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Prospects for the transmission planning in Europe towards a sustainable energy future: the REALISEGRID project

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REALISEGRID project
http://realisegrid.erse-web.it

Abstract

This work presents some preliminary results of the currently ongoing EC FP7 REALISEGRID project. First, the need for revision of current transmission planning criteria is highlighted. Specific attention has been then paid to a multi-criteria methodology developed within REALISEGRID to address the cost-benefit analysis of new transmission grid investments. This crucial stage of the transmission expansion planning process also needs to take into account innovative power transmission technologies.

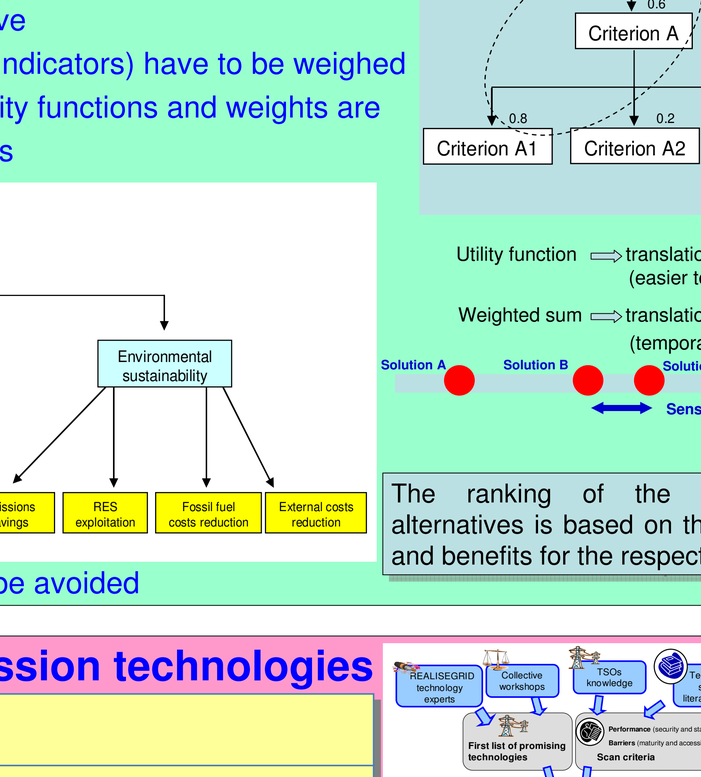
Introduction to REALISEGRID

REALISEGRID stands for "REseArch, methodoLogIes and technologieS for the effective development of pan-European key GRID infrastructures to support the achievement of a reliable, competitive and sustainable electricity supply".
The ultimate objective of REALISEGRID is to develop a set of criteria, metrics, methods and tools to assess how the transmission infrastructure should be optimally developed to support the achievement of a reliable, competitive and sustainable electricity supply in the EU.

Transmission Expansion Planning

European TSOs have to deal today with several challenges like:

- regional markets opening
- increasing level of inter-zonal congestions
- growing variable RES generation penetration
- changing regulatory framework
- assets ageing
- environmental and social constraints
- impact of active demand
- impact of distributed generation



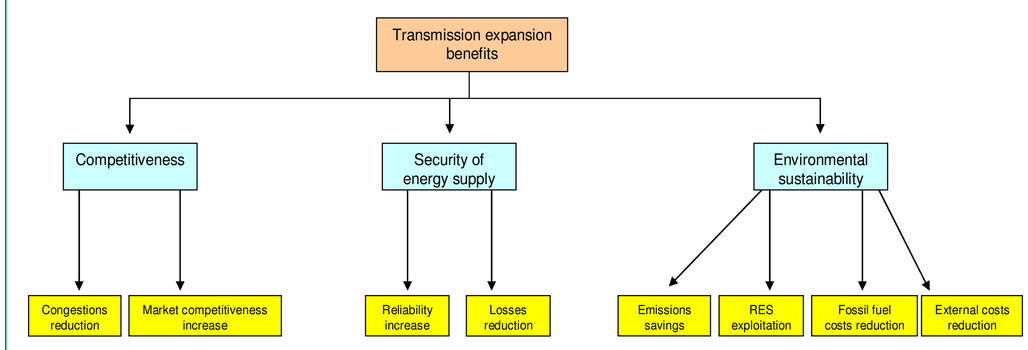
Possible benefits from transmission expansion:

system reliability, quality and security increase; network congestion reduction/unlock of more efficient plants; market competitiveness increase; system losses reduction; avoidance/postponement of investments; more efficient reserve management and frequency regulation; exploitation of generation mix (also in presence of RES); emission savings (in presence of RES); externalities reduction (in presence of RES); power system controllability increase (via PST/FACTS/HVDC); fossil fuel generation costs reduction (in presence of RES); facilitation of DG penetration towards T&D SmartGrids; improved dynamic behavior of power system.

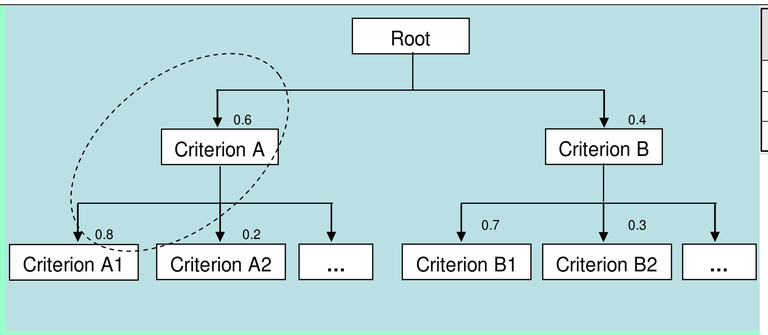
Expansion benefit	Key Indicator	Impact assessment
Reliability increase	$VOLL$	$\text{abs}(VOLL_{\text{with}} - VOLL_{\text{without}})$
Congestion reduction (substitution effect)	SW	$(SW^{\text{costs}}{}_{\text{with}} - SW^{\text{costs}}{}_{\text{without}})$
Market competitiveness increase (strategic effect)	SW	$(SW^{\text{strategies}}{}_{\text{with}} - SW^{\text{costs}}{}_{\text{with}})$
System losses reduction	L	$\text{abs}(L_{\text{with}} - L_{\text{without}})$
Increased exploitation of wind generation	UF $AIWP$	$(UF_{\text{with}} - UF_{\text{without}})$ $(AIWP_{\text{with}} - AIWP_{\text{without}})$
Emission savings	E	$\text{abs}(E_{\text{with}} - E_{\text{without}})$
External costs reduction	Ext	$\text{abs}(Ext_{\text{with}} - Ext_{\text{without}})$
Fossil fuel costs reduction	$Fcost$	$\text{abs}(Fcost_{\text{with}} - Fcost_{\text{without}})$

Cost-benefit analysis: multi-criteria methodology

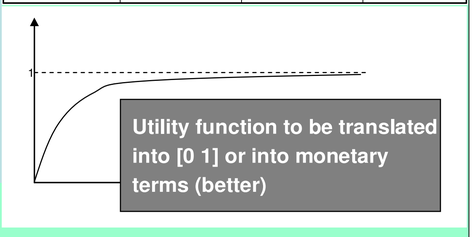
- A scoring number is needed to rank possible reinforcements and select the most promising ones in a society's perspective
- The different criteria for benefits evaluation (indicators) have to be weighed
- Top-down criteria tree, evaluation matrix, utility functions and weights are required instruments for multi-criteria analysis



Double-counting must be avoided



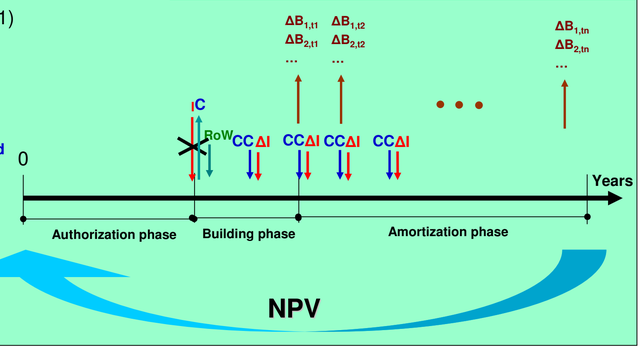
	Alternative 1	Alternative 2	…
Criterion 1			
Criterion 2			
…			



Utility function ⇒ translation into monetary terms (easier to understand, weights initialized to 1)

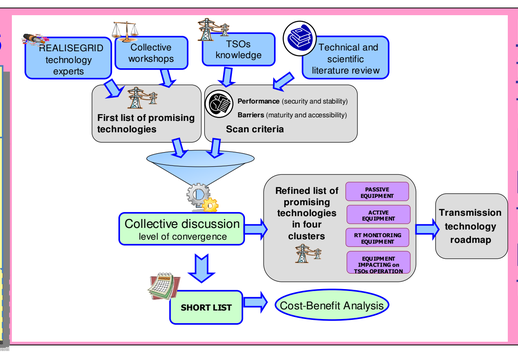
Weighted sum ⇒ translation into a mono-dimensional ranking (temporal axis considered through NPV)

The ranking of the different expansion alternatives is based on the NPV of total costs and benefits for the respective option



Selection of innovative transmission technologies

Real Time monitoring (RT)	RT1) RTTR-based cables/lines RT2) WAMS/PMUs		
Passive Equipment (P)	P1) XLPE underground cables P2) GILs P3) HTC P4) Superconducting cables P5) HVAC innovative designs	**Active Equipment (A)**	A1) Fault Current limiters A2) PST A3-4) HVDC A5-12) FACTS
Impacting technologies (ITO)	ITO1) Impact of Smart meters ITO2-6) Storage technologies for transmission (Hydro, CAES, FES, SMES, Na-S)		



Inclusion principle for technologies selection: technologies potentially helpful for TSOs and possibly interacting with the transmission planning are considered for deeper investigation

Future test case

TEN-E priority axis 'EL.2. Borders of Italy with France, Austria, Slovenia and Switzerland'

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[1] RSE (Ricerca sul Sistema Energetico) SpA is the recently changed denomination of ERSE (formerly CESI RICERCA) SpA