Zombie Electricity Utilities: A world with falling demand for on-grid electricity consumption

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Power systems used to be a dull topic

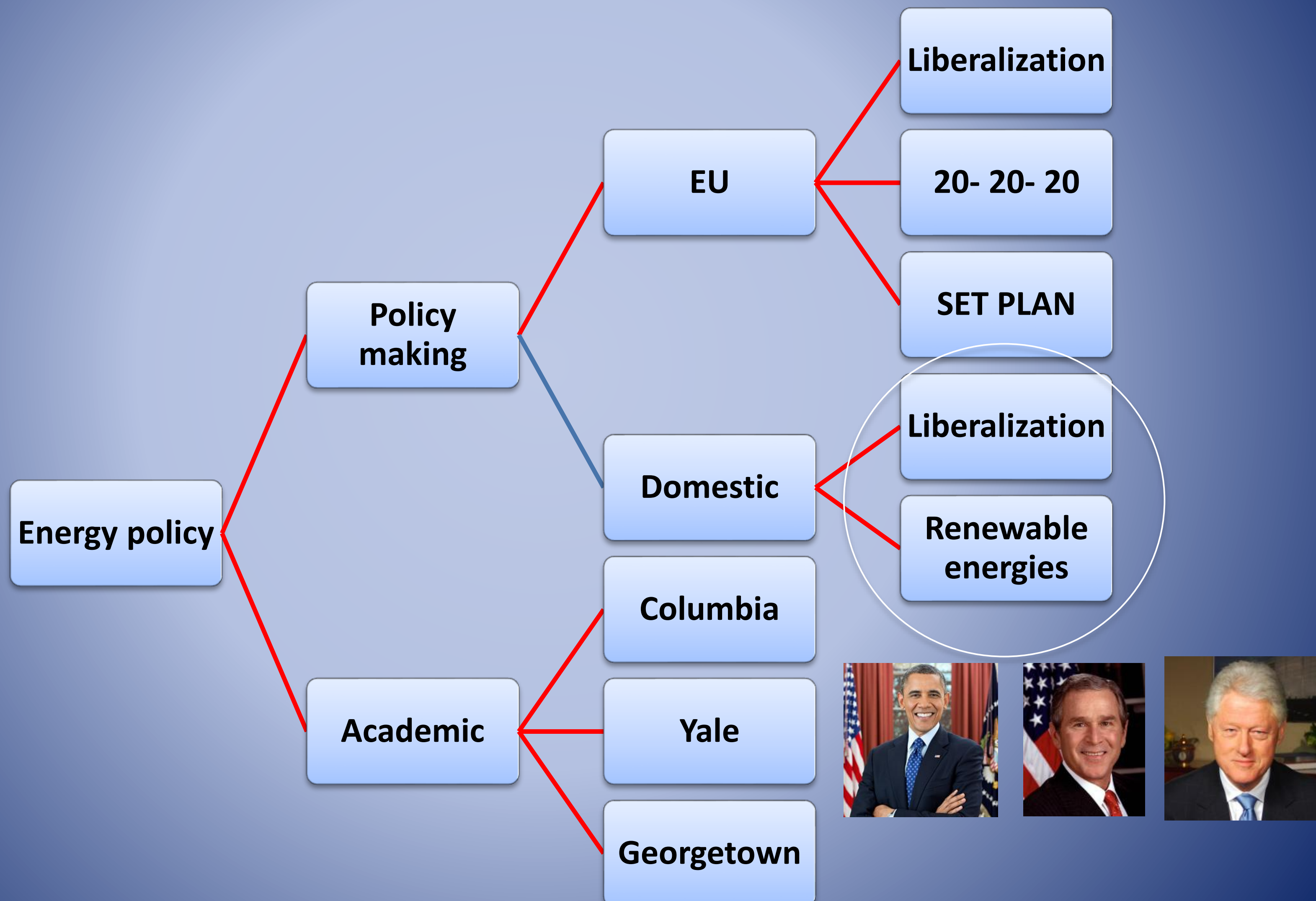
Value destruction	Negative wholesale prices	Curtailment	Super expensive nuclear power	Record low solar prices	100% renewables	Southern Australia
12 of the largest EU utilities reduced the value of their assets by $ 30 billion in 2015 bringing total **write downs** in the sector to $ 104 billion since 2010.	During 126 hours in 2015 Germany´s power station operators had to pay customers willing to take their power **– 9 $**/ MWh on average.	In the Chinese provinces of Jilin, Gansu and Xinjiang wind curtailment rates reached 32, 39 and 32 % respectively	The UK Gov. agreed to guarantee a price of $ 115/ Mwh over 35 years for electricity produced in the **Hinkley Point C nuclear power plant**	A Spanish company wins a bid in Chile to sell power from a 120 MW solar power plant **at 29.1 $/ MWh**	Portugal entirely **powered by renewables for 4 days**	Wind and solar capacity reached **43% in Southern Australia**

Capacity to anticipate market developments is crucial

US	Company	Market cap	Δ% 5 years
	Duke Energy	55 b$	27
	Con Edison	23 b$	33
	Next Era Energy	60 b$	165
	America Electric	32 b$	68
	DJI		57
EU			
Germany	E.On	14 bE	-63
	RWE	8.4 bE	-63
France	EDF	21.8 bE	-58
	Ngie	40 bE	-40
Italy	Enel	43 b E	44
Spain	Iberdrola	41.4 bE	42
Denmark	Dong Energy	17.1 bE	--
Portugal	EDP	10.4 bE	27
	Euro Stoxx 50		31


Day ahead market
March, 13
100
80
60
40
20
0
NY ISO
Nordpool
EPEX
AEMO balancing price
OMIE

My personal experience



2 little countries: Portugal and Denmark

Country	% electricity from renewables	% wind	% solar PV
Norway	99	1.5	--
Iceland	85	--	--
Austria	70	5.8	1.1
Sweden	63	7.3	--
Canada	59	3.4	--
Portugal	50	22.9	1.1
Denmark	49	40.6	1.8

- Portugal met during **4 days 100% of domestic consumption from renewable sources**, which the Guardian ranked as the 3^{rd} most important science achievement of 2016.

- Although the **1^{st} reverse auction for wind generation** is usually attributed to Brazil in 2008 actually it is not the case, it took place in Portugal in 2006.

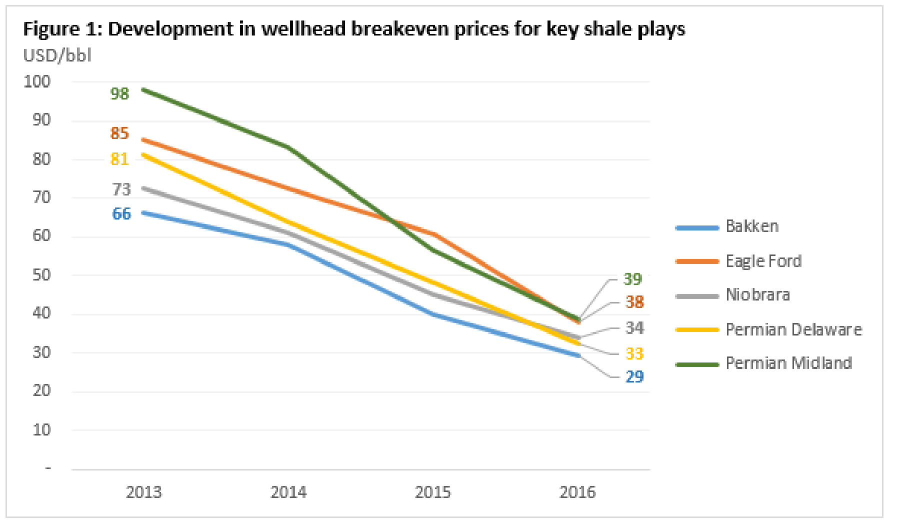
- Both countries achieved a large penetration of renewables with **a small contribution of distributed generation**.

- **None has problems similar to Germany (stranded assets, skyrocketing retail prices, negative wholesale prices, etc.)**

- **Their example is difficult/ impossible to replicate**. **There is no blueprint for success**.

The age of accelerations

System design
Regulation
Business



Source: Rystad Energy NASWellCube

"New power systems"

Zombie utilities

Super low cost VRE
+ Distributed energy
+ Behavioural changes

+Technology + markets - policies
US new approach to energy and climate change

1. Coal revival

"Putting coal country back to work"

Natural gas gained a 17 p.p. market share in power generation

2. Climate policies uncertainty

"A Chinese hoax"

CO_2 emissions peaked in …2007

3. Renewable energies

"Wind power kills all the birds"

PTC´s are earmarked until 2020

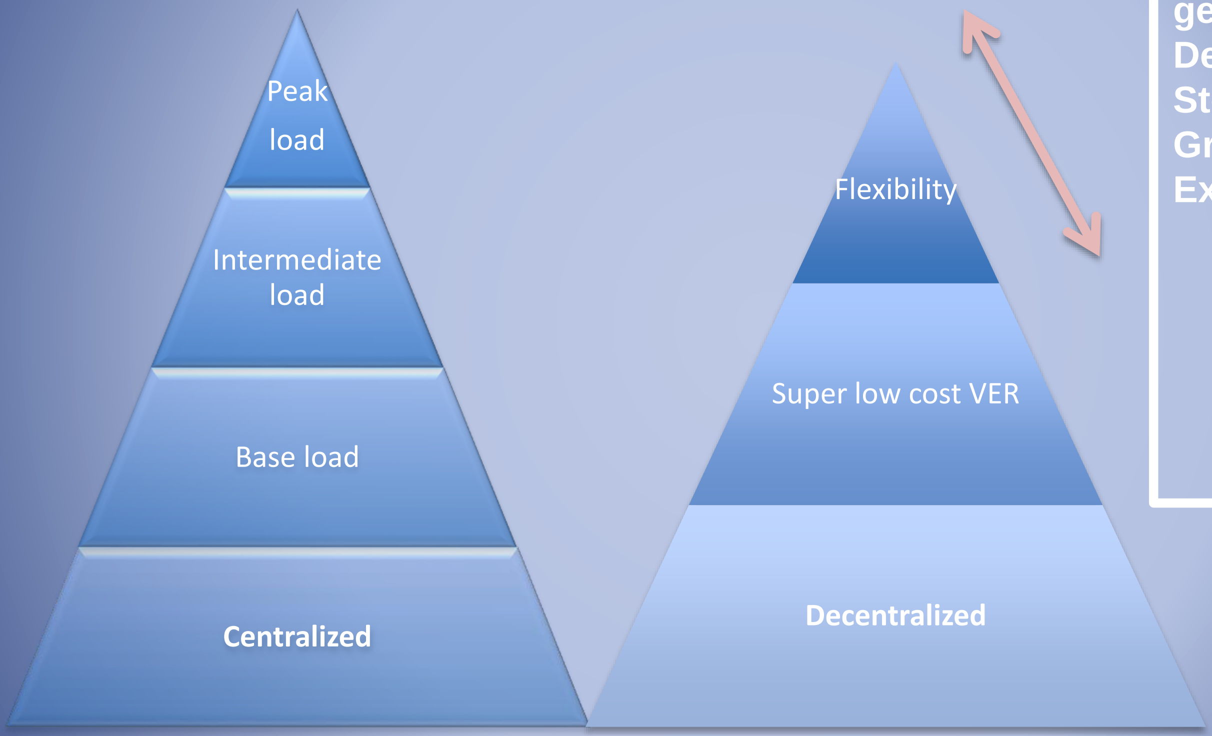
Technology and markets tend to dominate policies

WHAT IF PTC IS ELIMINATED IN 2020?

		Only CAPEX	CAPEX+ LOAD FACTOR
CAPEX	1500 $/MW	1070 $/ MW	1250 $/ MWh
WACC	6%		
FIXED O&M	70 $/ MW		
LOAD FACTOR	32%		36%
LCOE	71 $/ MWh	58 $/ MWH	58 $/ MWH
PTC subsidy	13 $/ MWh	0	
PPA= LCOE-subsidy	58 $/ MWh		

The same result can be achieved with a 30% CAPEX reduction or a combination of 16% CAPEX reduction + 4 p.p. increase in load factor

The "new power system"



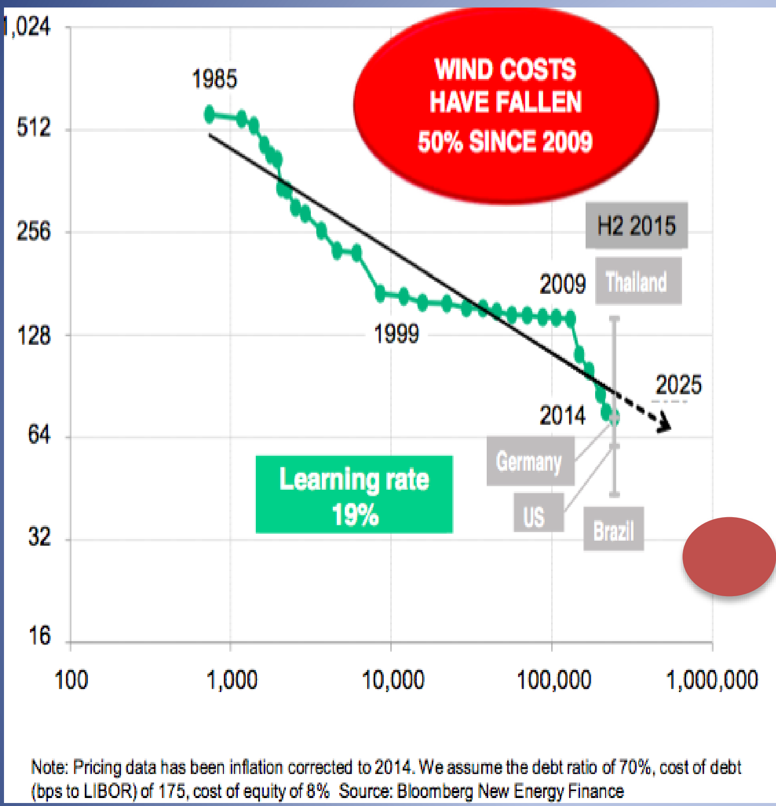
Larger "balancing areas"
Flexible generation
Demand response
Storage
Grid
Exports/ imports

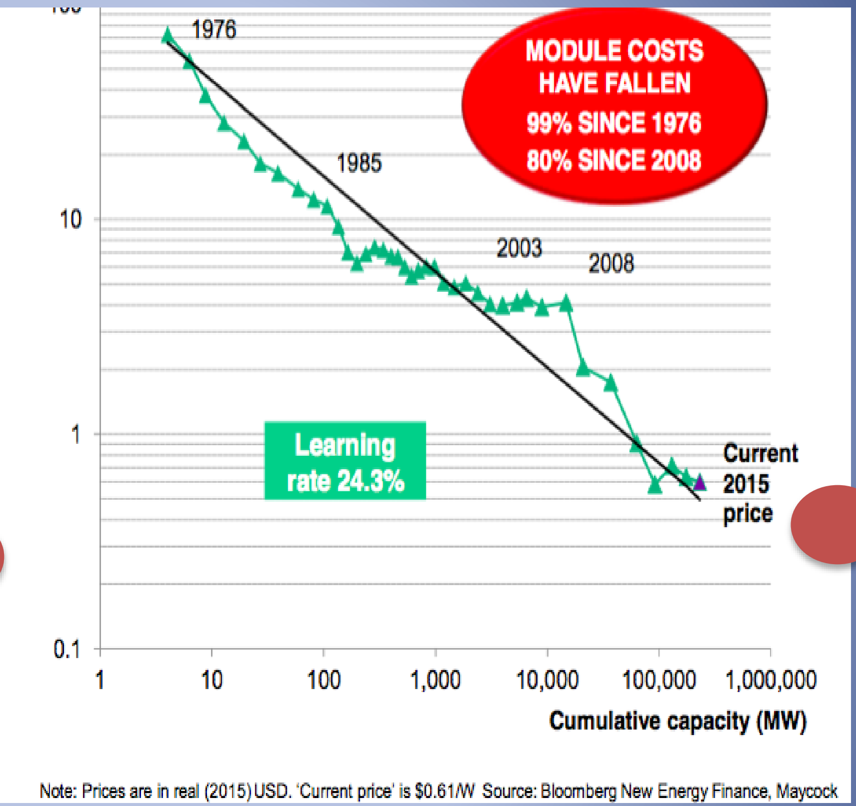
The transformation of electricity systems is the result of the combined effect of

1. Super low cost VRE
2. Distributed energy
3. Structural change in demand patterns (slowdown in electricity consumption), and
4. Policies (climate awareness).

CHALLENGES

1. SUPER LOW COST VRE





WIND

SOLAR PV

SOLAR PV HAS A HIGHER LEARNING RATE THAN WIND

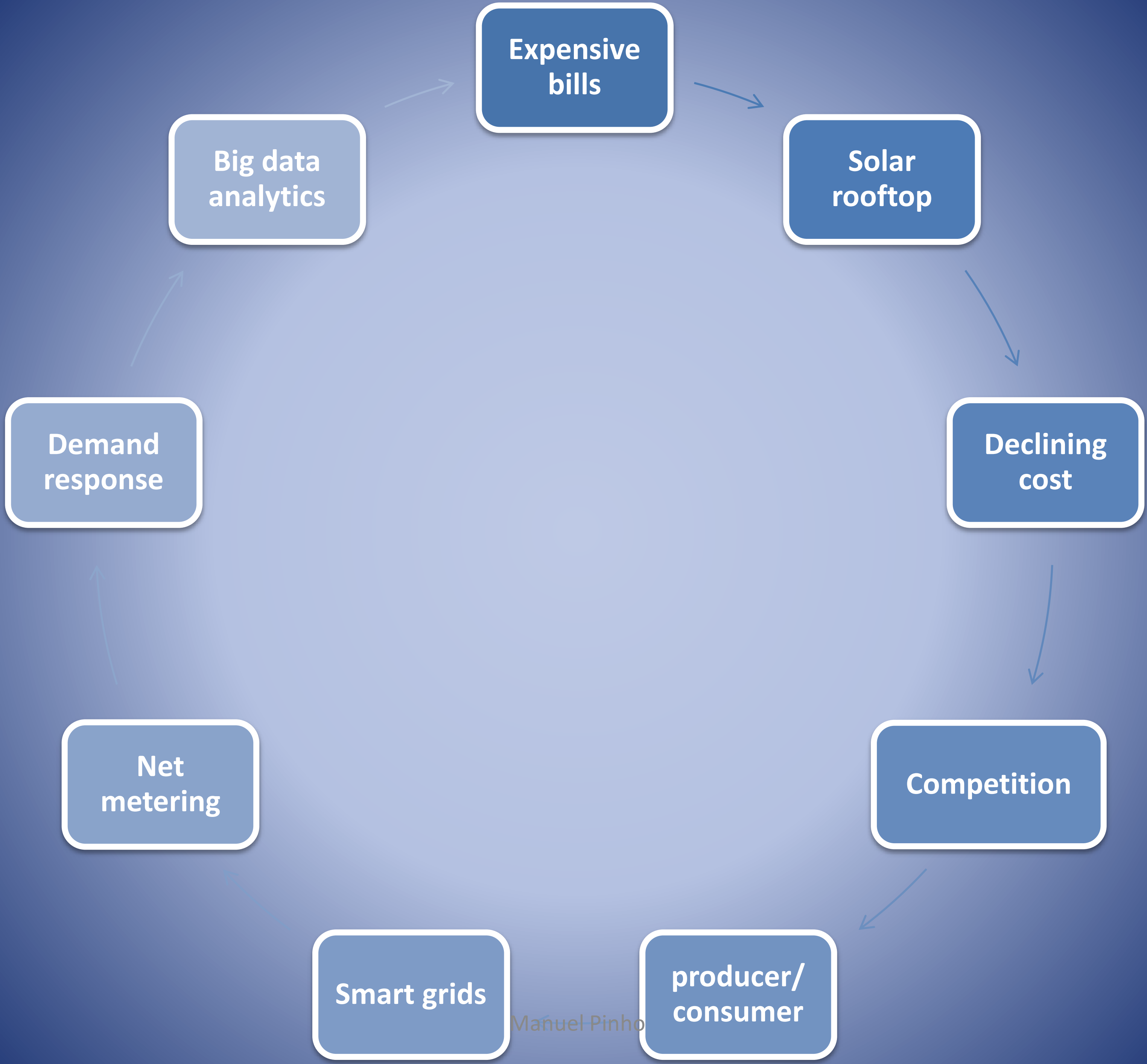
PROJECTED COSTS OF VRE (IRENA)

WEIGHTED AVERAGE	LCOE $/ MWh		
	2015	2025	Δ%
Solar PV	130	60	-59
Onshore wind	70	50	-26
Offshore wind	180	120	-35

2. Distributed energy

Distributed energy is a disruptive force that can be defined as energy technologies placed at the energy load and it includes 3 main types :

- *Energy extractors: technologies that reduce/ shift the load, such as energy efficiency and demand response.*
- *Energy technologies, such as solar PV;*
- *Distributed storage.*


Expensive bills
Solar rooftop
Declining cost
Competition
producer/ consumer
Smart grids
Net metering
Demand response
Big data analytics

3. BEHAVIORABLE CHANGES

In middle and high-income countries electricity consumption is growing slower than expected, or is flat.

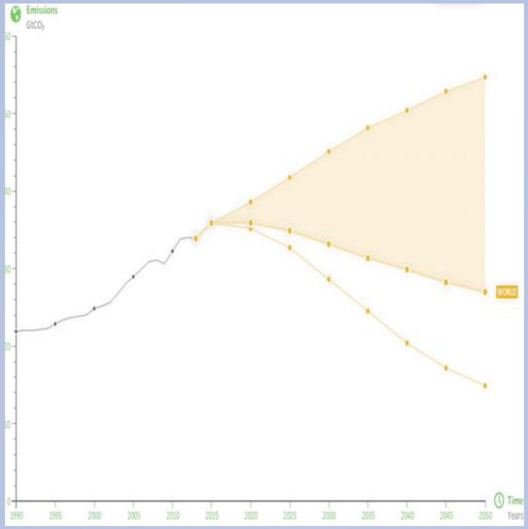
For example,

In Germany, electricity consumption reached a peak in 2007,

In China the growth rate of electricity consumption declined abruptly,

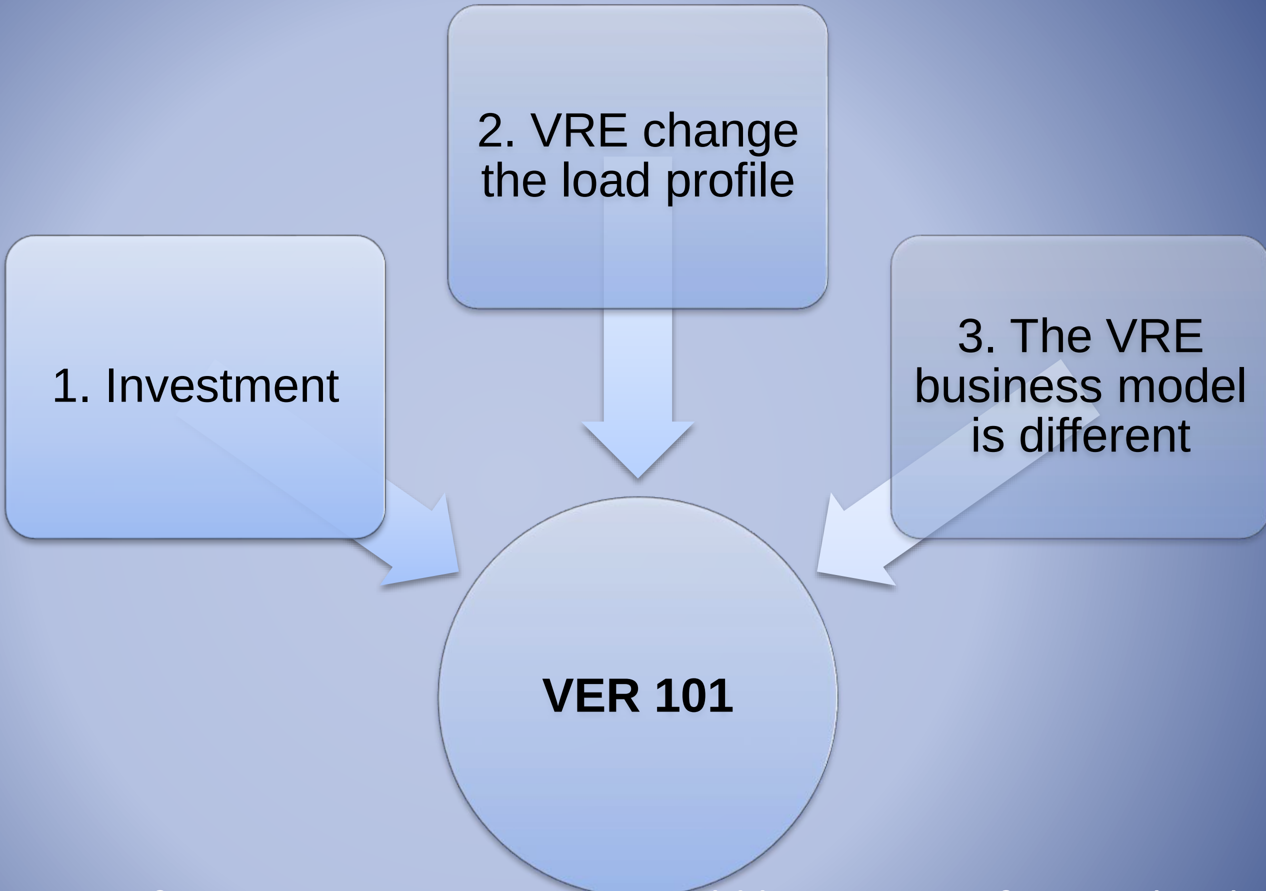
In the US it declined in 5 of the last 10 years.

4. CLIMATE AWARENESS



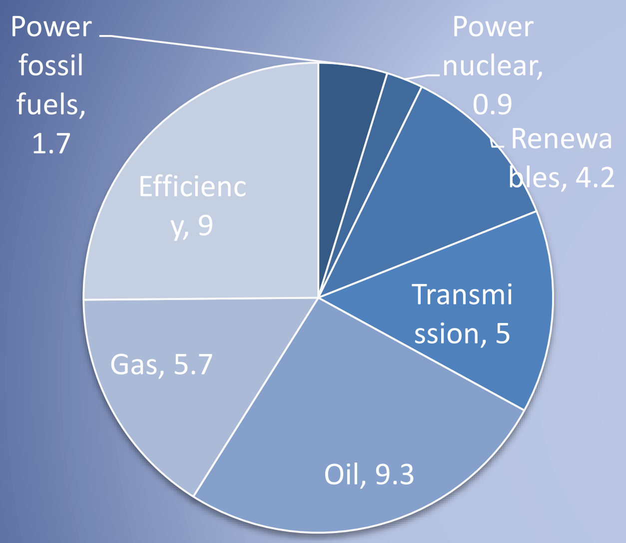
Renewables and end use energy efficiency= 2/3 abatement for 2° C

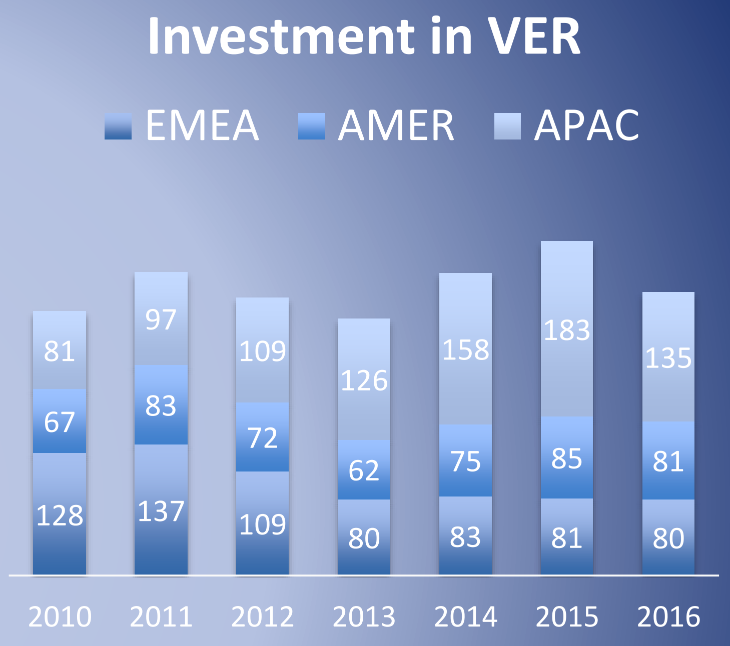
There are 2 types of renewable energies. Some resources (wind and solar) cannot be called upon when desired; they are variable **(VRE)**. Other resources (hydro, biomass) can be controlled to a larger extent and called to meet fluctuations in demand.



The integration of VRE in a power system would be a matter for another lecture

1. INVESTMENT

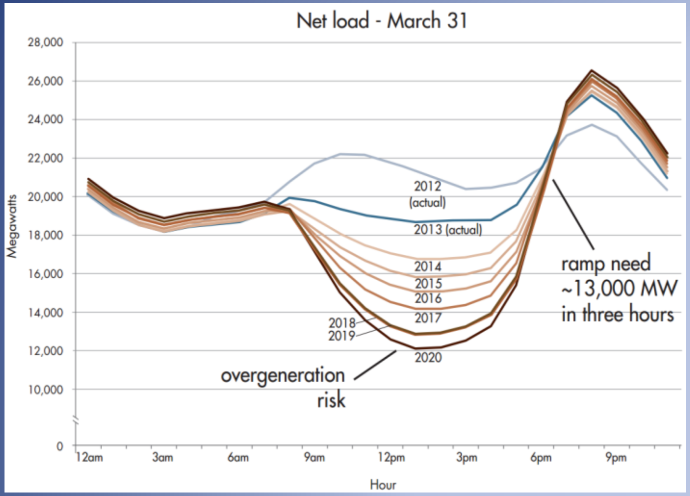


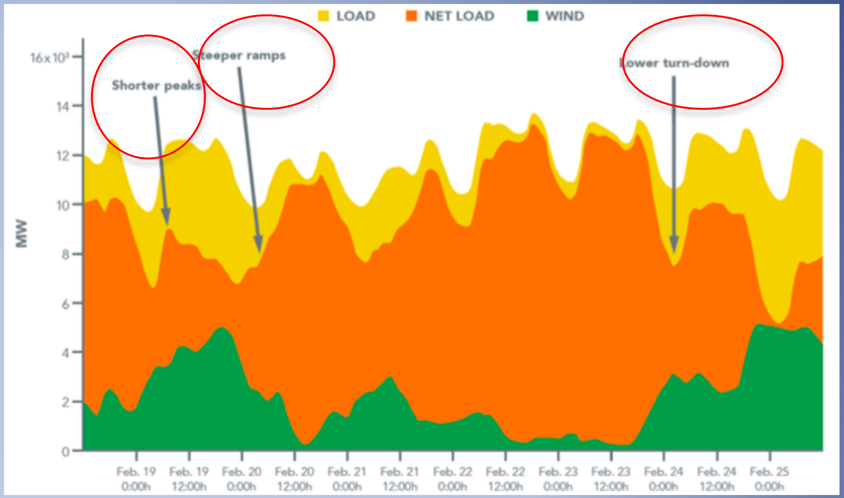


Investment in renewables= 4.2 trillion$ over 15 years

Investment in VRE > thermal generation

2. VER change the load profile





- **Steeper ramp**
- **Curtailment**

- **Shorter peaks**: Periods when generation is supplied at the higher level. This reduces the capacity factor of thermal power plants and reduces their capacity to recover costs;
- **Steeper ramps**: Higher rate of increase of thermal generation when wind power production fall as and at the same time demand increases.
- **Lower turndowns**: High wind output and low demand (i.e. during the night) creates the need for generators able to raise production if needed.

3. It is well known that the VRE business model is different from that of thermal generation

- VRE have **high fixed costs** and **very low variable costs**.

- Their LCOE is very sensitive to changes in overnight costs and to the capacity factor, hence the importance of technological improvements. It is also very sensitive to the WAAC, what explains the importance of clean energy finance.

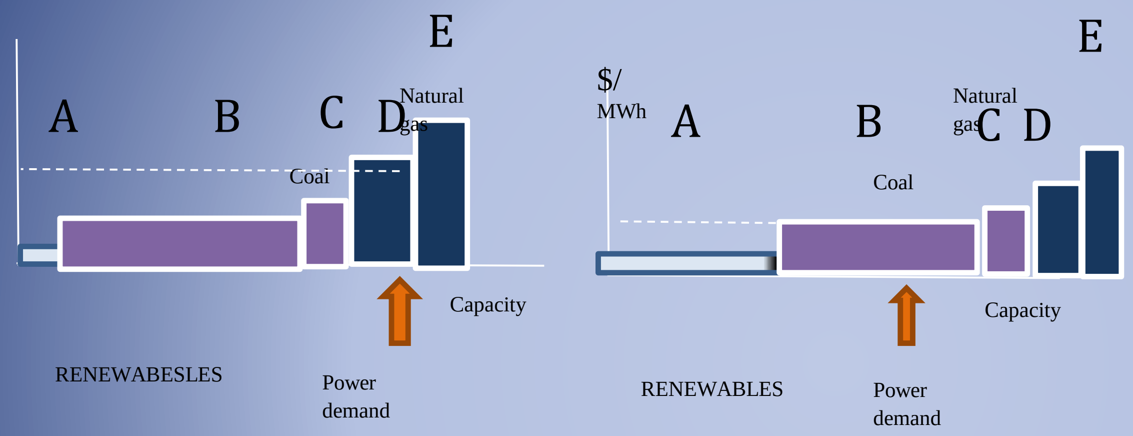
- In contrast with thermal generation VRE have close to zero marginal costs, therefore in a system of LMP they will run first.

Scissors effect

1. **Falling demand and decentralized generation**
2. **Lower wholesale prices**
3. **Smaller peak premium**

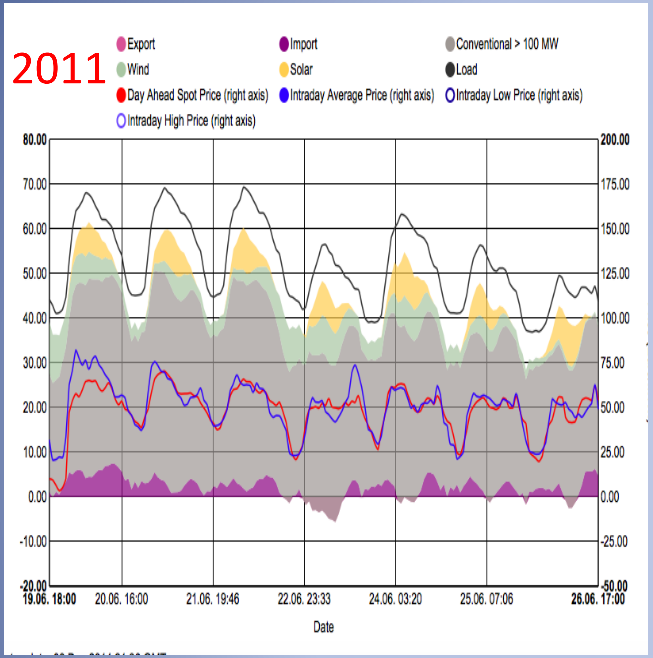
4. Amortization of unused thermal capacity
5. Transmission costs

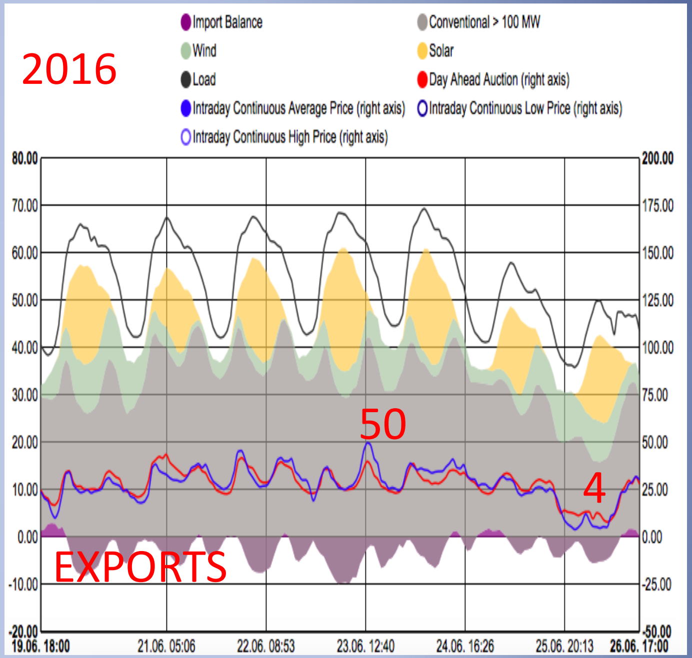
Lower wholesale prices



VRE with zero marginal cost reduce wholesale prices

Lower peak premium





The figures shows load and prices during a sunny week (25) in Germany. When solar exposure is high solar power steals base load and peak load from thermal generators.

ZOMBIE GRIDS

- Maintenance
- Bi directional transmission
- Integration of VRE

Increasing costs independent of sales

Declining revenues

- Distributed generation
- Net metering

1. **Reasons to be positive**
    1. Slowdown energy demand
    2. Improvement in energy efficiency
    3. Abundant fossil fuels
    4. Low cost VRE
    5. Climate awareness

2. New electricity system is emerging
    1. Decentralized
    2. Base load renewables
    3. Flexibility

3. Challenge
    1. Market design
    2. Regulation
    3. Electricity business

5. Scissors effect

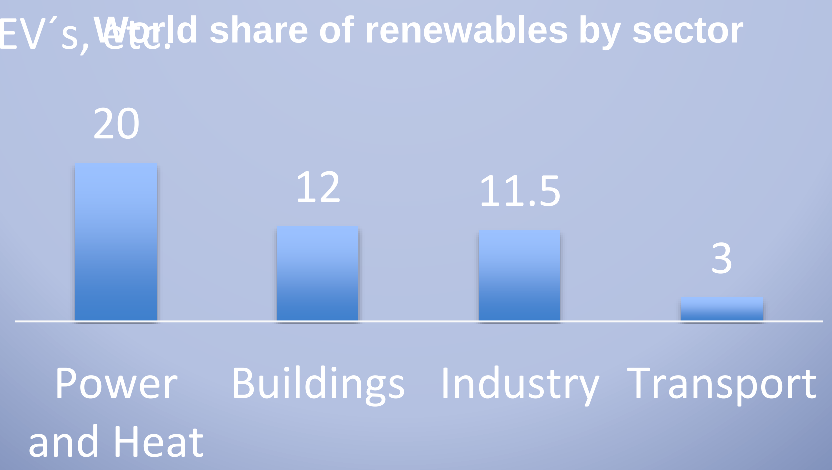
1. Lower revenue
    1. Wholesale prices
    2. Peak premium
    3. Decentralized generation
    4. Demand slowdown
    5. Lower capacity factor
2. Higher costs+ more competition

6. Capacity to anticipate market developments is crucial

Rate of technology diffusion

Costs of storage

EV´s, etc.




“ Would you tell me, please, which way I ought to go from here?
That depends a good deal on where you want to get to.


TOTO...
I'VE A FEELING WE'RE NOT IN KANSAS ANYMORE