Multi-Criteria Decision Analysis

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Overview

- What is Multi-criteria decision analysis? What is PROMETHEE?
- Criteria and criteria weighting
- (Draft) results and conclusions

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What is multi-criteria decision analysis?

- Most human decision-making problems are of a multi-criterial nature
- But usually, no solution exists which optimises all the criteria at the same time
- The basic data of such a multi-criteria problem is summarised in the evaluation table:

Alternatives/Policy Pathways	a_1	a_2	a_3	a_4	a_5
Criteria					
Effectiveness : f_1	$f_1(a_1)$	$f_1(a_2)$	$f_1(a_3)$	$f_1(a_4)$	$f_1(a_5)$
Static efficiency: f_2	$f_2(a_1)$	$f_2(a_2)$	$f_2(a_3)$	$f_2(a_4)$	$f_2(a_4)$
Dynamic efficiency: f_3	$f_3(a_1)$	$f_3(a_2)$	$f_3(a_3)$	$f_3(a_4)$	$f_3(a_4)$
Transaction cost efficiency: f_4	$f_4(a_1)$	$f_4(a_2)$	$f_4(a_3)$	$f_4(a_4)$	$f_4(a_4)$
Equity: f_5	$f_5(a_1)$	$f_5(a_2)$	$f_5(a_3)$	$f_5(a_4)$	$f_5(a_4)$
Soc.-pol. acceptability: f_6	$f_6(a_1)$	$f_6(a_2)$	$f_6(a_3)$	$f_6(a_4)$	$f_6(a_4)$
Legal feasibility: f_7	$f_7(a_1)$	$f_7(a_2)$	$f_7(a_3)$	$f_7(a_4)$	$f_7(a_4)$

- The analysis will produce a ranking of alternatives, depending on how highly each alternative scores in each criterion
- Obviously, the ranking also depends on the importance attached to each criterion by the decision maker
- For this analysis, we use the MCDA method PROMETHEE

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Criteria

Effectiveness	
Static Efficiency	
Dynamic Efficiency	Diversification of RES technology portfolio
	Technology learning - reduction of RES generation cost
Equity	
Environmental and economic effects	Avoided GHG emissions due to RES
	Avoided fossil fuel imports due to RES
Political Acceptability for national DMs	
Legal feasibility	

Data from Green-X modelling

Data from semi-structured interviews with national DMs

Data from legal analysis

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Decision makers

Stakeholder positions and criteria weightings elicited from various sources:

- Criteria weighting questionnaire (83 respondents)
- detailed interviews (8 interviewees)
- Publicly available sources, i.e. responses to the Commissions Green Paper Consultation “A framework for 2030 climate and energy policies”

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Decision maker prototypes

The Environmentalist	
Effectiveness	20%
Static Efficiency	
Dyn.Eff – Diversified Portfolio	25%
Dyn.Eff – Technology Learning	15%
Equity	
EnvEco – avoided GHG	30%
EnvEco – avoided fossil fuel imports	10%
Political Acceptability for nat. DMs	
Legal	

Real stakeholders are somewhere between these extremes

The Cost-Concerned	
Effectiveness	
Static Efficiency	45%
Dyn.Eff – Diversified Portfolio	15%
Dyn.Eff – Technology Learning	15%
Equity	15%
EnvEco – avoided GHG	
EnvEco – avoided fossil fuel imports	10%
Political Acceptability for nat. DMs	
Legal	

The Pragmatic	
Effectiveness	
Static Efficiency	20%
Dyn.Eff – Diversified Portfolio	10%
Dyn.Eff – Technology Learning	10%
Equity	
EnvEco – avoided GHG	
EnvEco – avoided fossil fuel imports	
Political Acceptability for nat. DMs	30%
Legal	30%

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"...it is about that stage of development of renewables, where you are trying to get your economies of scale, your wide-scale deployment, and that is why for us, effectiveness is the most important criterion." NGO respondent

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Political Acceptability for nat. DMs	
Legal	

"I would say the development of technologies is most important."
RES industry respondent

"...the EU must assess how the remaining emissions can be reduced by the deployment of renewable energy. "
Greenpeace response to Commission Green Paper

"...the EU should further reduce its import dependency on fossil fuels..."
EREC response to Commission Green Paper

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"...we are really concerned about the cost and the price impact of the existing way of supporting renewables." European industry respondent

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Equity	15%
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EnvEco – avoided fossil fuel imports	10%
Political Acceptability for nat. DMs	
Legal	

"The Commission loves targets and always wants to introduce targets [...][but] We think cost efficiency considerations have been missing." Energy industry respondent

"It is obvious that you have to make big investments to start off a learning curve." Energy industry respondent

"Avoided carbon emissions due to RES are not relevant, because under a functioning ETS they will just be avoided in another sector at lower cost." Workshop participant from energy industry

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""We want cost efficiency […] so it can be socially and politically acceptable to those who have to carry the burden." Energy industry respondent

The Pragmatic	
Effectiveness	
Static Efficiency	20%
Dyn.Eff – Diversified Portfolio	10%
Dyn.Eff – Technology Learning	10%
Equity	
EnvEco – avoided GHG	
EnvEco – avoided fossil fuel imports	
Political Acceptability for nat. DMs	30%
Legal	30%

"You have to see this pragmatically. Some things are not possible due to elections, to strategic publications and decisions..." Energy industry respondent

"Legal feasibility is the most difficult one. I either rank it very low, because I assume it as given, or very high, because if [a pathway] is not feasible according to EU regulation, then it is not possible to have it." RES industry respondent

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Policy Pathways

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Degree of harmonisation			*Support instrument* FIT (feed-in tariff)	FIP (feed-in premium)	QUO (quota system with uniform TGC)	QUO banding (quota system with banded TGC)	ETS (no dedicated RES support)	TEN (Tendering for large scale RES)
Full	•EU target •One instrument		1a	2a	3a	4a	5	6 Sensitivity to 7 (national support, but harmonisation for selected technologies)
Medium	•EU target •One instrument •Additional (limited) support allowed		1b	2b	3b	4b		
Soft	•EU & National targets •One instrument •MS can decide on various design elements incl. support levels		1c	2c	3c	4c		
Minimum	•With minimum design standards for support instruments	•EU & National targets •Cooperation mechanism (with or without increased cooperation)	7a **Reference** :national RES support with strong coordination - *with minimum design standards*					
None	•No minimum design standards for support instruments		7b **Reference:** national RES support with moderate cooperation - *without minimum design standards*					

Source: Adapted from Del Río, P., Ragwitz, M., Steinhilber, S., Resch, G., Busch, S., Klessmann, C., De Lovinfosse, I., Van Nysten, J., Fouquet, D., Johnston, A., 2012b. Key policy approaches for a harmonisation of RES(-E) support in Europe - Main options and design elements. (A report compiled within the project beyond2020 (work package 2), supported by the EACI of the European Commission within the "Intelligent Energy Europe" programme). CSIC, Madrid (Spain).

Degree of harmonisation			*Support instrument*	**FIT** (feed-in tariff)	**FIP** (feed-in premium)	**QUO** (quota system with uniform TGC)	**QUO banding** (quota system with banded TGC)	**ETS** (no dedicated RES support)	**TEN** (Tendering for large scale RES)
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Minimum	•With minimum design standards for support instruments	•EU & National targets •Cooperation mechanism (with or without increased cooperation)		7a **Ref**erence :national RES support with strong coordination - *with minimum design standards*					
None	•No minimum design standards for support instruments			7b **Ref**erence: national RES support with moderate cooperation - *without minimum design standards*					

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Results

Policy pathways / Criteria	a_1	a_2	a_3	a_4	a_5
f_1	$f_1(a_1)$	$f_1(a_2)$	$f_1(a_3)$	$f_1(a_4)$	$f_1(a_5)$
f_2	$f_2(a_1)$	$f_2(a_2)$	$f_2(a_3)$	$f_2(a_4)$	$f_2(a_4)$
f_3	$f_3(a_1)$	$f_3(a_2)$	$f_3(a_3)$	$f_3(a_4)$	$f_3(a_4)$
f_4	$f_4(a_1)$	$f_4(a_2)$	$f_4(a_3)$	$f_4(a_4)$	$f_4(a_4)$

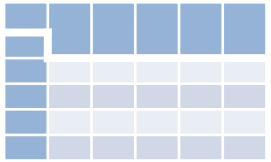
Evaluation table

Criteria weights

PROMETHEE

Generalised criteria

Outranking relations $\pi(a_i,a_j)$



Positive outranking flow $\Phi^+(a_i)$

Negative outranking flow $\Phi^-(a_i)$

Net flow $\Phi^-(a_i)$

PROMETHEE I:
Partial pre-order

PROMETHEE II:
Complete pre-order

Source: own visualisation based on information from Brans et al.(1986) How to select and how to rank projects: The PROMETHEE method.

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Results

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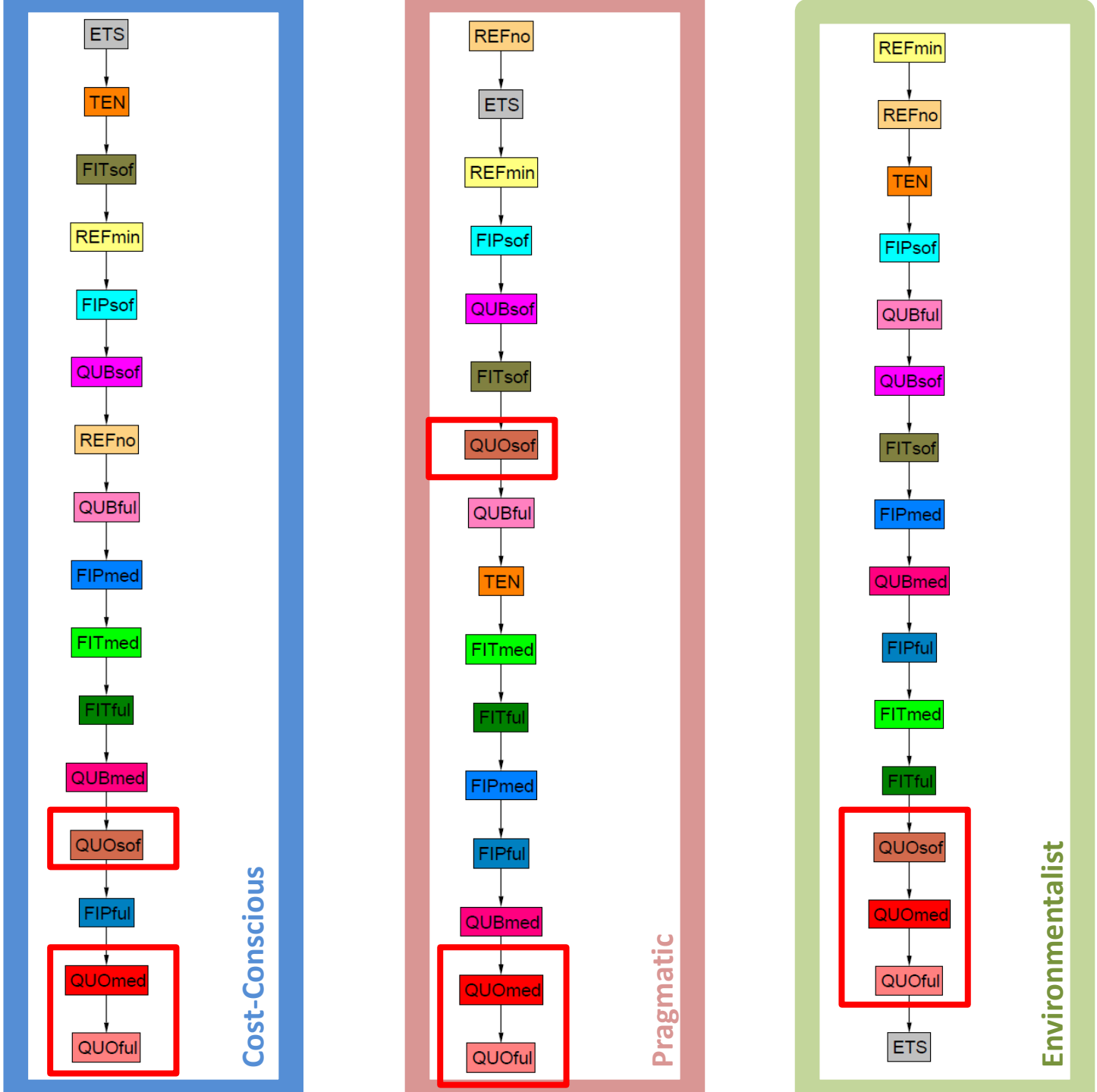
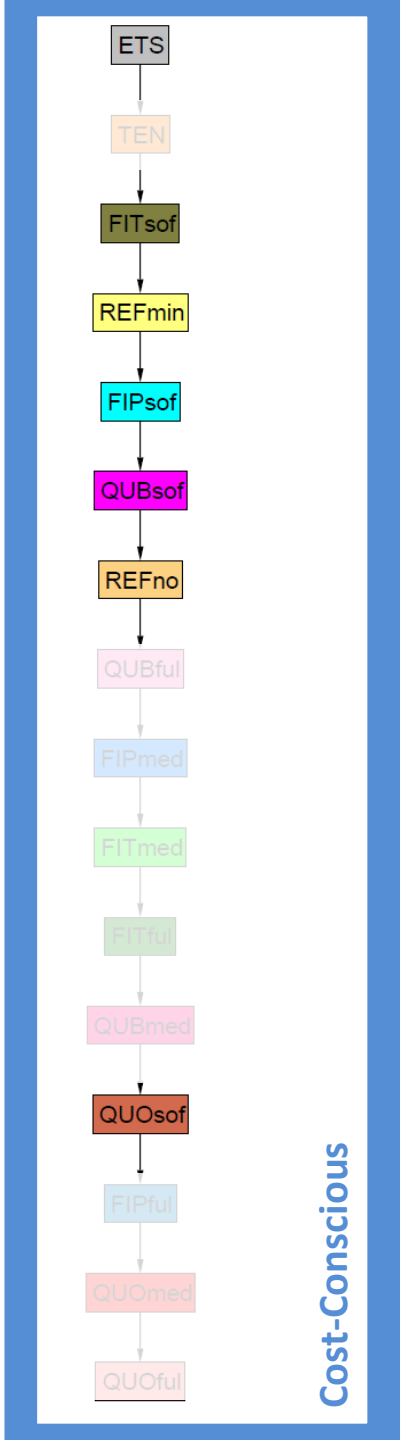


Technology-neutral quota scheme ranks low


ETS
TEN
FITsof
REFmin
FIPsof
QUBsof
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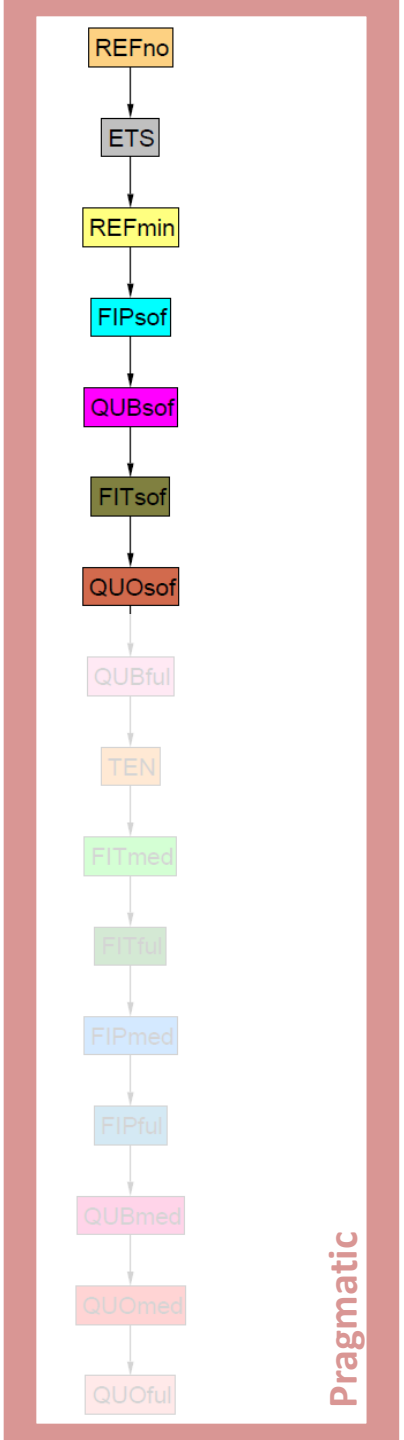
Cost-Conscious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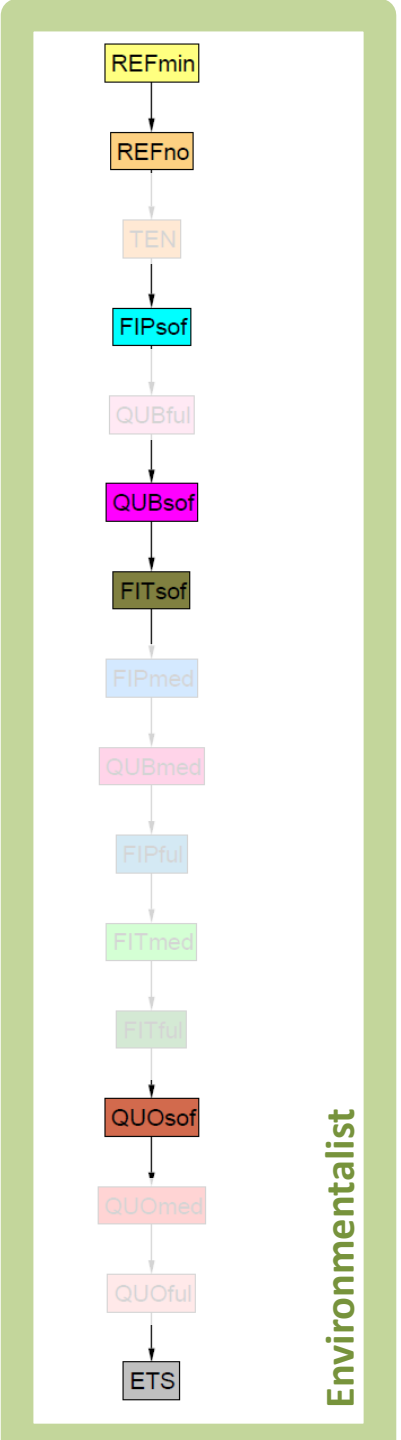
QUOmed
QUOful
Pragmatic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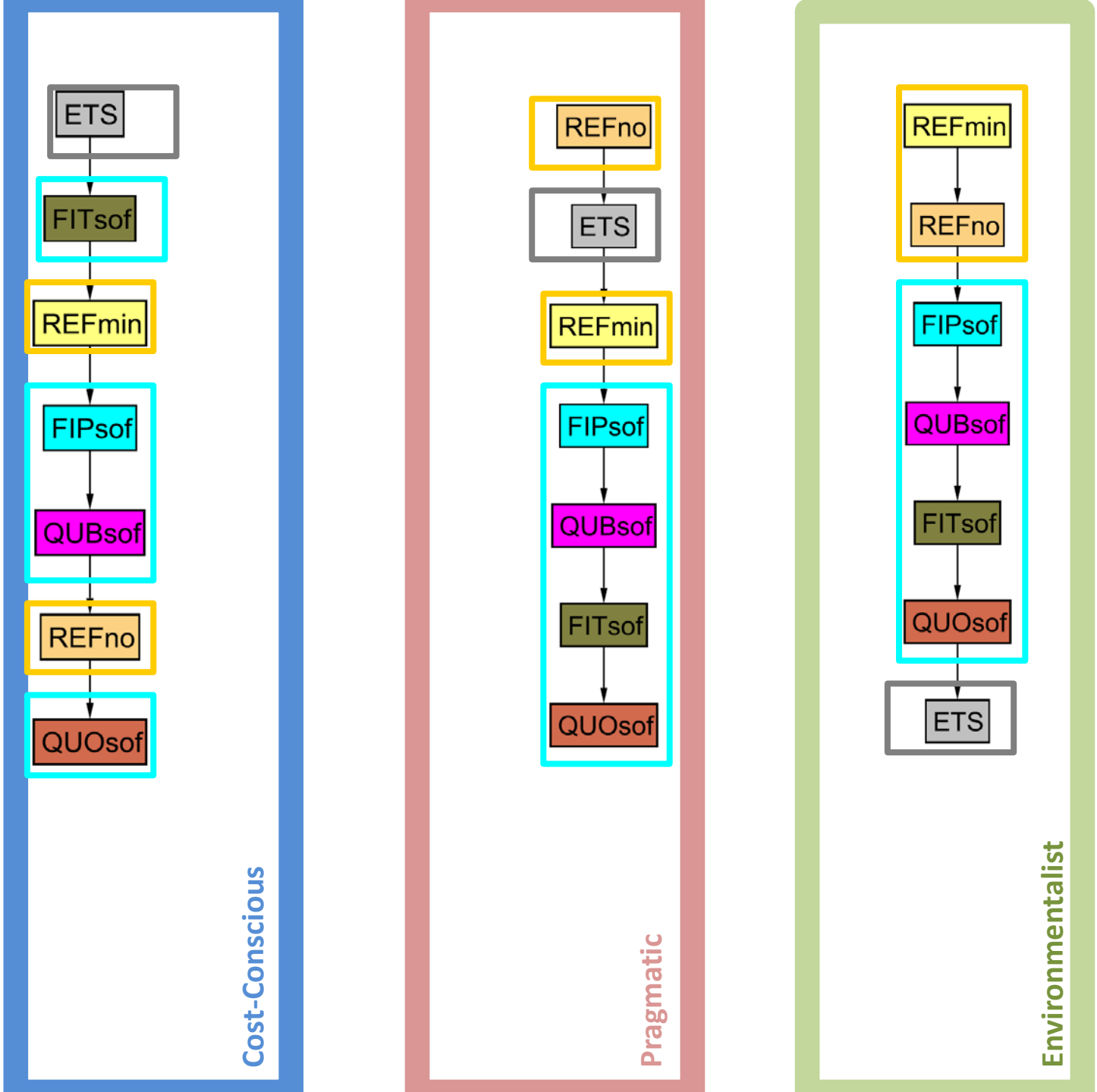
QUOful
ETS
Environmentalist



Reference (no/minimum harmonisation): preferred for the Environmentalist and the Pragmatic

ETS: preferred for the Cost-Conscious due to good static efficiency

Some agreement on ranking of
- **FIP(soft)**
- **FIT (soft)**
- **banded quota (soft)**
- **technology-neutral quota (soft)**

Conclusions

- ETS performs best in the *static efficiency* and *equity* criteria (and possibly *legal feasibility*), and worst in all other criteria => preferred for the Cost-Conscious, least preferred for the environmentalist.

If the decision for a RES target is taken…

- Technology-neutral quota schemes (full and medium harmonisation) tend to rank low for all decision makers => even if they were legally feasible, they are not preferable for anyone
- The Reference pathway (no/minimum harmonisation) performs well in *effectiveness, dynamic efficiency, equity, environmental and economic effects, socio-political acceptability* and *legal feasibility*

- The Reference pathway (minimum harmonisation), FIP (soft harmonisation), and FIT (soft harmonisation) are in the upper preference range for all decision makers and thus offer the most potential for compromise

- Support schemes/policies must be reliable and transparent!

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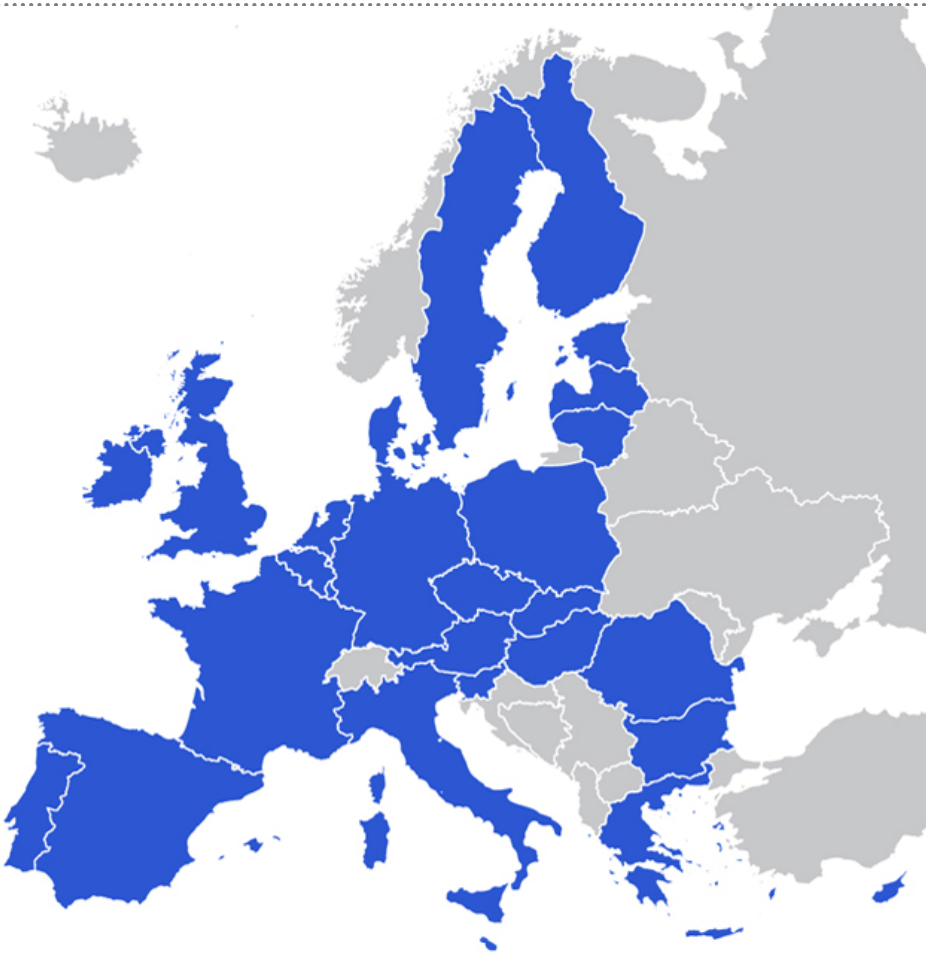
Thank you for your attention!



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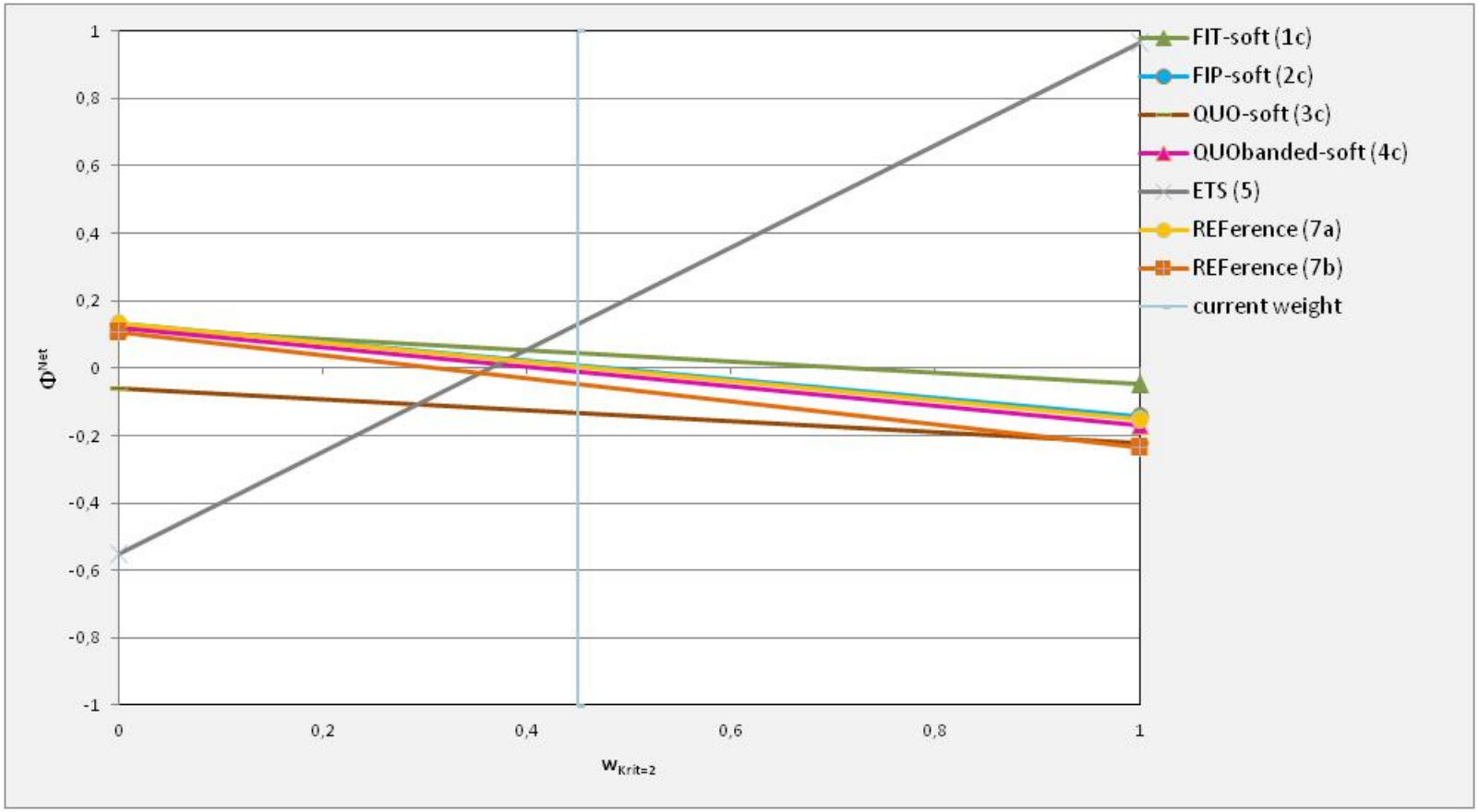
Sensitivities

"Walking weights" sensitivity for the Cost-Conscious, varying the *static efficiency* criterion while leaving all others equal.



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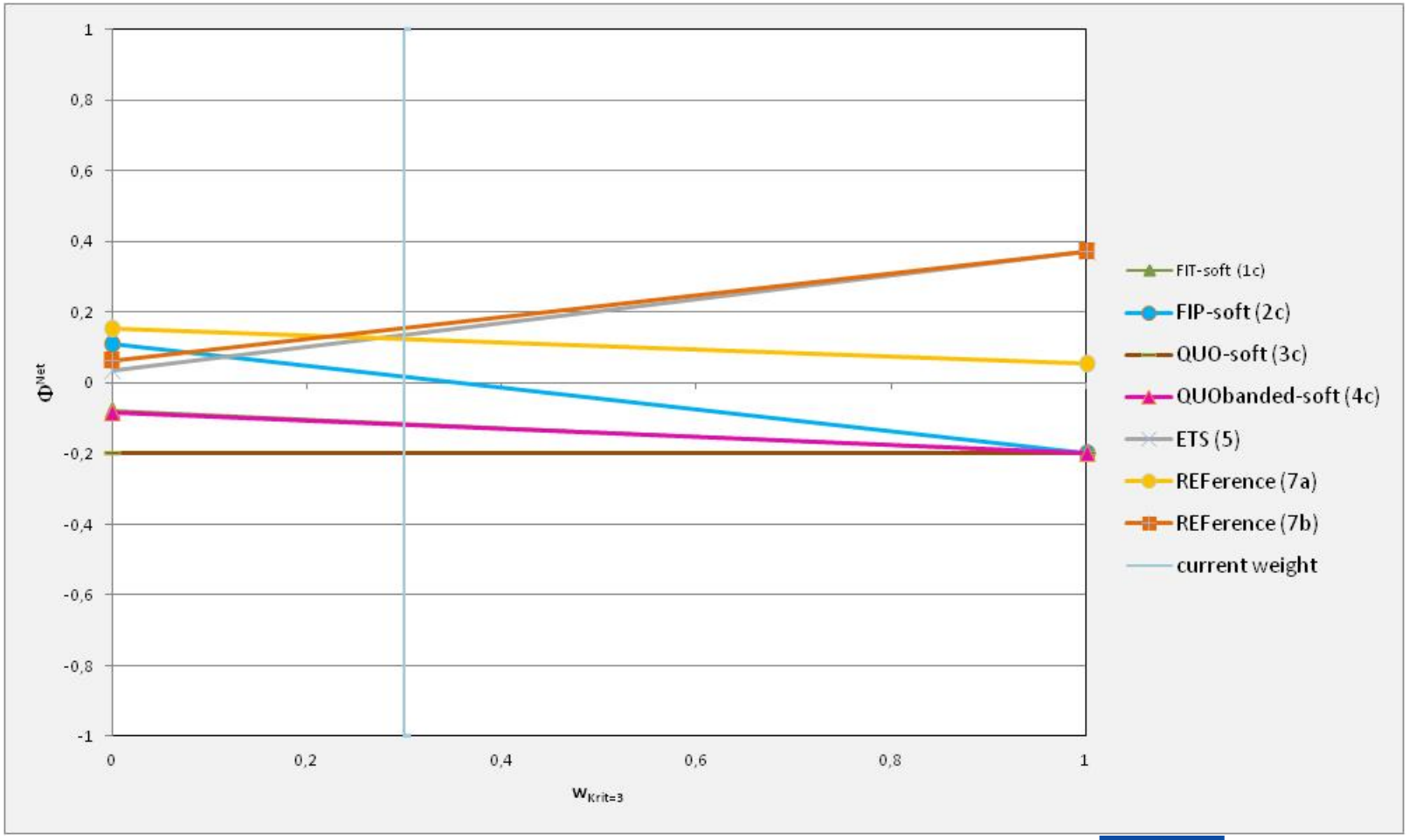
Sensitivities

"Walking weights" sensitivity for the Pragmatic, varying the *legal feasibility* criterion while leaving all others equal.



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