



The Abdus Salam
International Centre for Theoretical Physics



**ICTP Experts Meeting on "Science & Renewable Energy"
January 15 - 18, 2007**

Venue: ICTP Adriatico Guest House - Lundqvist Lecture Hall

310/1905

"Lessons Learned from Promotion Strategies for
Increasing the Share of Res-E"

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LESSONS LEARNED FROM PROMOTION STRATEGIES FOR INCREASING THE SHARE OF RES-E

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Vienna University of Technology

TRIEST, 16th January 2007

1. Introduction
2. Survey on policy strategies
3. Objectives of promotion strategies
4. A comparison of the success
5. Success criteria for Feed-in tariffs
6. Success criteria for TGC-based quotas
7. Investment subsidies
8. The issue of competition
9. Conclusions

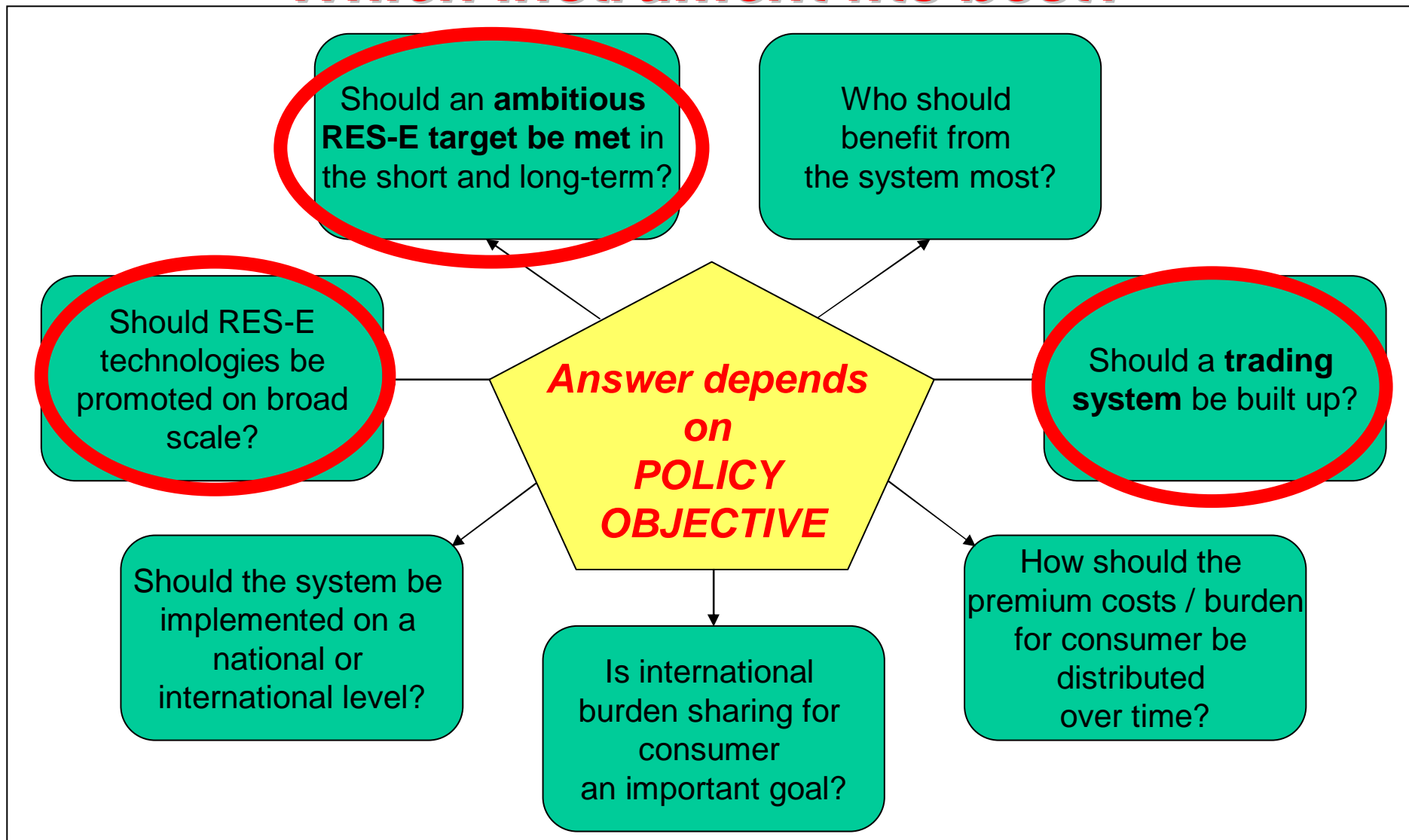
CORE MOTIVATION:

**Policy targets for an
INCREASE of RES-E!**

**(e.g. RES-E directive of the EC to
increase the share of RES-E from 12%
to 22% until 2010)**

What is the problem?

Which instrument fits best?



MAJOR PROBLEM:

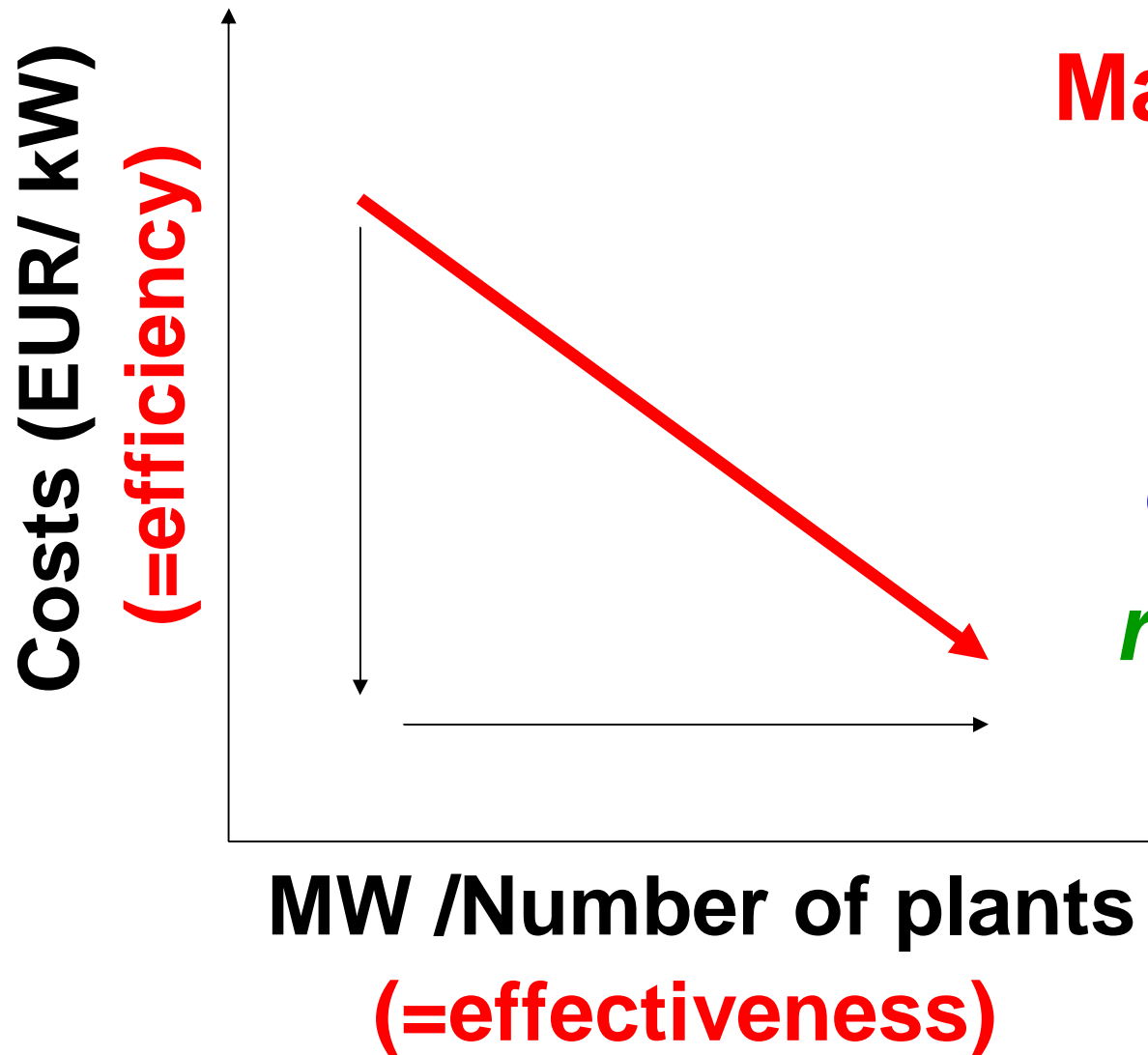
**Correct design of
promotion strategies**

- with respect to:
 - renewable targets
 - Financial incentives
 - Credibility for investors
 - Transfer costs!

2. SURVEY ON POLICY STRATEGIES

		REGULATORY	VOLUNTARY
Capacity-driven strategies	Generation-based	<ul style="list-style-type: none"> • RPS • Quota-based TGCs 	<ul style="list-style-type: none"> • National generation targets
	Investment focused	<ul style="list-style-type: none"> • Bidding/Tendering 	<ul style="list-style-type: none"> • National installation or capacity targets
Price-driven strategies	Generation-based	<ul style="list-style-type: none"> • feed-in tariffs, rate-based incentives • Net metering 	<ul style="list-style-type: none"> • Green Power Marketing <ul style="list-style-type: none"> • Green tariffs • Solar stock exchange
	Investment focused	<ul style="list-style-type: none"> • Rebates • Soft loans • Tax incentives 	<ul style="list-style-type: none"> • Contracting • Shareholder progr. • Contribution • Bidding
Other		—	<ul style="list-style-type: none"> • NGO-marketing • Selling green buildings <ul style="list-style-type: none"> • Retailer progr. • Financing • Public building prog.

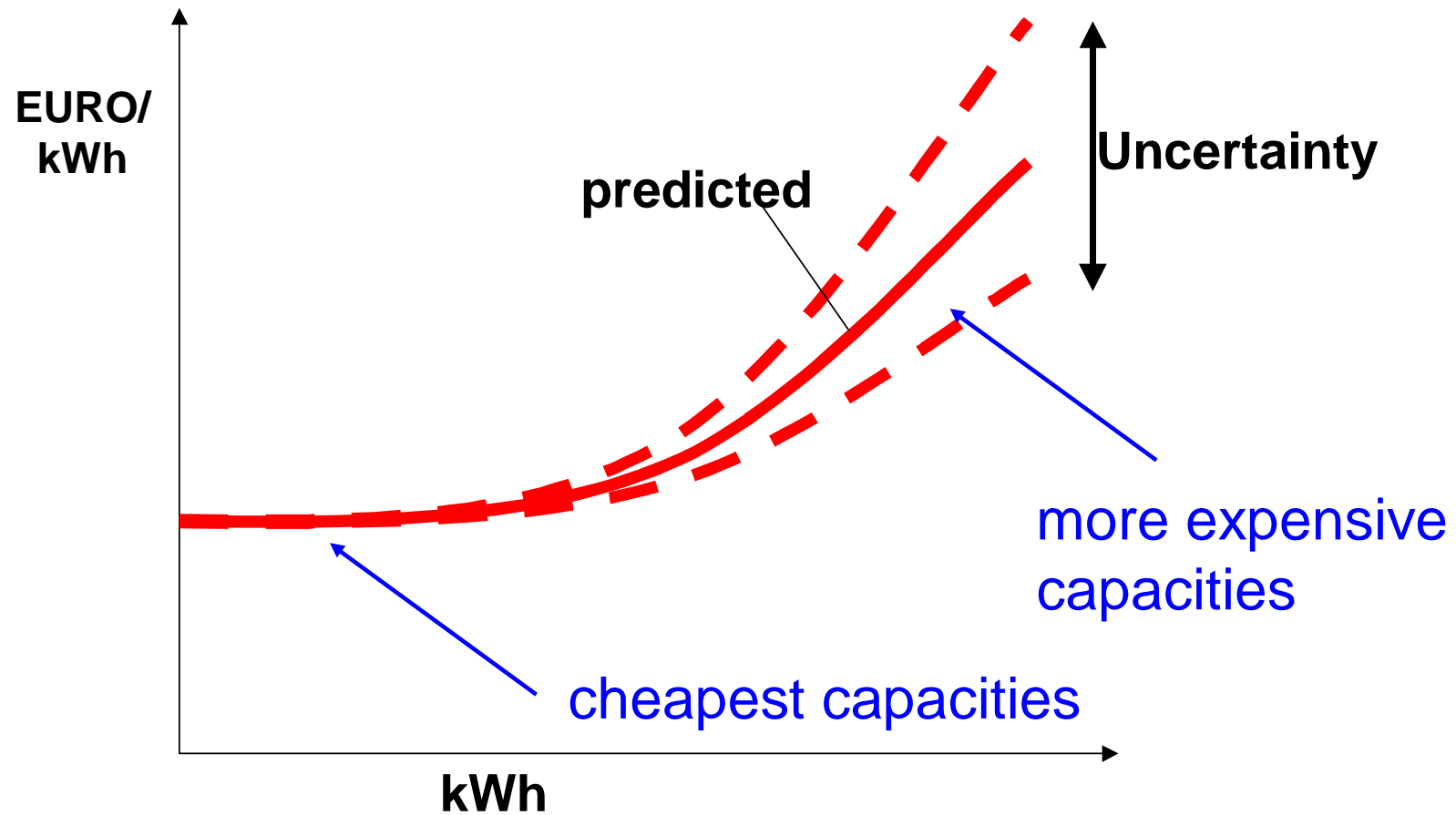
3. REQUIREMENTS TO SUCCESSFUL STRATEGIES



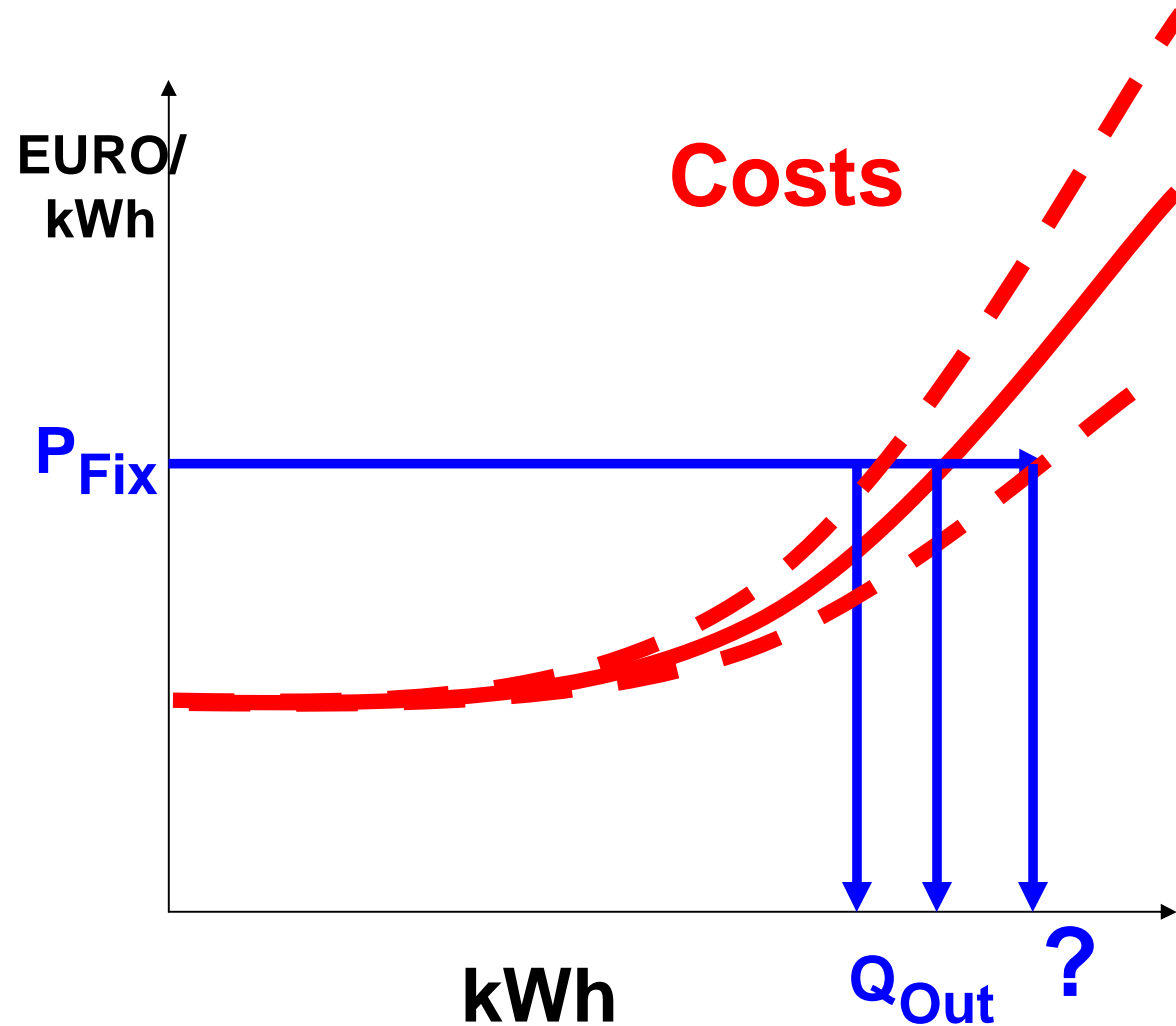
Major objectives:

- increase the amount of electricity from *renewables* and
- reduce costs!

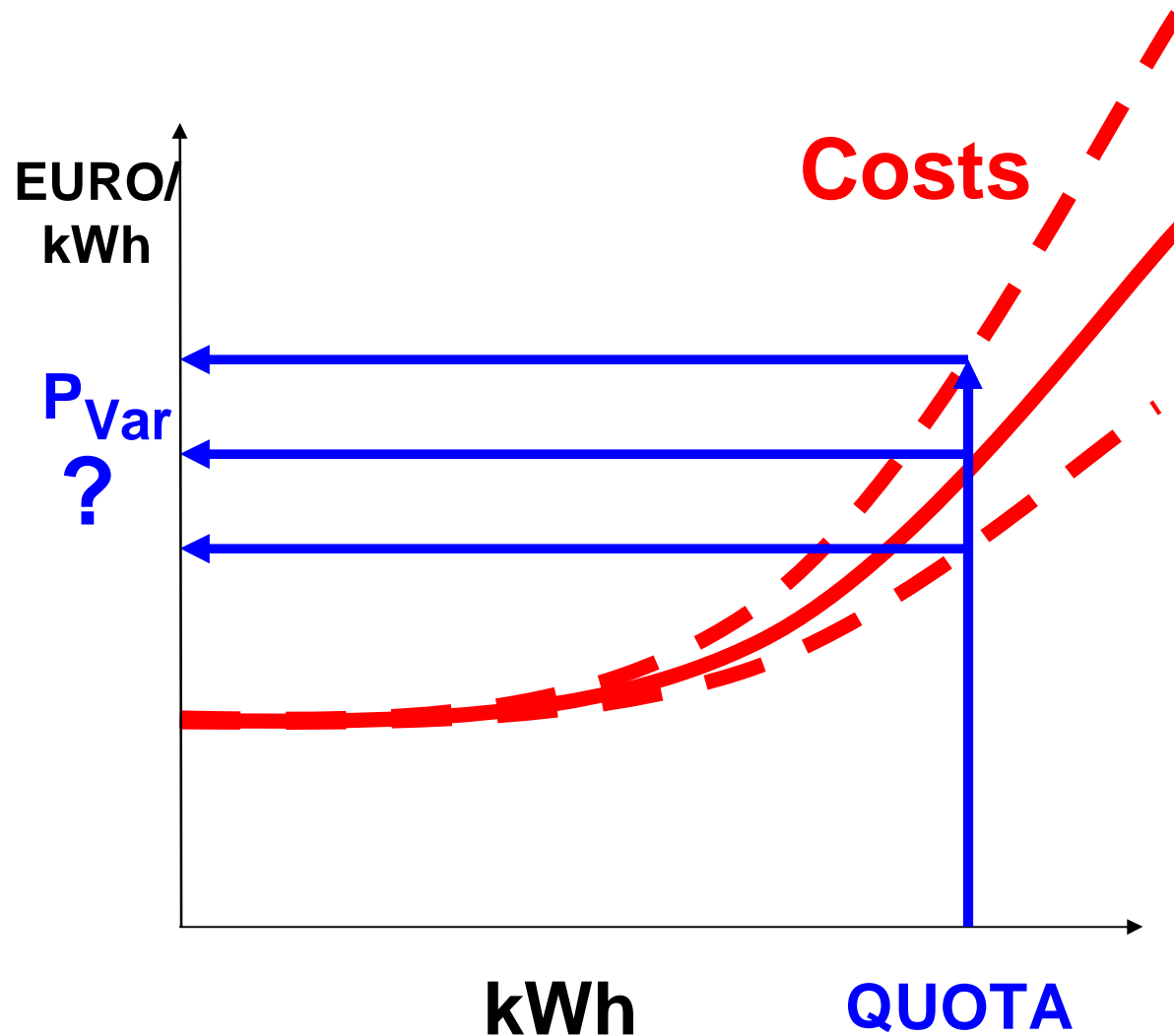
STATIC COST RESOURCE CURVES



HOW FEED-IN TARIFFS WORK



HOW QUOTA-BASED TRADABLE GREEN CERTIFICATES WORK



***All regulatory promotion strategies --
Quota-based TGC systems, Feed-in
tariff systems, rebates -- create***

artificial markets

and cause

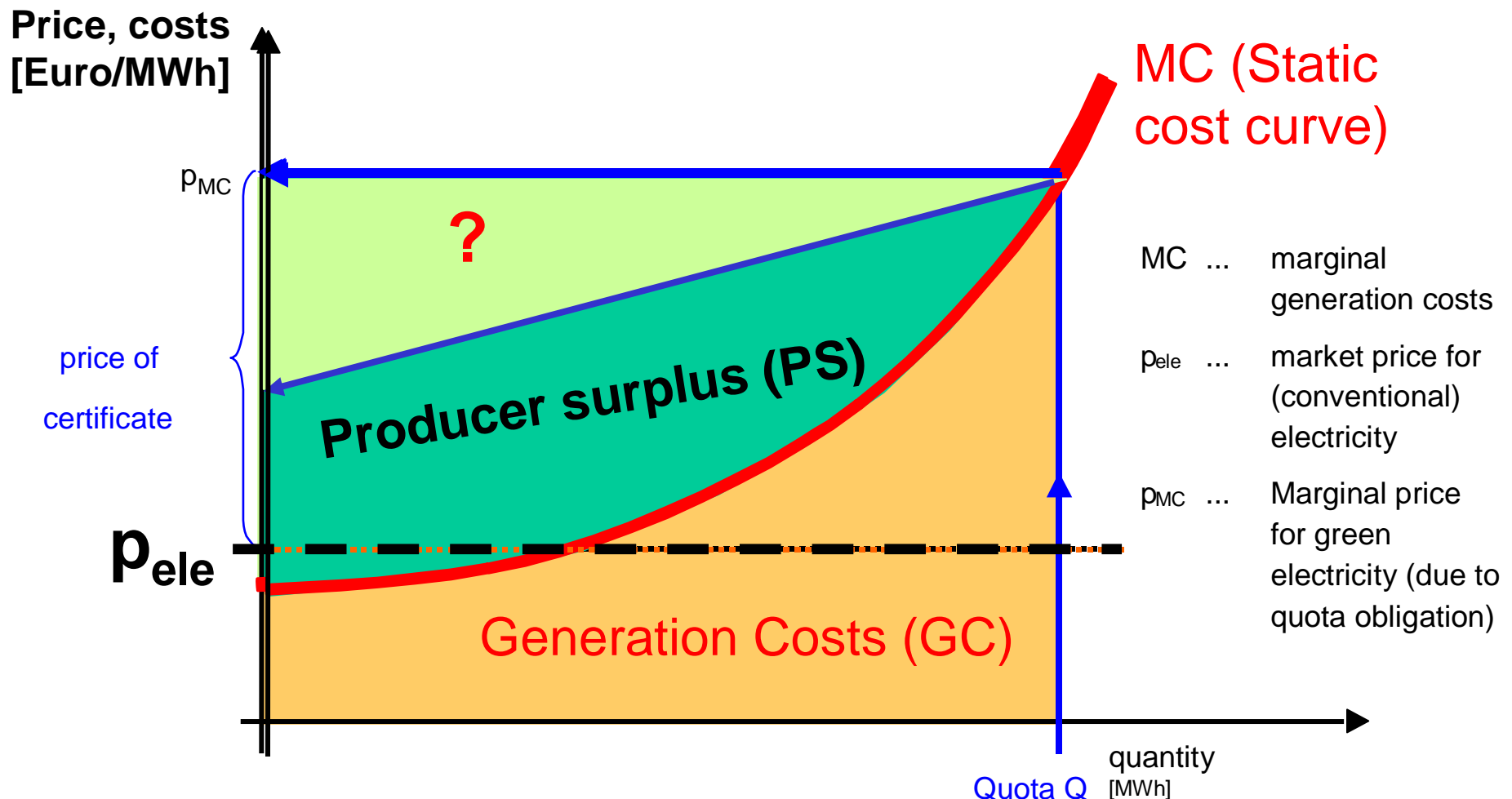
transfer costs (additional costs)

*Why is it important to
minimize these additional costs?*

*These additional costs have finally to be
paid by the final customers*

**(regardless which promotion scheme is
chosen)**

Minimise additional costs for consumers = **Producer Surplus** + **Generation costs** - **Revenues electricity market**



The lower the costs are which have finally to be paid by final customers

the higher will be public acceptance

the larger will be the amount of additional electricity generated from RES.

EU-Project **Green-X**

DG Research

Web: www.green-x.at

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

File Select parameter Simulation Results Additional tools Window ?

Energy policy instruments - Electricity

Select Germany Wind onshore

Germany Wind onshore

Feed in tariff | Tradable Green Certificates | Additional instruments

☒ Feed in tariff

☒ Fixed tariff

☐ Premium tariff

Valid for plants not older than 15 year(s)

Guaranteed tariff for 20 year(s)

☐ Flat rate

Value €/MWh

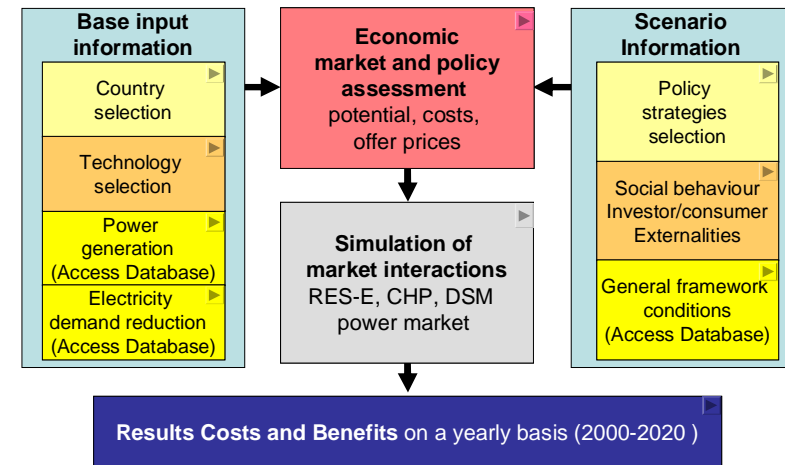
☐ Stepped rate

Maximum value 85.26 €/MWh Full load hours to 1800

Minimum value 61.74 €/MWh Full load hours to 3275

OK Cancel

The toolbox **Green-X**



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

File Select parameter Simulation Results Additional tools Window ?

Results - Country specific - Cross-section

Select European Union 15 2011

European Union 15

General Results	
Total Electricity Consumption	3.106.825,00 GWh
Share of total electricity consumption	100,00 %
Total Electricity Generation	3.091.155,25 GWh
Share of total electricity consumption	99,50 %
Electricity Generation	
Total Electricity Generation	3.091.155,25 GWh
of which from renewable energy sources (RES)	687.574,44 GWh
Share of total electricity generation	18,66 %
Share of total electricity consumption	19,56 %
of which from electricity plants (ELE)	555.582,81 GWh
Share of total electricity generation	17,97 %
Share of total electricity consumption	17,88 %
of which from combined heat and power plants (CHP)	51.391,61 GWh
Share of total electricity generation	1,66 %
Share of total electricity consumption	1,67 %
Generation Costs	
Total Generation Costs due to renewable energy sources (RES)	24.836,06 Mill. Euro per year
of which due to electricity plants (ELE)	20.741,35 Mill. Euro per year
Share of total generation costs	80,31 %
of which due to combined heat and power plants (CHP)	4.094,72 Mill. Euro per year
Share of total generation costs	16,49 %
Total Costs for Society	

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

File Select parameter Simulation Results Additional tools Window ?

Results - Technology specific - Cross-section

Select Denmark 2020

Denmark

Technology	Electricity Generation	Share of Electricity Generation	Electricity Generation new plants	Share of Electricity Generation new plants	Installed capacity	Share of Installed capacity	New installed capacity
	GWh	%	GWh	%	MW	%	MW
Total Renewable Energy Sources (RES)	9.080,29	100,00	38,67	100,00	3.522,69	100,00	10,47
without large scale hydro power	9.080,29	100,00	38,67	100,00	3.522,69	100,00	10,47
of which combined heat and power (CHP)	1.403,65	15,46	11,54	29,33	269,95	7,65	1,75
Bioogas	130,65	1,54	0,96	2,33	33,97	0,96	1,38
Biomass	1.435,53	15,81	15,97	41,30	271,88	7,72	2,76
Geothermal electricity	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Hydro power	27,18	0,30	0,00	0,00	9,67	0,27	0,00
Small scale (< 10MW)	27,18	0,30	0,00	0,00	9,67	0,27	0,00
Large scale (> 10MW)	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Landfill gas	106,36	1,17	6,95	17,88	18,65	0,53	1,29
Sewage gas	67,23	0,74	0,00	0,00	14,94	0,42	0,00
Solar	0,91	0,01	0,00	0,00	1,28	0,04	0,00
Photovoltaic	0,91	0,01	0,00	0,00	1,28	0,04	0,00
Solar thermal	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Tidal	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wave	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Wind	7.388,44	81,37	20,68	53,49	3.185,67	90,43	7,39
onshore	8.823,19	88,27	1.215,45	3.143,11	3.765,11	106,88	515,49
offshore	1.261,93	13,80	137,28	355,00	401,95	11,41	40,00

EU-Project **Green-X**

DG Research

Web: www.green-x.at



This research project is supported by the European Commission, DG Research under the Fifth Framework Programme and contributing to the implementation of the Key Action "Socio Economic aspects of energy within the perspective of sustainable development. Methodologies for global systems analysis" within the thematic programme "Energy, Environment and Sustainable Development"
Contract No. ENG2-CT-2002-00607



Platform Win2000 SP3
Win XP SP1
Version 4.4.3

... to simulate various policy strategies for the promotion of RES-E in a dynamic framework on a national or international level (*considering DS-effects*)

**(Current: EU-25, end 2006: EU28,
future: EU 39???)**

THE „POLICY“ TRACK OF EEG EU PROJECTS

1999

2001

2003

2005

2007

ELGREEN

theoretical modeling

GREEN-X

TRACK:
GREEN-NET

OPTRES

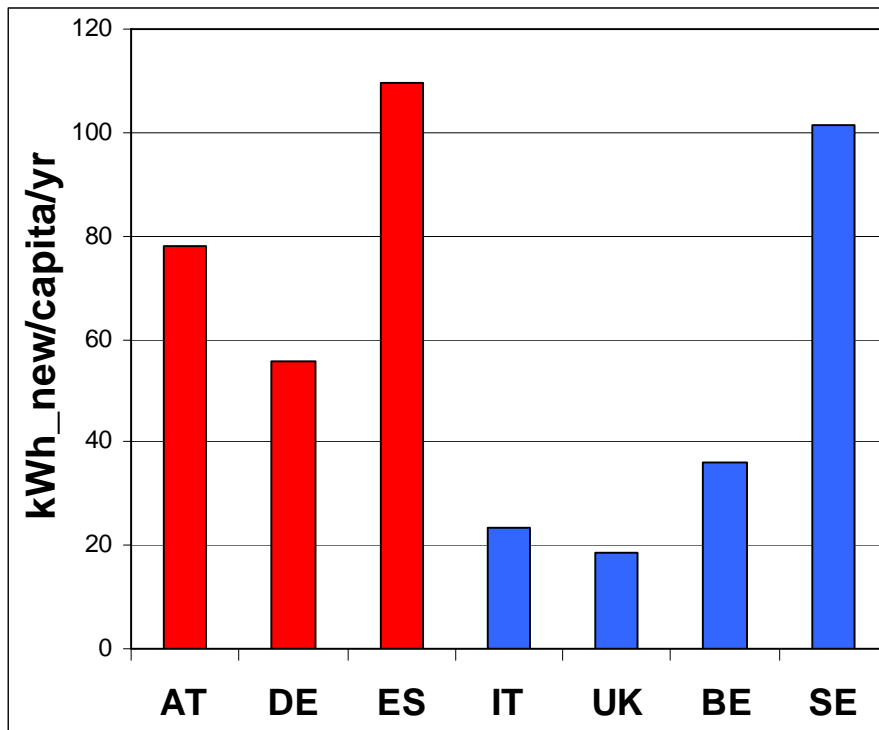
PROG-RES

FUTURES-E

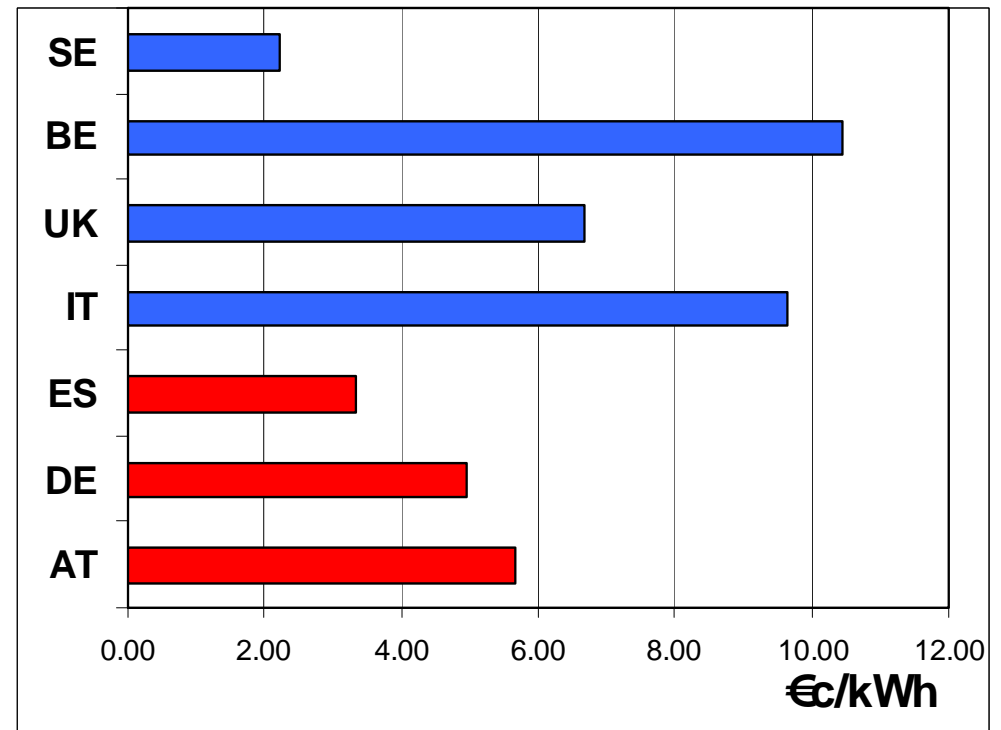
empirical application

4. LESSONS LEARNED: COMPARISON OF STRATEGIES

Effectiveness:

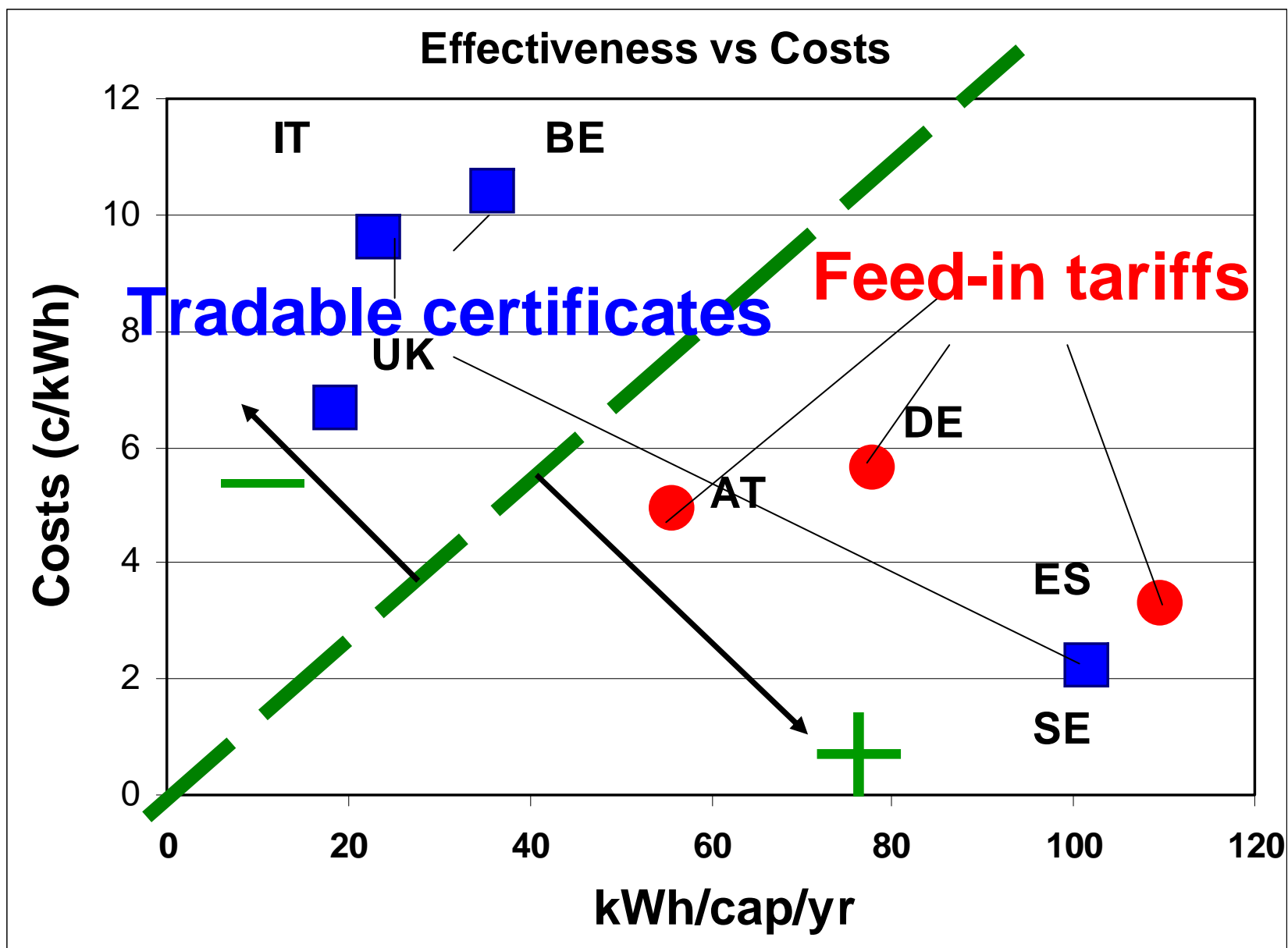


Costs:



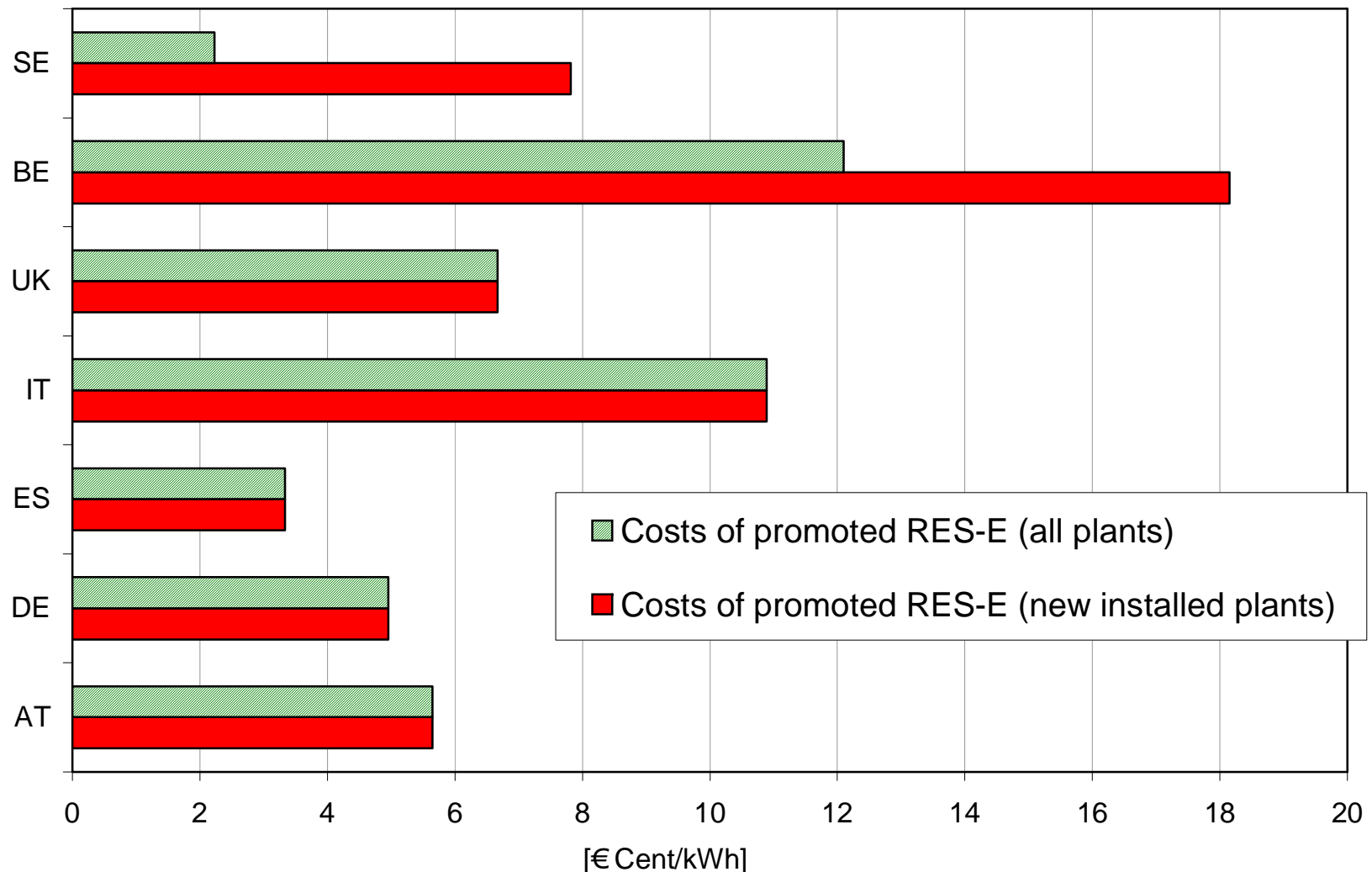
(2000-2004)

EFFECTIVENESS VS COST

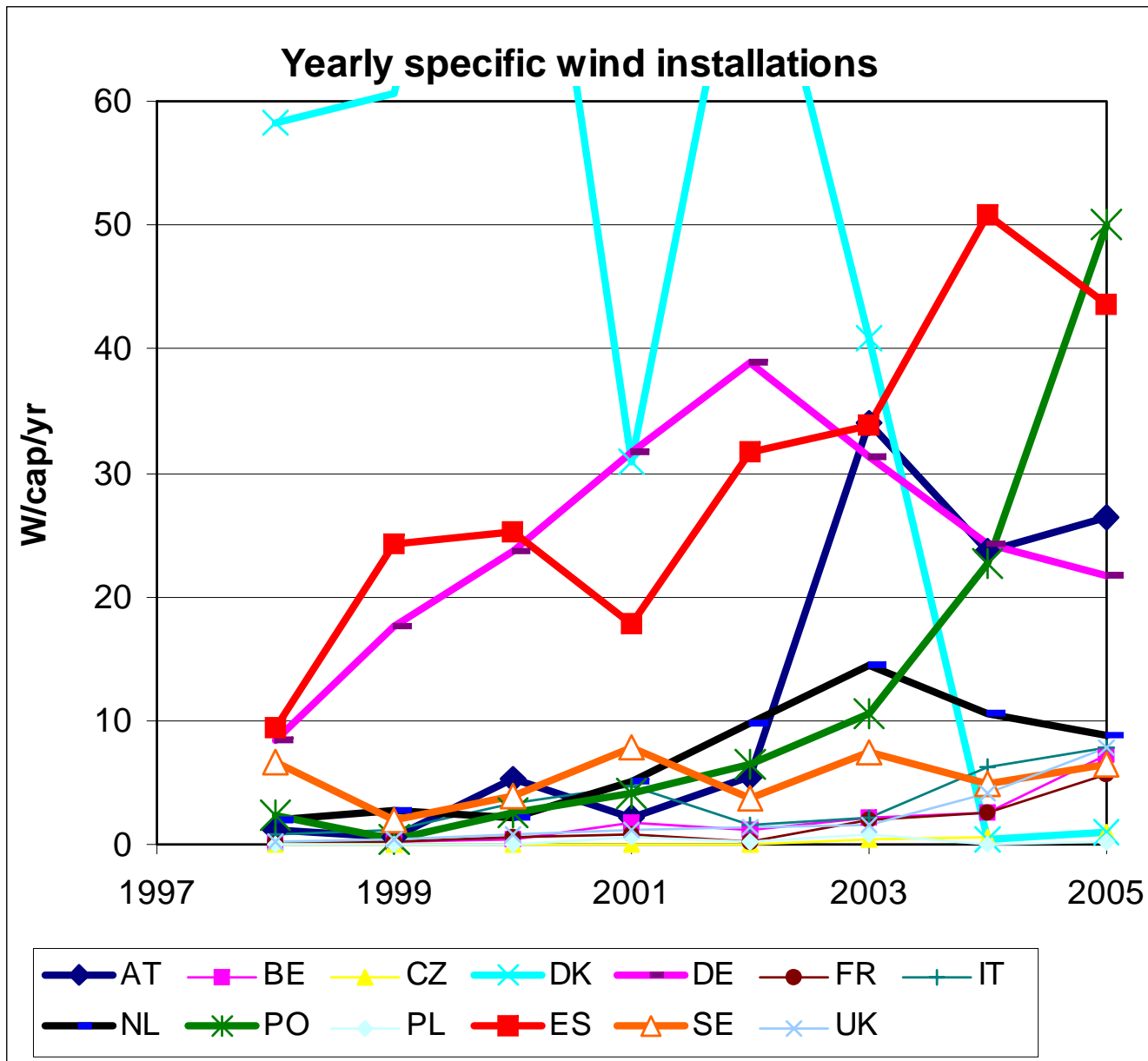


Costs of promoted kWh vs costs of new kWh

Costs of promoted RES-E versus costs of "new" RES-E

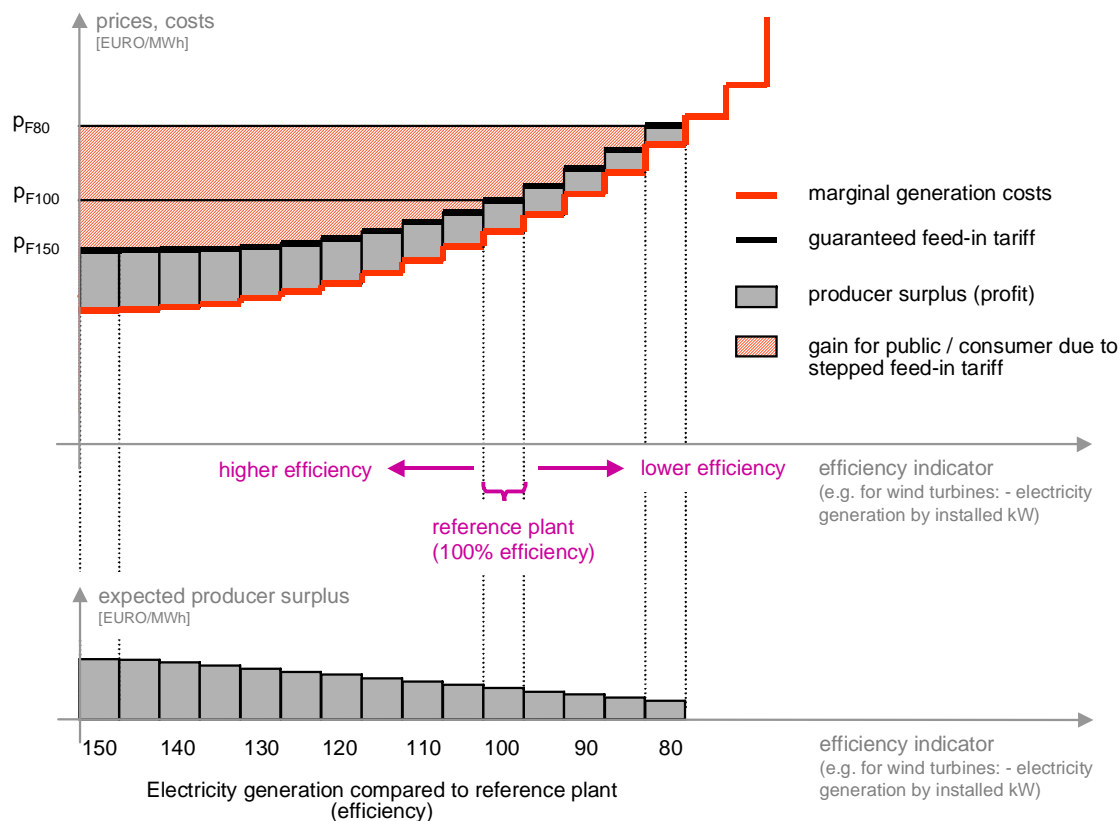


WIND: INSTALLATIONS PER YEAR



5. SUCCESS CRITERIA FOR FIT's

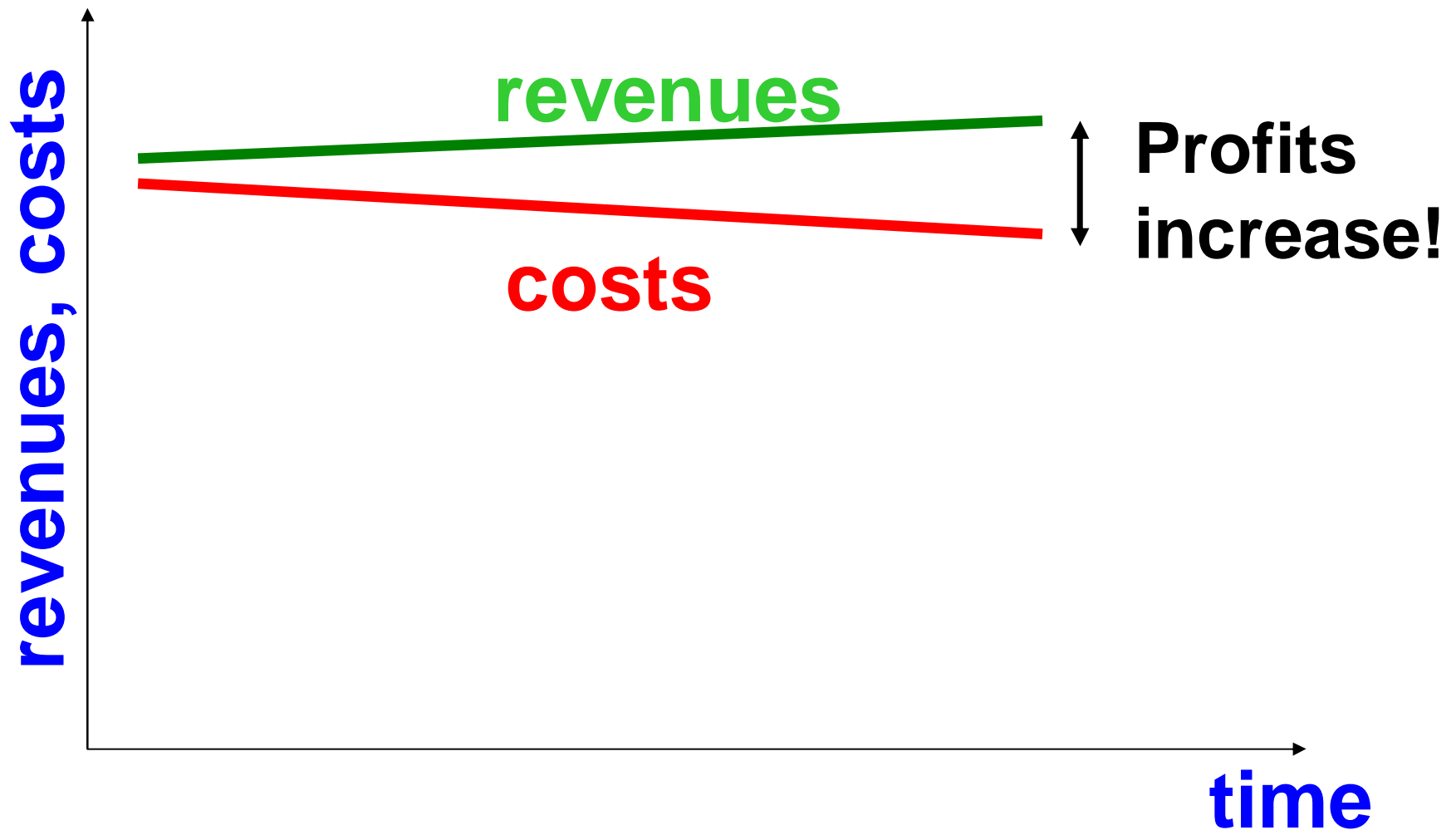
1 Use a stepped FIT and calculate starting values carefully



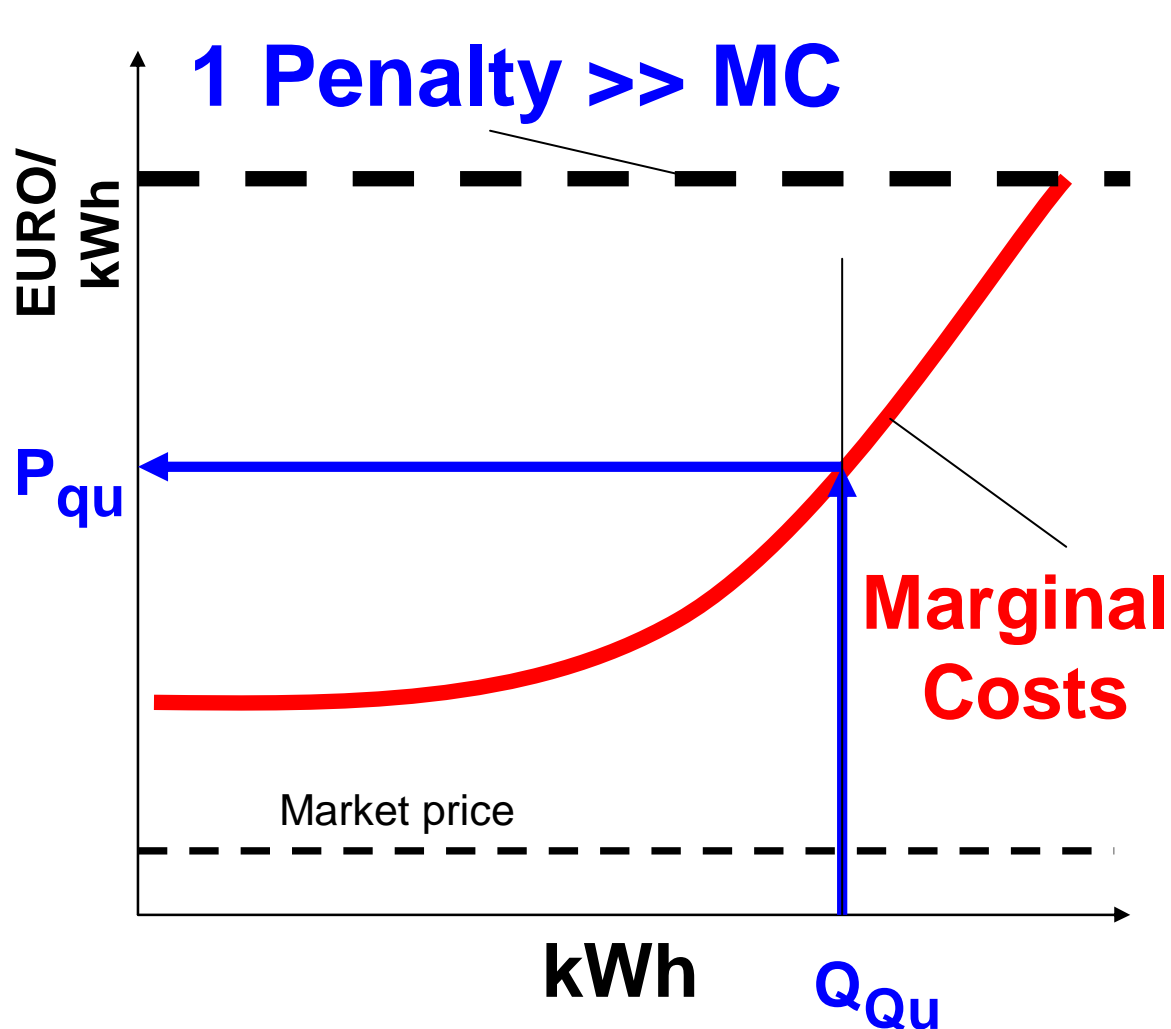
2 Decrease
over time!

3 Realistic
time
frame

EMPIRICAL PROBLEM OF FITs: The example of wind



6. SUCCESS CRITERIA FOR QUOTA-BASED TGC's



2 Ensure long-term planning horizon!

3 Focus on new plants

1 Market is too small:

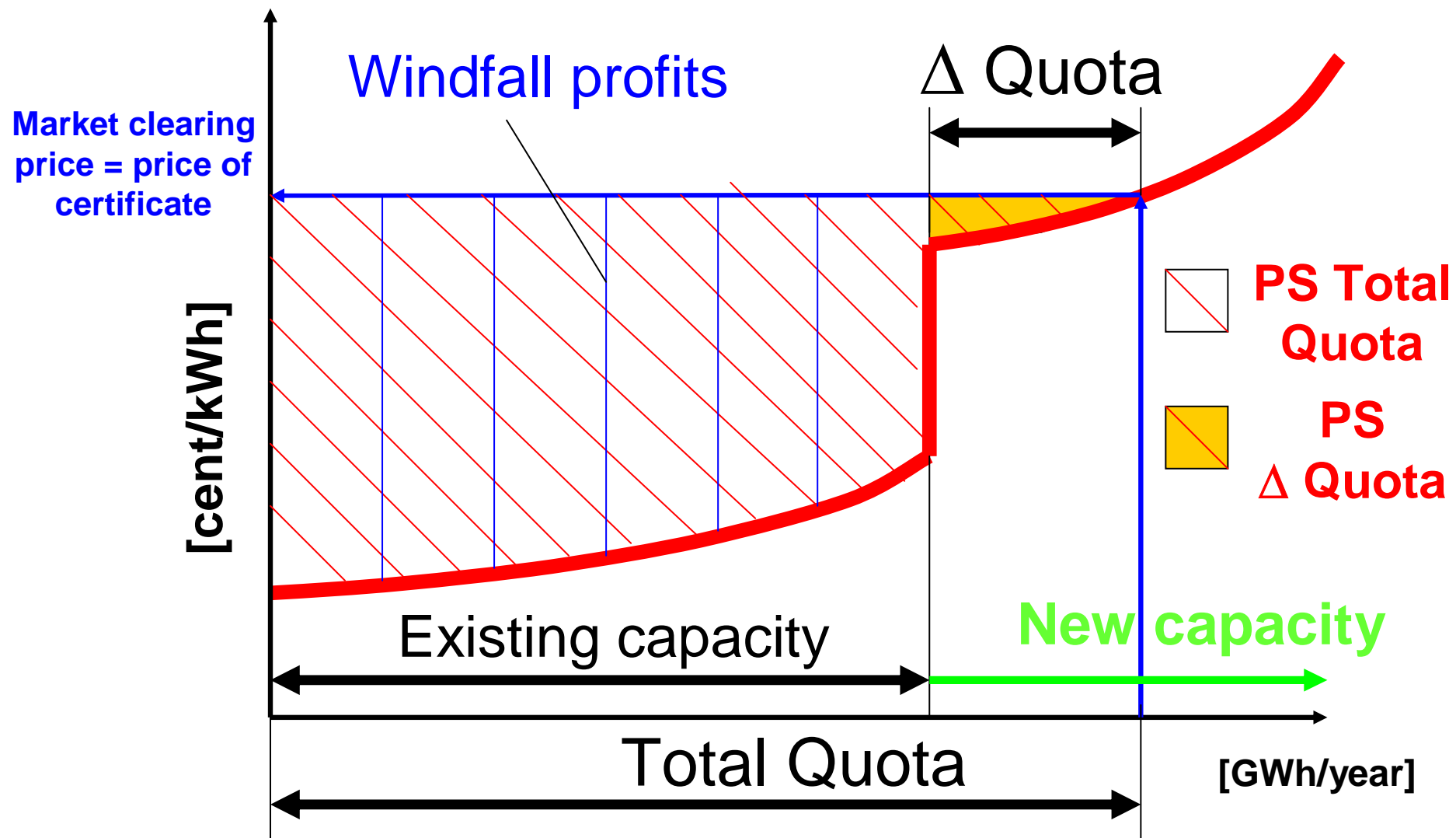
e.g. in a small country for one technology with very limited potential -> Non-Liquid because every single plant is known (e.g. Flanders (BE))

2 Windfall profits for existing capacities (e.g. Flanders (BE), Sweden)

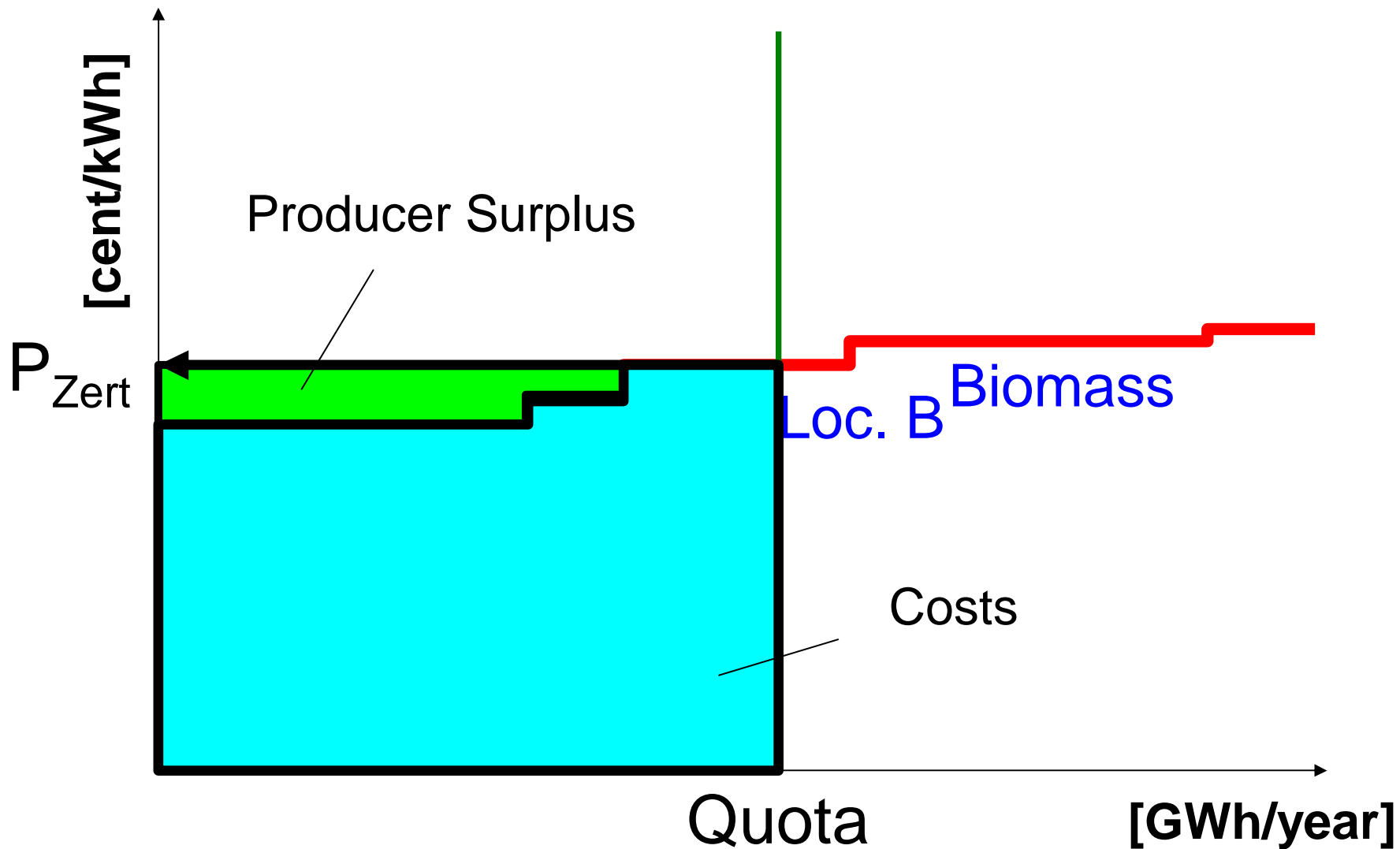
3 Penalty is too low (e.g. UK)

4 Planning horizon too short (e.g. UK 2003, Italy)

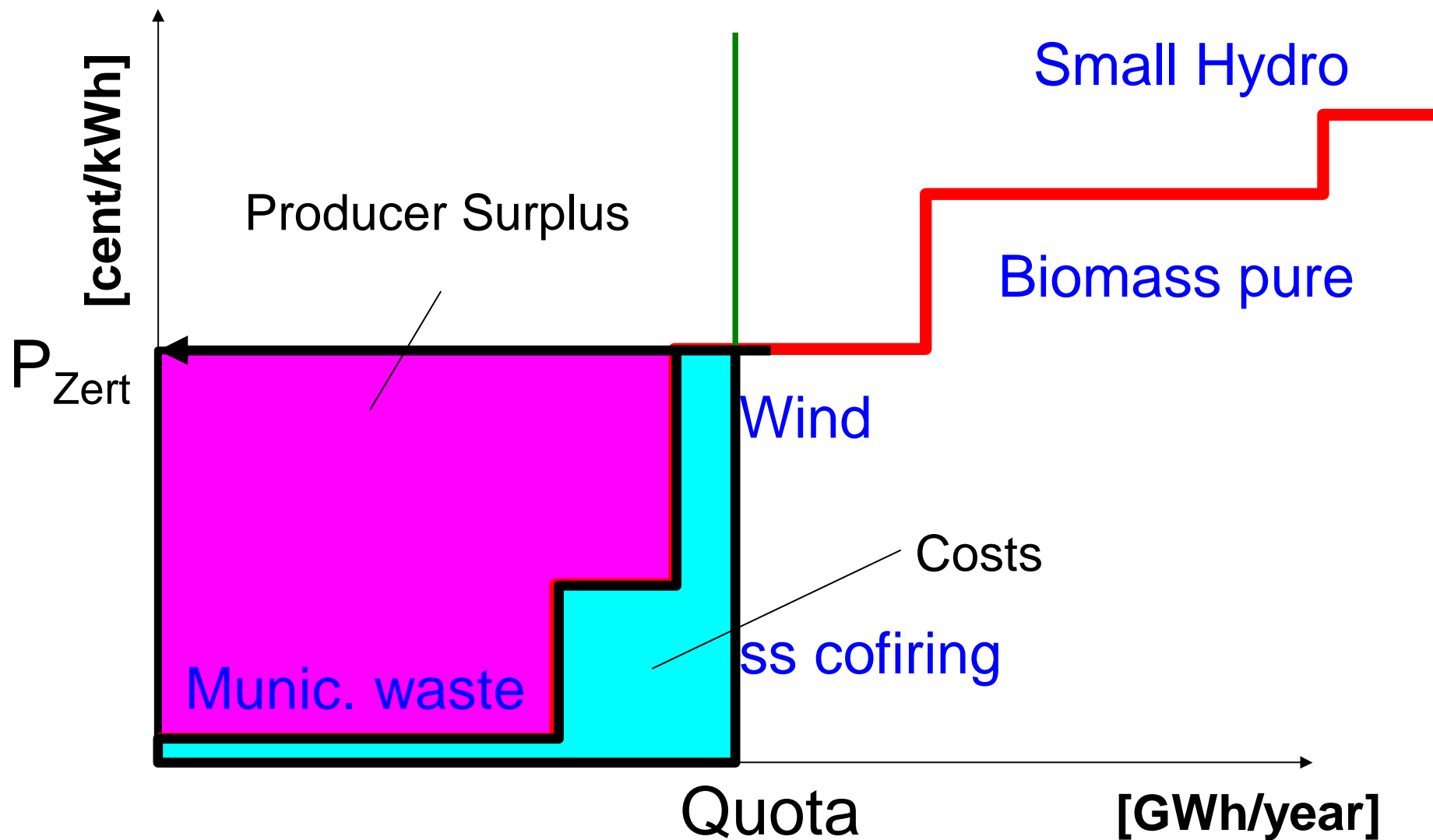
QUOTA: EXISTING VS NEW CAPACITY



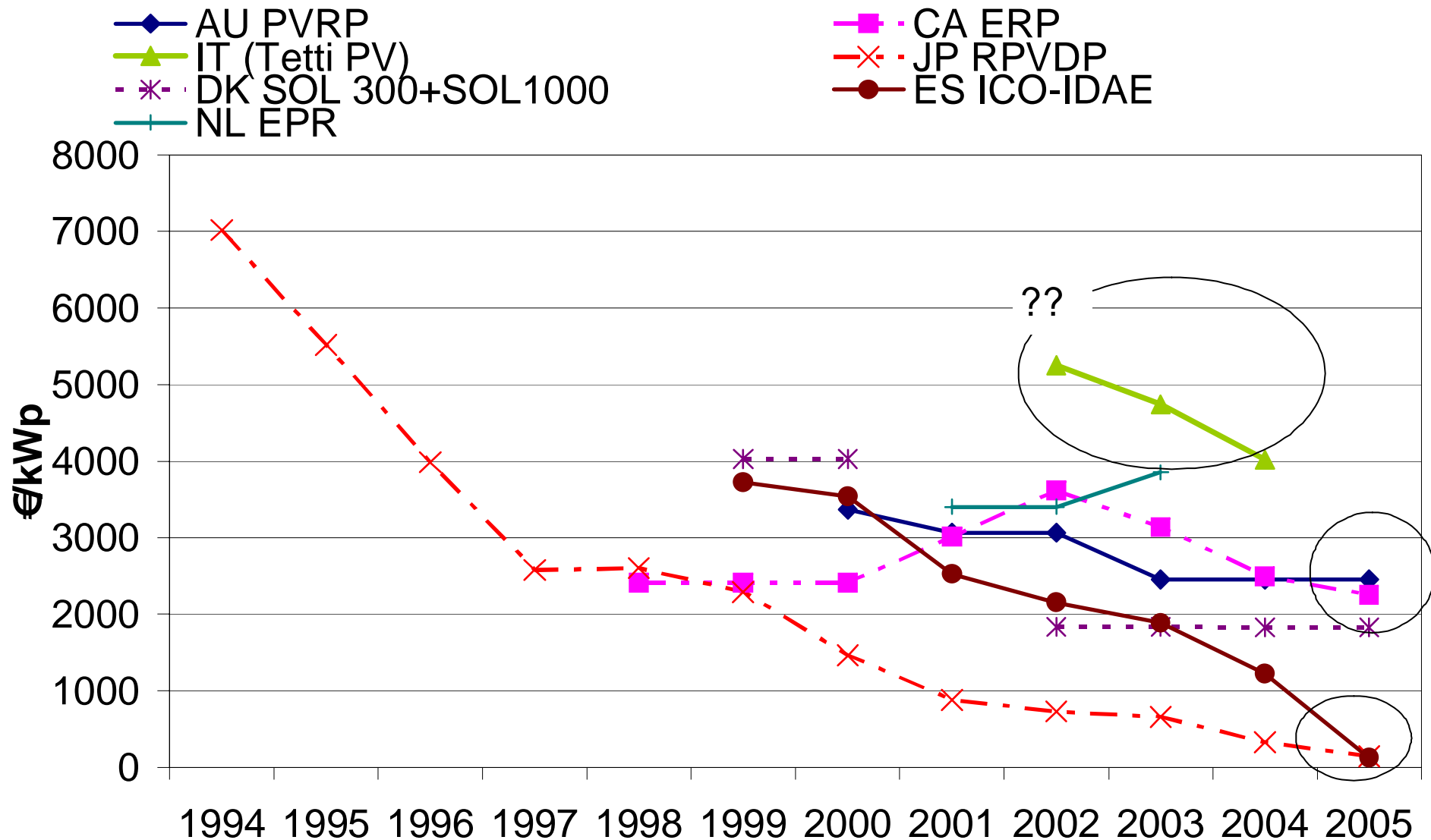
IMPACT OF THE SHAPE OF THE COST CURVE



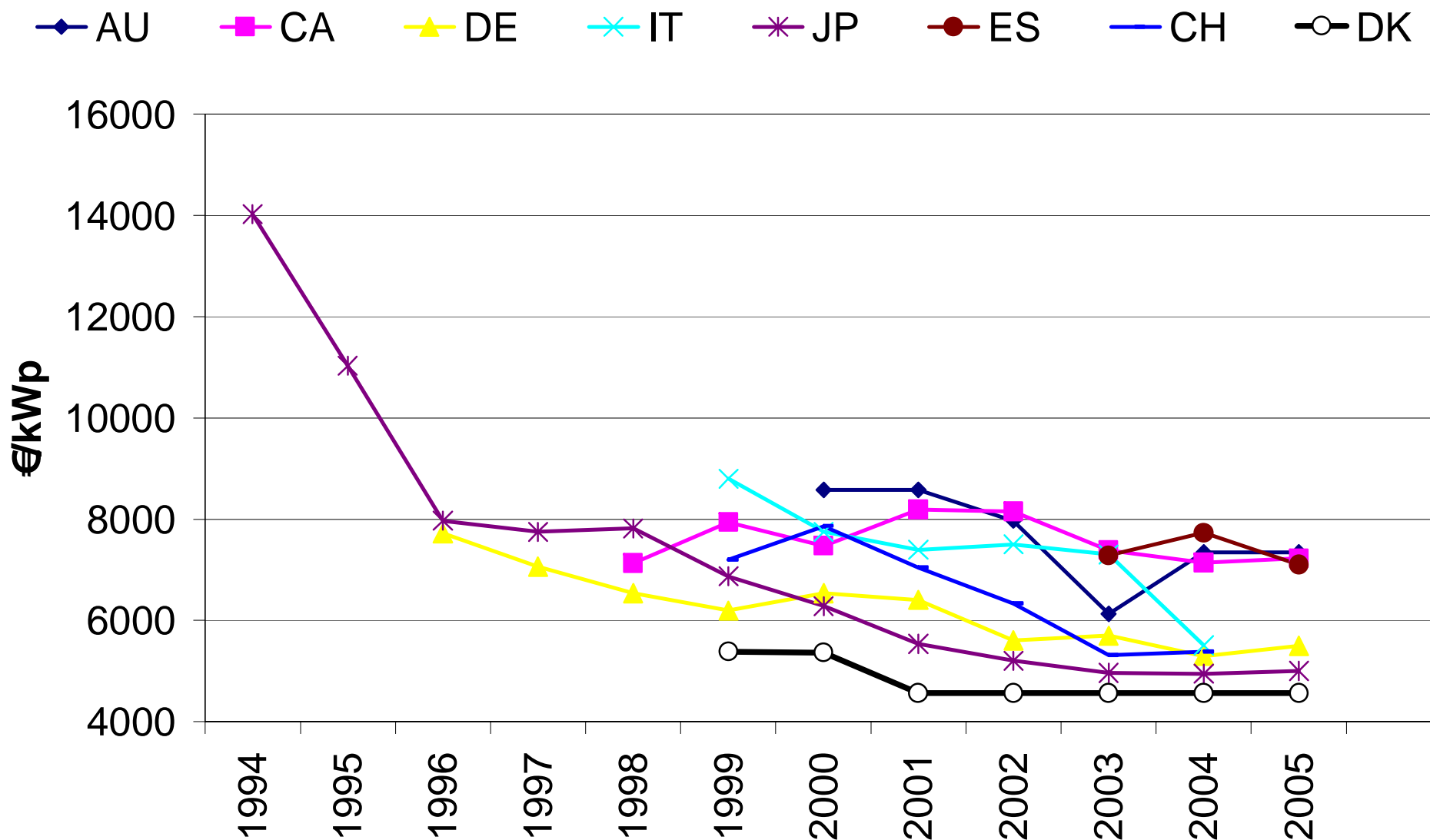
IMPACT OF THE SHAPE OF THE COST CURVE



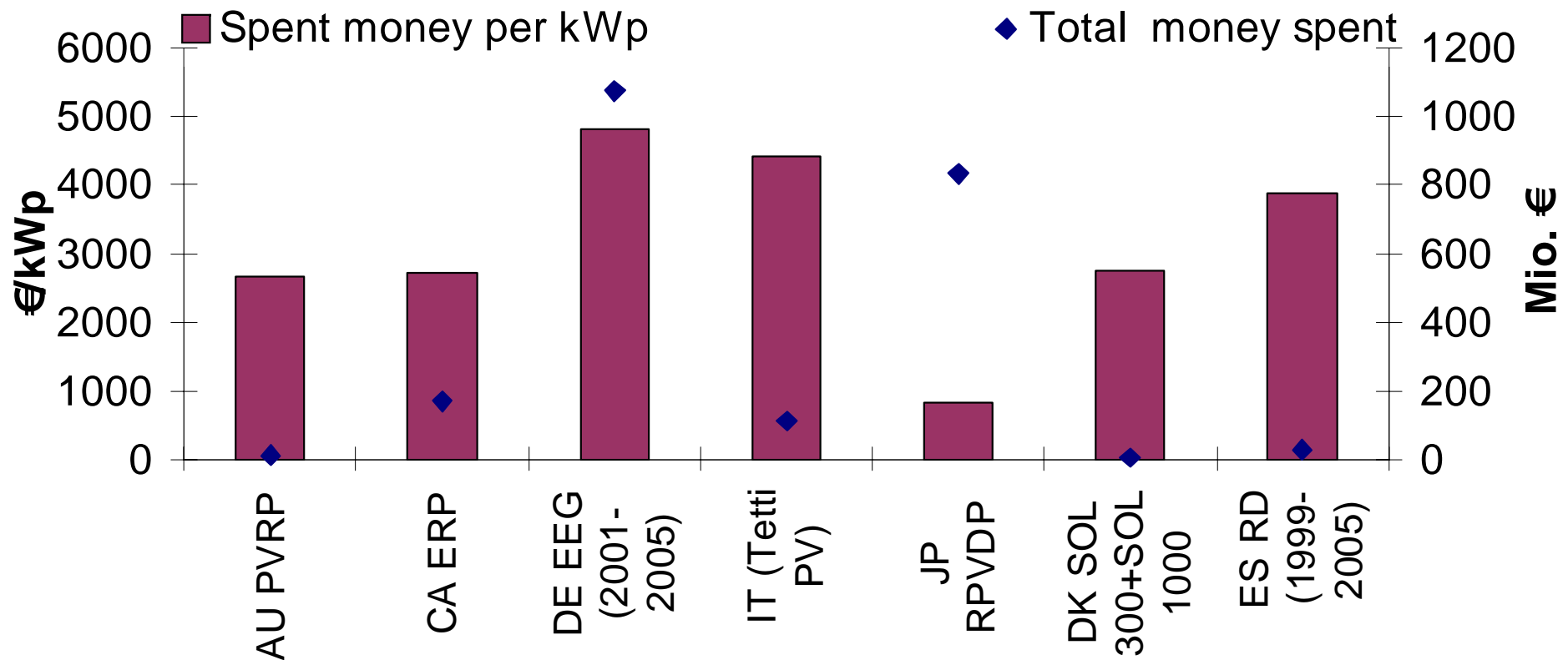
7.INVESTMENT SUBSIDIES FOR PV



COST DEVELOPMENT FOR PV



PUBLIC MONEY SPENT FOR PV



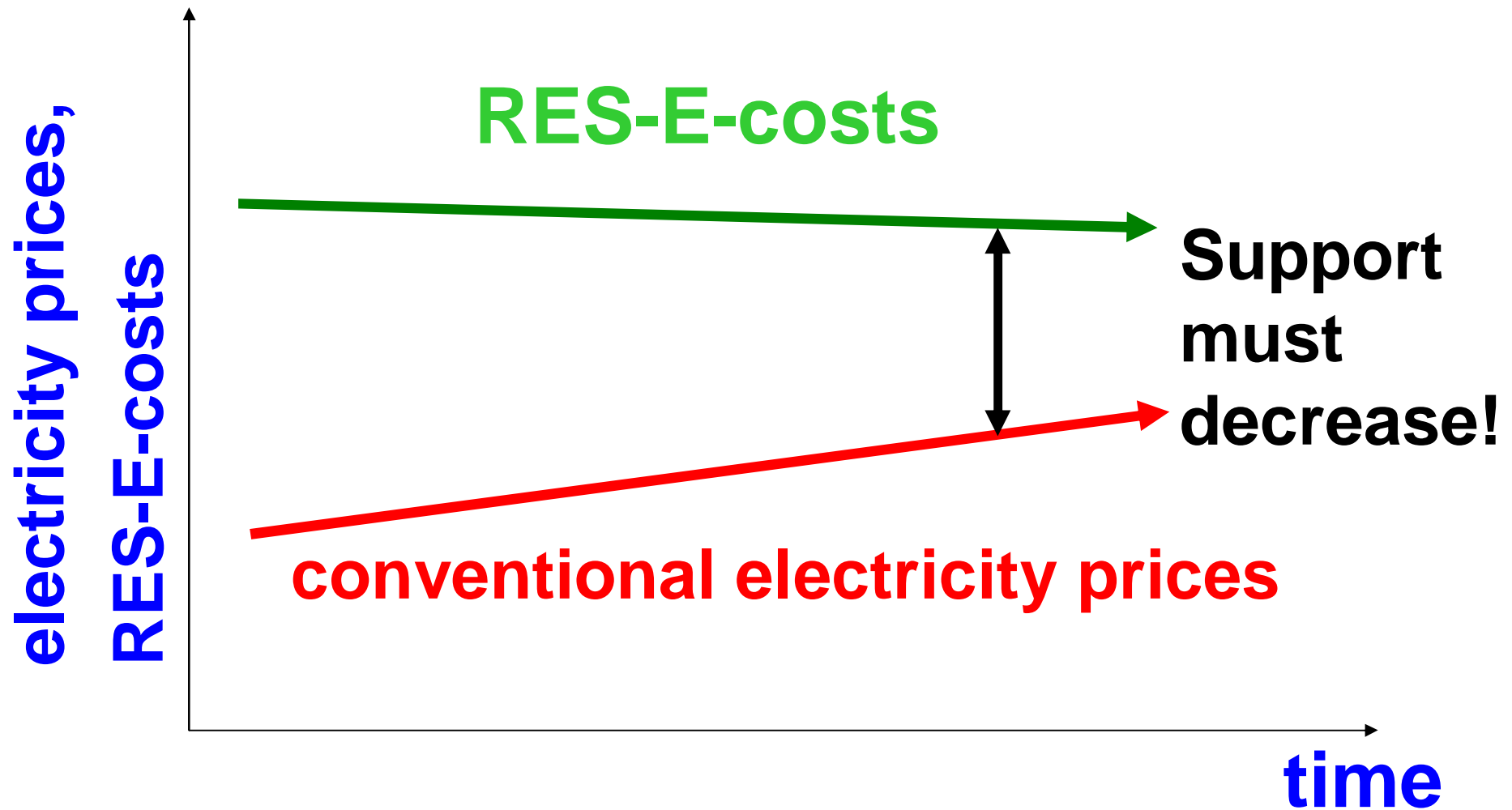
8. COMPETITION?

- **Competition among manufacturers exist**
- **Most important argument for TGCs: it is assumed that they foster competition between generators**
- **Objective of competition -> competitive prices**
- **competitive prices:**
 Prices = marginal costs (of generation)
- **Currently:**
 certificate prices > average feed-in-tariffs
- **No indicator for real competition in TGC markets!**
- **-> Utilities are in favour of TGC because they can make more money in TGC markets !**

- No “One size fits all” approach!
- Careful design of a strategies:
by far the most important success criteria!
- There should be a clear focus on NEW capacities!
- To ensure significant RES-E deployment in the long-term, it is essential to promote a broad portfolio of different technologies
- For FIT: Consider „learning“ by a dynamic component!
- Ensure credibility of the system! Avoid „stop-and-go“ approaches

IMPROVE THE CURRENT SYSTEMS!

DYNAMICS FOR FIT AND INVESTMENT SUBSIDIES IMPORTANT!



- Instead of harmonisation: Stimulate/Foster competition between promotion schemes/between countries: Which system/where provides new RES-E capacities at lowest costs for society?
- Exchange lessons learned for improvement of strategy design!
- Currently, for feeding electricity into the grid a well-designed (dynamic) FIT provides a certain deployment of RES-e fastest and at lowest costs for society
- However, for sustainable policy -> parallel focus on demand-side conservation of high priority!











A collage of four images: wind turbines on a hill, solar panels, a hand holding wood chips, and a dam. The text 'INTERESTED IN FURTHER INFORMATION?' is overlaid in large green letters.

INTERESTED IN FURTHER INFORMATION?

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