Deriving future support schemes of RES, by considering the cost evolution of RES technologies at volatile energy and raw material prices accompanied by technological learning impacts

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Green-X
Deriving optimal promotion strategies for increasing the share of RES-E in a dynamic European electricity market

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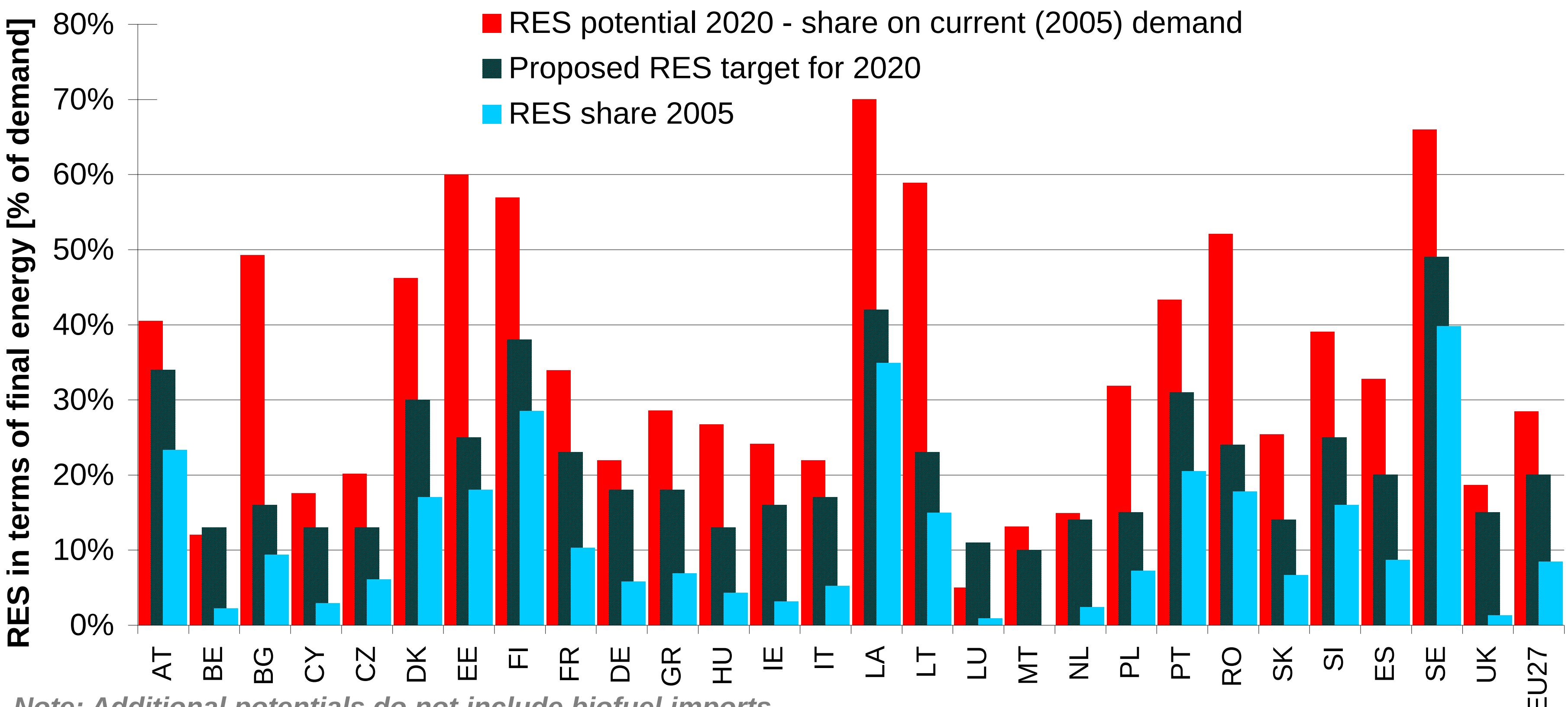
Motivation

National RES targets for 2020 – the binding goal!



Note: Additional potentials do not include biofuel imports

How the European Commission set the targets … **„FLAT RATE“ & „GDP-Variation“**

… i.e.: RES-target$_{2020}$ = RES$_{2005\%}$ + 50% *RES$_{NEW\ \%}$ + 50%*"RES$_{NEW\ \%}$ GDP-weighting"-"first mover bonus"

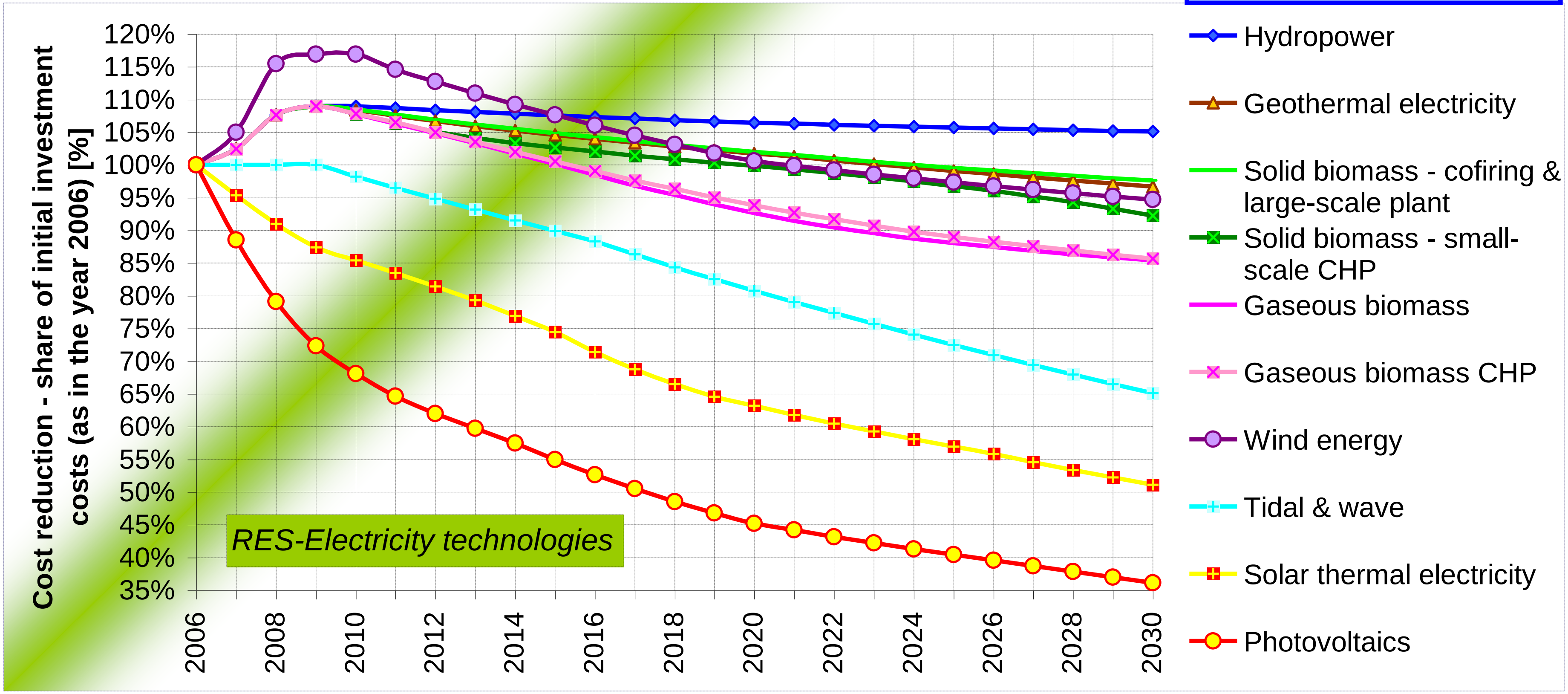
Status quo

- RES simulation tool Green-X
- Models impact of policy measures in all three energy sectors
- Dynamic cost resource curves
- Considers technology diffusion
- Technological learning and other cost influencing parameters

Status quo

RES cost evolution

Source: Green-X database

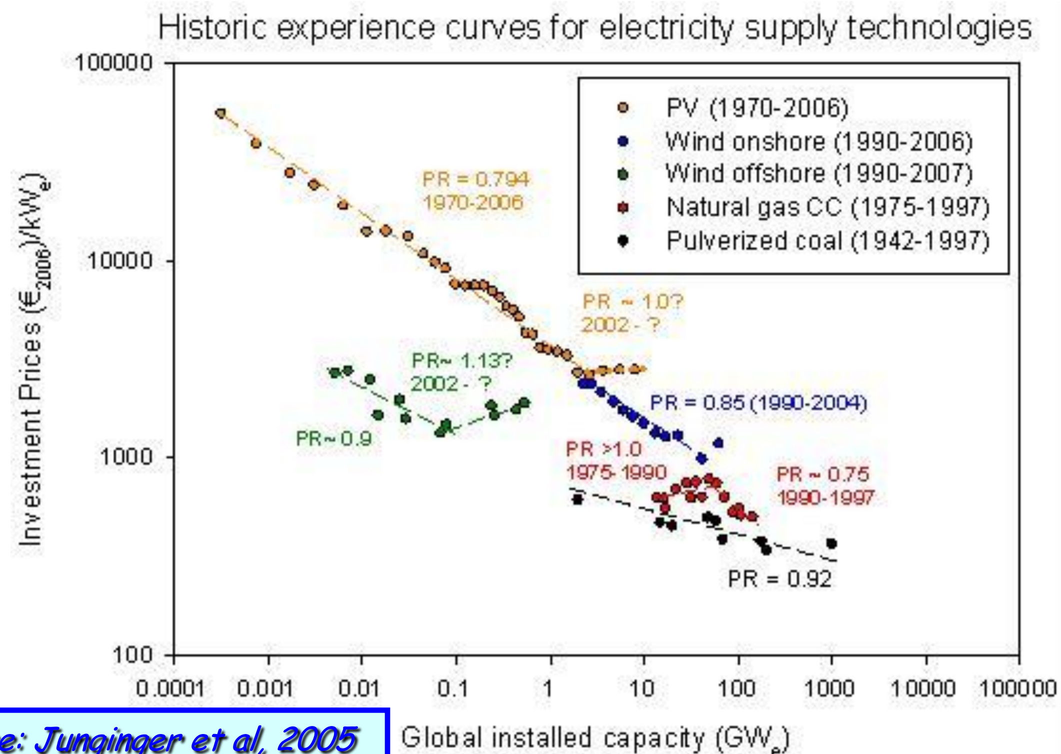


→High energy prices changed the overall situation

… Prior learning expectations will not be met with a continuation of high energy prices

(i.e. an increase of investment cost could be observed for almost all energy technologies in 2006 to 2008 caused by increasing energy and raw material prices)

Resulting (investment) cost reduction due to technological progress (learning) (according to the policy *scenario*)



Source: Junginger et al, 2005

$$c(x_t) = c(x_0) \cdot \left(\frac{x_t}{x_0} \right)^{-b}$$

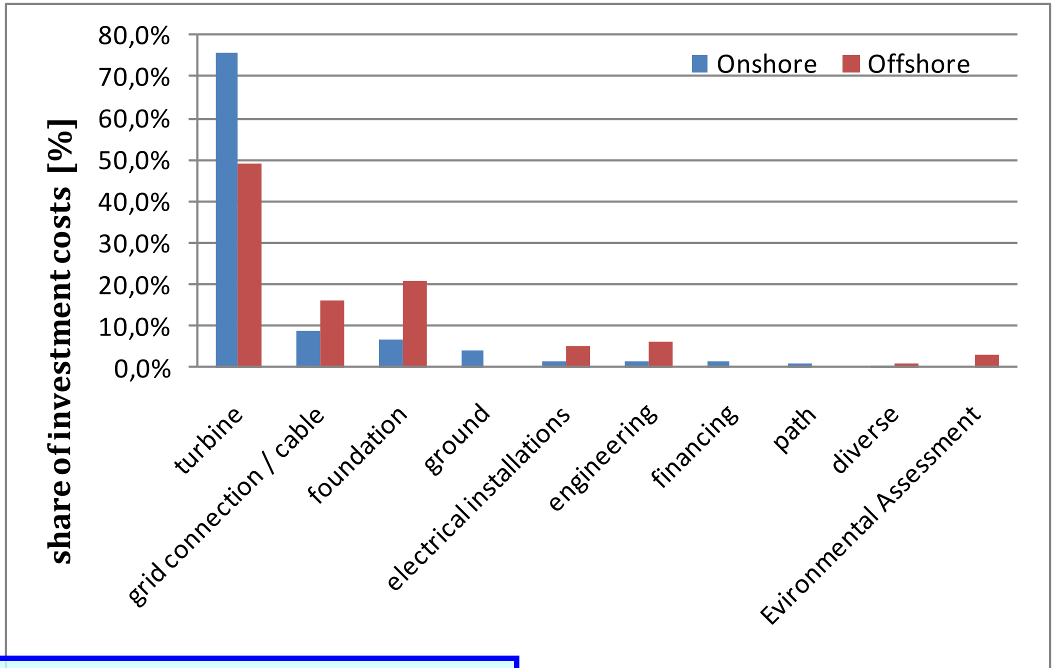
$$LR = 1 - 2^{-b} \qquad PR = 1 - LR$$

$$c(x_t) = c(x_0) \cdot \left(\frac{x_t}{x_0} \right)^{-b} \cdot KS^{-LS}$$

R&D based knowledge stock KS determination:

- *cumulative **R&D expenses** directed towards a **specific technology***
- ***delay of spent R&D expenditures** must be taken into account, addressing the fact that knowledge tends to depreciate in the sense that the **impact of past R&D expenses gradually decreases**.*

Theory and approaches



Source: Schumacher et al, 2010

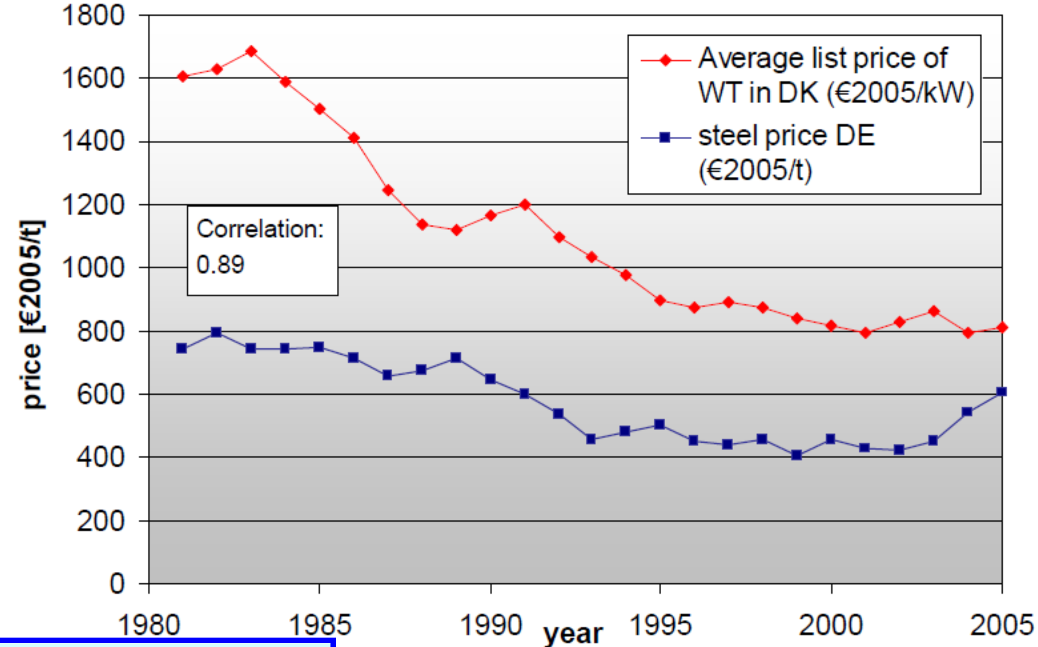
$$c(x_t) = \sum_{i=0}^{n} c(x_{0i}) \cdot \left(\frac{x_{ti}}{x_{0i}}\right)^{-b_i} \cdot CP^{LCP_i}$$

$$LR = 1 - 2^{-b} \qquad PR = 1 - LR$$

Component technological learning approach:

- ***Overall learning effect might be limited*** *due to hardly any opportunity for future doubling of the overall capacity but several* ***components*** *within the technology might* ***have this potential*** *a future doubling*
- *Wind energy: onshore and offshore* ***turbines****, installations*
  PV power: ***module type****, installation*

Theory and approaches



$$c(x_t) = \sum_{i=0}^{n} c(x_{0i}) \cdot \left(\frac{x_{ti}}{x_{0i}}\right)^{-b_i} \cdot CP^{LCP_i}$$

$$LR = 1 - 2^{-b} \qquad PR = 1 - LR$$

Source: Folz et al, 2008

Impact of raw material prices:

- ***Raw material prices*** *show strong* ***impacts on costs of energy technologies****, or at least certain components*
- *Impact (might) partly* ***compensate*** *the* ***technological learning effect***
- *Beyond a certain threshold of raw material prices,* ***material substitutions*** *might be the* ***consequence***

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Expected results

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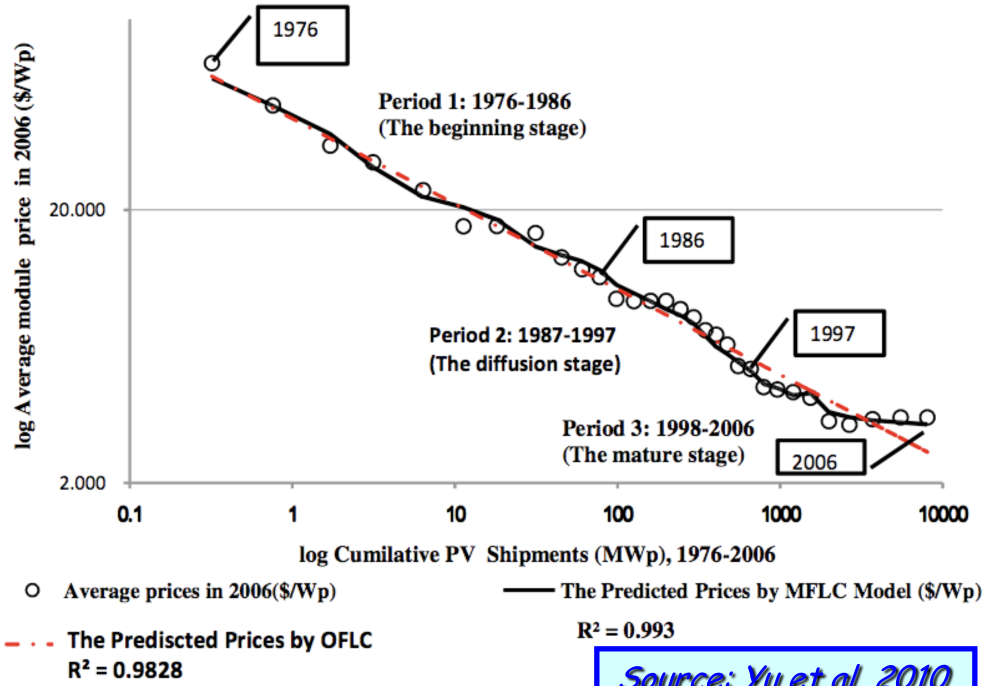

Source: Yu et al, 2010

$$c(x_t) = \sum_{i=0}^{n} c(x_{0i}) \cdot \left(\frac{x_{ti}}{x_{0i}}\right)^{-b_i} \cdot CP^{LCP_i}$$

$$LR = 1 - 2^{-b} \qquad PR = 1 - LR$$

Precise approximation of cost evolution approach based on:

- ***Long observation period*** *is necessary for determination of* ***learning rate***
- ***Learning*** *does* ***not change*** *over time per definition –* ***other impacts*** *relevant*
- ***Precise approximations*** *for future cost developments are* ***essential*** *in order to design* ***effective*** *and* ***efficient RES support measures***

Practical implementation

Component learning:

- ***Simultaneous*** *production of* ***components*** *to be defined*
- *Especially* ***difficult*** *in* ***Biomass*** *sector*
- ***Capacities, initial points*** *and* ***learning rates*** *required –* ***source*** *selection*

Impact of raw material prices

- *Volatile price development of materials –* ***references, sources****?*
- ***Impact factor*** *might change over time – empirical,* ***exogenously*** *determined*
- ***Combination*** *of raw material price and technological learning is important in order to* ***not overestimate one effect***
- ***Linking*** *raw material price* ***to oil price*** *– or other relevant influencing parameter (demand and supply…)*
- *Smooth* ***material substitution*** *beyond certain level of material price*

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Thanks for your attention!

In case of questions / remarks …

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