Technology-specific or technology-neutral? Designing support schemes for renewables cost-effectively

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Strommarkttreffen, Berlin, 14. August 2015

OUTLINE

- Introduction
- Benefits of technology-specific support
- Conclusion

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TECHNOLOGY-SPECIFIC RES SUPPORT IS UBIQUITOUS

Feed-in tariffs for electricity generation from renewable energy sources (RES) in Germany in 2014

Wind	4,95 – 15,40 Ct/kWh
Photovoltaic	9,23 – 13,15 Ct/kWh
Biomass	5,85 – 15,26 Ct/kWh
Geothermal	25,20 Ct/kWh
Water	3,50 – 12,52 Ct/kWh
Landfill, mine gas	3,80 – 8,42 Ct/kWh

Source: BMWi 2014

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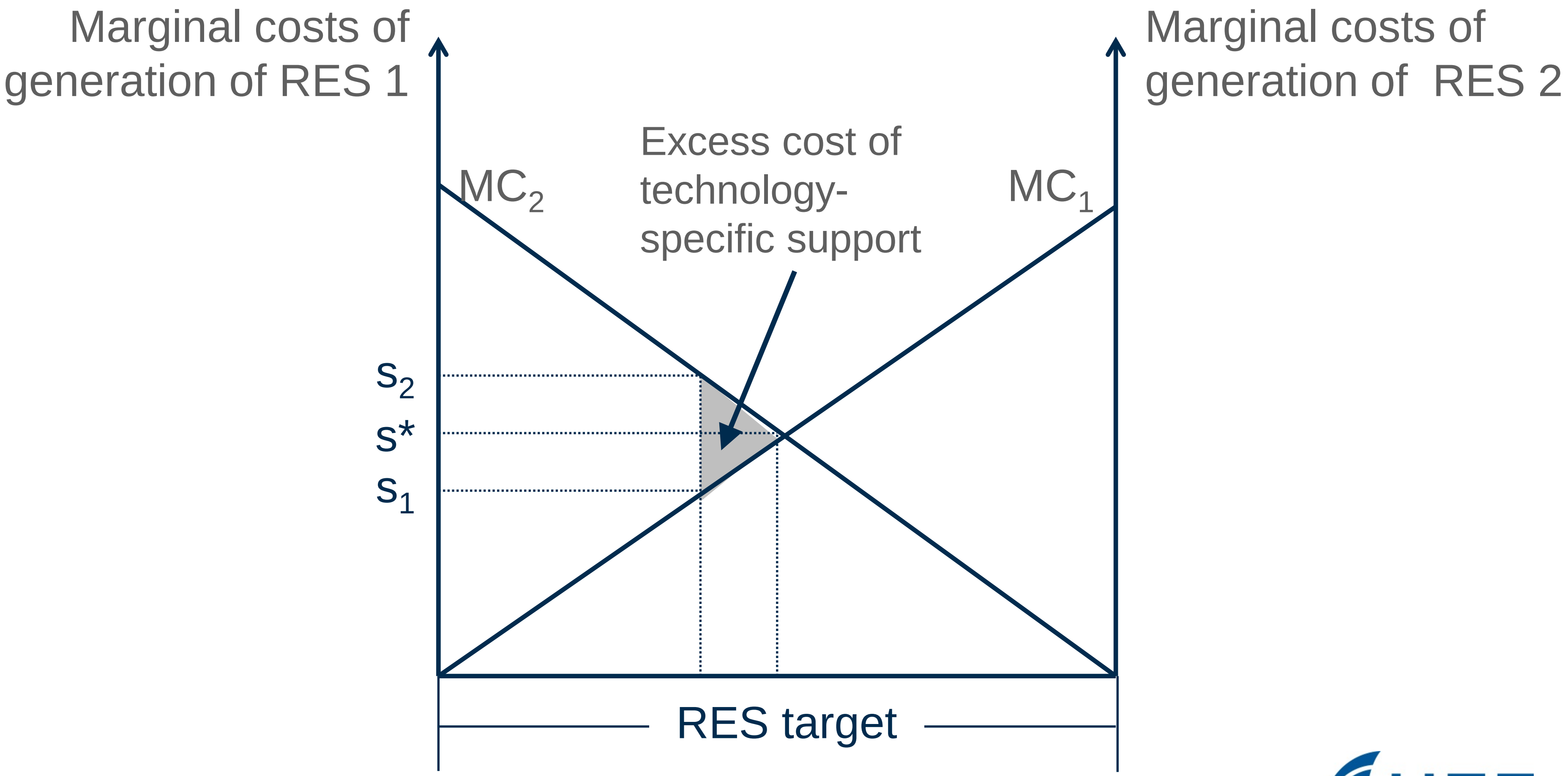
CRITIQUE: TECHNOLOGY-SPECIFIC RES SUPPORT IMPAIRS COST-EFFECTIVENESS



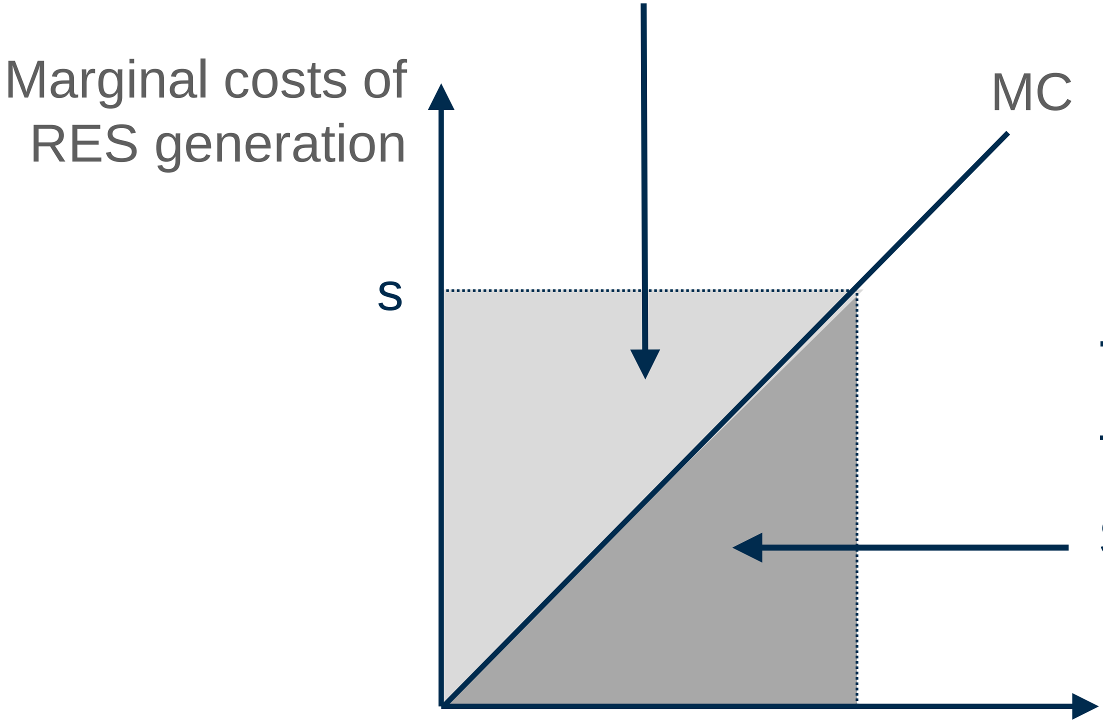
RESEARCH QUESTIONS

Under which conditions can technology-specific support improve cost-effectiveness?

- Technology market failures?
- Uncertainty and capital market failures?
- Path Dependencies?
- Negative externalities of RES deployment?

CONTRIBUTION TO LITERATURE

Existing studies: Technology-specific support brings down consumer costs by reaping producer rents
(e.g. Bergek/Jacobsson 2010, Held et al. 2014, Resch et al. 2014)



This study: Can technology-specific support bring down producer costs?

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MODEL ASSUMPTIONS

- Partial-equilibrium model of the power sector with two periods, discounting at at rate δ between period
- Two types i of RES power: wind w and photovoltaics p
- Power generation in both periods: x_t^i
- Generation costs in period 1: $c_1^i(x_1^i)$
- Generation costs in period 2: $c_2^i(x_2^i, x_1^i)$

with $\partial c_2^i / \partial x_1^i < 0$ (= technology learning)

OPTIMIZATION PROBLEMS

- Social planner aims to attain a certain renewables target $\bar{Z}$ in period 2 at least total cost C:

min $C = \sum_i c_1^i\left(x_1^i\right) + \delta \sum_i c_2^i\left(x_2^i, x_1^i\right)$

subject to $\bar{Z} = \sum_i x_2^i$

- Representative firm in renewable sector aims to maximize its profit π given a subsidy to RES generation in both periods, s_t^w and s_t^p :

max π $= \sum_i s_1^i x_1^i - \sum_i c_1^i\left(x_1^i\right) + \delta\left[\sum_i s_2^i x_2^i - c_2 \sum_i\left(x_2^i, x_1^i\right)\right]$

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ISSUE 1: TECHNOLOGY MARKET FAILURE

- Knowledge created by learning may spill over to other firms; technology-specific spillover rate ρ^i

- Optimal RES subsidy in period 1: $s_1^i = -\delta\left(1-\rho^i\right)\frac{\partial c_2^i}{\partial x_1^i}$

- Technology-specific design in period 1 optimal if:

(1) Learning varies with technologies:
$\partial c_2^w / \partial x_1^w \neq \partial c_2^p / \partial x_1^p$

(2) Spillovers vary with technologies: $\rho^w \neq \rho^p$

ISSUE 2: UNCERTAINTY AND CAPITAL MARKET FAILURES

- Future net income from RES investment uncertain
- Firms risk-averse due to capital market failures:

(1) Firms‘ discounting > social discounting: $\delta^{f} < \delta^{s}$
(2) Firms‘ discounting varies with technologies: $\delta^{fw} \neq \delta^{fp}$

- Optimal RES subsidy in period 1: $s_1^i = \left(\delta^{fi} - \delta^{s}\right)\frac{\partial c_2^i}{\partial x_1^i}$

- Technology-specific design in period 1 optimal if:

(1) Learning varies with technologies: $\partial c_2^w / \partial x_1^w \neq \partial c_2^p / \partial x_1^p$
(2) Risks vary with technologies: $\delta^{fw} \neq \delta^{fp}$

Only second-best solution!

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ISSUE 3: PATH DEPENDENCIES

- RES investments produce techno-institutional path dependencies and lock-in effects
- Switching costs: $c_2^p(x_2^p, x_1^p, x_1^w)$ with $\partial c_2^p / \partial x_1^w > 0$ and v.v.

- Optimal RES subsidy in period 1: $s_1^w = -\delta \frac{\partial c_2^p}{\partial x_1^w}$, $s_1^p = -\delta \frac{\partial c_2^w}{\partial x_1^p}$

- Technology-specific design in period 1 optimal if:

(1) Switching costs vary with technologies: $\partial c_2^p / \partial x_1^w \neq \partial c_2^w / \partial x_1^p$ (holds true if switching costs are progressive and one technology dominates RES deployment period 1)

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ISSUE 4: NEGATIVE EXTERNALITIES

- RES deployment also produces negative externalities: environmental and system integration costs: $e_t^i(x_t^i)$

- Optimal RES subsidy in period 1: $s_1 = -\frac{\partial e_1^i}{\partial x_1^i}$
- Optimal RES subsidy in period 2: $s_2 = \frac{1}{\delta}\left(\lambda - \frac{\partial e_2^i}{\partial x_2^i}\right)$

- Technology-specific design in both periods optimal if:

(1) Externalities vary with technologies:

$\partial e_t^w / \partial x_t^w \neq \partial e_t^w / \partial x_t^p$

Only second-best solution!

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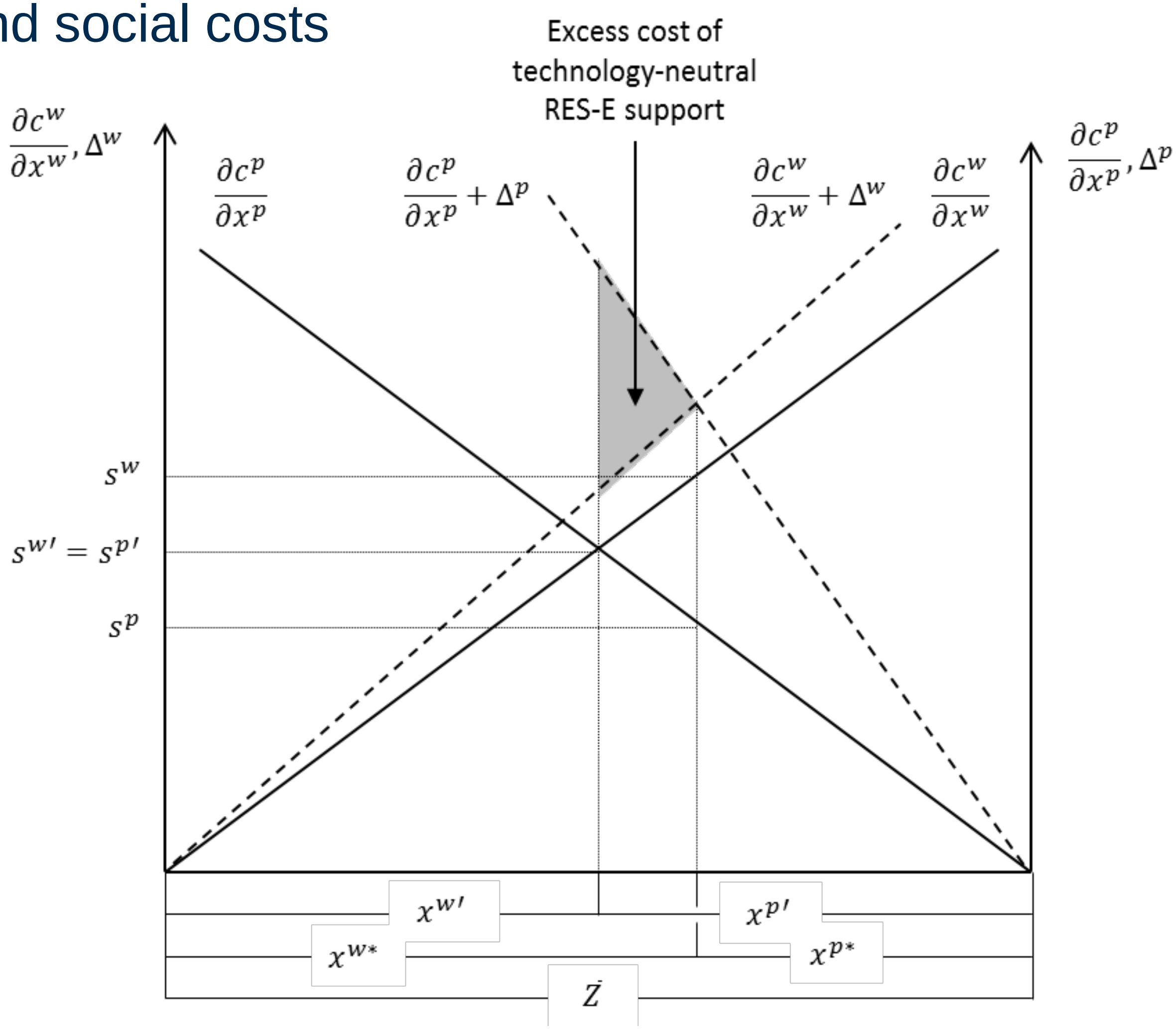
GRAPHICAL ILLUSTRATION

- Market failures may drive a wedge Δ^i (positive or negative) between private and social costs



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CAVEATS TO DESIGNING TECHNOLOGY-SPECIFIC RES SUPPORT

- Asymmetric information: How specific in detail?
- Political economy: Premium to simplicity?
- Picking winners or „being picky on your picks“?

CONCLUSION

- Technology-specific RES support may increase cost-effectiveness, also in second-best settings.
- Technology-specific RES support is not by definition welfare-increasing!
- But neither is technology-neutral RES support!

Thank you for your attention!

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