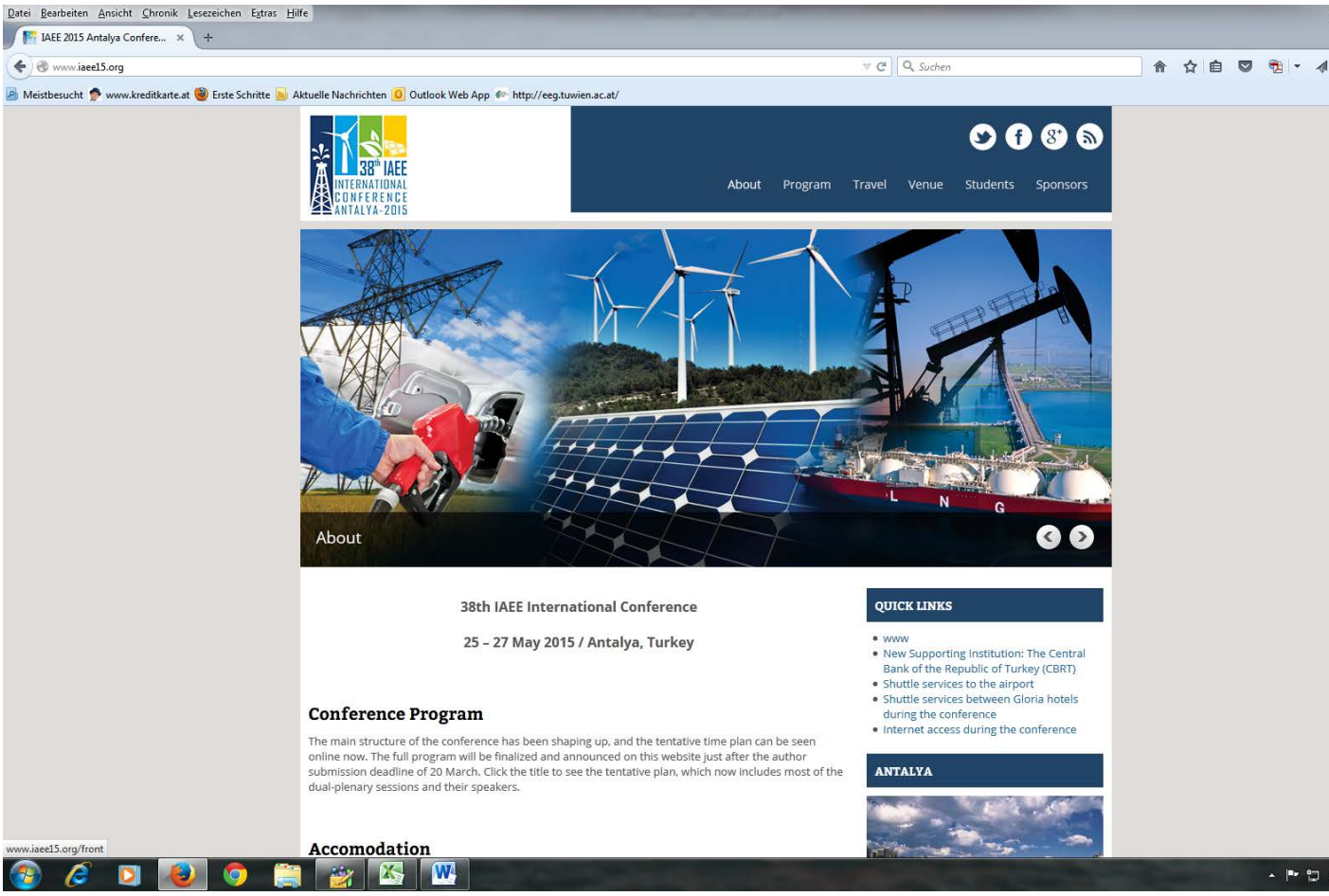
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38th IAEE INTERNATIONAL CONFERENCE ANTALYA-2015
About Program Travel Venue Students Sponsors
About
38th IAEE International Conference
25 – 27 May 2015 / Antalya, Turkey
Conference Program
The main structure of the conference has been shaping up, and the tentative time plan can be seen online now. The full program will be finalized and announced on this website just after the author submission deadline of 20 March. Click the title to see the tentative plan, which now includes most of the dual-plenary sessions and their speakers.
Accomodation
QUICK LINKS
www
New Supporting Institution: The Central Bank of the Republic of Turkey (CBRT)
Shuttle services to the airport
Shuttle services between Gloria hotels during the conference
Internet access during the conference
ANTALYA
www.iaee15.org/front




The EU-project BETTER http://www.better-project.net

What role for renewable energy from North Africa, Western Balkans and Turkey?

Gustav Resch, André Ortner, Marijke Welisch, Gerhard Totschnig
Vienna University of Technology, Energy Economics Group (EEG)

38th IAEE International Conference
Gloria Golf Resort Conference Center
25th – 27th May 2015, Antayla, Turkey

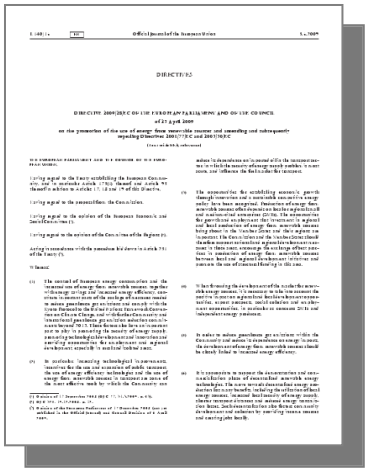
TU WIEN TECHNISCHE UNIVERSITÄT WIEN Vienna University of Technology

EEG Energy Economics Group

Starting point – RES targets of the EU

RES-Directive 2009/28/EC of sets legally binding targets:

- 20 % RES share on gross final consumption by 2020;
- Nat. targets: flat rate approach adjusted to GDP.



Directive incorporates some instruments to promote international cooperation in order to meet the 20% EU 2020 target.

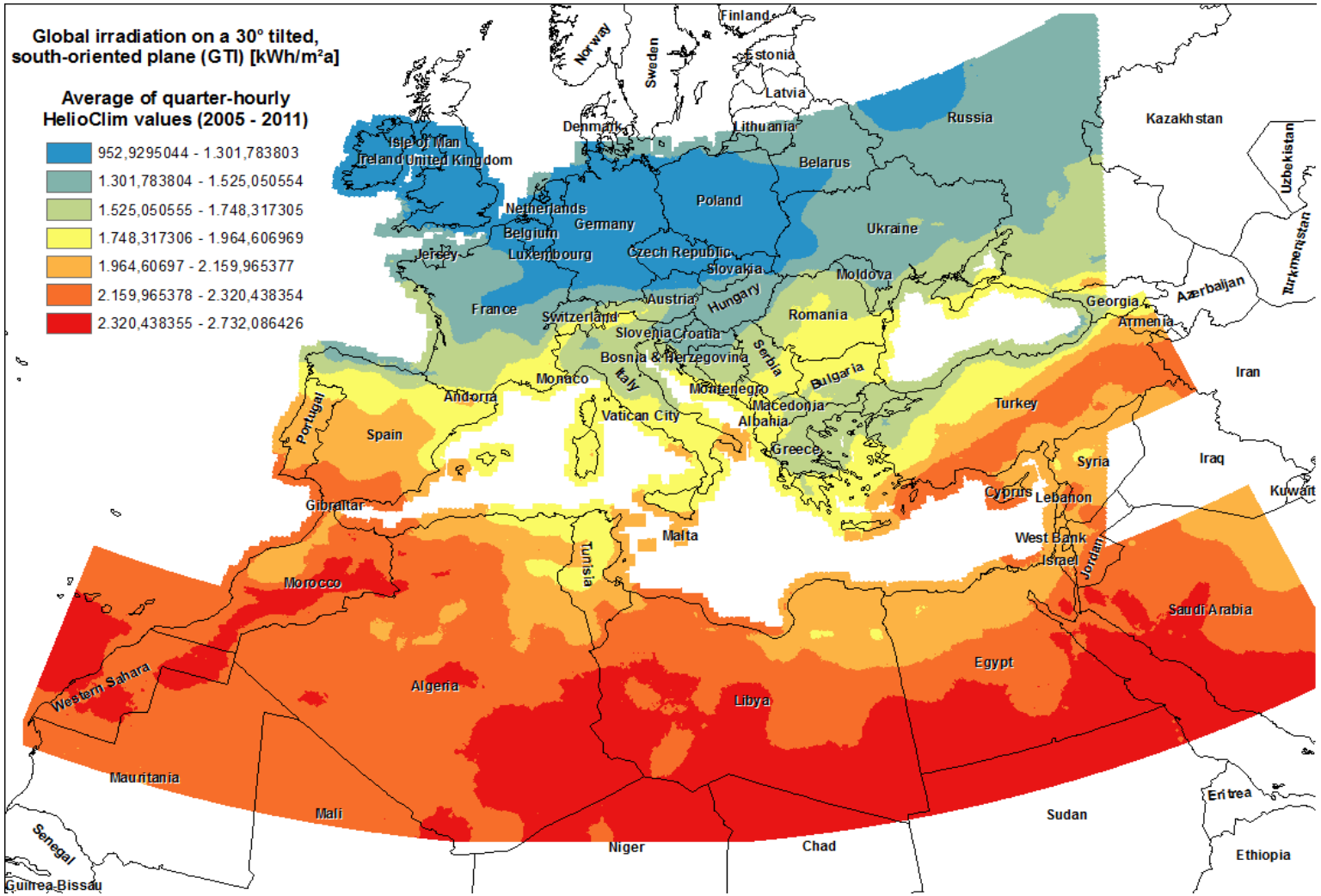
COOPERATION MECHANISMS

- Statistical Transfers *(Art 6)*
- Join projects within MS *(Art 7)* and with 3rd countries *(Art 9)*
- Join support schemes (*Art. 11)*

- **Produce RES where Potentials are high and costs are low**
- **Share RES credits**

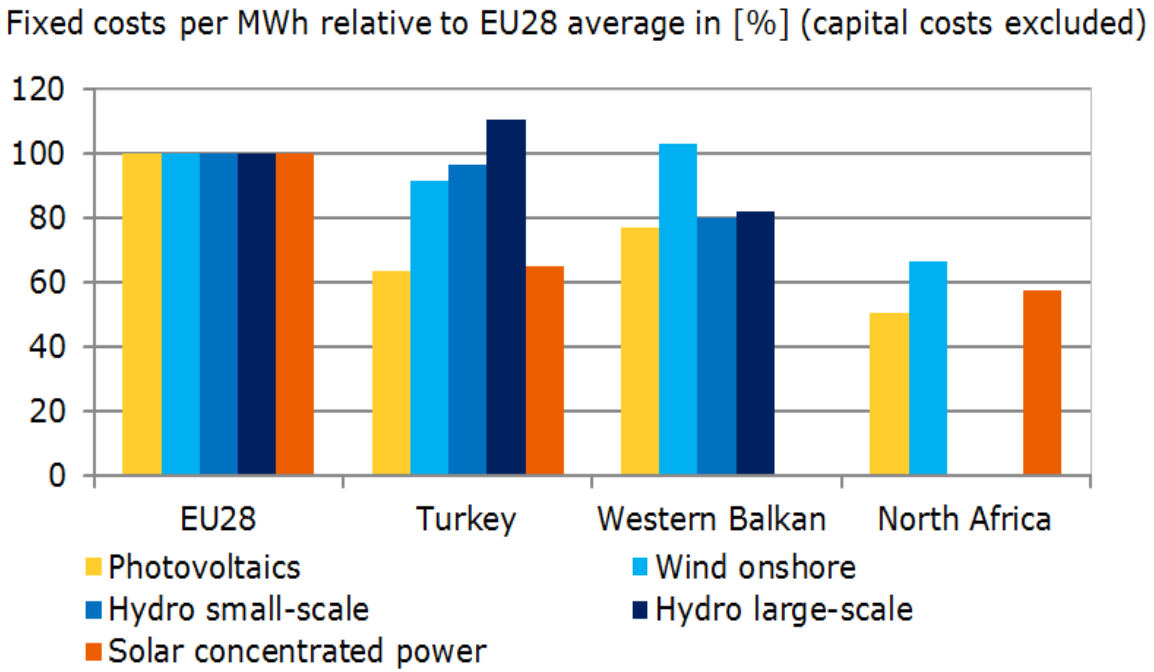
Motivation

Average global irradiation on a south oriented solar PV plane for the years 2005-2011



Motivation

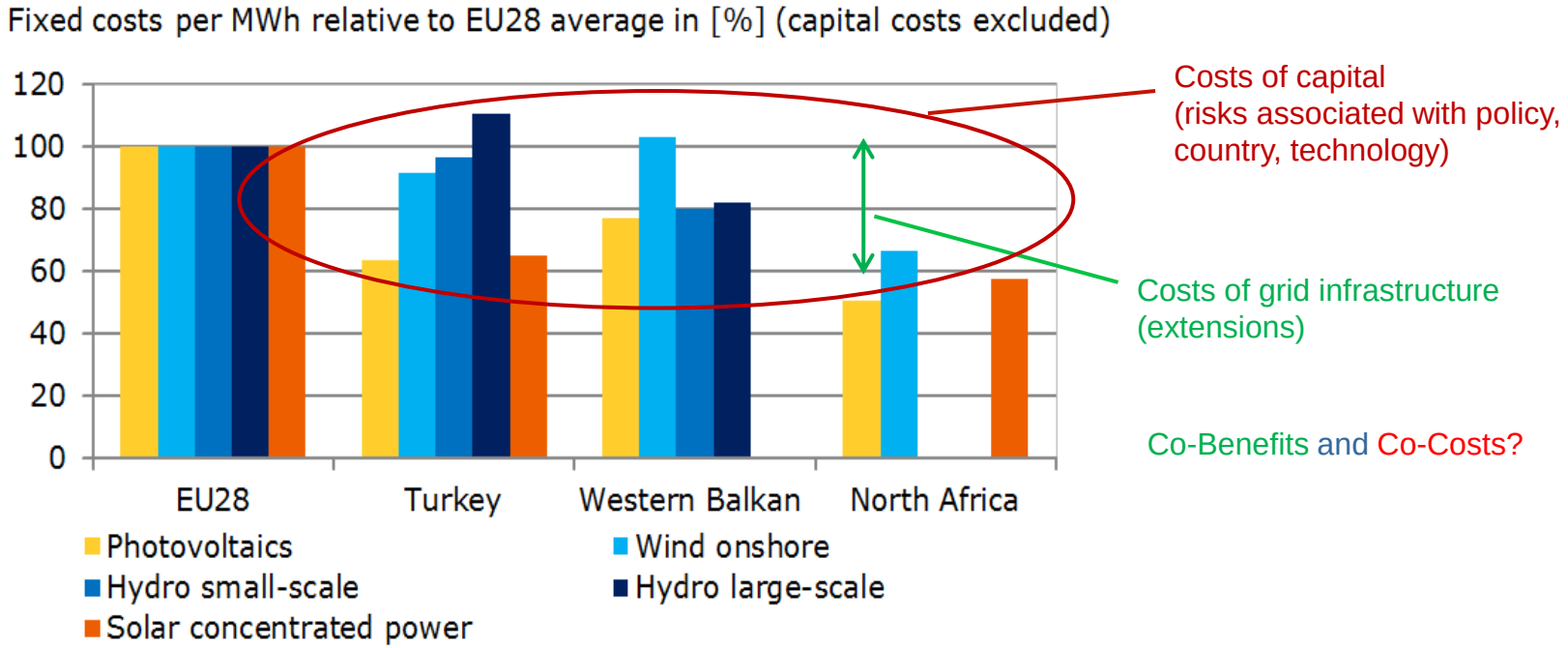
Comparative advantage of selected RES compared to EU28 average values of fixed costs per unit



- The costs of installing PV panels are on average around 20 to 50% lower than within the EU28.
- Cost comparison is mainly based on differences in resource qualities. To get a holistic picture also financing costs including the evaluation of country specific risks as well as additional costs stemming from necessary infrastructure

Motivation

Comparative advantage of selected RES compared to EU28 average values of fixed costs per unit

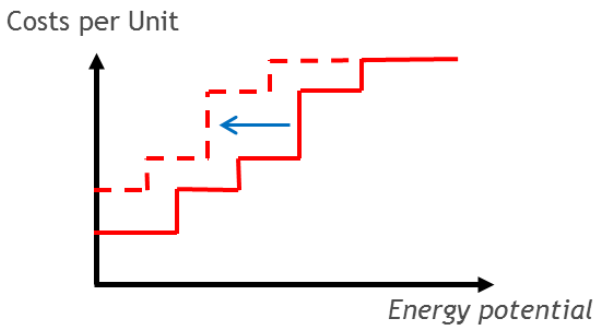


- The costs of installing PV panels are on average around 20 to 50% lower than within the EU28.
- Cost comparison is mainly based on differences in resource qualities. To get a holistic picture also financing costs including the evaluation of country specific risks as well as additional costs stemming from necessary infrastructure

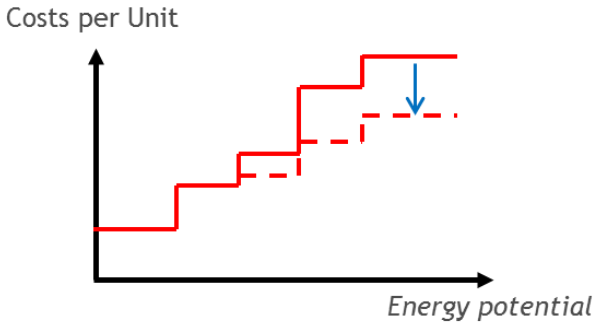
Methodology

RES generation costs

Dynamic cost-resource curves



Shift due to utilization of existing resources

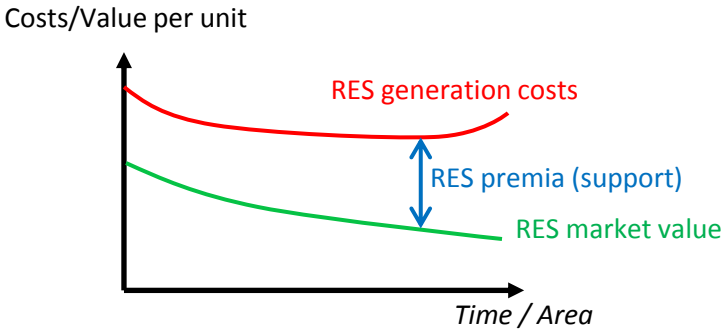


Shift through technology learning

Assumptions

- What areas are eligible for deployment of RES (exclusion of nature reserve/parks, minimal distance to streets/buildings, …)
- What concrete technology is used for conversion and how is it installed? (hub height and capacity of wind turbines, installation angle of PV, …)
- What are the endogenous/exogenous learning rates per technology? (RES deployment in the rest of the world, technology innovation, steal/concrete prices)
- What risks are associated with deploying a certain type of RES (support instrument, country risk, technology risk, type of investor …)

RES support costs

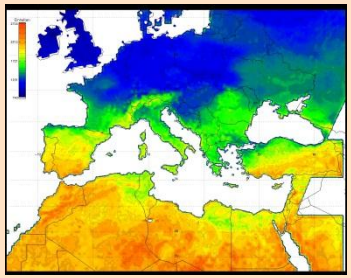


Assumptions

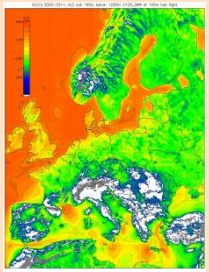
- What are the wholesale electricity prices in different regions?
- What type of support is applied (FiT, RES premia, RES quota, auctions, …)
- Are RES allowed to participate in all electricity markets (day-ahead, intra-day, balancing markets)
- How does the expansion of RES influence electricity prices?

Applied energy models (Green-X and HiREPs)

Solar PV

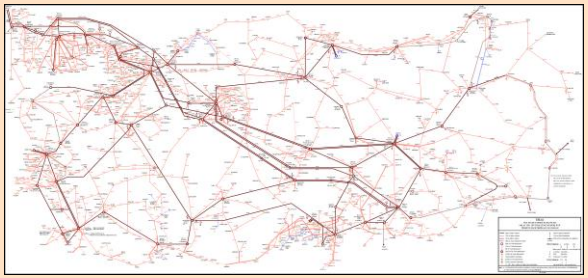


Wind



Locational power plant database

Transmission Grid



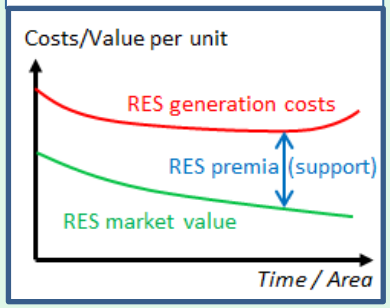
Energy/CO2-prices
Technology costs

Yearly time resolution (2006 – 2050)

RES policy

Non-economic barriers

Dynamic cost-potential curves



RES support expenditures

RES investments

ITERATION

RES deployment

RES market values, Electricity prices

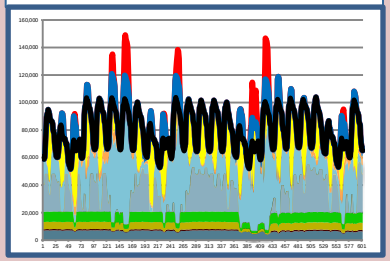
Hourly time resolution (8760h)

Supply

Storage

Demand

Common electricity market model



Electricity prices
Total system costs

Power plant dispatch/ -commitment

Transmission grid extensions

Selection of assessed cases

Cooperation scenario

EU RES ambition level

Details

Sector scope
Electricity

Time scope
Yearly (2015 – 2040)

EU ambition level
Weak* RES-E ambition:
48% (2030)
55% (2040)
Strong RES-E ambition:
59% (2030)
77% (2040)

Target setting approach
EU 2020 method applied to all years and TK, WB

*) Weak RES-E ambition was calculated as least-cost share resulting from an overall RES target of 27% in 2030

EUonly
- RES quota scheme among EU28
- National quota scheme in neighbour countries

WEAK / STRONG RES-E ambition

EUplus
- RES quota scheme among EU28 + neighbours
- Physical imports from North Africa required

WEAK / STRONG RES-E ambition

Results

How does full cooperation in the form of an international RES quota scheme impact ...

Generation … the amount of RES electricity produced in the different regions?

Economics

… additional costs and benefits compared to no cooperation?

… monetary flows between the regions?

… wholesale electricity prices in selected countries?

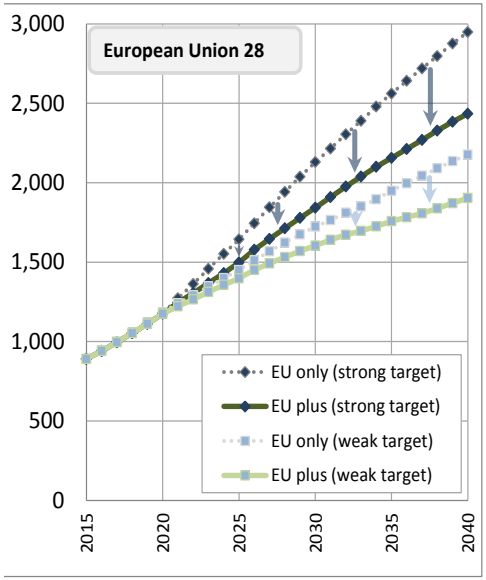
Infrastructure … needs for grid infrastructure extensions from NA to the EU?

Results

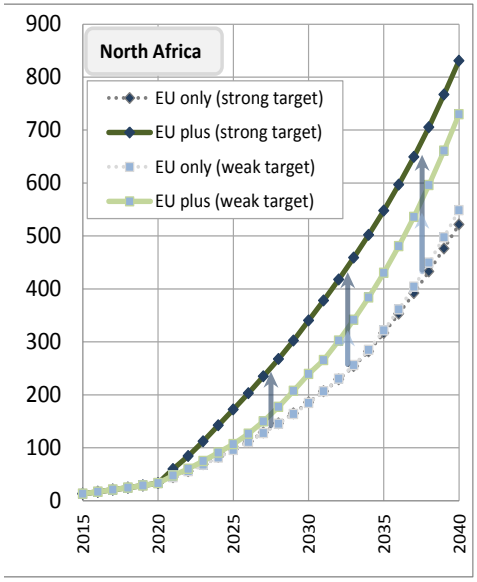
How does full cooperation in the form of an international RES quota scheme impact …

Generation … the amount of RES electricity produced in the different regions?

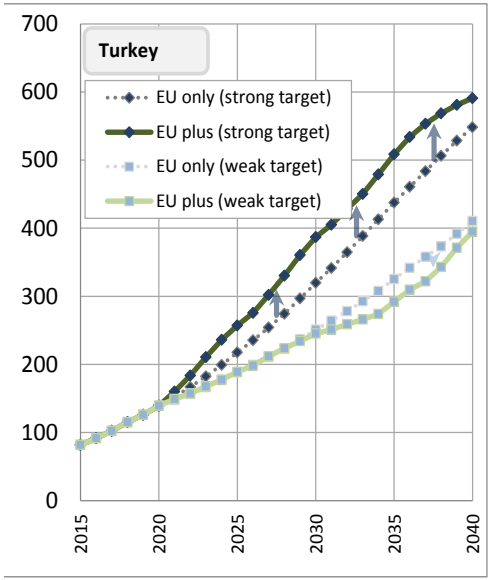
RES-E generation in TWh



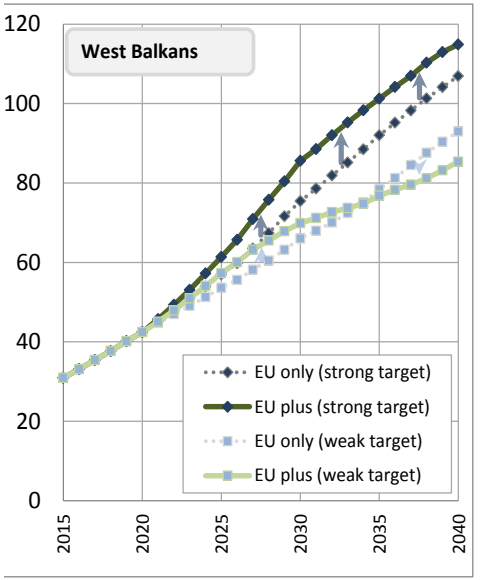
RES-E generation in TWh



RES-E generation in TWh



RES-E generation in TWh



Results

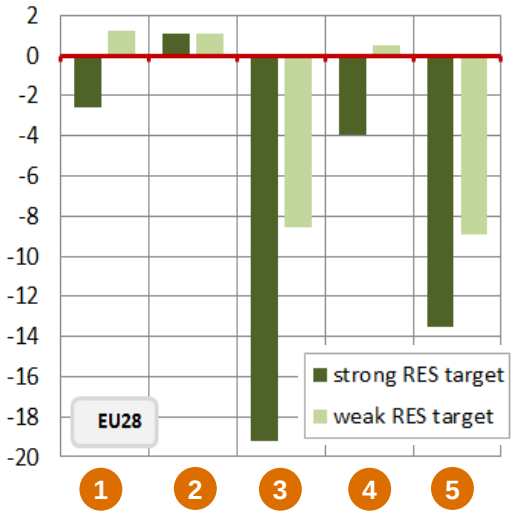
How does full cooperation in the form of an international RES quota scheme impact …

Economics

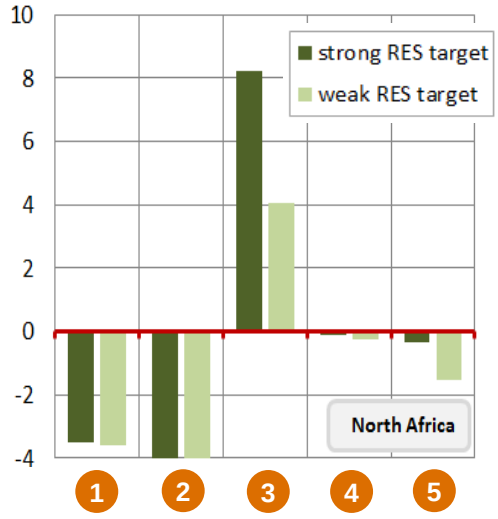
… additional costs and benefits compared to no cooperation?

1. Avoided fossil fuels
2. Avoided CO2 emissions
3. Capital expenditures
4. Additional generation costs
5. Support expenditures

Change in bill. EUR/yr



Change in bill. EUR/yr



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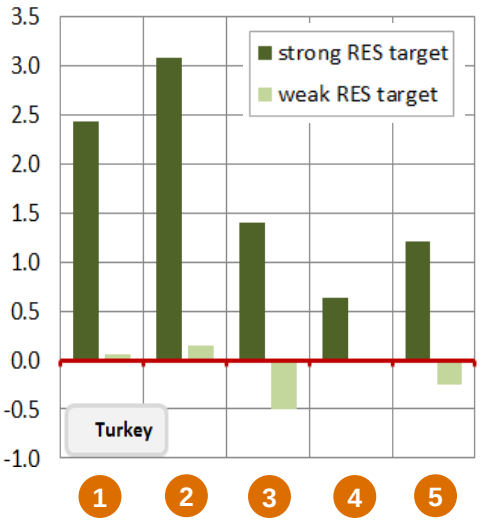

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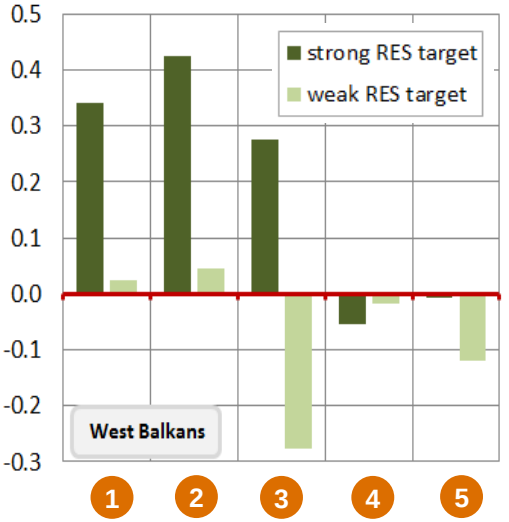
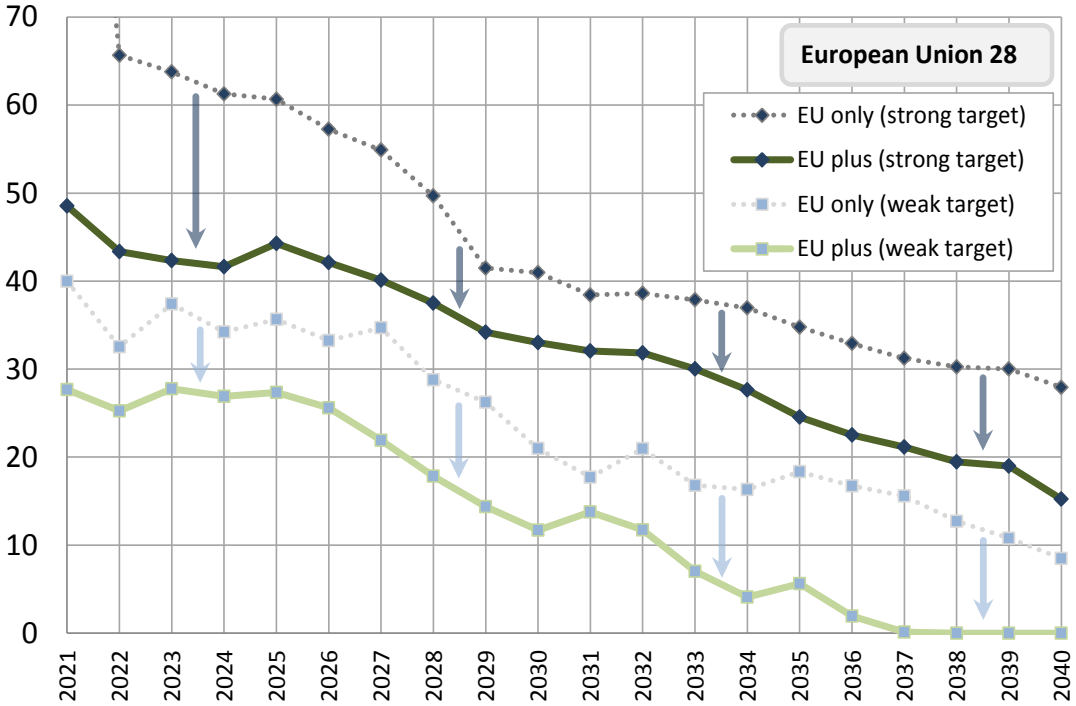


How does full cooperation in the form of an international RES quota scheme impact ...

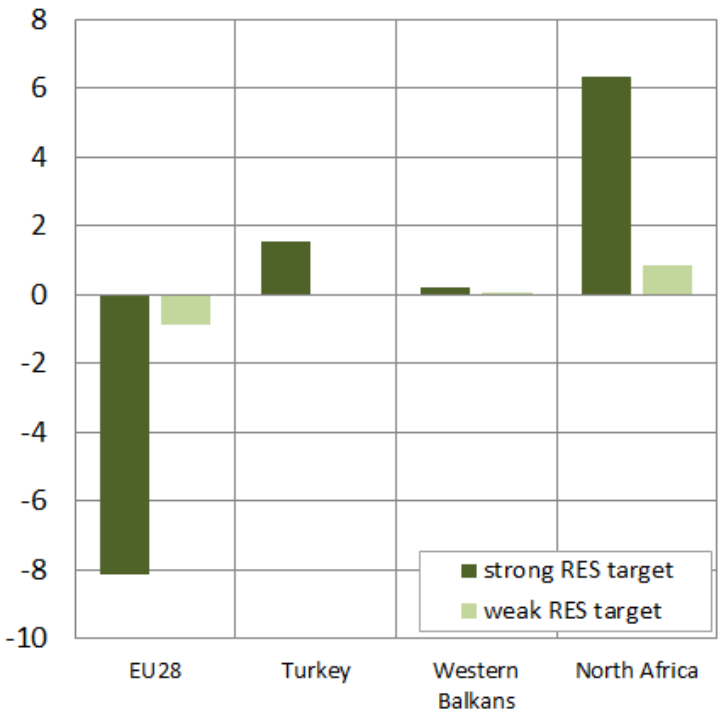
Economics

… monetary flows between the regions?

Price of certificate / RES premium in EUR/MWh



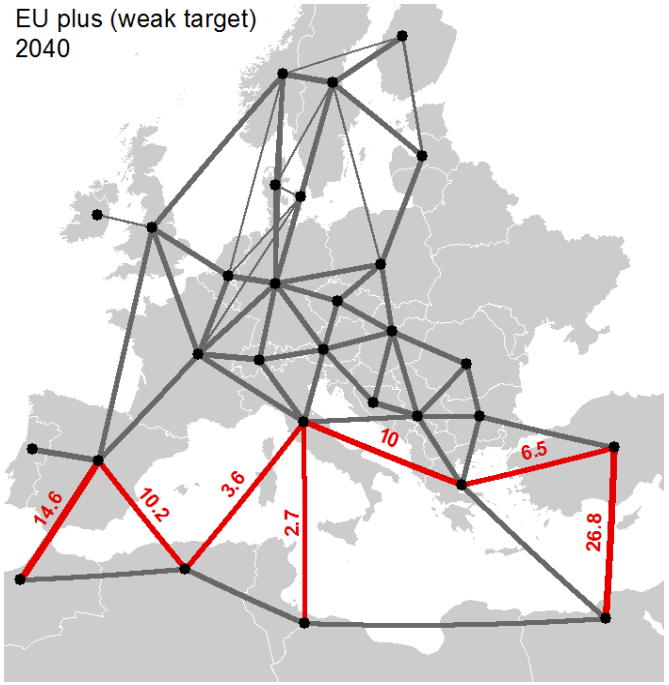
Monetary transfers in bill. EUR/yr

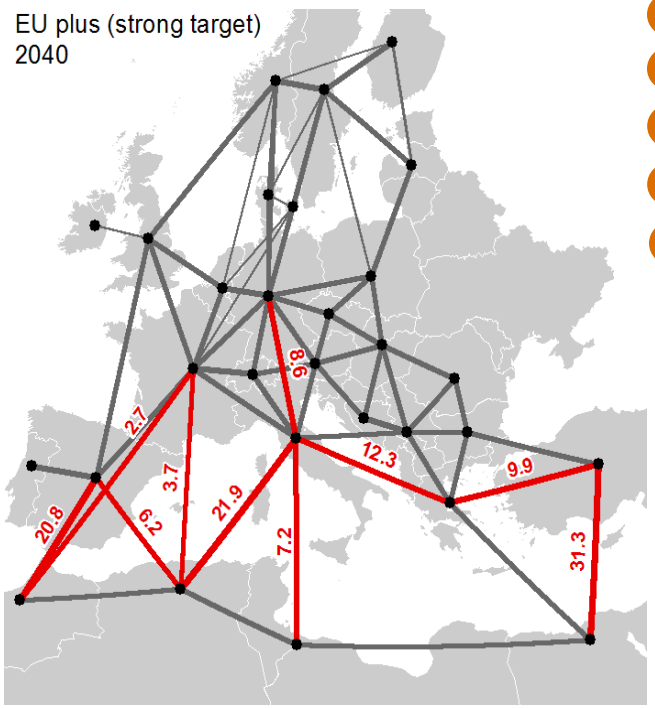


Results

How does full cooperation in the form of an international RES quota scheme impact …

Infrastructure … needs for grid infrastructure extensions from NA to the EU?





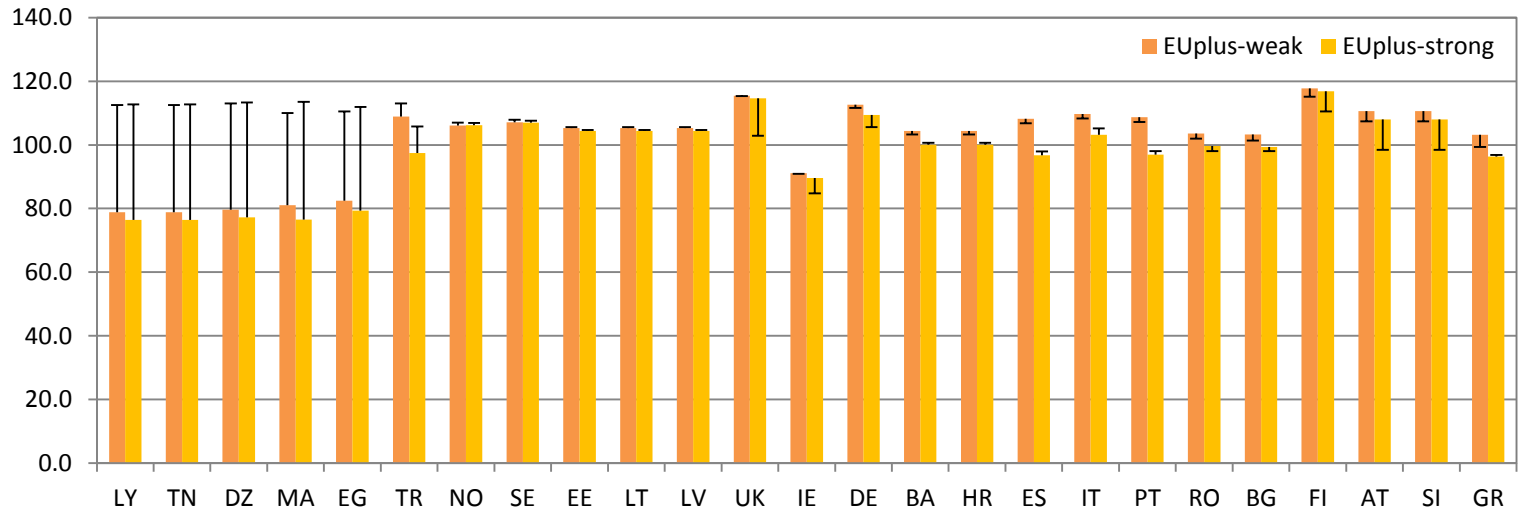
1. New installed HVDC capacity [GW]
2. New installed HVDC capacity [GW-km]
3. Imported amount of RES [TWh]
4. Discounted expansion costs [bill. EUR/yr]
5. Specific grid expansion costs [EUR / MWh]

	Weak	Strong
1	74	124
2	78,021	146,850
3	296	464
4	2.9	5.5
5	9.9	11.8

How does full cooperation in the form of an international RES quota scheme impact ...

Economics … wholesale electricity prices in selected countries?

Yearly average electricity price (change) in EUR/MWh



Summary

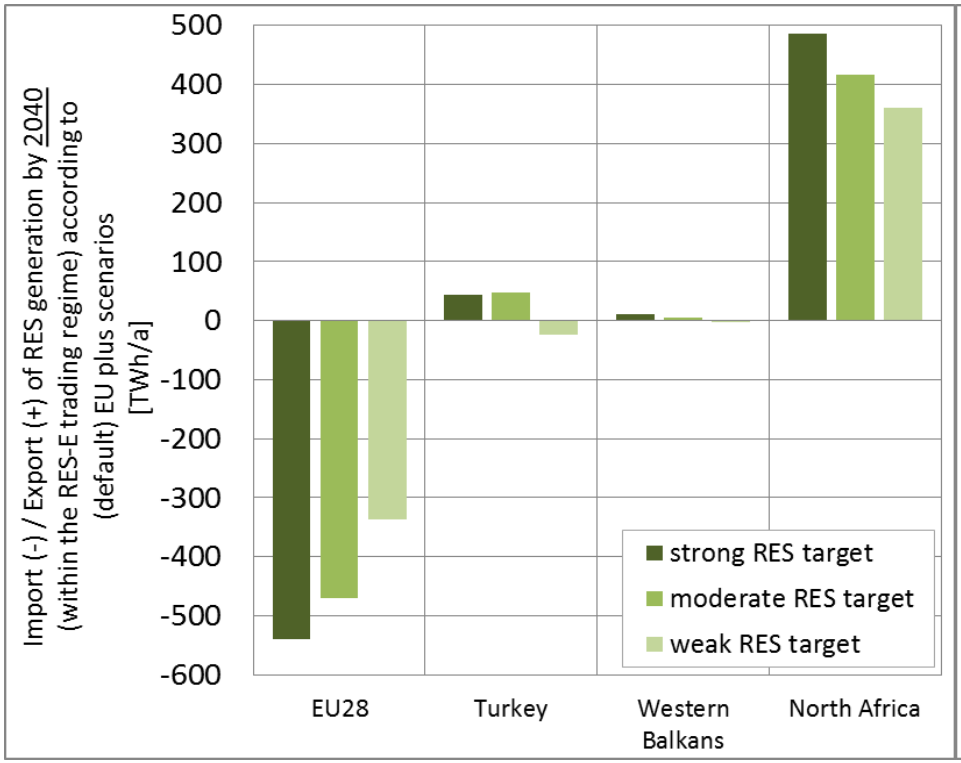
- RES-E cooperation is not a game changer for the EU
- Potential benefits considerably depend on future RES ambition levels
- In a fully harmonized RES-E quota scheme the EU could import 9 to 12% of its demand
- This accounts for savings up to 8 to 13 bill. EUR per year (23% to 30% of av. RES-E support)
- North Africa is the main contributor to EU imports
- The necessary additional infrastructure to import these amounts is managemable (no supergrid approach all over Europe necessary)
- Corresponding infrastructure add-ons range around 10 to 12 EUR/MWh
- Electricity prices in the EU do not “collaps” – however, drop in North Africa

Back-up

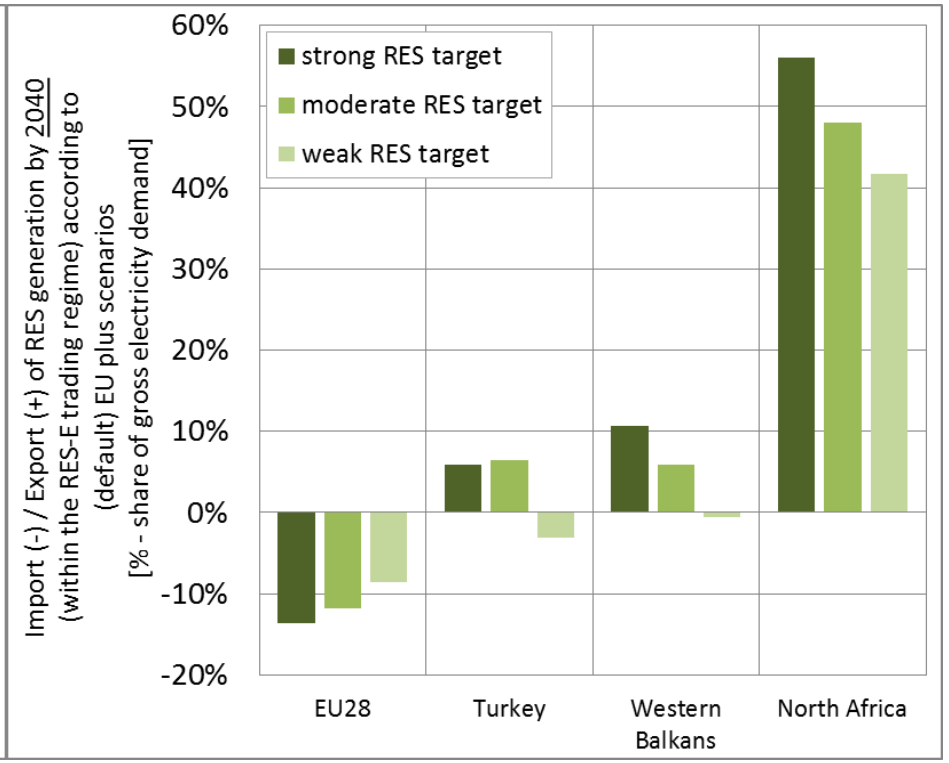
BACK-UP slides

Benefits of RES cooperation (Electricity)

Absolute amount of trade flows in [TWh]



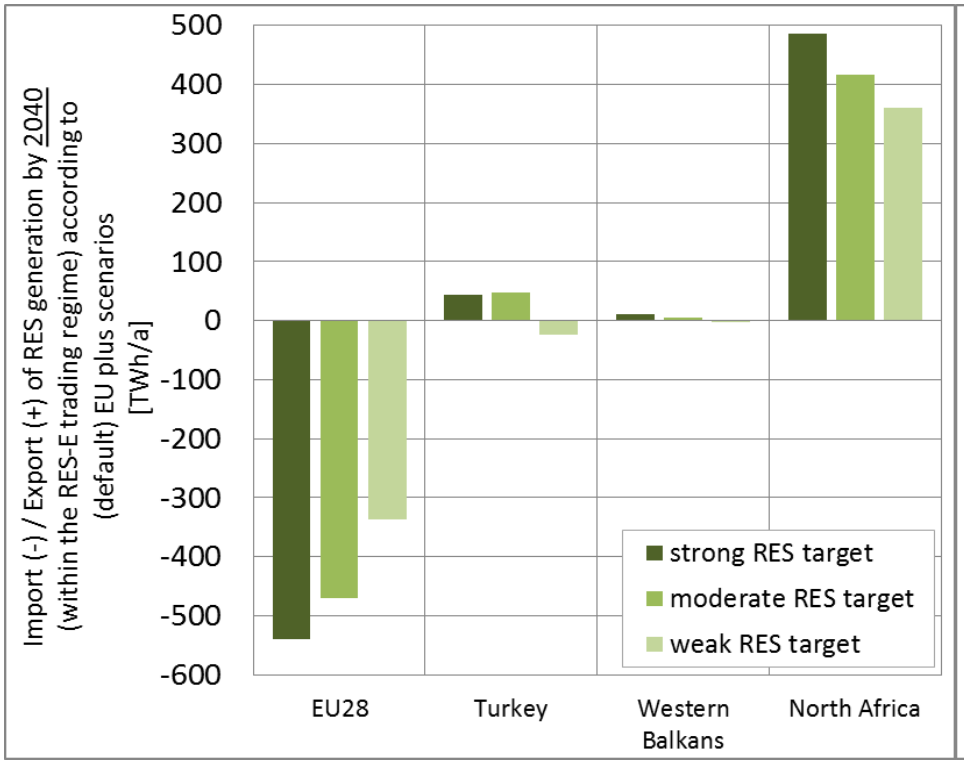
Relative amount of trade flows in [%]



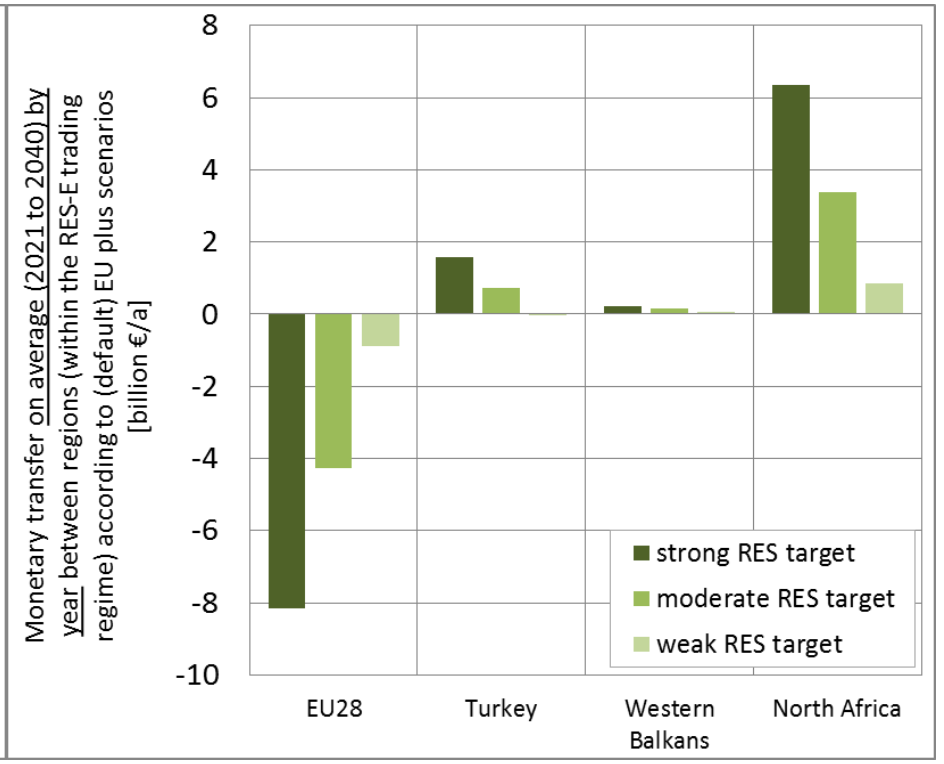
- Assumption that a joint market is established for RES in the electricity sector, allowing full RES cooperation across the EU and its assessed neighbouring countries in the period post 2020
- EU28 Member States import between 8.5 and 13.6% of RES as share of their gross electricity demand in 2040
- Turkey could be a net importer of 2% (~10 TWh) in a weak RES target scenario, whereas (virtual) exports could amount up to almost 7% in 2040 assuming a strong RES target

Benefits of RES cooperation

Absolute amount of trade flows in [TWh]



Monetary transfers [bill. EUR/ yr]



- Financial

Benefits of RES cooperation

Assessed cases
(Green-X)

	EU only: **reference case of no RES co-operation with EU neighbours***	EU plus: **default case of full RES co-operation between the EU and its neighbours** beyond 2020	Sensitivity analysis (related to "EU plus" scenarios), incorporating regional specifics: **Turkey: non-affiliation to EU/EC** (… low domestic RES targets by 2030 and beyond)	Sensitivity analysis: **North Africa: moderate AC grid expansion** (… reduced expansion of wind & PV)
Strong RES target **by 2030** (i.e. 32.5% RES at EU level) **and beyond**	**EU only** (strong target)	**EU plus** (strong target)	*Sensitivity case:* **EU plus – Turkey: non-affiliation to EU/EC** (strong target)	*Sensitivity case:* **EU plus – North Africa: moderate AC grid expansion** (strong target)
Moderate RES target **by 2030** (i.e. 30% RES at EU level) **and beyond**	**EU only** (moderate target)	**EU plus** (moderate target)	*Sensitivity case:* **EU plus – Turkey: non-affiliation to EU/EC** (moderate target)	*Sensitivity case:* **EU plus – North Africa: moderate AC grid expansion** (moderate target)
Weak RES target **by 2030** (i.e. 27% RES at EU level) **and beyond**	**EU only** (weak target)	**EU plus** (weak target)	*Sensitivity case:* **EU plus – Turkey: non-affiliation to EU/EC** (weak target)	*Sensitivity case:* **EU plus – North Africa: moderate AC grid expansion** (weak target)

Ambition level related to ***RES cooperation with neighbours*** →

Ambition level related to ***RES deployment*** ↑

**Full RES cooperation between EU Member States is however assumed*

Benefits of RES cooperation

Assessed cases
(Green-X)

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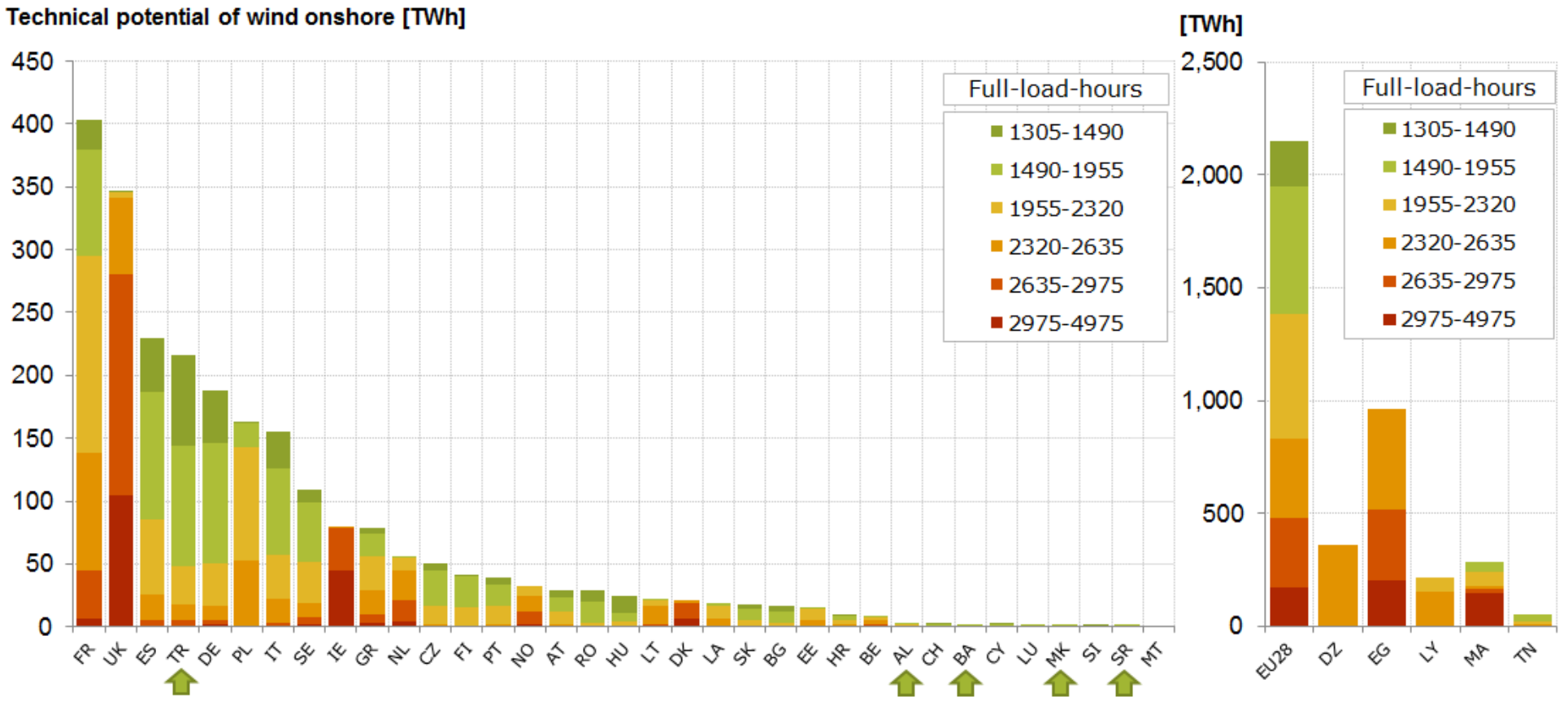
Ambition level related to ***RES cooperation with neighbours*** →

Ambition level related to ***RES deployment*** ↑

**Full RES cooperation between EU Member States is however assumed*

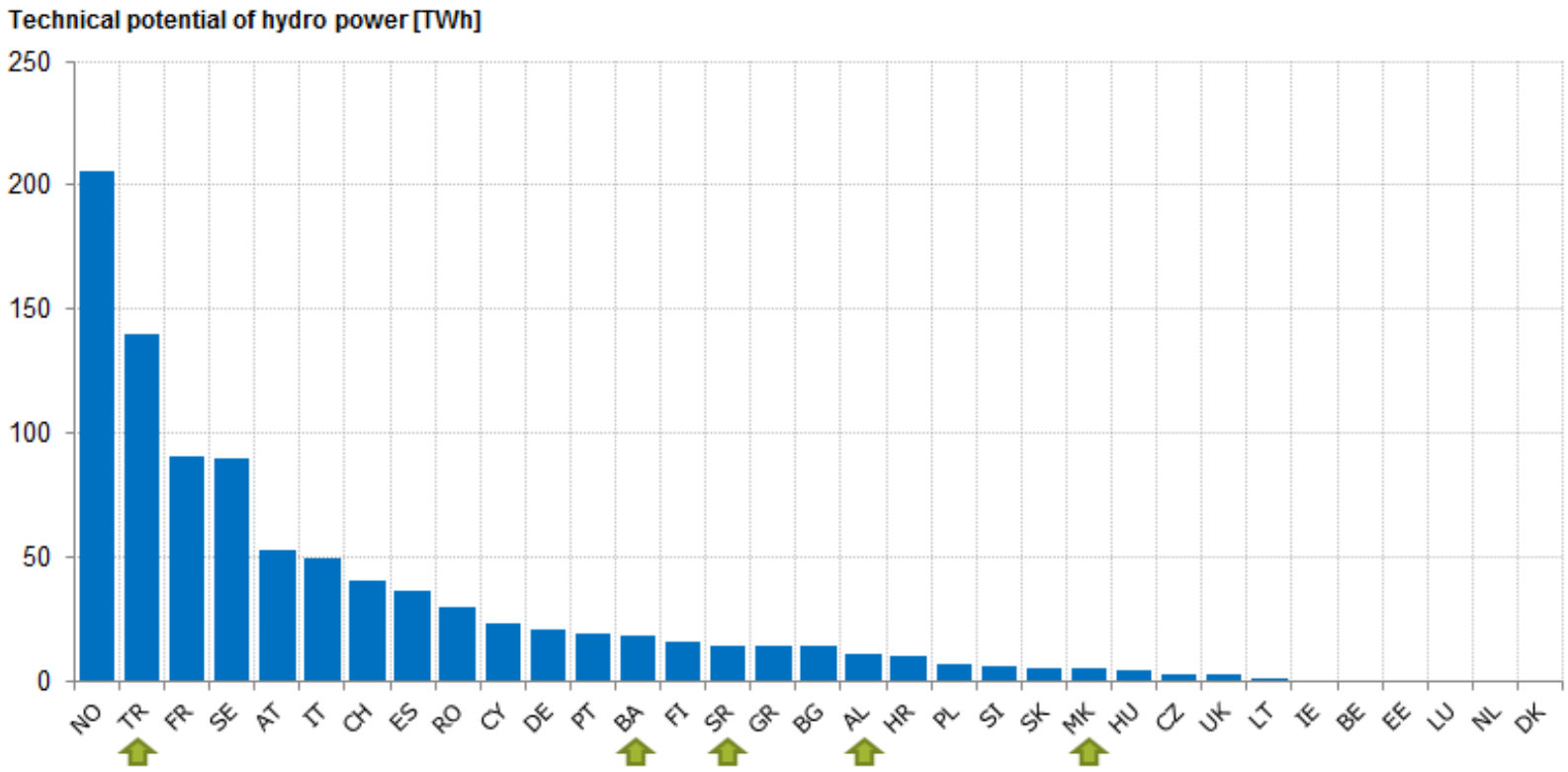
Motivation

Comparison of wind onshore potentials of EU countries with those of Turkey, Western Balkans and North Africa.



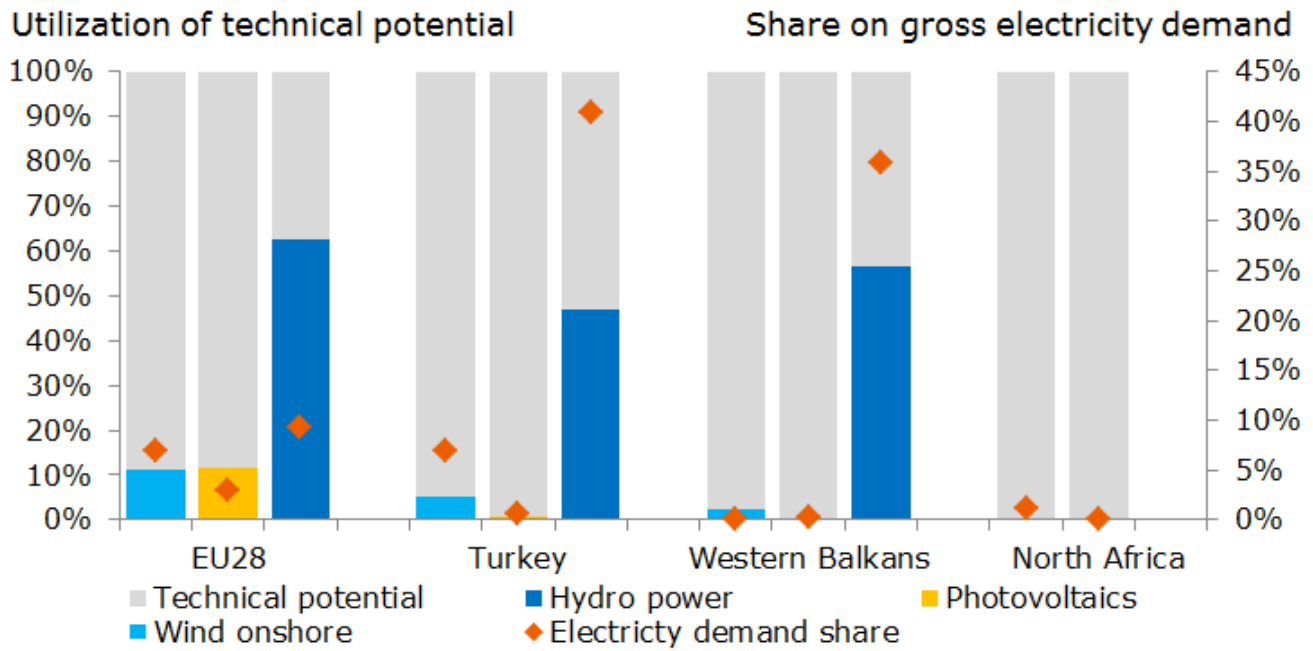
Motivation

Comparison of hydro power potentials of EU countries with those of Turkey, Western Balkans and North Africa.



Motivation

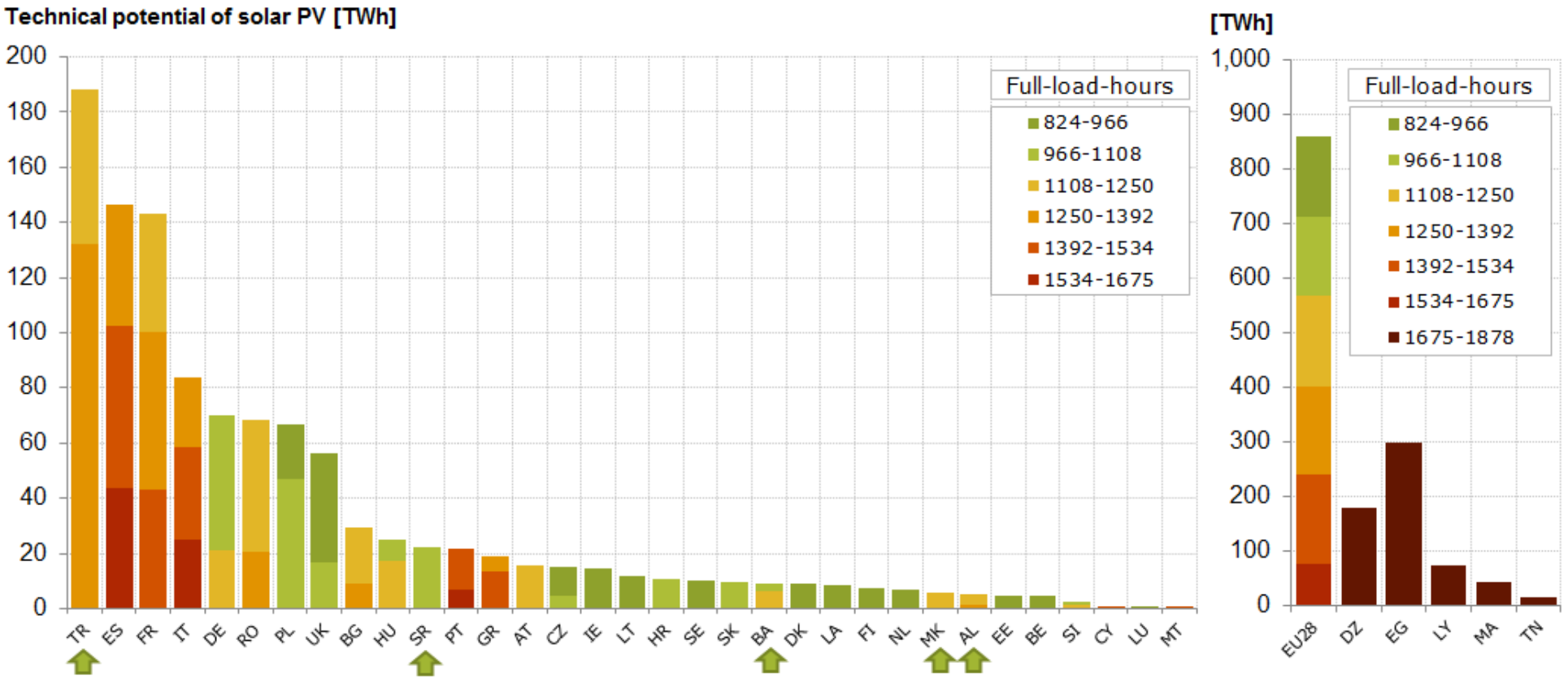
Overview of 2015 deployment of selected RES as share of technical potential and as share gross electricity demand



- Hydro power potentials have already been utilized approximately half of the available potential in all regions
- Whereas in Europe this share accounts only for 10% of gross electricity demand the shares in the Western Balkans and Turkey is around 40%.
- With regard to wind and solar PV only the EU28 show utilization shares of around 10%, whereas in the remaining regions nearly all of the available potentials are still untapped.

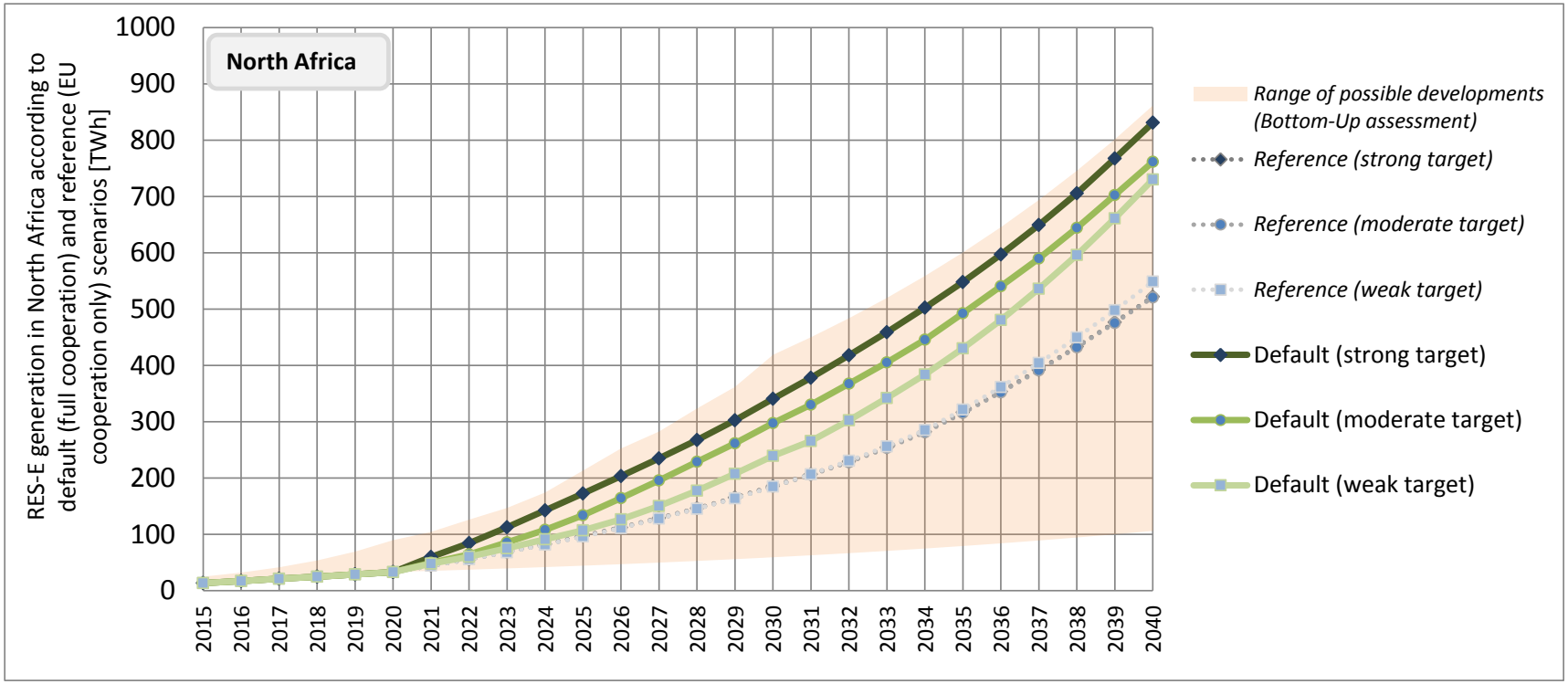
Motivation

Comparison of solar PV potentials of EU countries with those of Turkey, Western Balkans and North Africa.



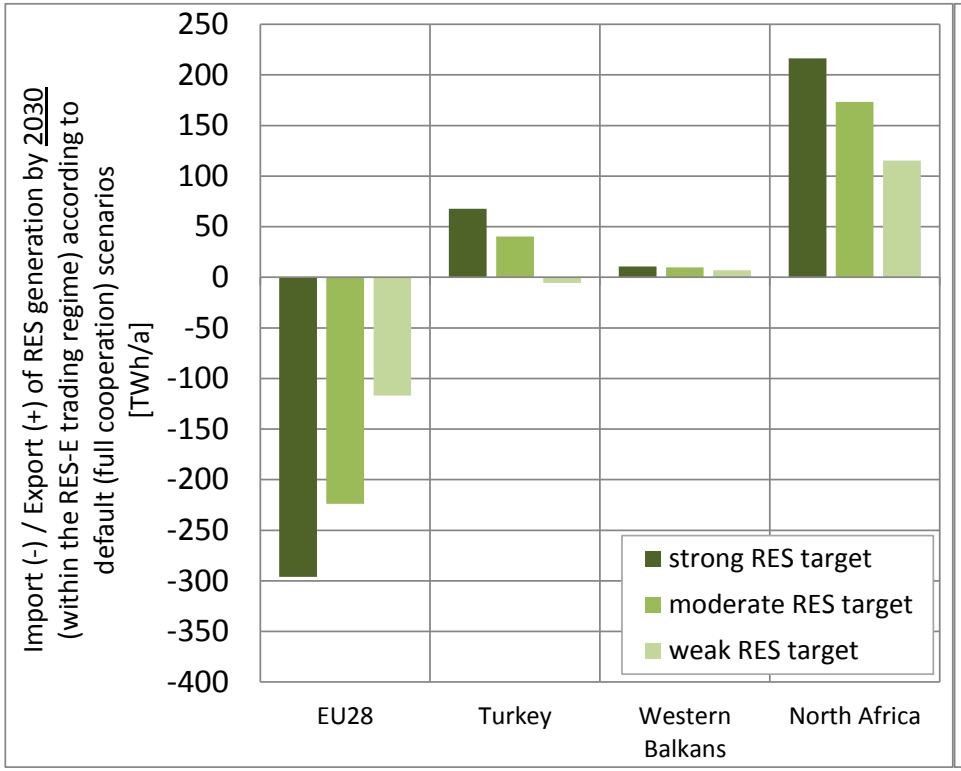
Benefits of RES cooperation

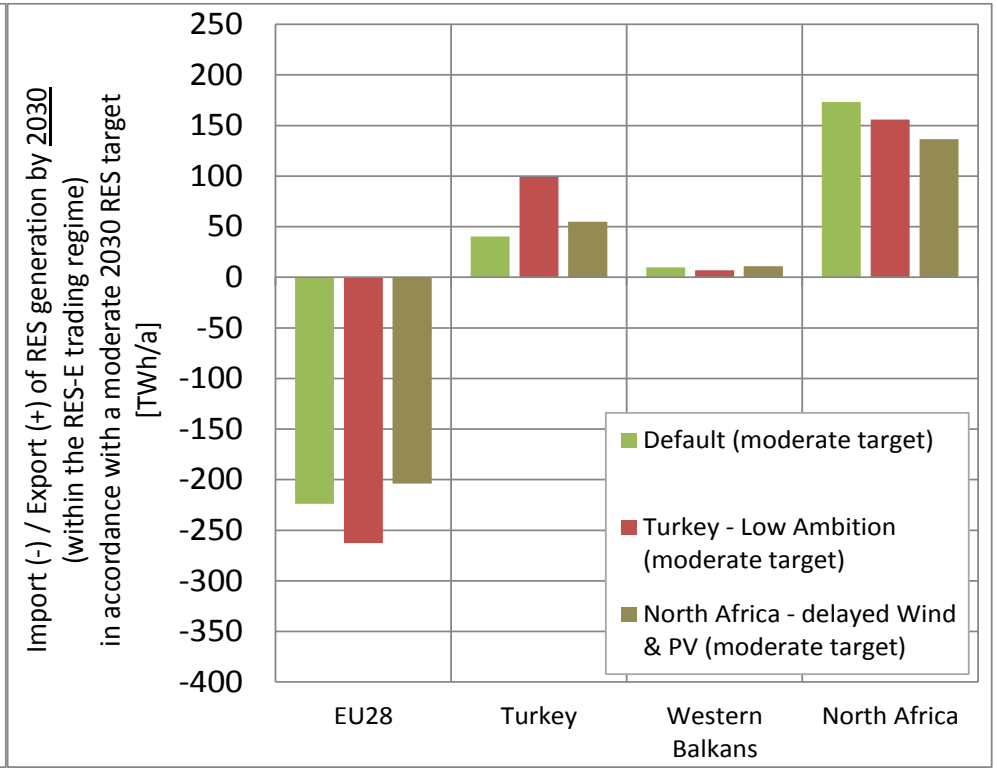
Modelled RES deployment within North Africa for different cooperation scenarios



Benefits of RES cooperation

Absolute amount of trade flows in [TWh]

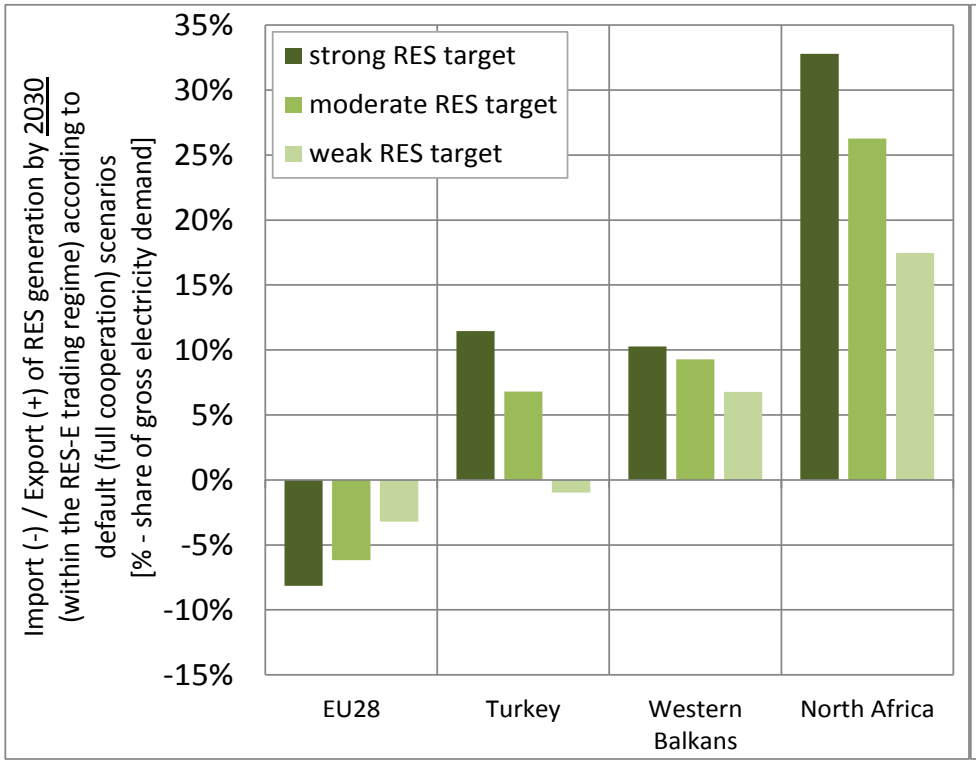


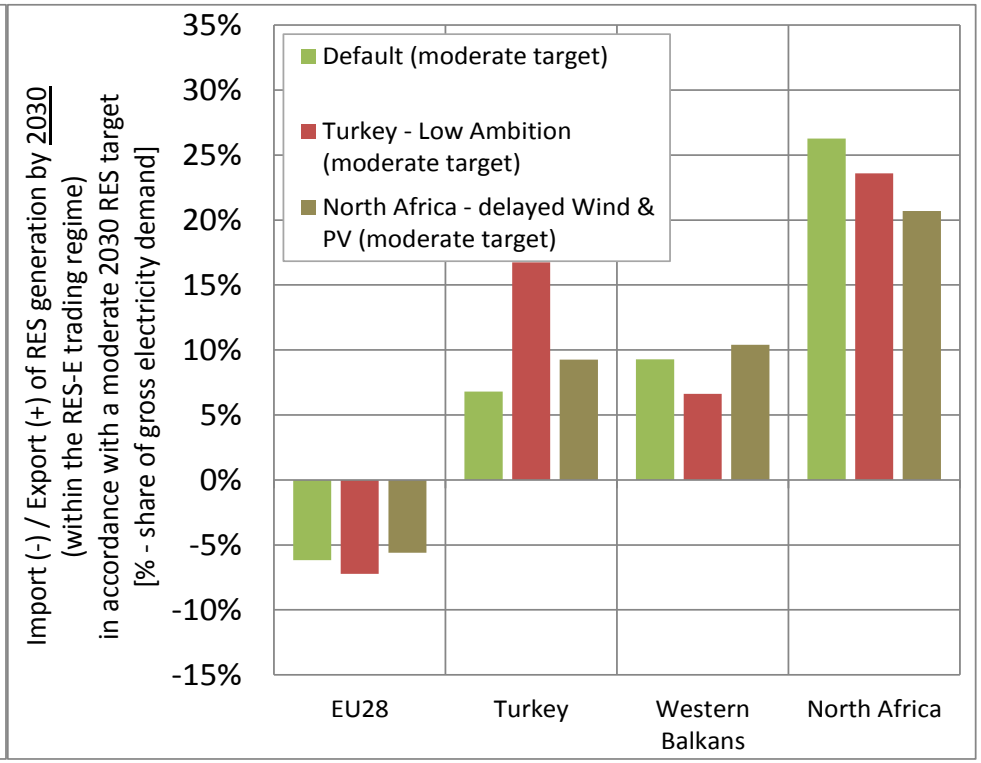


- Blabla

Benefits of RES cooperation

Relative amount of trade flows in [%] of gross electricity consumption

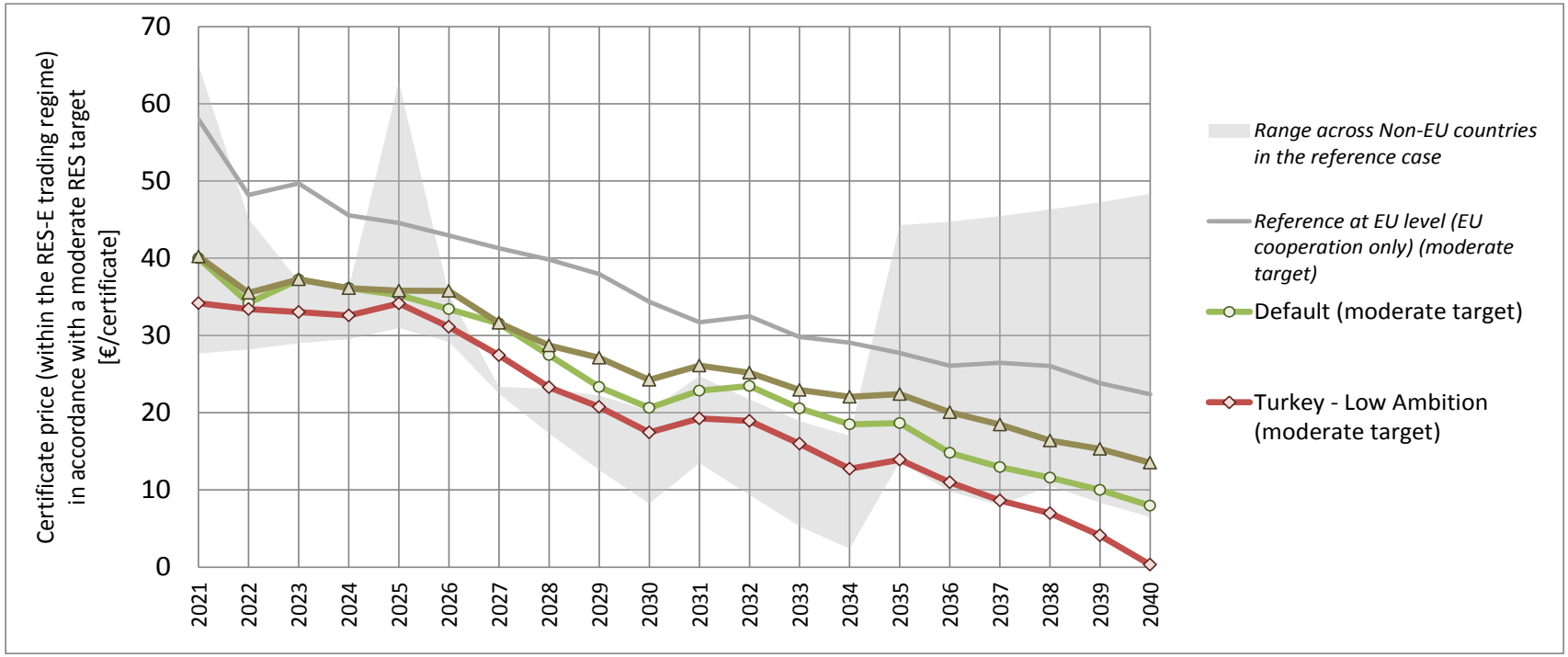




- Blabla

Benefits of RES cooperation

RES premium in [€/MWh] for different cooperation scenarios



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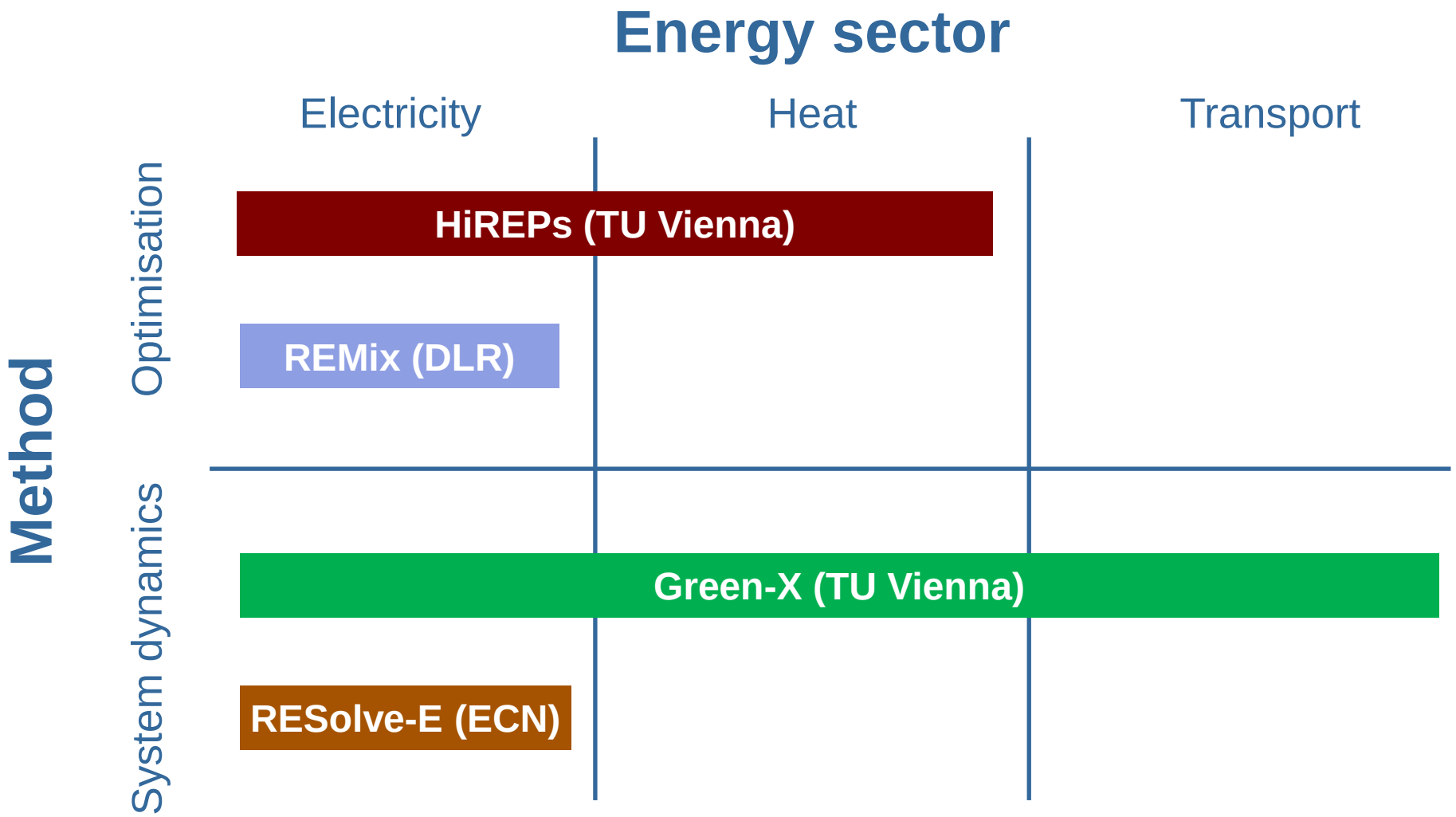
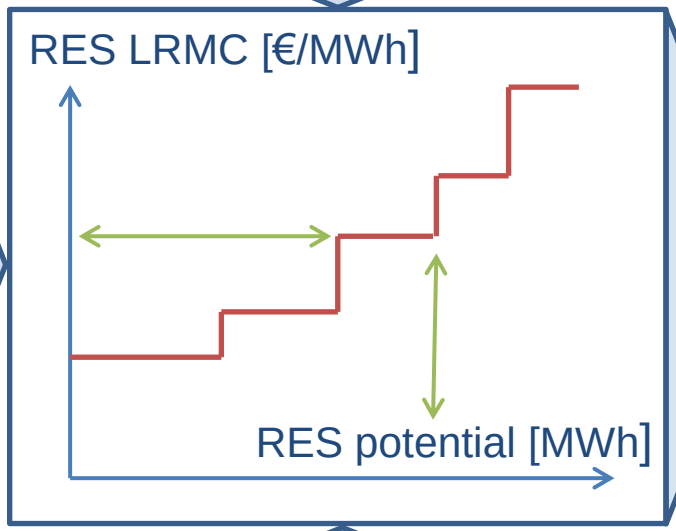
Involved models



Green-X model overview

RES policy (FiT, FiP, Quotas, Invest. support, ETS, …)

Countries (EU27+15)
RES-Technologies
RES-Potentials
Fuel/CO2-Prices
RES-Costs
- Investment costs
- O&M costs
- Financing costs (WACC)



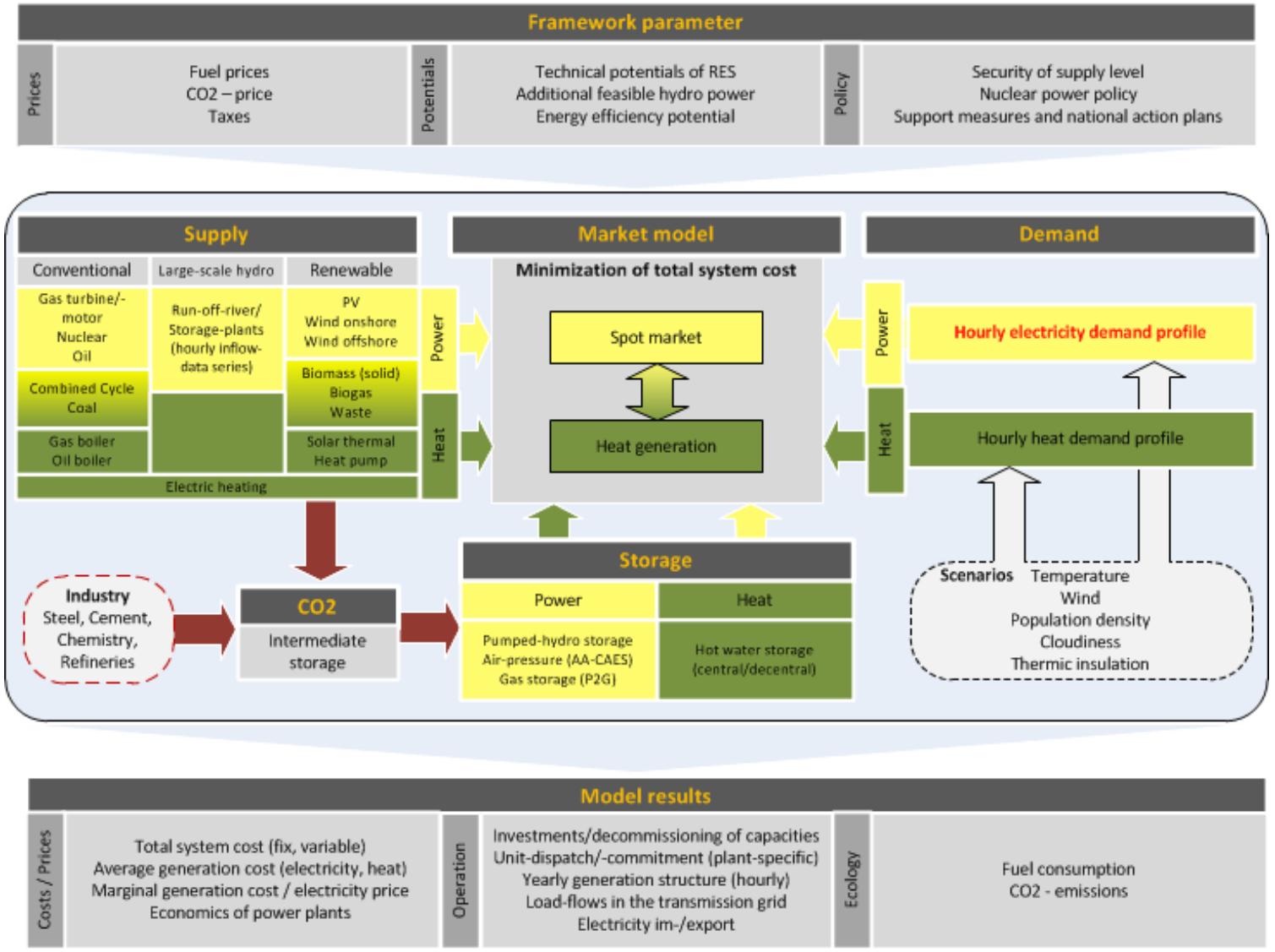
RES investments
- Electricity, Heat, Transport

Capital expenditures
Support expenditures
Generation costs (+)
CO2-savings
Biomass trade

Non-economic barriers (Social acceptance, capacity limits (industry, grid), administrative barriers)

Yearly time resolution (learning rates, barrier mitigation)

HiREPS model overview



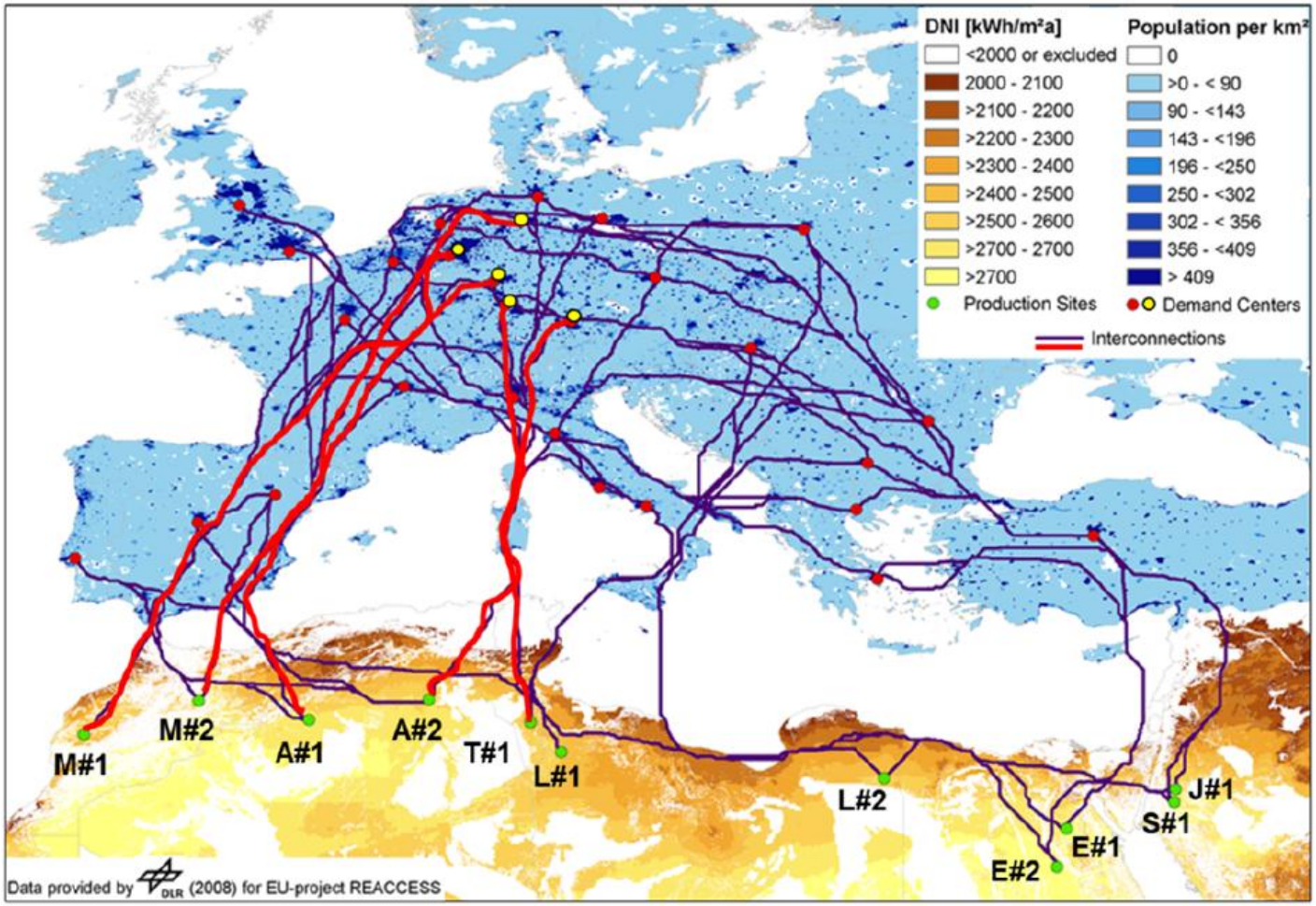
Infrastructure requirements

Two different concepts for imports from North Africa

	Point-to-point trade Trieb (2014), TuNur Project	Synergies through connection Desertec, Zickfeld (2012), Price Waterhouse Coopers (2010)
What type of energy?	Power on demand from CSP plants with thermal storage in NA exclusively dedicated to export	Energy surplus from technology-open, supply-driven production from RES mix (wind, PV, CSP) in NA
What infrastructure?	Point-to-point HVDC lines to European centres of demand	Point-to-point HVDC lines to European centres of demand
Grid integration	CSP plants not connected to national grid in NA	All RES plants produce for domestic demand and surplus will be exported
Accountability	Full traceability and accountability of RES generation	No traceability of RES generation and bottlenecks within European grid

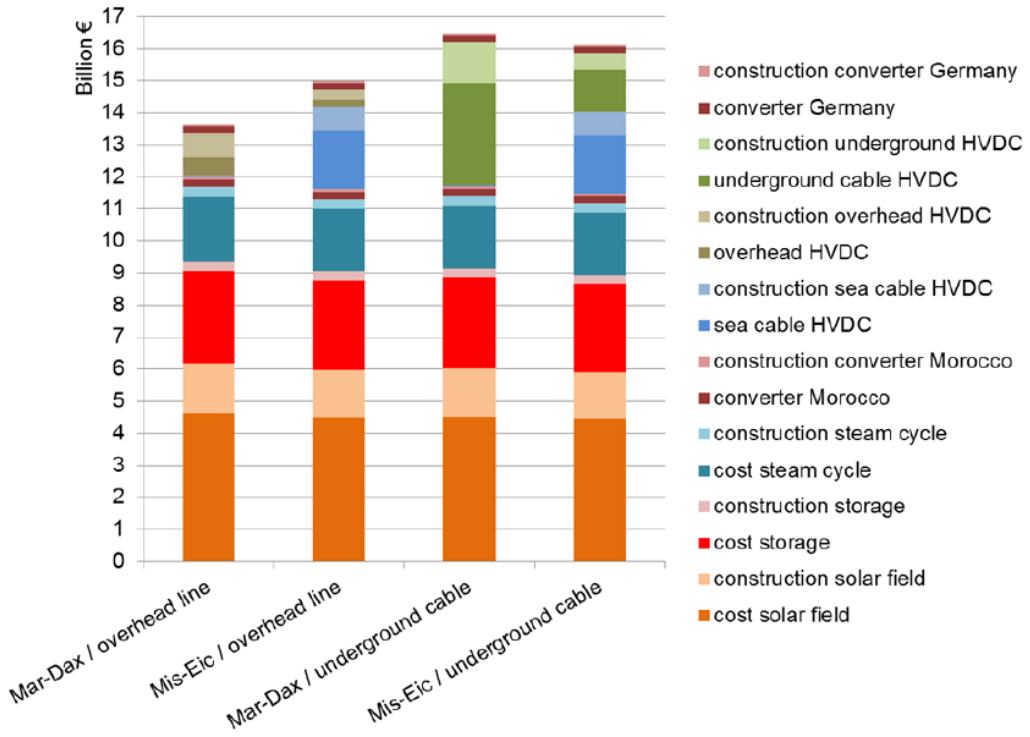
Infrastructure requirements

Potential Point-to-point HVDC links from North Africa to Europe



Infrastructure requirements

Investment costs Trieb (2014), Hess (2012)



Annual operation costs Trieb (2014)

Alternative	Marrakesch-Daxlanden	Missour-Eichstetten
Overhead HVDC	1.56; 32% 0.23; 5% 3.12; 63% ∑4,91 €Cent/kWh	1; 23% 0.28; 6% 3.06; 71% ∑4,34 €Cent/kWh
Underground HVDC	0.67; 16% 0.40; 10% 3.12; 74% ∑4,19 €Cent/kWh	0.67; 17% 0.34; 8% 3.06; 75% ∑4,07 €Cent/kWh

O&M CSP O&M HVDC compensation costs

- Investment cost repayment period decisive (5 yrs -> 500 €/MWh, 40 yrs -> 220 €/MWh)
- Annual operation costs vary between 40 and 50 €/MWh -> backstop technology
- Compensation costs are crucial (land use, concessions, transmission fee, …) -> can range up to 10 €/MWh

Open question: What are future expected market values of CSP within Europe? -> Modelling activity ongoing