CZ-AT Summer School
Vienna, June 2019

Recent developments on EU electricity markets

Jaroslav Knápek

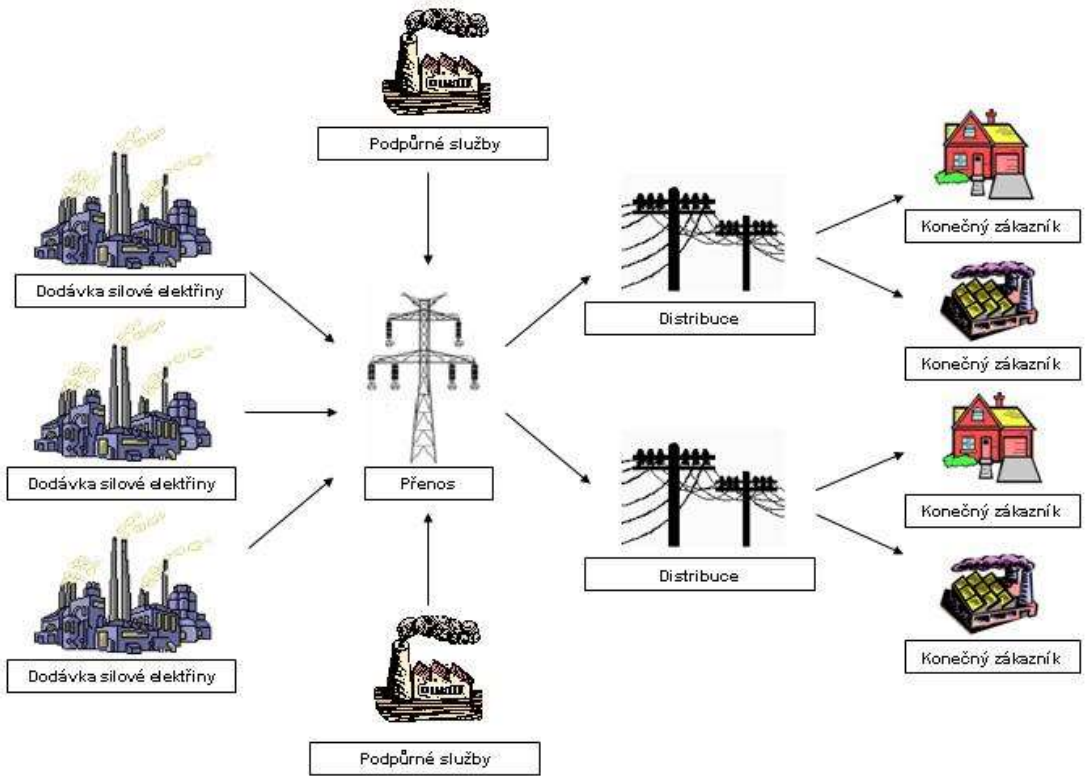
Czech Technical University in Prague,

FEE

Content

1. Electricity as the comodity, time constants, black out
2. Power market, power grid
3. EU energy policy pillars
4. EU energy policy targets to 2030
5. CE market with electricity
6. Energy only market and its distortions
7. Merit order effect
8. Loop flows
9. Possible scenarios of development
10. CZ position

Power grid topology



TS: 400 and 220 kV

DS: 110, 35, 22 kV and 230/400 V

Electricity as the commodity

- balance between supply and demand at any instant
  - NO BALANCE FICTION!
- electricity: active and reactive power
  - necessity to keep the balance
  - to respect distribution profiles
  - to keep voltage (and frequency)
- power flows: according to the physical flows
  - physical flows versus traded flows

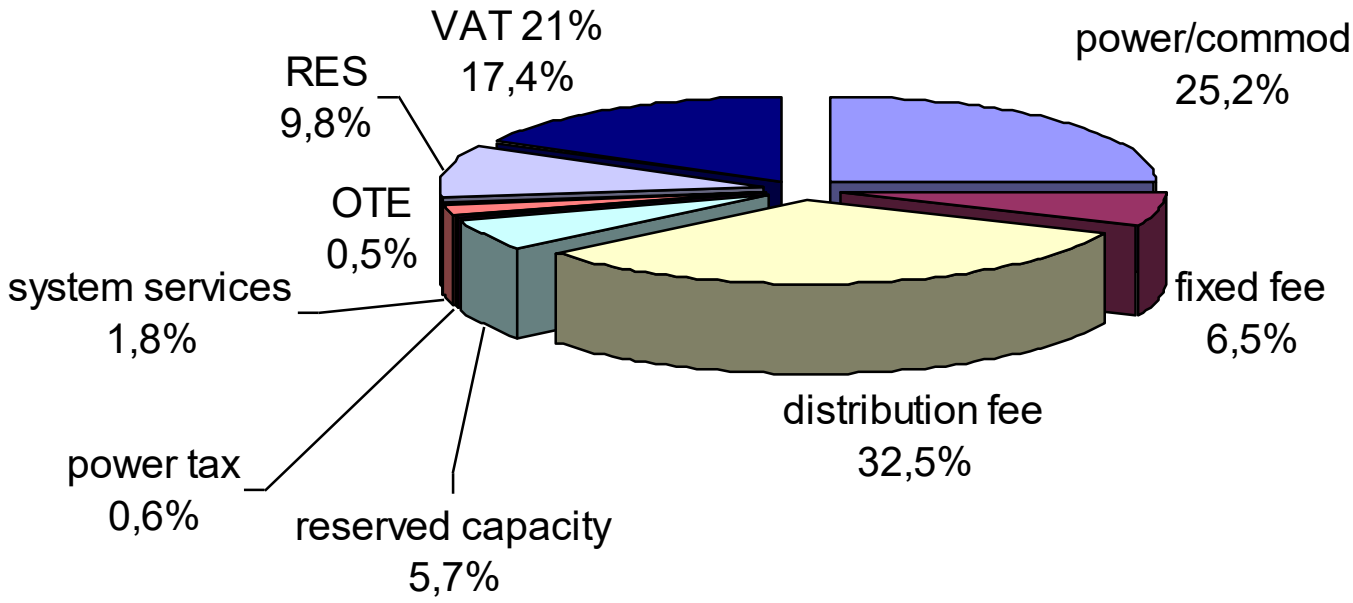
Time constants

- **Seconds**: if demand is not covered with supply
  - BLACK OUT: Restoration of the grid from the blackout need hours (days) blackouts: 11/2006 (Northern Germany, France, Italy, Spain, Belgium) – 12 mil. affected
  - See: https://www.youtube.com/watch?v=A30DdnsICuw
- **One or two decades**:
  - Preparation and construction of power plants
- **40-60 years:** investment horizon for conventional power plants

Blackouts

- Italy 2003, Sept. 28, 56 mil., night
- Sweden, Denmark 2003, 4 mil., 7 hours
- Turkey 2015: 70 mil., 10 hours
- New York: 1977, 25 hours, 9 mil., Looting and vandalism, 1 bil. USD damages
- CZ analysis: after 72 hours completely collapse

Price of electricity for final consumers

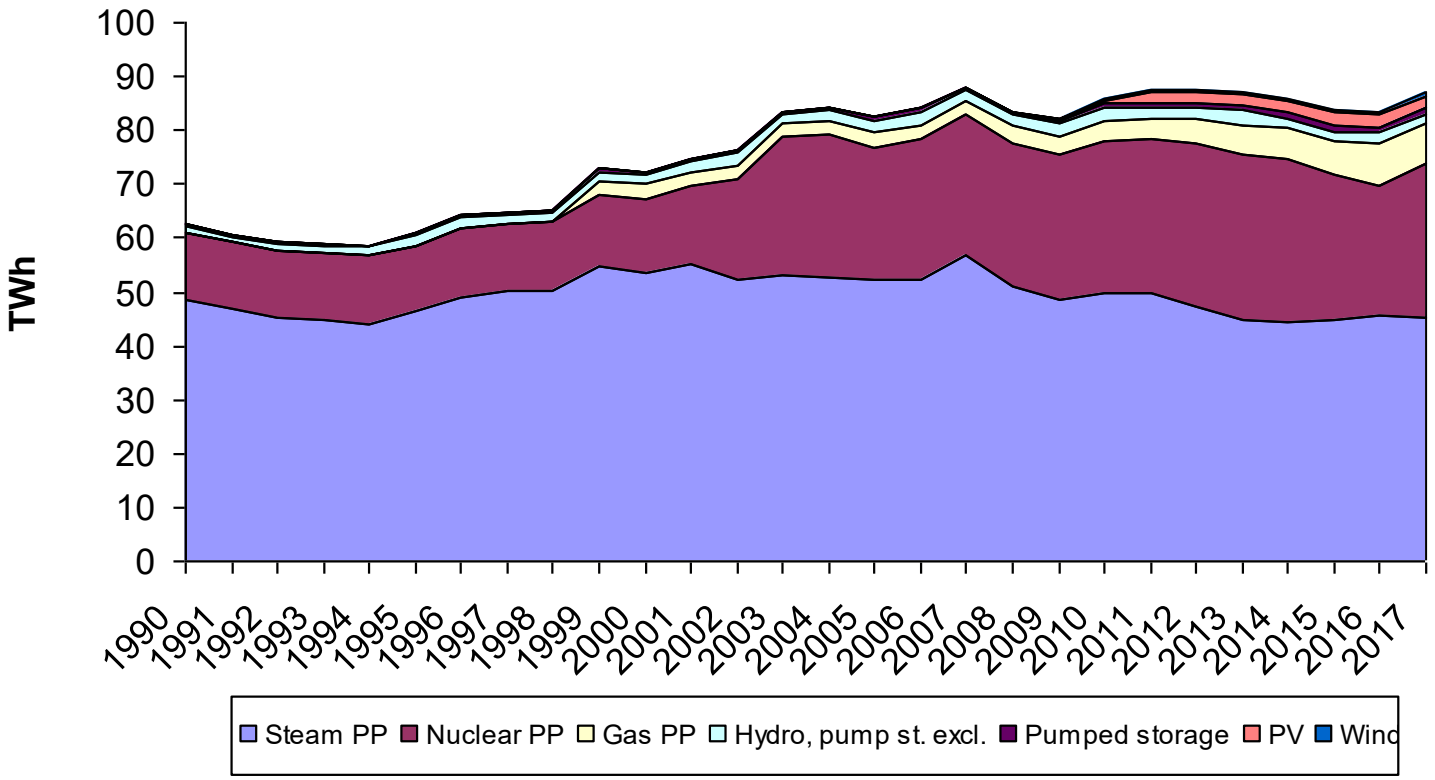


CZ, 2018: tariff D02d, 2,5 MWh/year

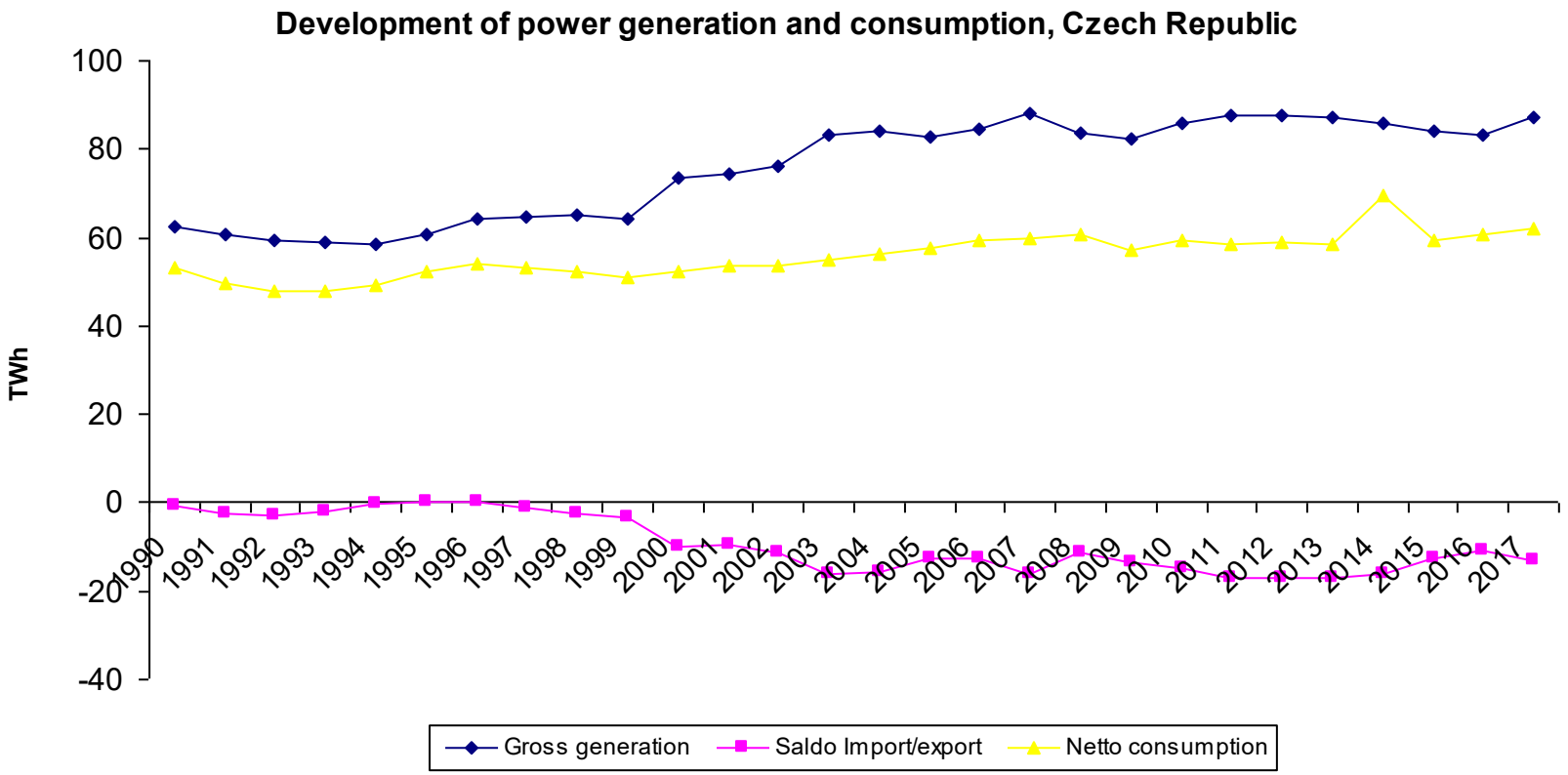
Cost recovery

commodity - MWh	79,4%
distribution - MWh	85,1%

CZ power generation

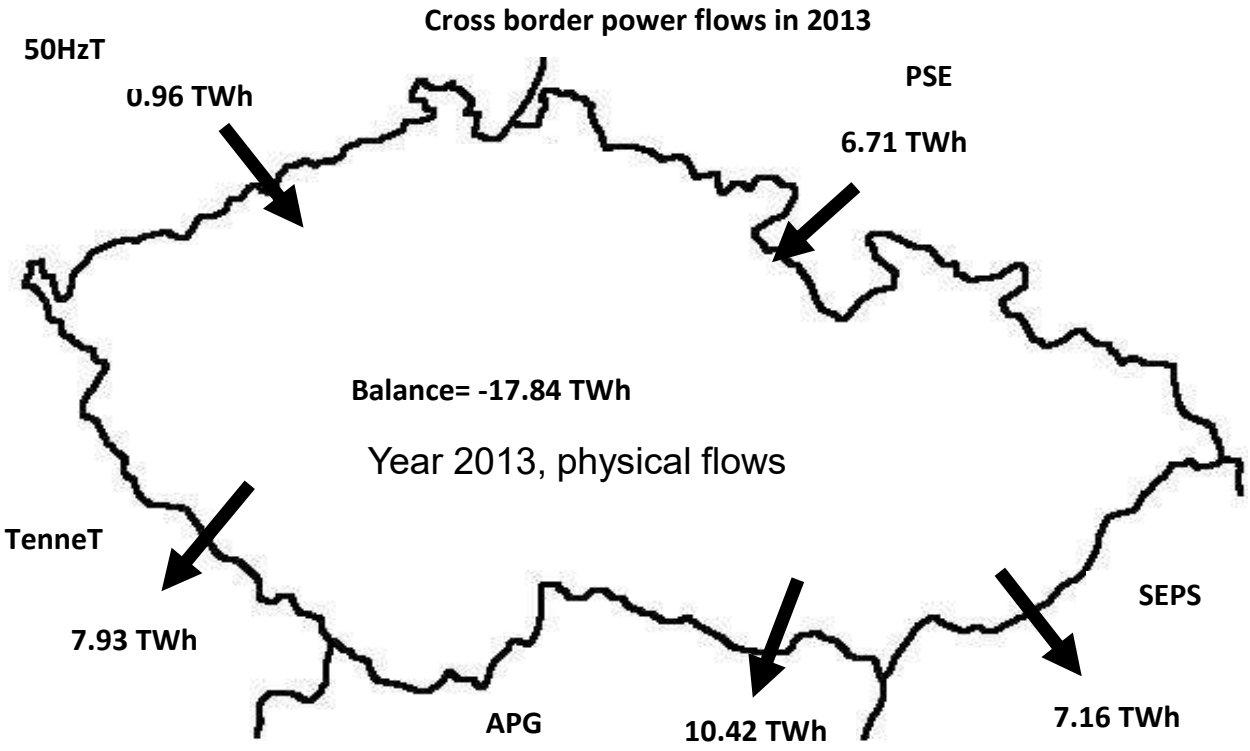


CZ power generation



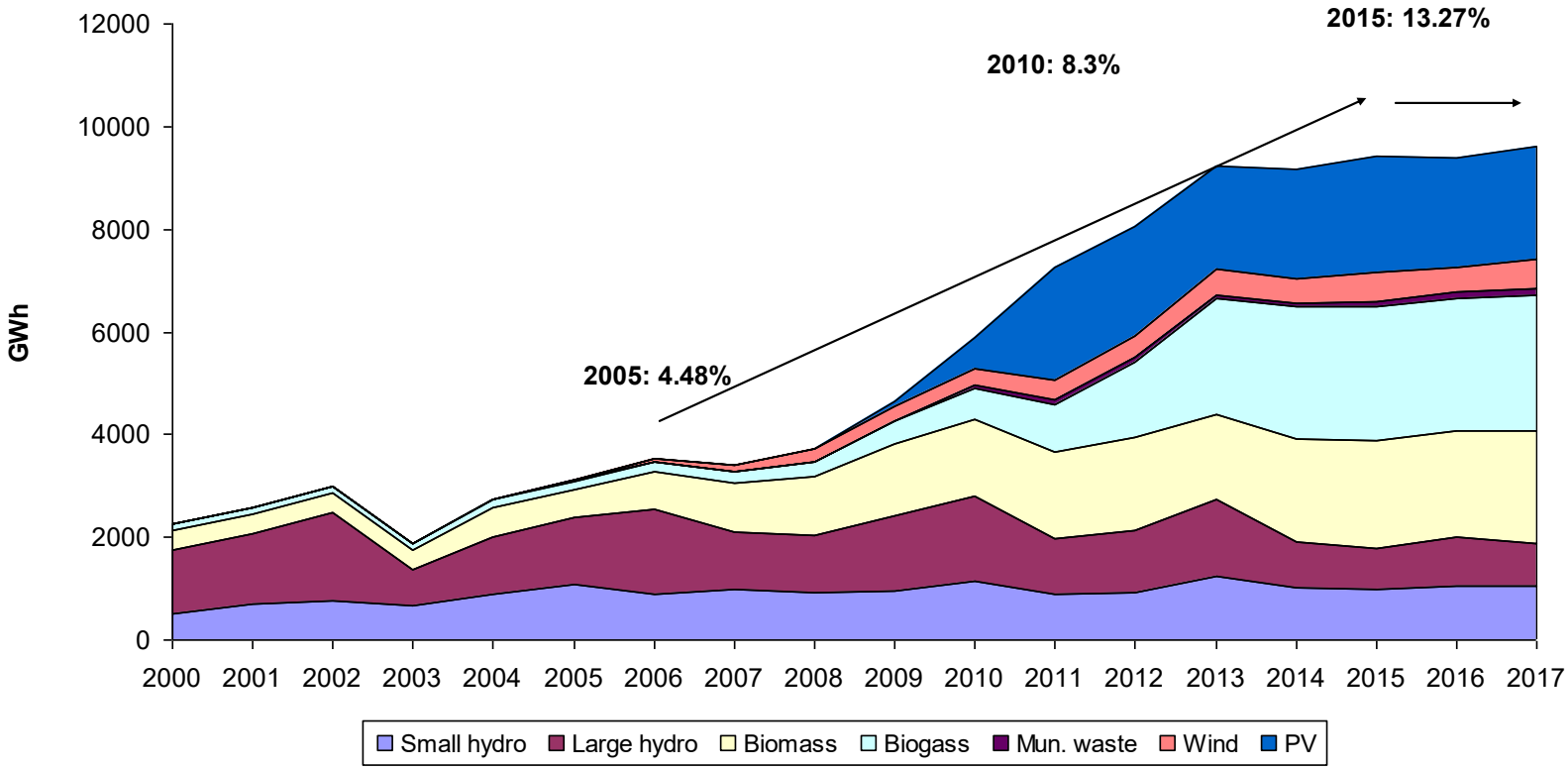
2013: 58,6 TWh, netto consumption

Czech Rep. – significant power exporter 2



Source: CEPS

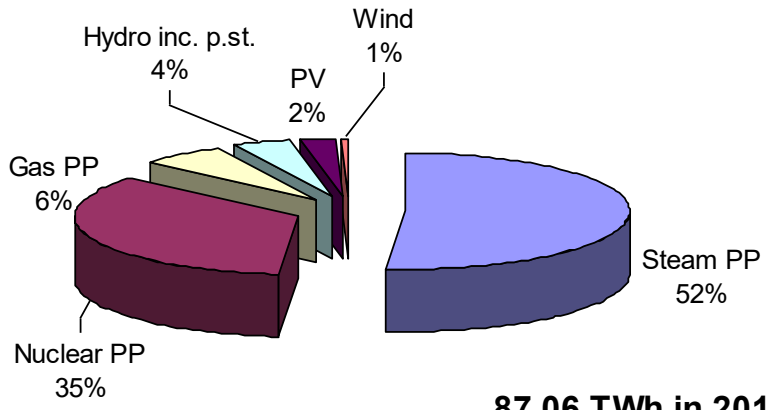
Power from RES



9,2 TWh, 13.17% in 2013

9.6 TWh, 13.03% in 2017

Czech republic – future of power generation



87,06 TWh in 2013

Source: MPO

High share of (brown) coal in power generation

Available coal reserves are being quickly depleted (impact of regional limits – highly sensitive political topic)

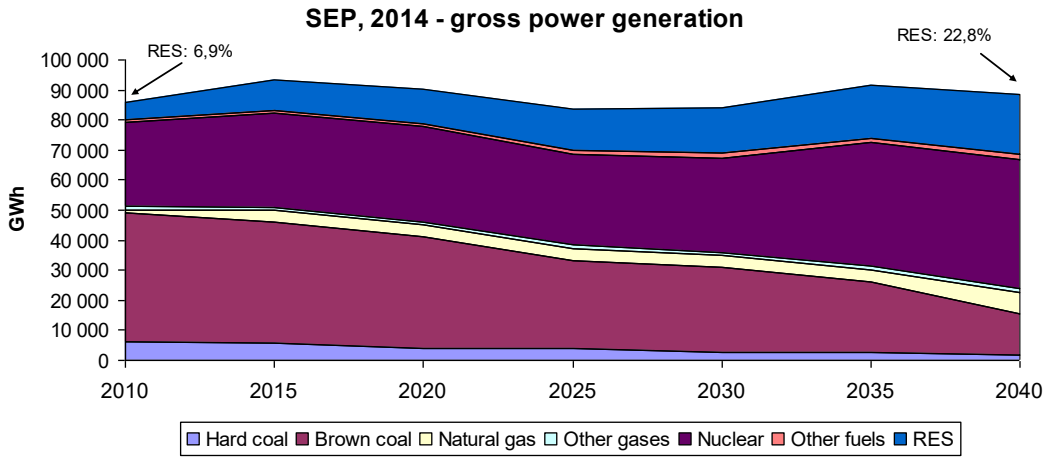
Shut down of part of (old) coal PP

CCGT Pocerady: 840 MW (2014) – example of power market impact to investment decision

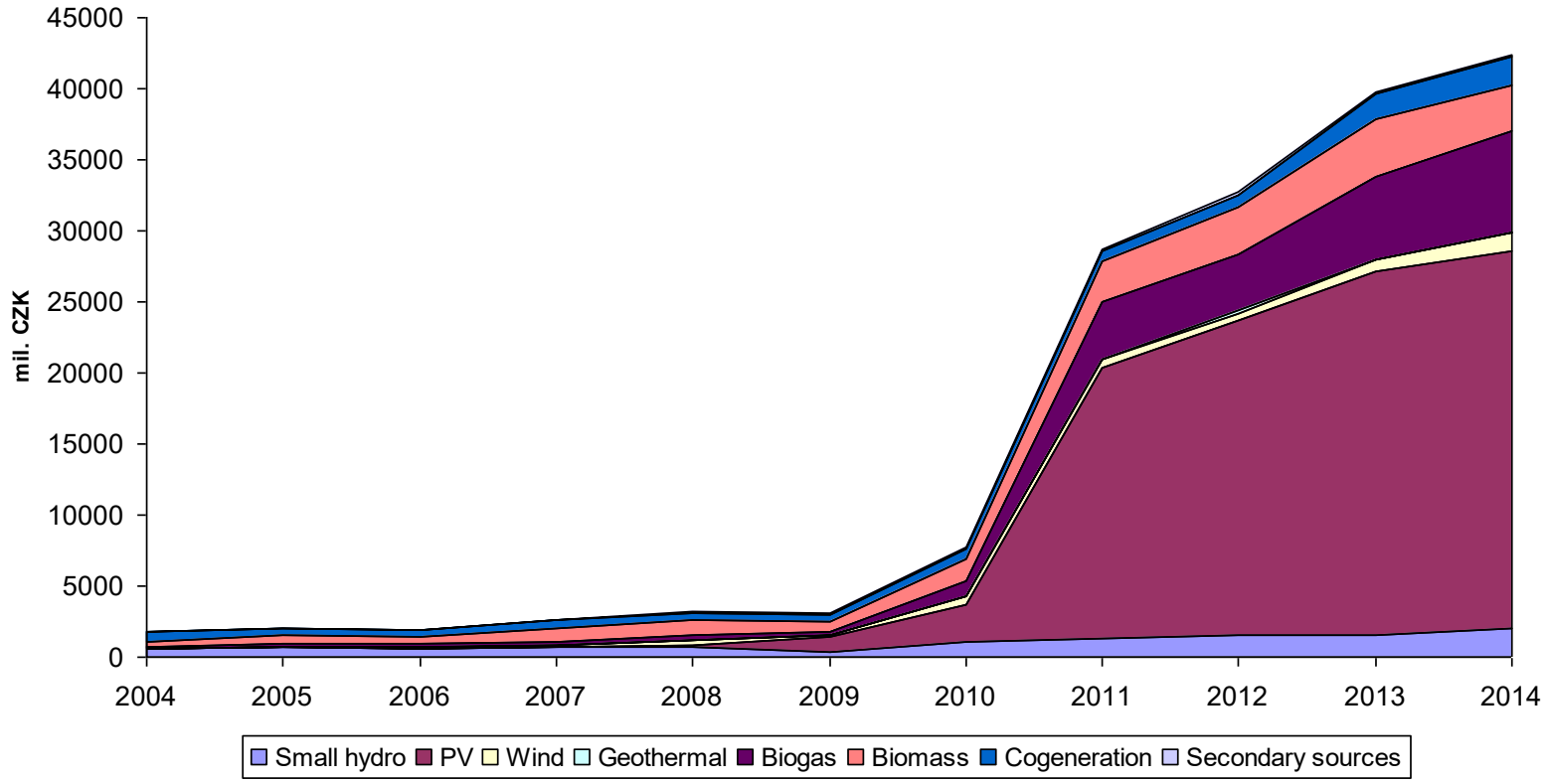
Source: SEP 2014

Czech Energy Policy – 2014 update:

- the power export is no more the goal
- since 2025 – minimum power export



RES support cost



Power market liberalization

- till mid of 90ies: vertically integrated power companies (monopolies)
- basis of liberalization of power market were founded by the EU Directive 96/92/EC (only minimum opening and liberalization)
- second energy package", EU Directive 2003/54/EC – legal and functional splitting of power companies (2004-2007 market liberalized for all consumers)
- third liberalization package", 2009, full liberalization, separation of TSO (3 models), energy only market

EU energy policy – pillars, targets and measures

2 pillars of EU energy policy		
	common market	**decarbonization**
targets	-reliability of (power) delivery -effective allocation of capital -EU competitiveness	-20% CO2 reduction in2020 -80-95% CO2 reduction in 2050
measures	-liberalization -increased competition -market coupling (interconnection)	-EU ETS -RES support -Energy efficiency

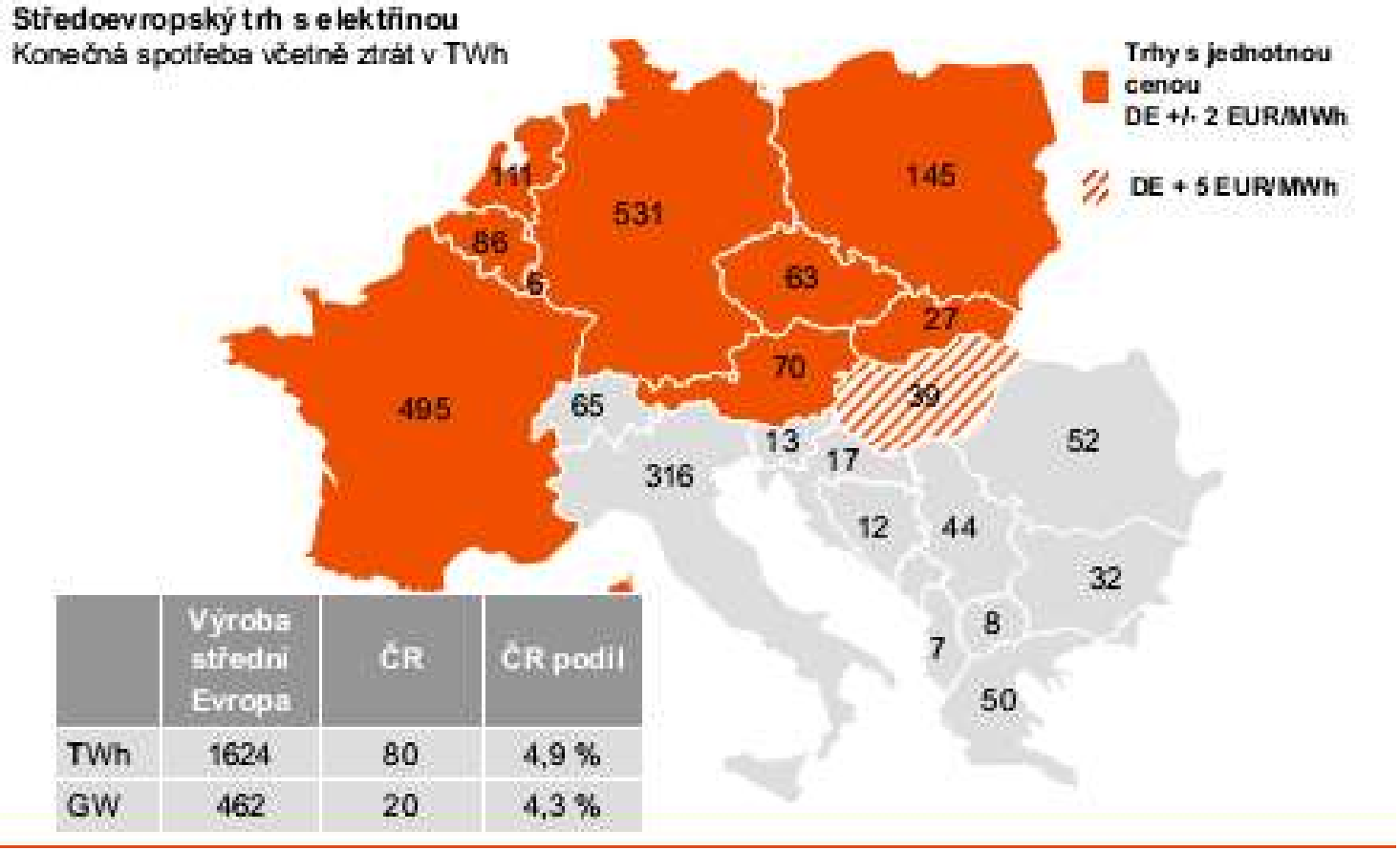
EU energy policy – New targets to 2030

- CO_2 reduction by 40% (annual reduction of emission roof for branches under ETS by 2,2 % after 2020, increase from current 1,74%)
- 27% RES share on final energy consumption (which means up to 47% on power consumption)
- increase of energy efficiency

Inconsistency of measures

Measures for decarbonization		
	compatibility with common market	impact to EU ETS
EU ETS	**-one EU market** **-market forces**	
RES support	*-subsidies* *-each MS has unique support scheme* *-asymmetric impacts on households and industrial branches in MS*	*-negative impact on EU ETS functioning* *-negative impact on market with electricity (merit order effect)* *-gas is becoming uncompetitive with coal*
EED	*-unique scheme in each MS, increase of transaction cost, asymmetric impact*	*-negative impact on EU ETS functioning* *-positive effects in branches with subsidies*

Central European Market with electricity



	Výroba střední Evropa	ČR	ČR podíl
TWh	1624	80	4,9 %
GW	462	20	4,3 %

source: P. Cyrani, Jak skončí krize jednotného trhu, 2014

Energy only market

Energy only electricity markets recovery of costs comes from energy (and operating reserves) and not capacity

Present state

- effective functioning of short term (energy markets) – but from one point of view only
- power branch is living at the expense of the future
- no investment into new generation capacities instead of RES
- no proper investment signals, only political decisions
- there are no common rules on common market with electricity
- real threat of missing installed power in conventional PP in next decade
- great troubles of gas fired PP – operational loss due to low power prices

Example of market distortions consequences

Development of clean spark spread for gas fired PP

(CCGT, 58% efficiency, market prices of NG)

source: P. Cyrani, Jak skončí krize jednotného trhu, 2014

Example of market distortions consequences 2

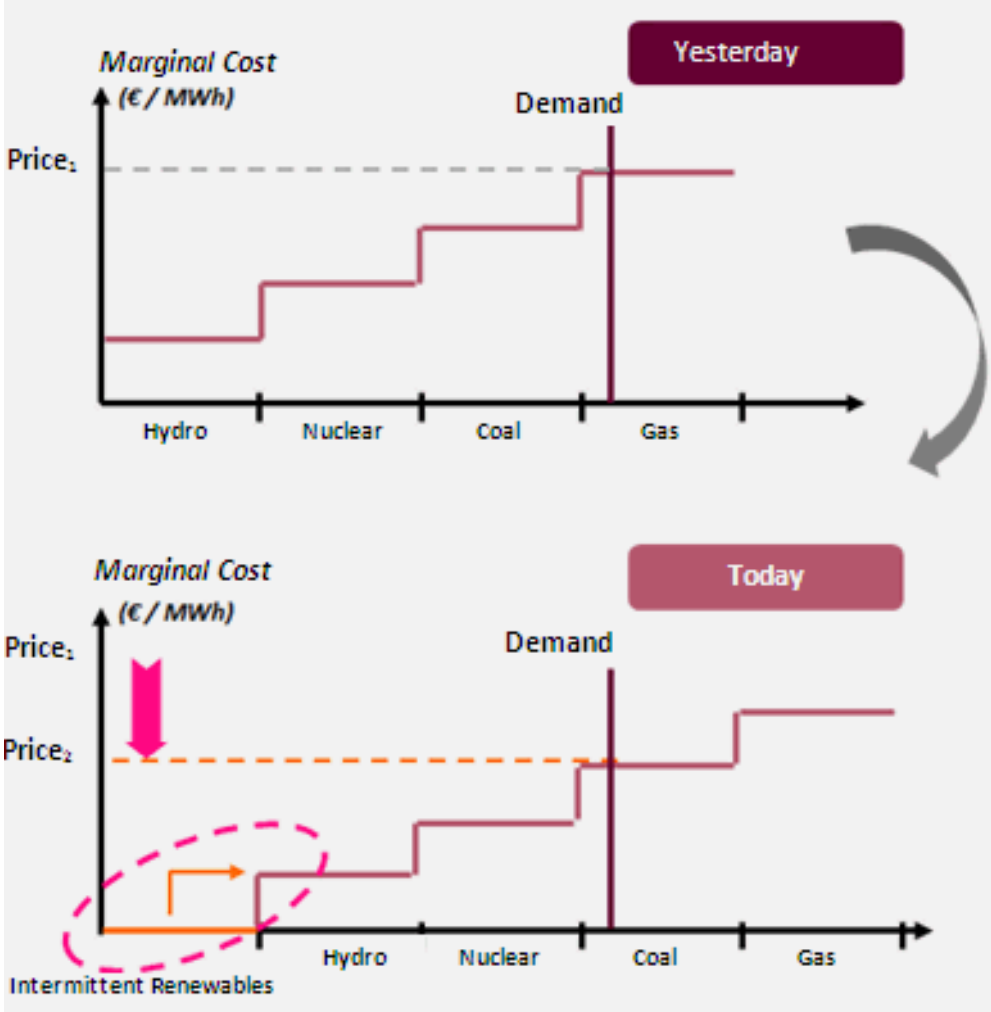
Troubles of gas fired PPs result from:

- quick decrease of power prices
- lower ration between peak/base load prices
- E.g. case of new CCGT power plant Pocerady – 840 MW installed capacity (app. 600 mil EUR investment cost)

Merit order effect

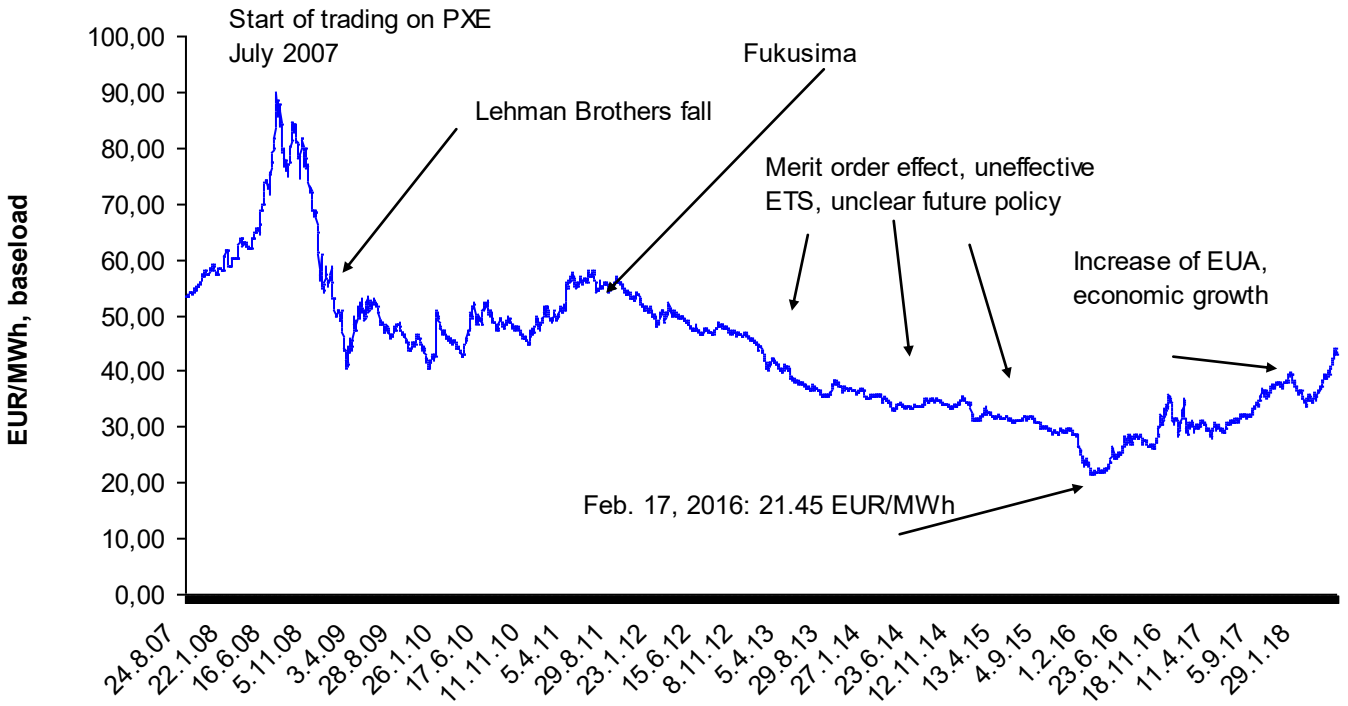
- RES power generation has (thanks to subsidies) short run marginal cost close to zero (wind, PV)
- reduced load factor of conventional PP – problems in recovery of fixed cost

Merit order effect



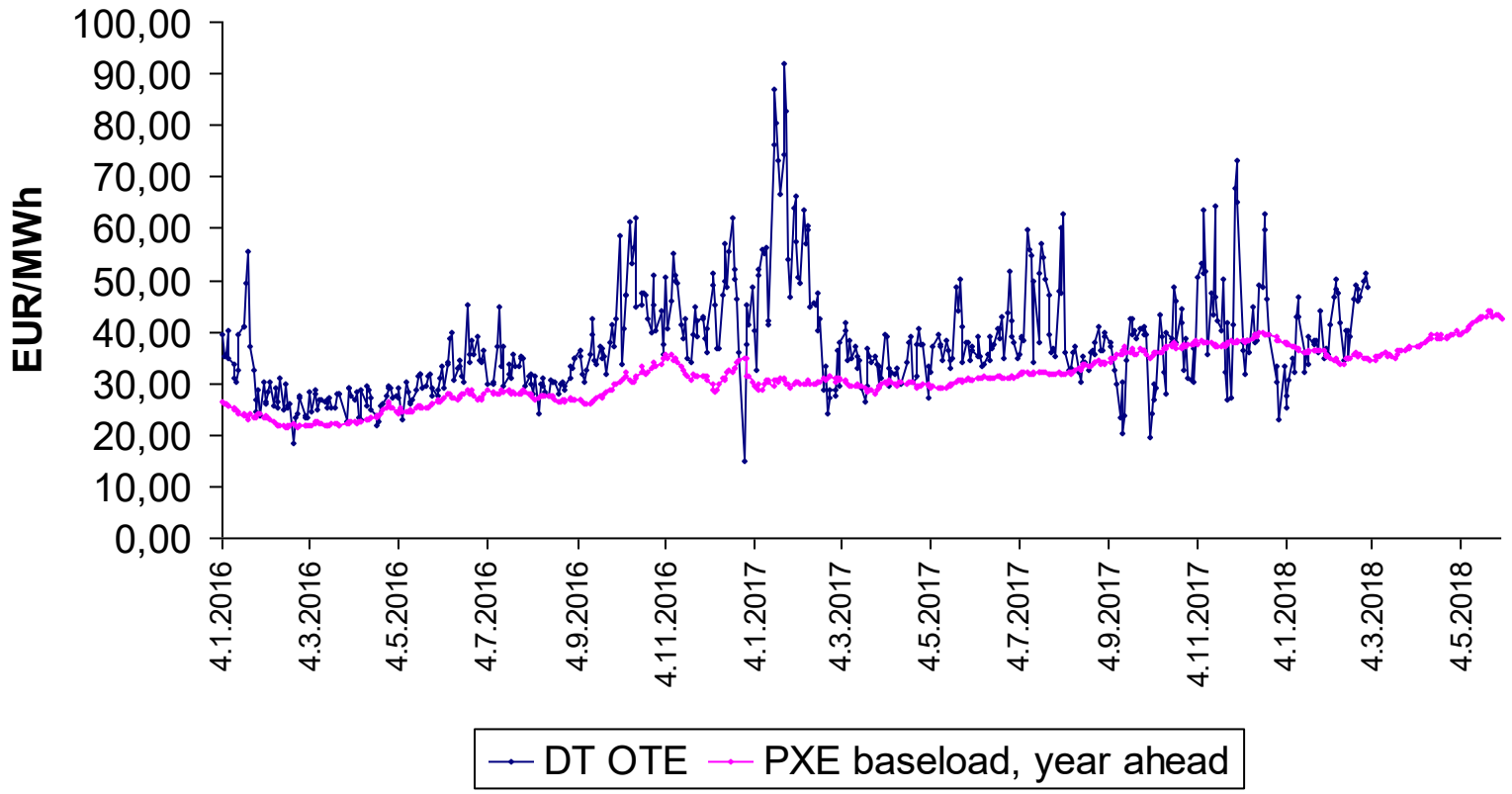
Source: http://energy.sia-partners.com/files/2013/07/Image2.png

Development of electricity price on PXE



Development of electricity price on PXE – Base load, year ahead

Development of electricity price on PXE



Development of electricity price> Short term and long term market

Czech power market - EEX

EEX: Power Exchange Central Europe, a.s.

- start of trading: July 17, 2007
- October 2008: trading with power from Slovakia
- March 2009: trading with power from Hungary
- December 2013: trading with CZ natural gas
- September 2014: Polish and Romanian power included
- November 2014: E-auction of power for final consumers
- Electricity futures - physical delivery or financial settlement including the physical fulfilment

Czech power market – OTE

among other:

- the Czech electricity and gas market operator (estab. 2001)
  - day-ahead electricity market (since 2002)
  - the intra-day and block electricity markets

Day-ahead market - CZ

- 15,11 TWh (2014) – av.price: 33 EUR/MWh, 12,99 TWh (2013)
- intra-day market: 443 GWh
- 105 registered players (producers, wholesalers, big consumers)

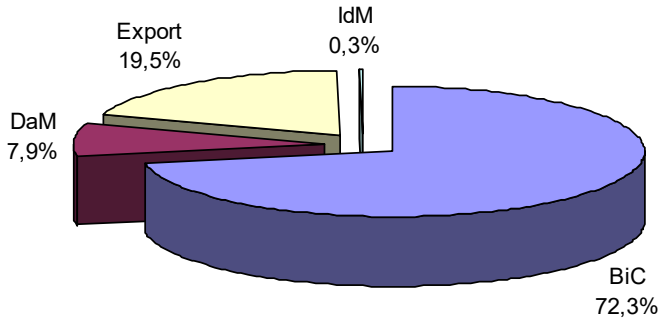
Czech power market – OTE2

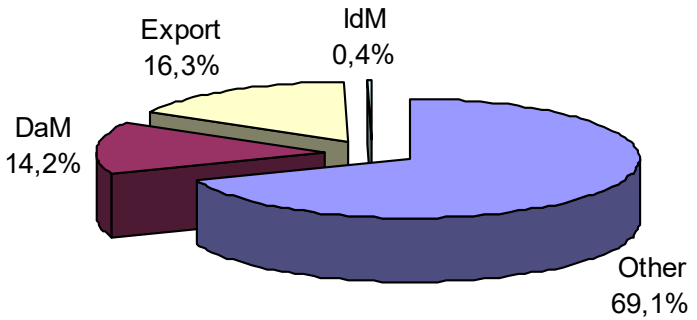
Market coupling:

- Sept. 2009: start of Czech-Slovak Market Coupling
- May 2011: CZ, SK, HUN signed Memor. of Understanding
  - Sept. 2012: start of CZ-SK-HUN coupled market operation
  - July 2011: Memor. of Understanding with ROM and POL
  - Nov. 2014: ROM joined market, POL observing member
  - agreed close cooperation with NEW region

CZ power market – 2013/2017

Source: OTE annual market, 2013,2017





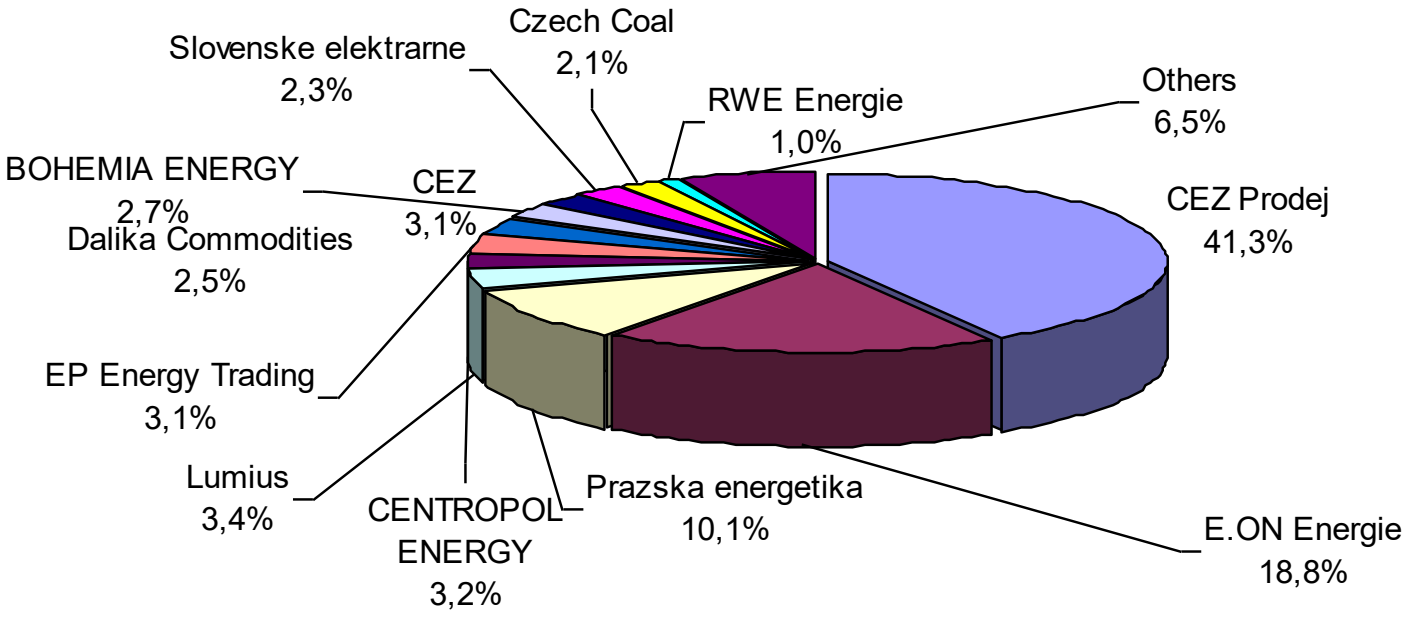
Other: Bilateral intrastate contracts (EEX, direct contracts), bilateral export and import contracts

DaM: spot market

2013: 147 TWh

2017: 144,6 TWh

CZ power market - players



Source: OTE

Shares of specific BRPs in electricity consumption in CR in 2013

Market participants – balance responsible poarties

CZ priorities- EU 2030 goals

CZ position for EU 2030 goals

- one binding target only – CO2 reduction
- RES and targets only indicative
- support of EU ETS reform
- fair cost burden sharing of CO2 reduction out of ETS
- energy security, technological neutrality
- economic competitiveness
- elimination of power (energy) markets distortions

Source: T. Prouza, State secretary for EU affairs, 2014

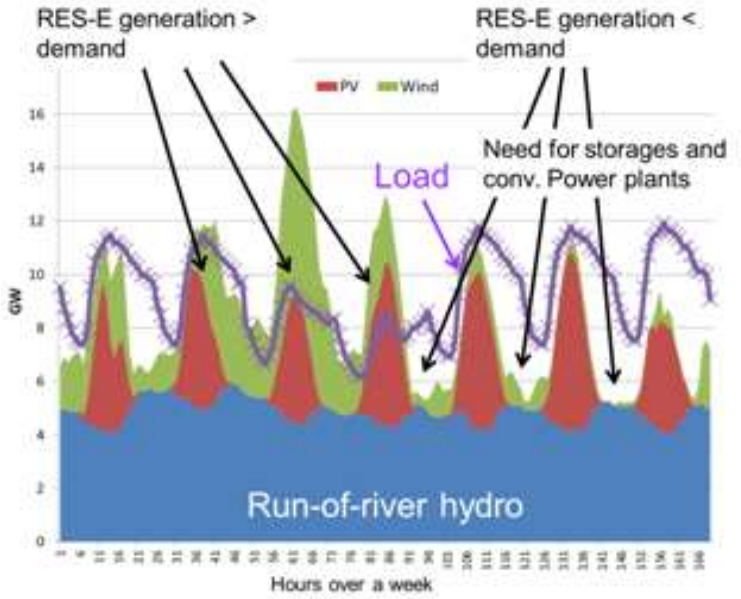
Energy only market

"Energy only electricity markets recovery of costs comes from energy (and operating reserves) and not capacity"

Present state

- effective functioning of short term (energy markets) – but from one point of view only
- power branch is living at the expense of the future
- no investment into new generation capacities instead of RES
- no proper investment signals, only political decisions
- there are no (kept) common rules on common market with electricity
- real threat of missing installed power in conventional PP in next decade
- great troubles of gas fired PP – operational loss due to low power prices

Necessary changes in power market functioning due to RES massive penetration



Performance of VR from wind, photovoltaics and run-of-river hydro plants over a week in summer on an hourly base in comparison to demand (Source: Haas [4])

Tariff problem

Currently major part of fixed power generation and grid cost is transferred to final consumers via power consumption

- power generation cost – e.g. coal fired: app. 50% fixed cost, nuclear much higher, CCGT major role of fuel cost
- grid cost: > 85% of distribution grid cost is fixed cost
  - but see example of CR: price at LV has 85% variable component
  - does not correspond with the grid cost strucuture

Tariff problem II

Electricity savings – power (kW) versus energy (kWh)

Recovery of fixed cost via variable component:

• do not motivate to power (kW) savings, distribution companies should guarantee “purchased” power, impact to grid development planning

• prosumers concept: e.g. small PV on the roof – leads to the energy savings but not to power savings, might results in transfer part of cost to households having no PV

Recovery of fixed cost via fixed component

• reduce motivation to energy savings

• results in electricity price increase of low consuming households

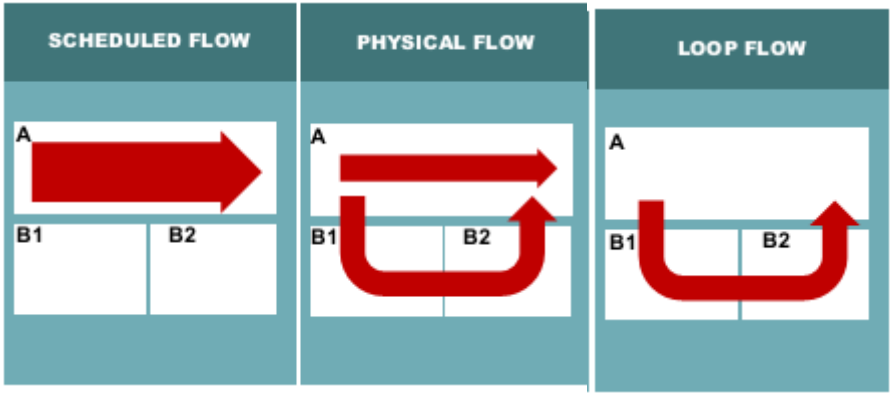
Infrastructure development is not accompanying power market changes

Development of transmission infrastructure is slower than dynamics of power generation in intermittent sources:

- problem with loop flows
- reduced market effectiveness
- reduced security of supply
- adverse distribution effects, forced investment in host area
- induced investment - e.g. planned investment in phase shifters on the D-CZ border

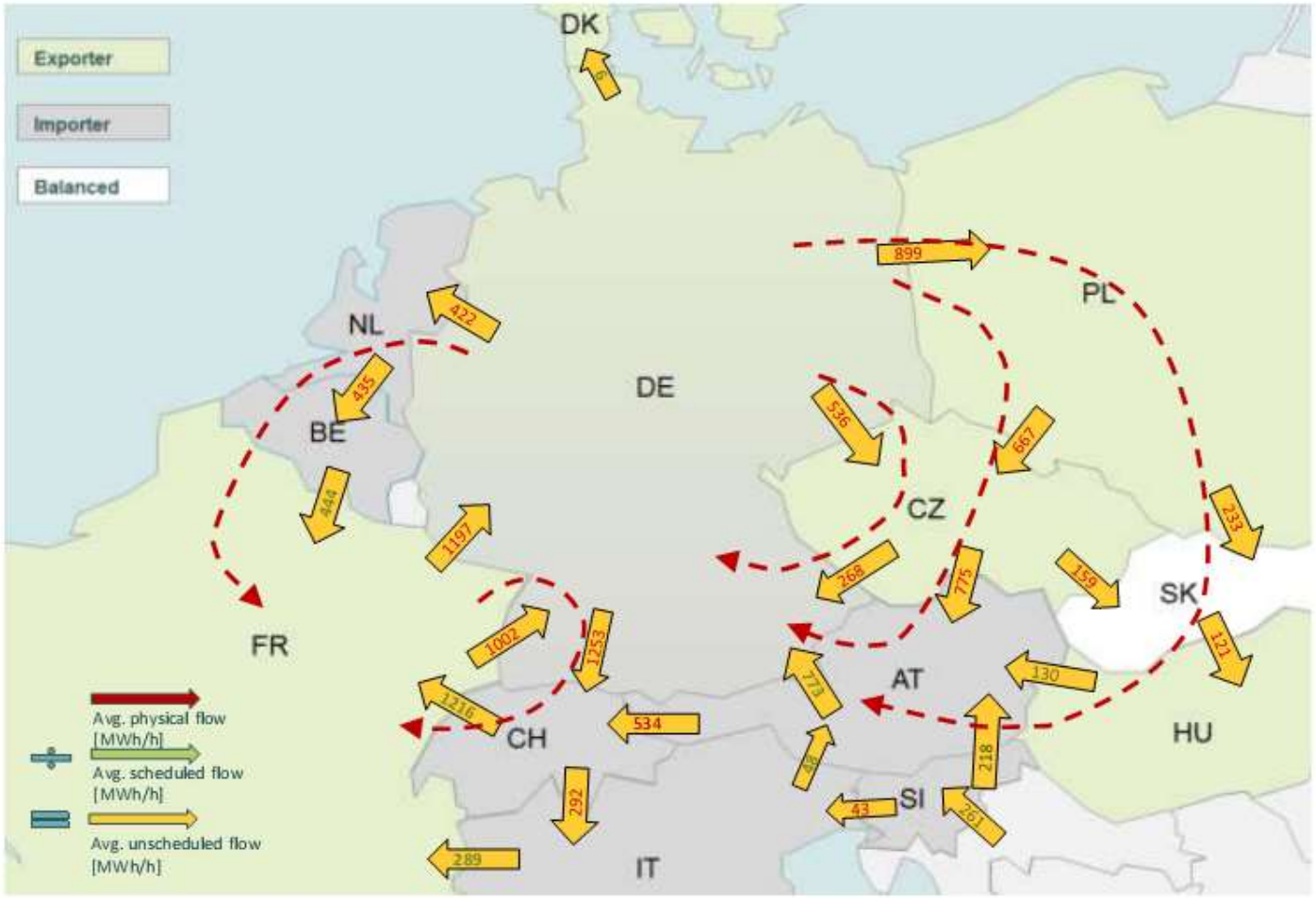
Power flows

- market (scheduled) flows: result of commercial transaction (seller to buyer)
- physical flows (measured): real flows in the grid of according to Kirchhoff's 1st law
- loop flows: physical flows occurring in external (i.e. host) area as the result of congestions in primary control area



Source: http://ec.europa.eu/energy/gas_electricity/studies/doc/electricity/201310_loop-flows_study.pdf

Loop flows

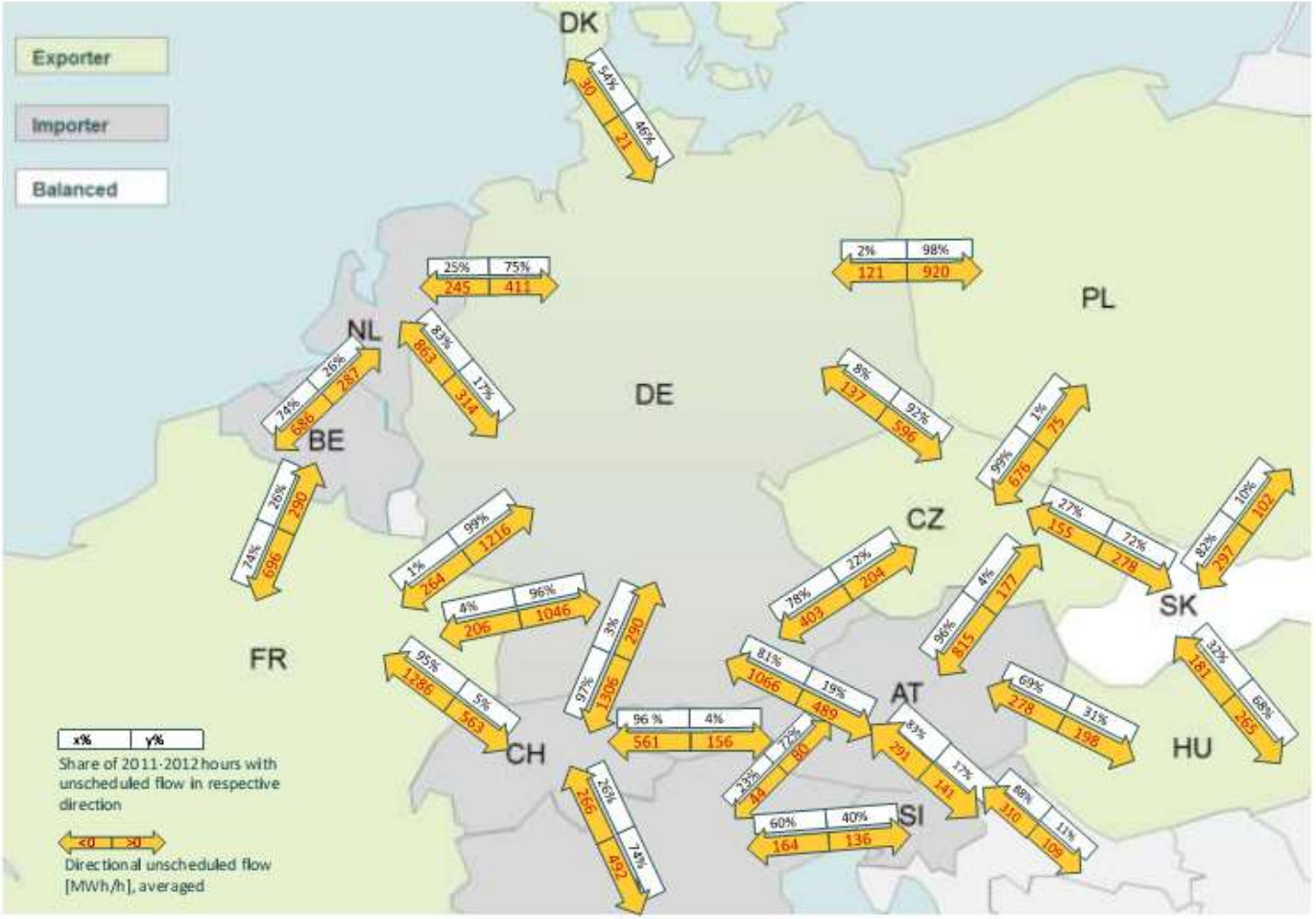


Source: THEMA Consulting Group, based on data from 16 TSOs

Average unscheduled flows (2011-2) in MWh/h

Source: http://ec.europa.eu/energy/gas_electricity/studies/doc/electricity/201310_loop-flows_study.pdf

Loop flows 2

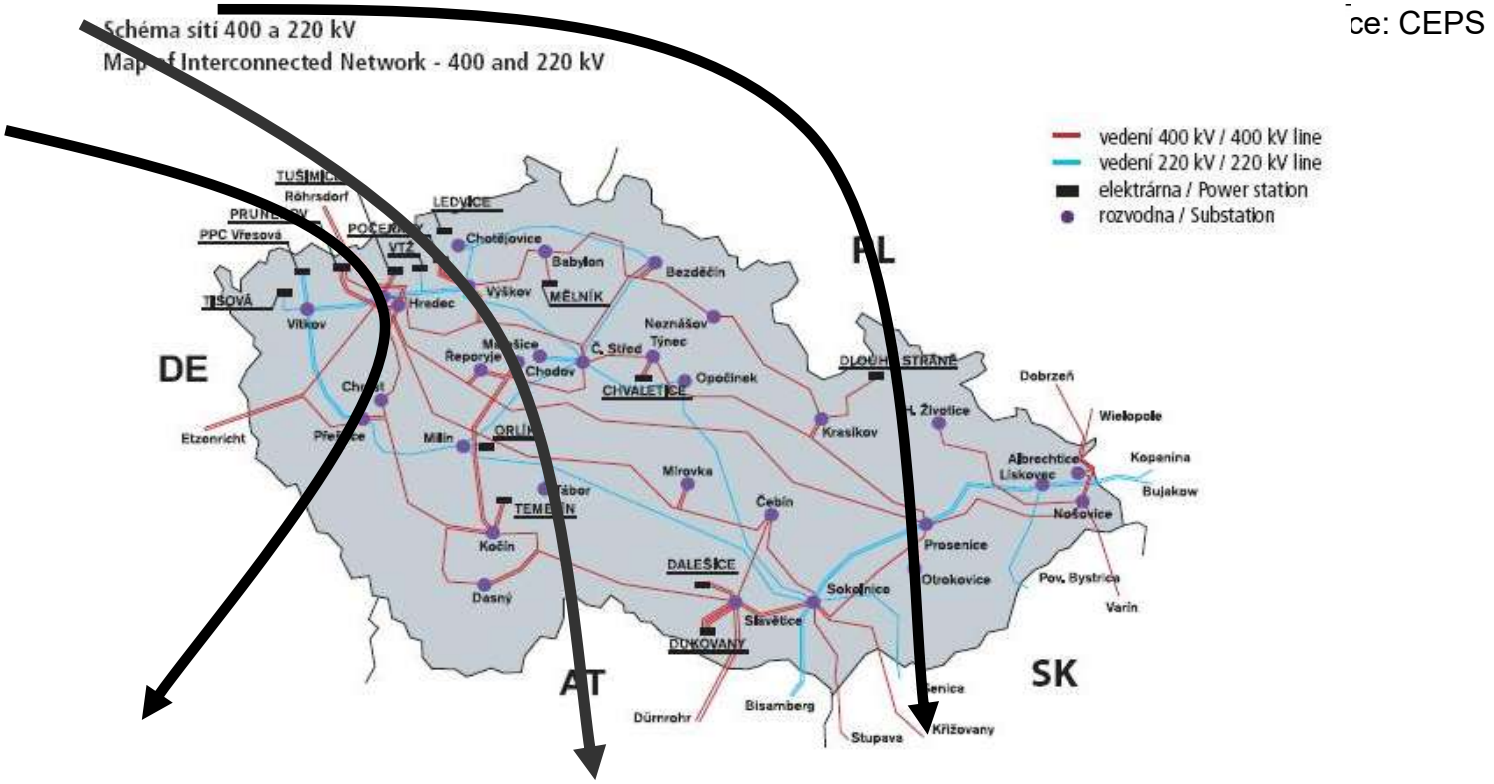


Source: THEMA Consulting Group, based on data from 16 TSOs

Average unscheduled flows (2011-2) in MWh/h and share of hours with unscheduled flows

Source: http://ec.europa.eu/energy/gas_electricity/studies/doc/electricity/201310_loop-flows_study.pdf

Czech Rep. – loop flows



Problem: Loop flows from N. Germany to S. Germany and Austria, end of 2014: > 3400 MW from Germany to Austria

Threat for TS stability, installation of “phase shifters”, 1st installation in 2015-2016 (Hradec)

Possible scenarios of development

(as defined by CZ deputy minister responsible for energy branch, Mr. Solc, May 2014)

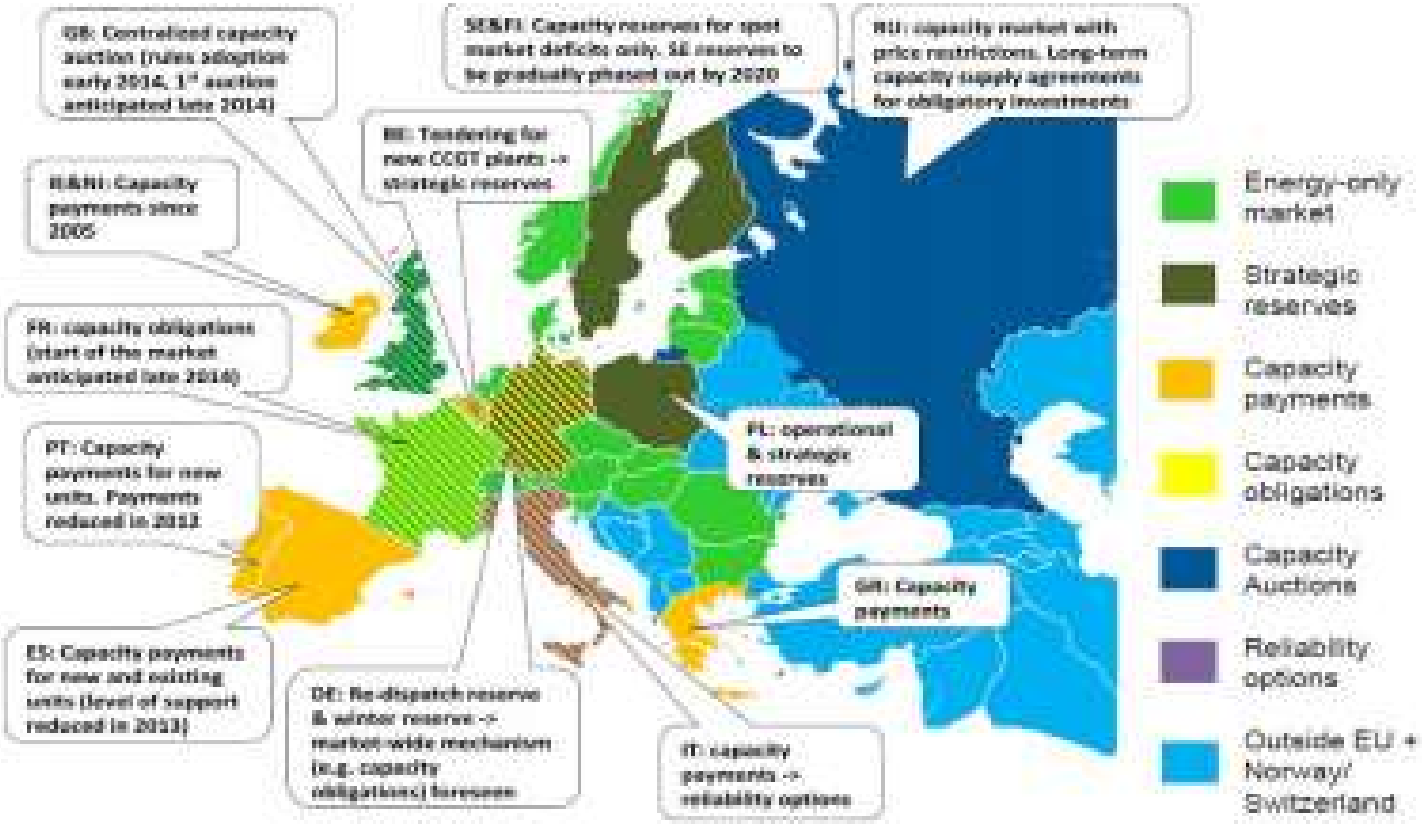
- **return back to energy only market: 10% probability**, but
  - changes of political decisions are needed
  - stability in energy legislation and consistency in goal definition
  - effective ETS
  - separation of political decisions from technical ones
  - strict application of the rules in EU context
- **separation of energy market from capacity market: 50% probability**, but it needs
  - standardization of capacity mechanisms
  - rules for cross borders exchanges
  - solution of reliability issues

Possible scenarios of development 2

- failure of common market: probability 40%
  - disintegration of common market to the regional ones with similar political interests or structure

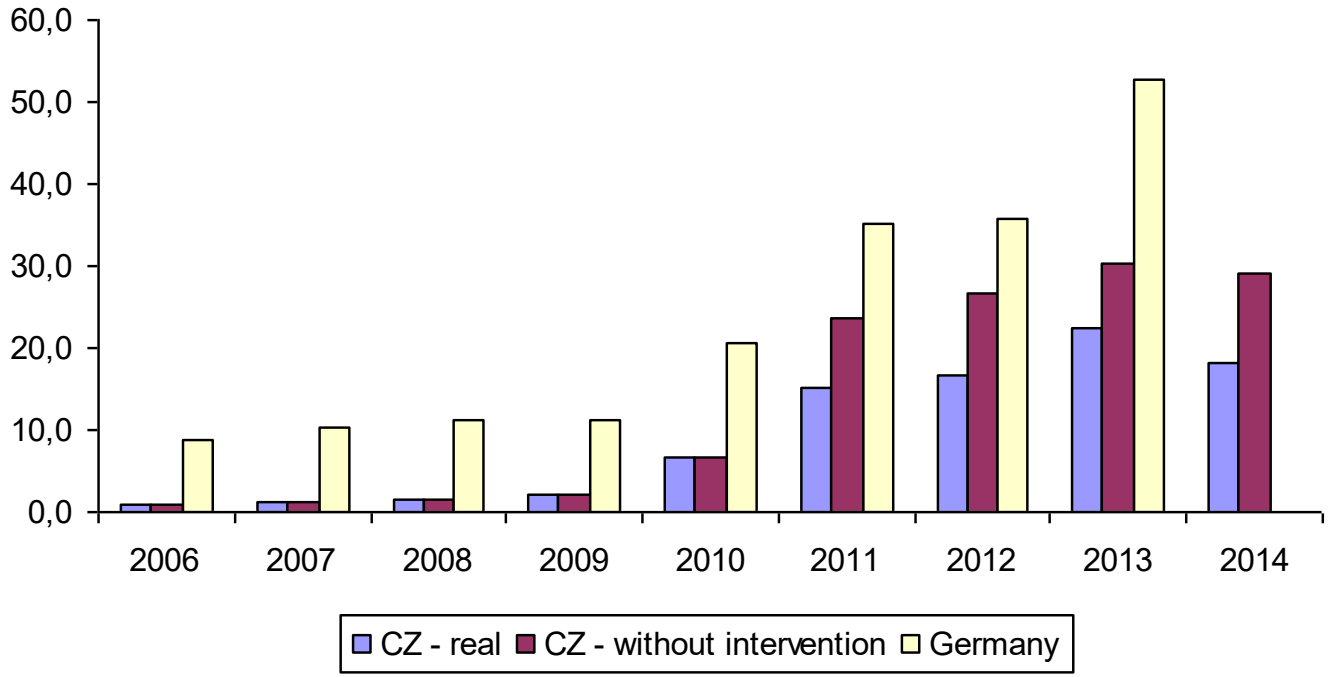
High uncertainty with the future

MS are searching for their own solutions



source: P. Cyrani, Jak skončí krize jednotného trhu,

RES extra cost



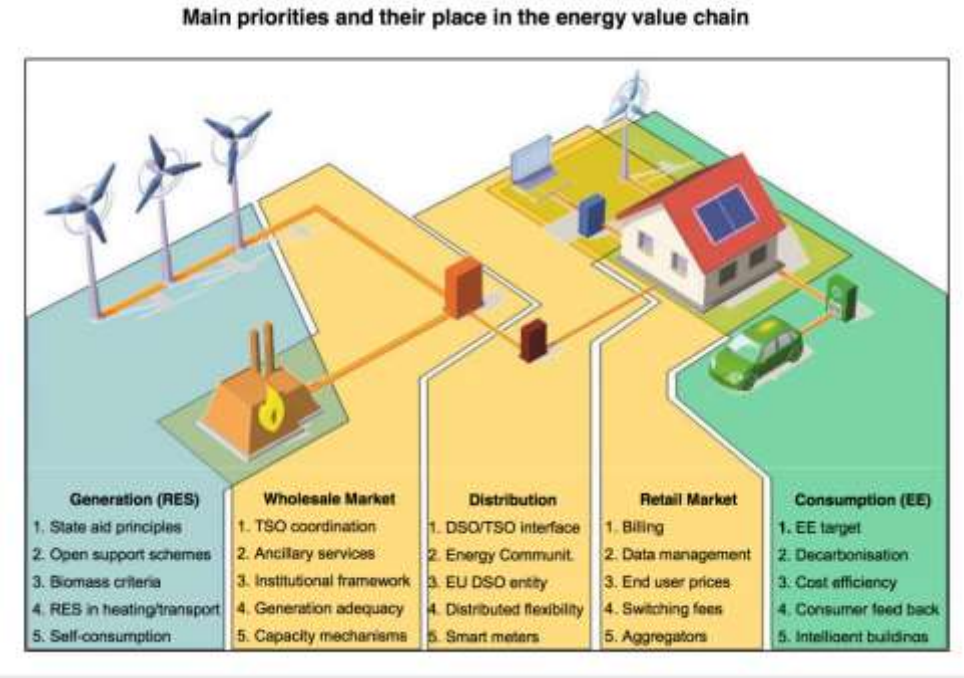
RES fee in CZ and Germany in EUR/MWh (no VAT)

Great differences in financing mechanisms and RES fee value, asymmetric impact to industrial companies and to households, Germany has exemptions for energy intensive industries

EU winter package

(as presented in November 2017)

- path to energy union, reliable energy (electricity) delivery
- low emitting sources, better functioning of power markets
- decline of coal use for power generation, higher importance of energy savings (+increasing role of consumers)
- 8 legislative proposals and many other nonlegislative documents



Thank you for your attention !

Děkuji za pozornost!