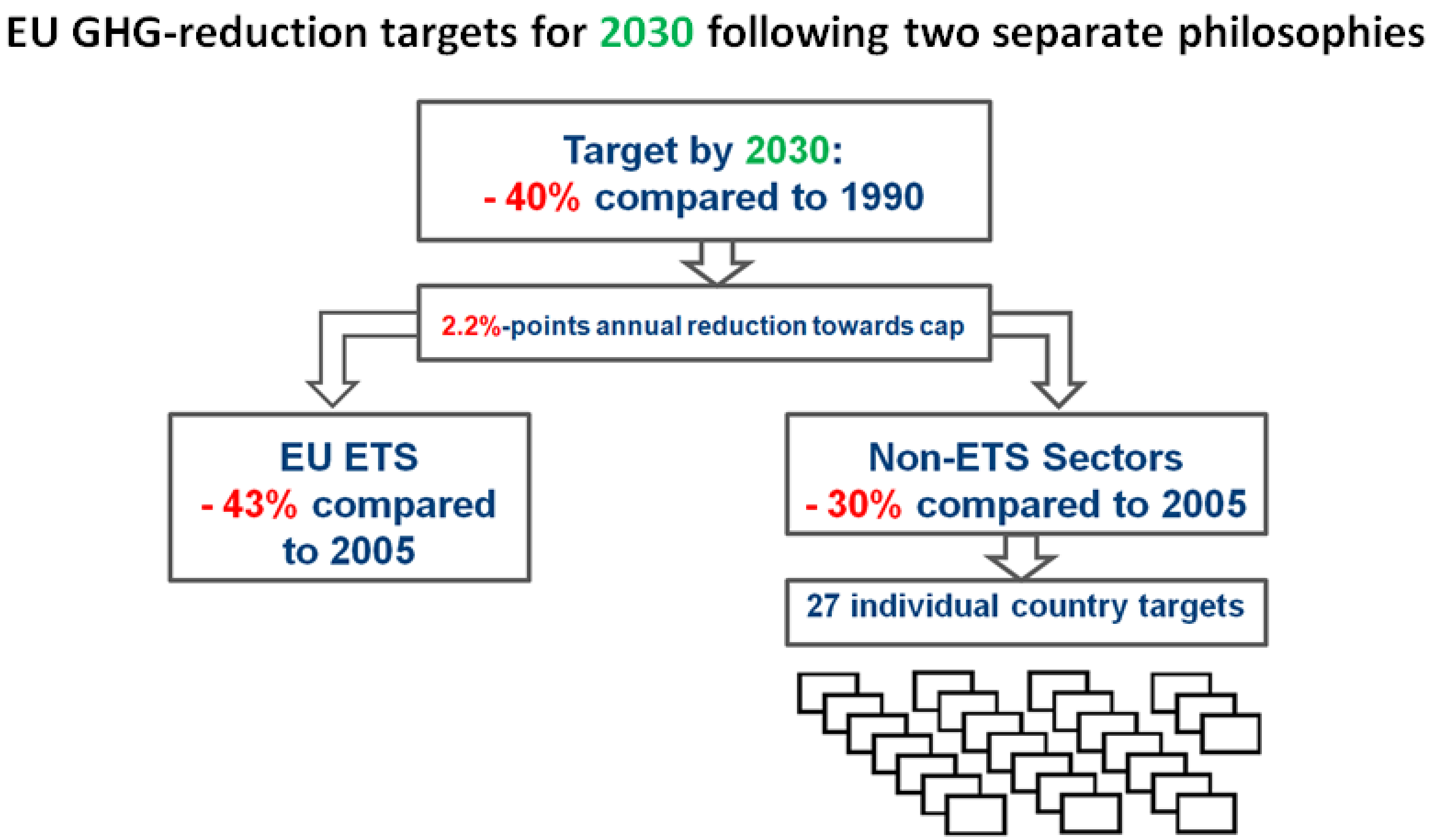
EU energy and climate policy towards 2030



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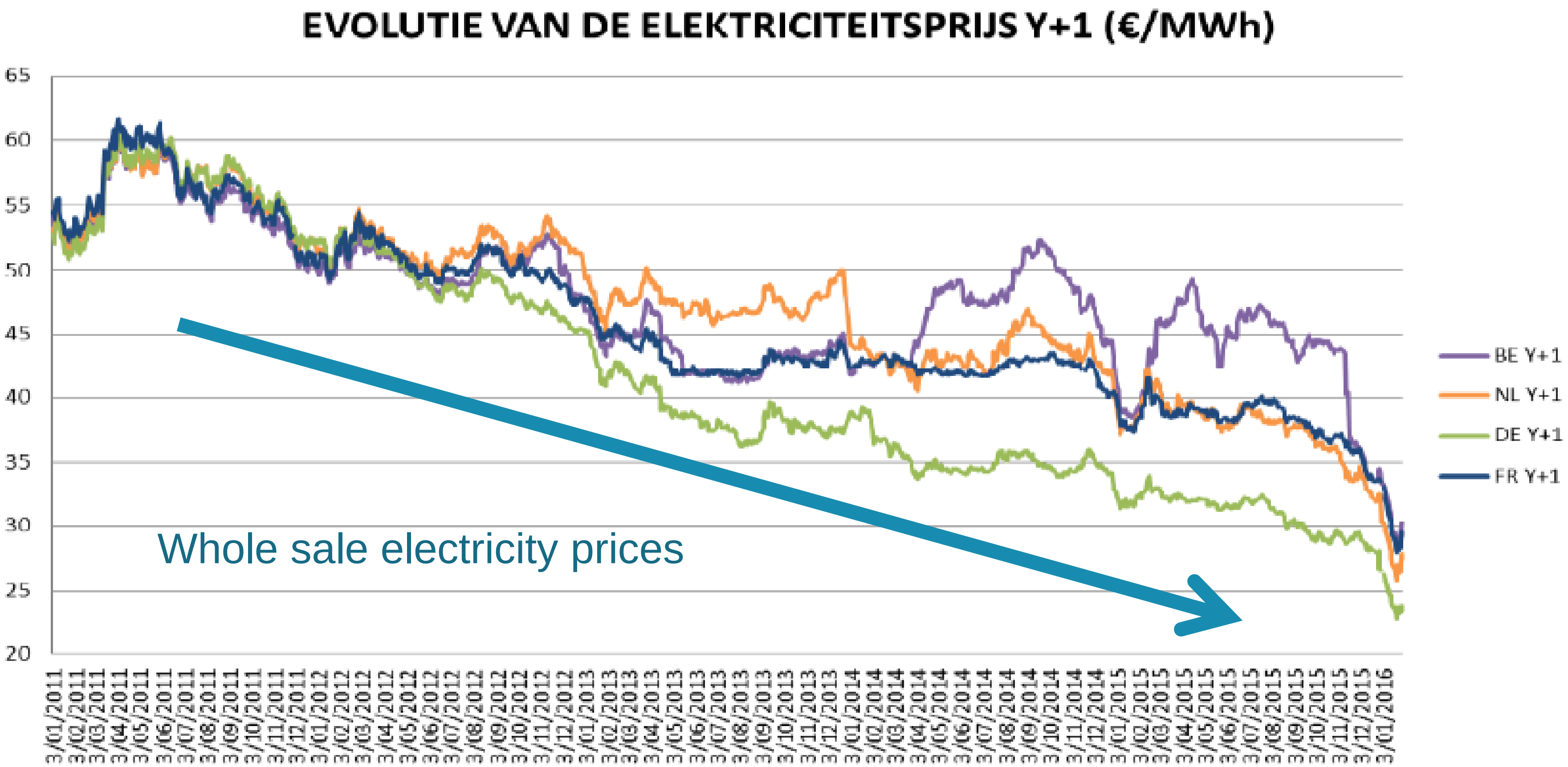
Example dichotomy electricity prices



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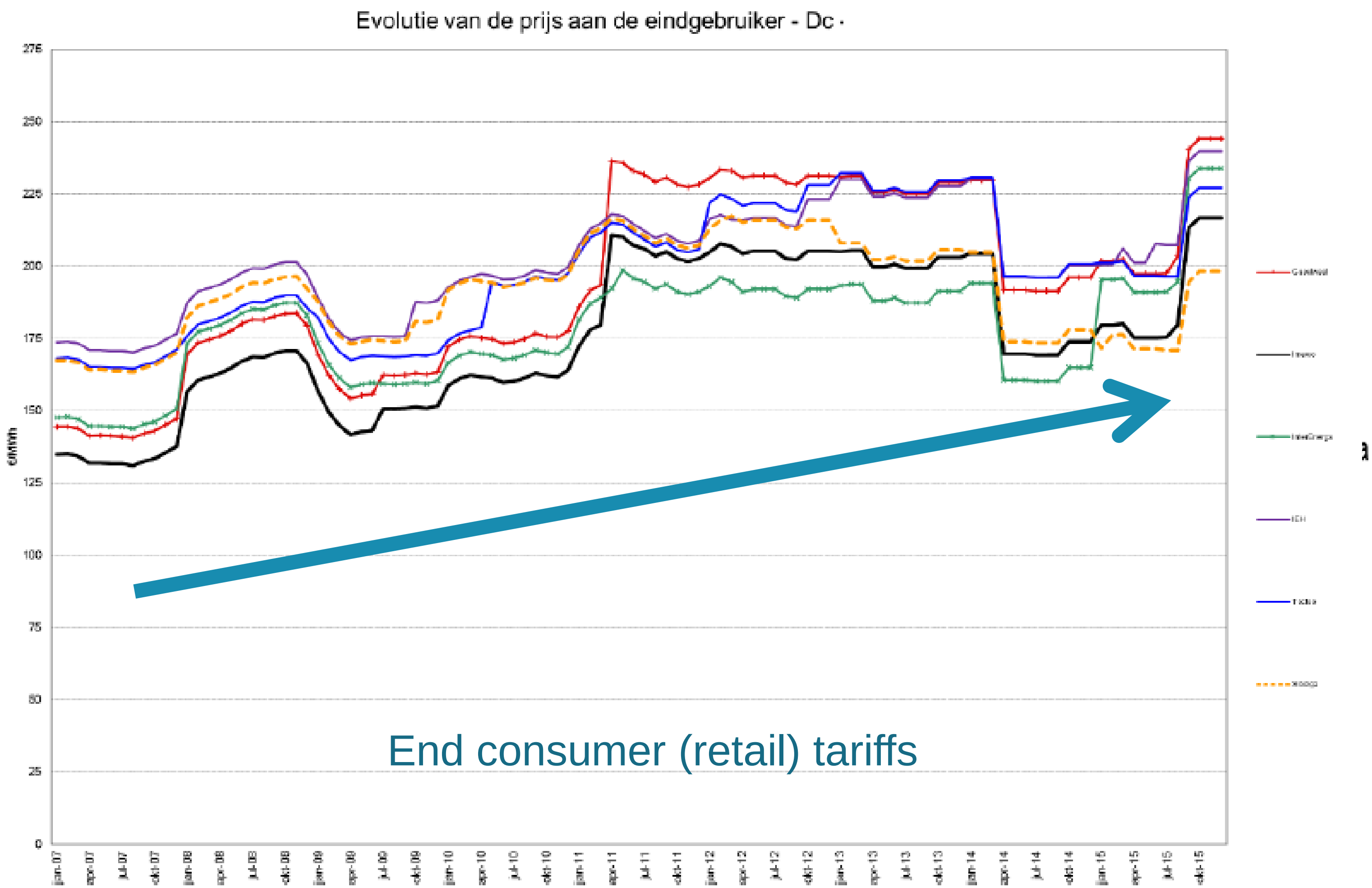
Example dichotomy electricity prices



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Near & Far-Future Challenges

- Commission EU has launched new energy market design proposal (Winter Package Nov 30 2016)
  - Tries to correct flaws in the system (CEU recognized flaws)...
  - Currently treated by EU Parliament and Council...
  - Hopefully final outcome will remain ± consistent ??

- But long-term issues to be studied further!
  - Ample zero marginal cost generation → pricing?
  - More RES piling up at same moment? Superfluous... Storage or ESI (heat, transport, P2fuel)
  - Concern: more self consumption – emergency pricing?

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Conclusions

- EU policy makers picture a rosy situation. But...
- European electricity system is in crisis
  - Many distortions
  - System cost grossly underestimated
  - To be paid for by consumers, tax payers or share holders (pension funds...)
- Energy issue is very complicated because interactions

  → Need more need to study the system effects
- Policy makes must acknowledge system effects:
  - Need stable & simple regulatory environment
  - Give freedom to market players to provide services: ESCOs, Aggregators...
- Far future daunting challenges!

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