The cost of renewable energy:

A critical assessment of the Impact Assessments underlying the Clean Energy for All Europeans-Package

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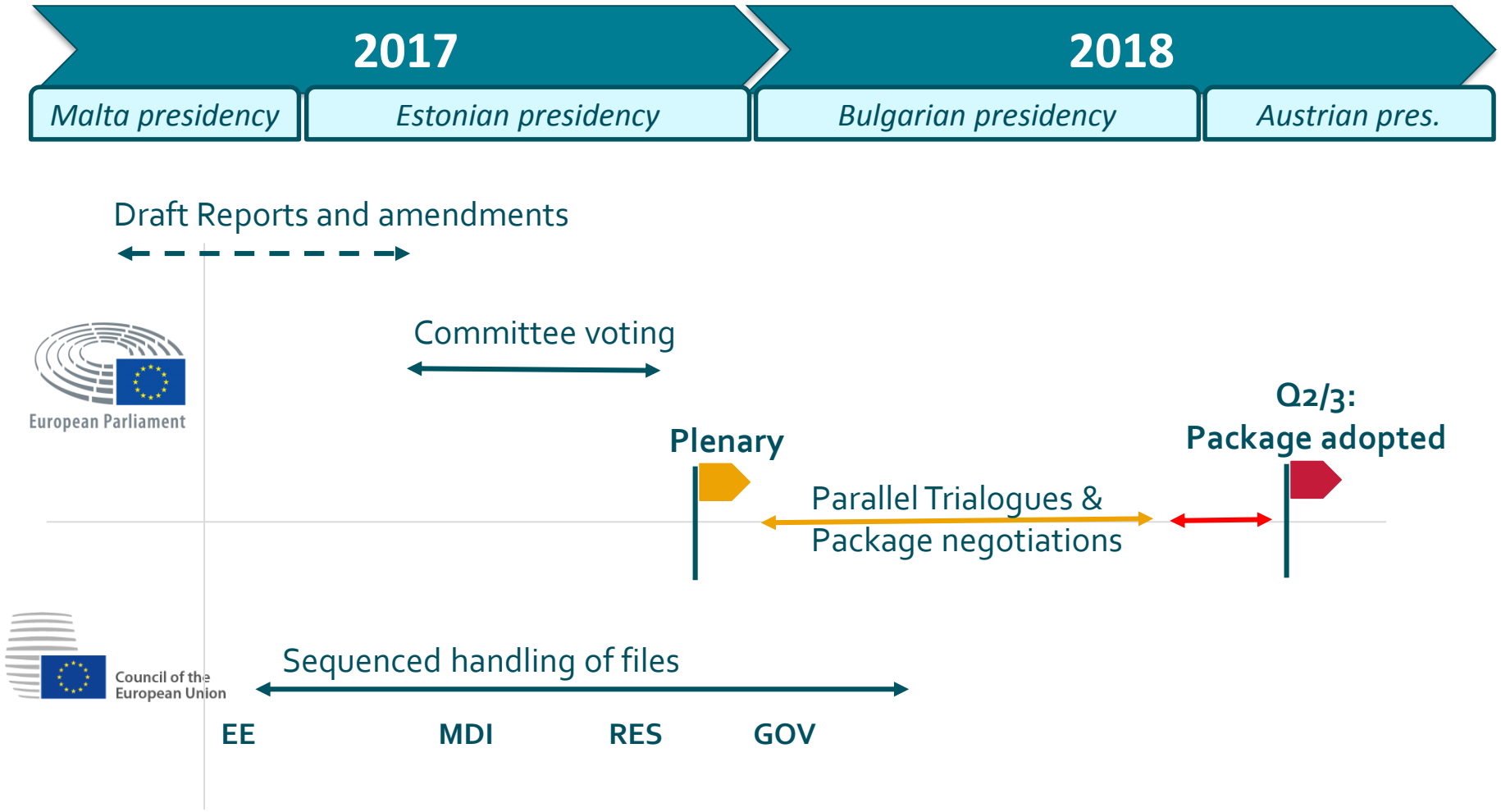
State of play: outlook

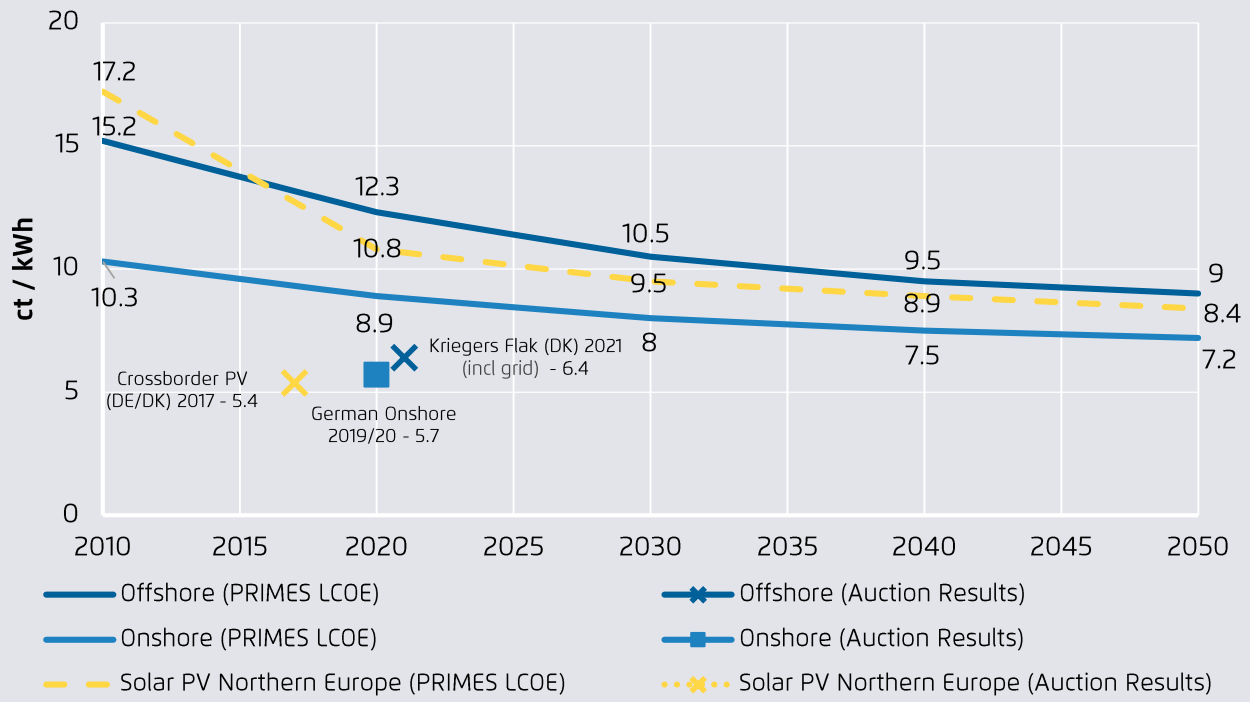


Background: Why energy modelling matters and how it was done for the CE4ALL-package

- Commission proposals are accompanied by an impact assessment. This involves at minimum a *qualitative* analysis of expected impacts, often also a *quantitative* analysis (e.g. *modelling)*.
- While modelling does not provide a prediction of future developments, it does help empower decision-makers to anticipate the potential impact of specific choices and options as well as trade-offs that may exist.
- The European Commission underpins its climate and energy policy proposals with extensive energy system modelling, the results of which play a substantial role in determining the outcome of the Commission impact assessment. Assumptions underlying Commission modelling determine to a large extent whether and to which degree certain policy choices will be regarded as beneficial.
- Since 2003, European Commission services have mostly made use of the PRIMES-model; an energy market engineering-economic model owned and run by the Technical University of Athens. Its results have been a critical reference point for the European energy and climate debate, in the 2050 Roadmap exercise as well as in the 2030 target-setting process.

Background: Recent auctions in the real world resulted in significantly lower costs for renewable energy projects than suggested by Commission modelling.

Comparison of PRIMES LCOE cost assumptions with the results of recent auctions by year of expected realization



Source: COM (2016) EU Reference Scenario 2016; BNetzA (2016, 2017); Danish Energy Agency (2016); ICIS (2017); Vattenfall (2016)

- The use of competitive auctions has led to an intense period of downward price discovery for these technologies that has dramatically reduced the level of support needed to develop new renewables capacity.
- Since the beginning of 2016 alone, several auctions have resulted in support payment guarantees awarded to successful bidders reflecting levelized costs of producing electricity that are below those assumed under PRIMES modelling for the year 2030.

The Clean Energy for All Europeans Package - Context

- Commission analysis in 2012/13 showed that higher renewables and efficiency scenarios would result in higher investment costs, but lower energy purchases. Overall system costs for a scenario with 30% RES were similar to one with 27% RES, assuming ambitious EE policies. A scenario with 45% GHG emission reductions and 35% RES was found to be only slightly more expensive (0.62%).
- In 10/2014 decision by EUCO on EU climate and energy targets for 2030: -40% reductions of GHG emissions against 1990 baseline, at least 27% improvement in energy efficiency, at least 27% RES-share in gross final energy consumption
- In CE4All Package, Commission proposes 27% RES target / no EU-level instrument for reaching the RES target / no binding Member State targets for 2030 / national 2020 targets proposed as baseline.
- Czech proposal to introduce a target corridor for MS to allow for more „flexibility“ in target delivery
- EP Rapporteurs for the ‘Clean Energy for All Europeans’-Package calling for an increase in ambition and a strengthening of the files. New Draft Reports of the RED Re-cast and the Governance Regulation call for 35% and 45% RES targets, respectively.

Overview of Key Shortcomings

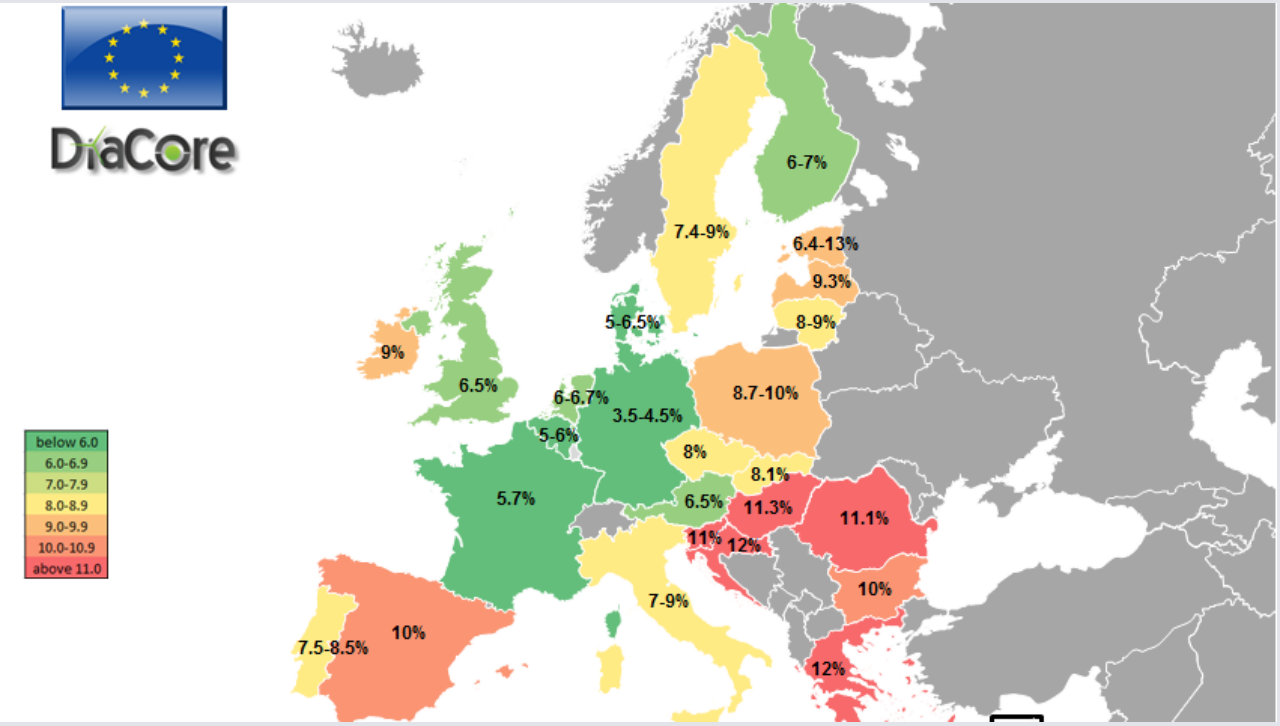
- Against this background, Agora Energiewende assessed the Commission Impact Assessment for the ‘Clean Energy for All Europeans’-Package and identified key shortcomings.

- The target scenarios of PRIMES in the 2016 modelling exercise:

1	Overestimate the costs of renewable energy
2	Overestimate the price of CO_2 and thereby exaggerate the role of markets in driving the development of renewable energies in Europe
3	Downplay the importance of robust sectoral policies and frameworks for developing Europe’s renewable energy resources at lowest possible cost

Cost of capital is a major determinant of the cost of renewable energy and varies substantially between EU Member State

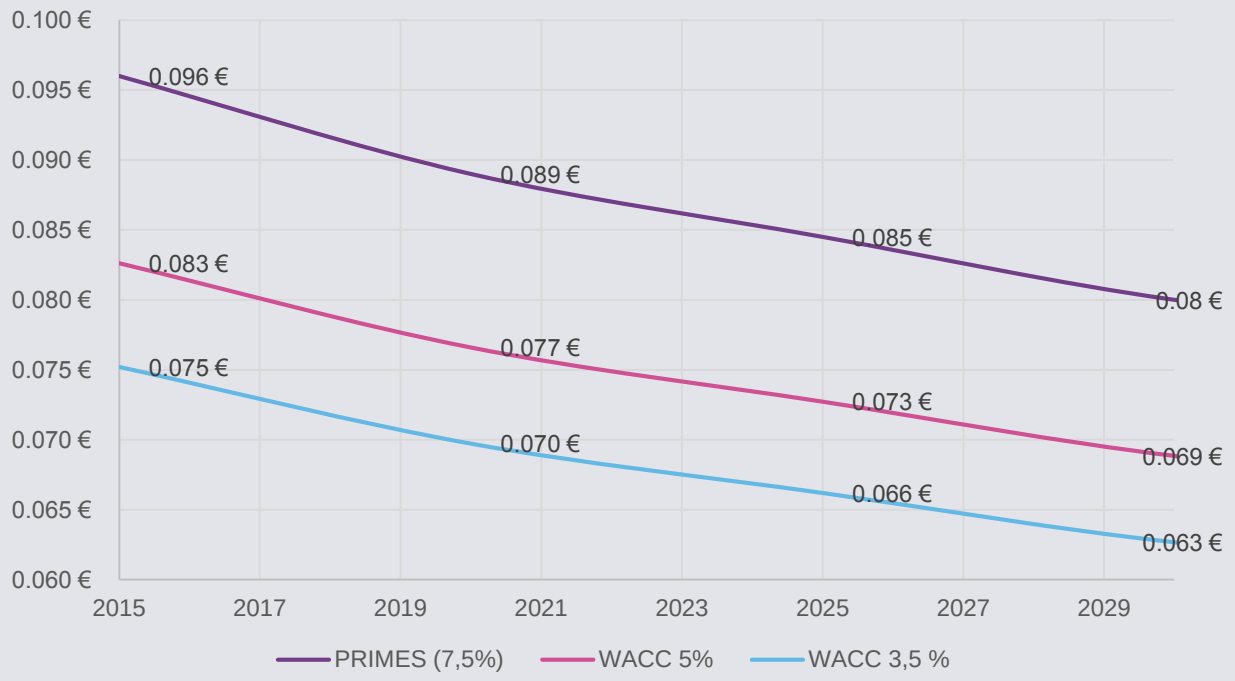
Estimated weighted average cost of capital for onshore wind in Europe in 2014



Source: DiaCore (2016), *The impact of risks in renewable energy investments and the role of smart policies*.

Shortcoming 1: Overestimating the costs of renewables due to simplified assumptions concerning cost of capital for renewable investment

Impact of lower WACCs on PRIMES LCOE for Onshore Wind

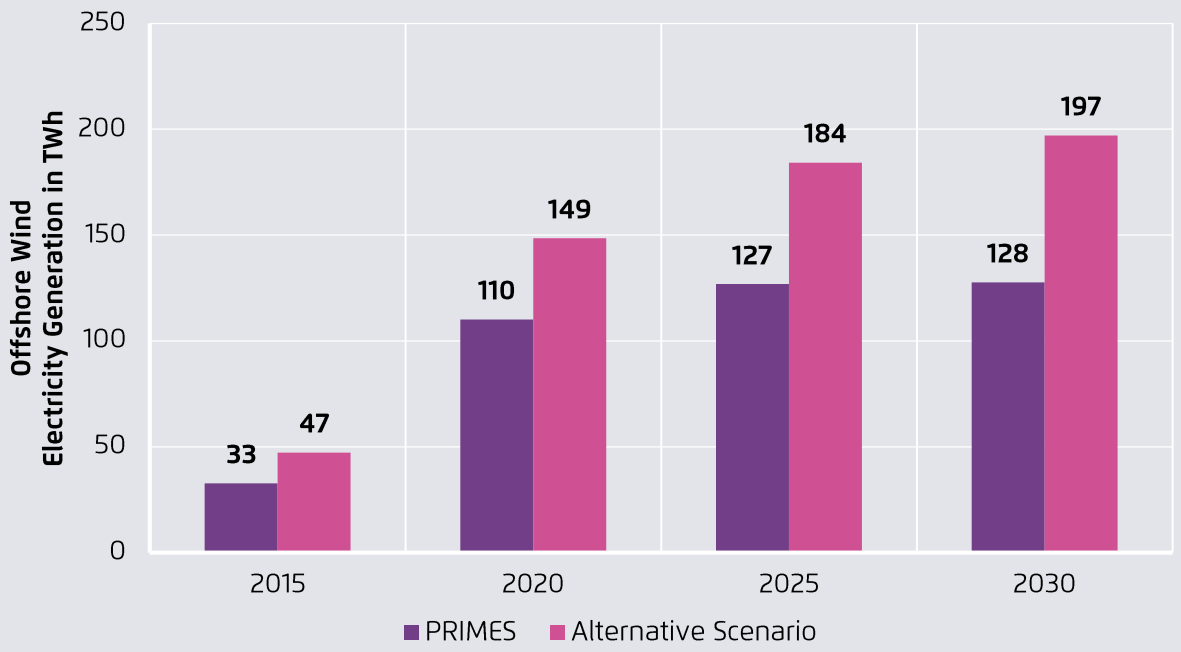


Source: COM (2016) EU Reference Scenario 2016 and own calculations based on PRIMES assumptions

- The Commission modelling for the central target scenarios EUCO27 and EUCO30 applies a flat-rate value for cost of capital of 7.5 percent across the whole of Europe.
- This is a rate significantly higher than capital costs for competitive technologies (e.g. wind onshore and solar PV) in mature markets (e.g., Germany, UK, Netherlands, France) where a majority of renewables investments in Europe is currently happening.
- In consequence, the Commission central scenarios set costs of renewable electricity projects in these primary markets up to 20 percent higher in 2030 than plausible.

Shortcoming 1: Overestimating the costs of renewables due to outdated assumptions on capacity factors

Offshore Gross Electricity Generation (in TWh) for COM 2016 Reference Scenario vs. Alternative Scenario with Higher Capacity Factors

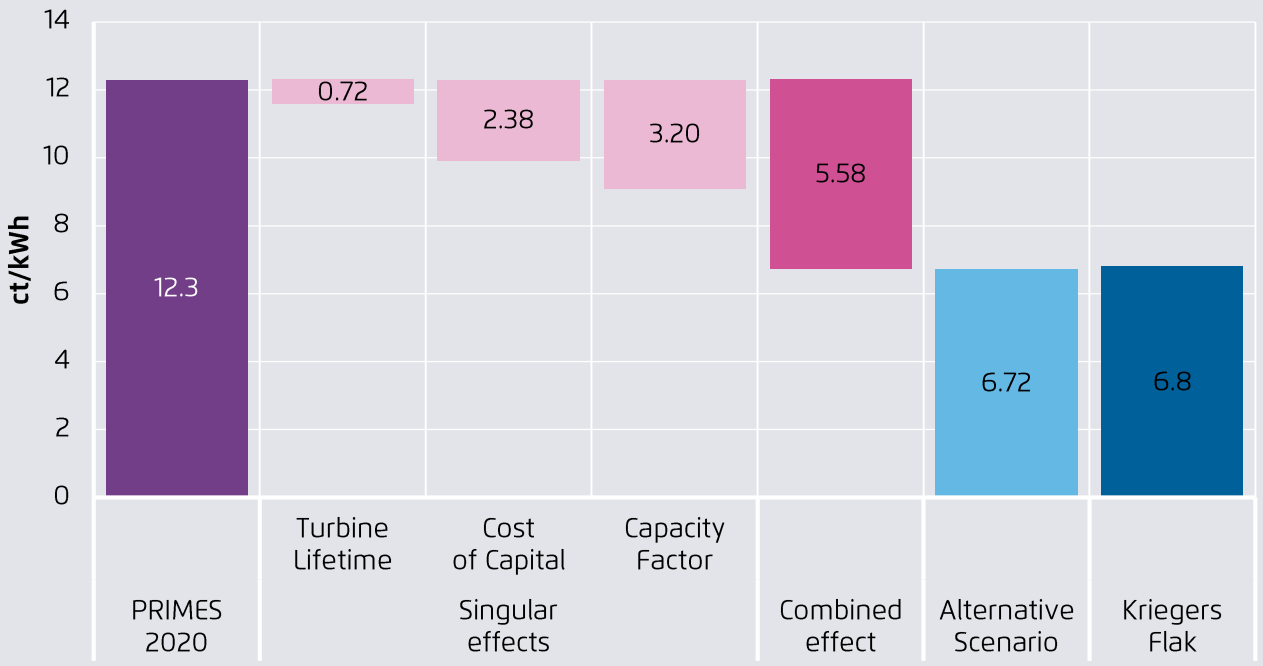


Source: COM (2016) EU Reference Scenario 2016 and own calculations based on PRIMES assumptions

- The PRIMES modelling for offshore wind installations results in significantly lower than plausible yearly full load hours (3.000-3.350 / capacity factor of 34-38%), compared to the averages reported by Danish Regulatory Agency (4.400 / 50%) for 2015.
- Applying such a higher capacity factor in the European Commission's 2016 Reference Scenario would increase the yearly electricity production by offshore wind farms from 128 TWh to roughly 197 TWh in 2030.
- Put differently, the same capacity of offshore wind resources would generate approximately 54 percent more electricity than projected in the Commission Reference Scenario.

Conclusion 1: A 27% RES share cannot be the cost-optimal contribution towards the 40% GHG target – RES share needs to be set significantly higher

PRIMES 2020 Offshore Wind LCOE vs. Alternative Scenario and Real World Auction Results



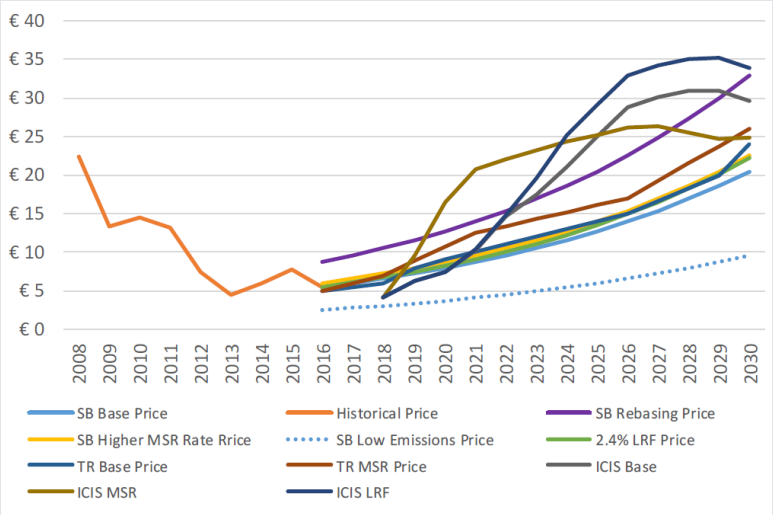
Source: EU Reference Scenario 2016 and own calculations;

- Taken together, our findings (lower WACC, higher capacity factors) imply that the central target scenarios in PRIMES are significantly overestimating the costs of investments in renewables and particularly the costs for developing Europe's offshore wind resources
- The contribution of renewables should be higher as renewable energies are relatively more competitive than other alternatives deployed by PRIMES (e.g., nuclear or carbon capture and storage).

Note on Figure: Assumptions for singular effects (from left to right): Extension of operating lifetime from 20-25 years; Reduction of WACC from 7.5% to 3.5%; Increase of capacity factor to 4400 hrs; Kriegers Flak estimate includes grid costs.

Shortcoming 2: ETS prices are projected at significantly higher levels than by carbon analysts in the real market, thus overestimating purely market-driven deployment of renewable

ETS Prices in PRIMES target Scenarios for the COM Impact Assessment vs. Price forecast for annual average prices under the EU ETS



Ref2016	EUCO27	EUCO30	EUCO3030
34	42	27	27

Source: RED Re-cast IA (2016); EU Reference Scenario 2016; Sandbag (2017)

- PRIMES applies the assumption of perfect foresight for investors, and that the ETS is already driving behavioural change today, including significant levels of renewable generation capacity being autonomously built in the reference scenario.
- The EU ETS is structurally oversupplied. The cumulative surplus now exceeds 3 billion tonnes CO_2, almost twice the volume of annual ETS emissions.
- The 2020-30 contribution of the ETS to increasing electricity market revenues for RES producers will be smaller than projected by the Commission.
- Prices for CO_2 allowances are unlikely to make a significant contribution to reliably switching from coal- to gas-fired generators before the end of the decade.
- **Conclusion: The Commission modelling exaggerates the projected relevance of carbon markets as a driver of cost-effective renewable energy development in key target scenarios**

Shortcoming 3: The Commission's scenarios downplay the importance of robust renewables frameworks to reduce uncertainty and to bring down cost

Average profits and losses for different plant categories in the case of an EOM from 2020-2050 in EUR/kW for EU-28

	2020	2025	2030	2035	2040	2045	2050
Total	-46.9	9.1	35.7	78.4	68.8	129.2	80.5
Solids	69.9	94.8	1.6	-111.5	-80.9	-89.7	-207.7
Steam turbines oil/gas	-66.2	-116.7	-117.3	-93.8	-90.7	-68.5	-120.9
CCGT	-75.1	-55.6	-23.2	27.6	-23.5	21.1	-59.6
Peak	-53.7	-50.1	-51.9	-11.8	224.2	344.1	36.8
Nuclear	-47.5	102.8	141.0	249.4	233.8	374.5	259.4
Lakes	144.0	162.3	185.6	205.9	211.9	270.5	263.4
Run of River	268.4	309.3	335.4	355.3	304.9	345.3	209.0
Geothermal	153.3	235.4	313.8	438.3	477.1	443.4	356.1
Wind onshore	1.9	30.7	82.2	117.2	118.5	173.1	142.1
Solar PV (large)	-63.0	-1.2	25.6	58.6	49.0	86.1	62.5
RES (small)	-115.0	-101.4	-48.5	34.7	19.1	24.9	5.0
Wind offshore	-6.2	-83.8	-85.9	-18.2	2.6	127.7	55.9
Biomass	-137.9	-171.2	-141.3	-59.0	-74.1	20.5	13.2
Solar thermal	-678.7	-666.4	-466.2	-422.0	-385.3	-265.1	-415.0
Tidal	-5,569.9	-4,105.4	-308.5	-252.8	-175.7	-116.0	-130.0
CHP solids	-136.9	-203.5	-208.5	-227.6	-315.5	-364.8	-434.8
CHP gas	-163.8	-185.8	-169.3	-128.4	-207.7	-235.5	-328.0
CHP biomass	-338.5	-336.1	-324.0	-289.9	-292.3	-128.3	-90.1
CHP oil	-333.2	-459.2	-487.9	-372.3	-367.8	-629.5	-413.8

Source: NTUA modelling (PRIMES/OM), MDI Impact Assessment

- The Commission concludes for the central target scenarios that under the right framework conditions only minimal support for renewable energy will be needed for certain renewable technologies (e.g. onshore wind, solar PV).
- Key assumptions affecting this projection are improved market functioning due to removing priority dispatch and increased investor confidence in a rising ETS price.

Shortcoming 3: The Commission's scenarios downplay the importance of robust renewables frameworks to reduce uncertainty and to bring down cost

- However, a deeper look into the Commission Impact Assessments shows that the headline political message "mature renewables will be able to stand on their own feet after 2020" needs significant nuancing.
- For example, the COM target scenarios use input parameters ("RES-Values") for electricity, H&C and transport that *implicitly* include renewable energy-specific policies and measures
- The average renewables value was set at 7 €/MWh for EUCO27, 16 €/MWh for EUCO30, and at 58 €/MWh to reach a share of 30 percent renewables in the case of EUCO3030

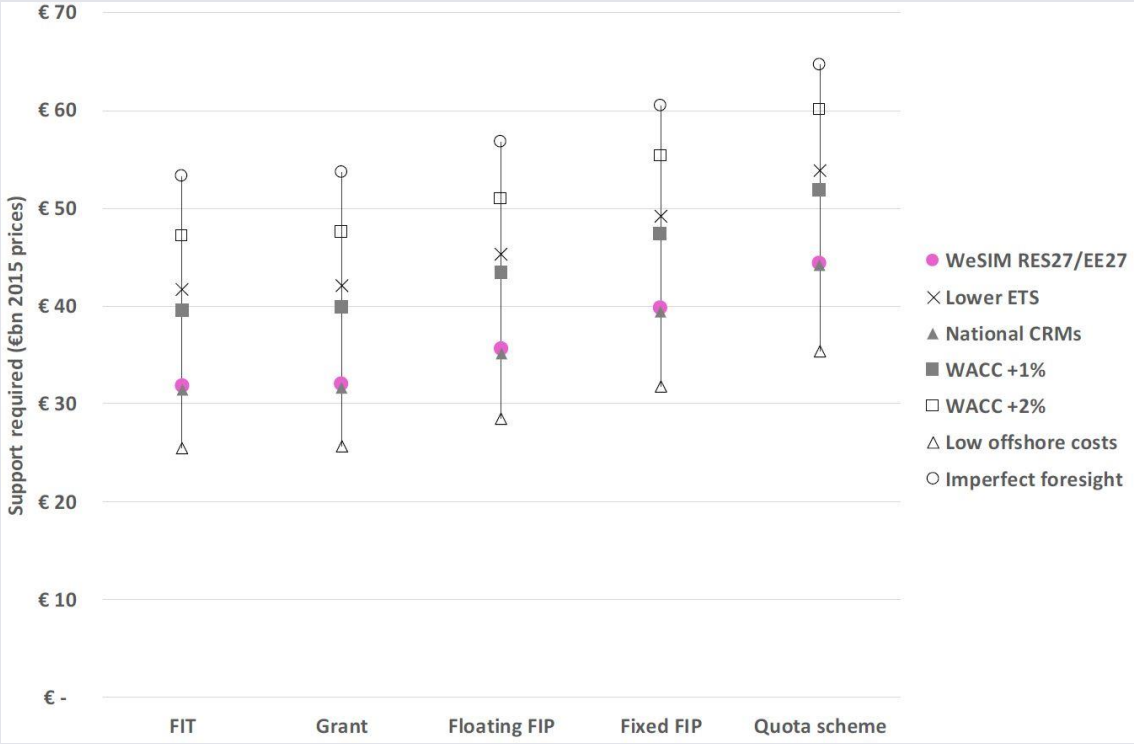
The Commission's qualitative assessment is more explicit on the preconditions for a market-based financing of renewables

- 1) continued decrease in technology costs,
- 2) the availability of (reasonably cheap) capital,
- 3) social acceptance,
- 4) sufficiently high and stable fossil fuel prices,
- 5) addressing the current surplus of carbon allowances,
- 6) reducing the occurrence of low or negative market prices,
- 7) reducing balancing costs for renewables producers,
- 8) bringing additional revenues to RES producers in balancing and ancillary services markets,
- 9) ensuring a timely and sufficient deployment of all sources of flexibility in order to limit the renewables "cannibalization effect",
- 10) and electricity overcapacity effectively exiting the market

Source: RED Re-Cast IA

Conclusion 3: It is a combination of power market design reforms with robust EU-level and national renewable energy policies and frameworks that will deliver least cost renewable energy investments in Europe.

Funding gap between 2020-2030 for RES investments in €bn (2015 prices) by sensitivity



Source: CEPA (2017) Supporting investments into renewable electricity in the context of deep market integration of RES-e after 2020

- Robust renewable energy frameworks, favourable financing conditions, well-functioning power markets, the early retirement of generating overcapacity in particular of inflexible baseload coal-fired generator, and a meaningful ETS allowance price could combine to fully phasing-out the need for specific support to renewable energy projects.
- Competitive tendering will automatically show where and when investors consider the appropriate conditions to be in place

Overall Conclusions

1) Renewables are significantly cheaper than modelled by the Commission.

2) A significantly higher than 27 percent share of RES is cost-effective to reach the 40%GHG target. Real world RES costs would allow for a higher GHG target at the same cost.

3) New modelling with updated cost assumptions and higher RES shares is needed.

4) Robust renewable energy frameworks are fundamental for unlocking Europe's renewable energy potential at lowest possible cost.

5) Robust renewable energy frameworks combined with improved power market functioning can bring the need for premium payments above market price down to almost zero.

6) The setting of a higher level should be informed by Europe's interest to be home to a vibrant renewable energy industry that creates new economic and employment opportunities.

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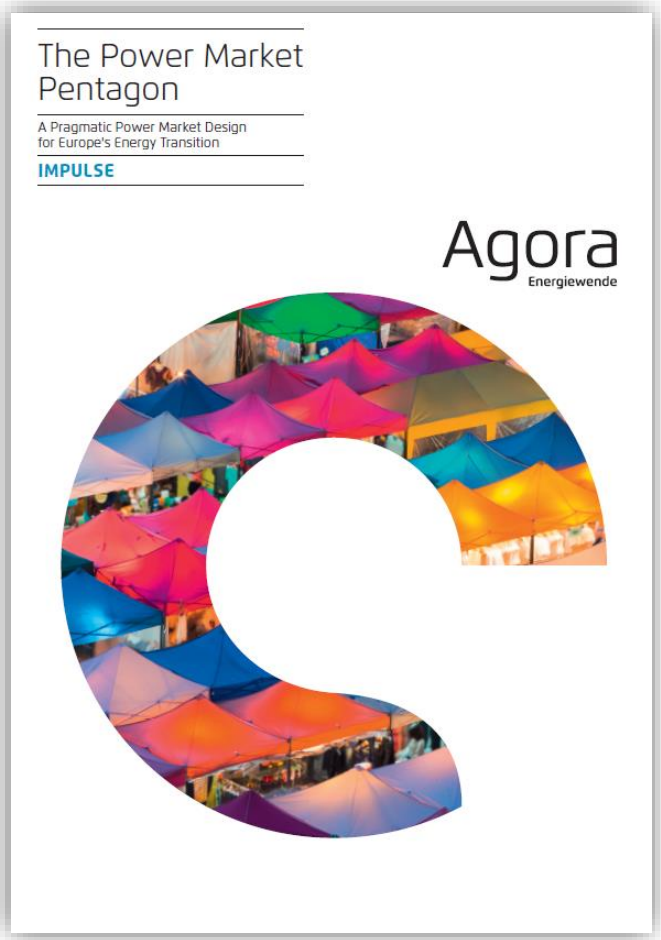

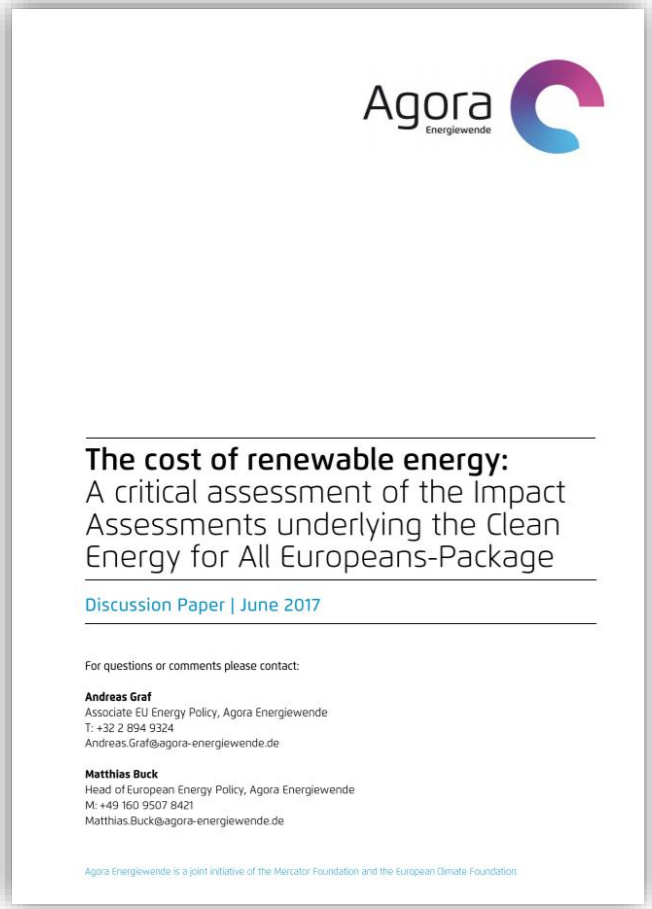

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Questions or Comments? Feel free to contact me:

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Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.

Background: Despite a favourable quantitative assessment of the cost of high RES ambition, a political decision was taken in 2014 to support a 27% target.

Key modelling results for target scenarios from the 2014 Commission Impact Assessment on the2030 climate and energy policy framework

	Scenarios			
	REF	GHG40/EE	GHG40/EE/RES30	GHG45/EE/RES35
Total System Costs*	2,067	2,089	2,089	2,102
Investment Expenditure*	816	875	879	909
Fossil Fuel Net Imports*	461	441	439	434
GHG 2030	32.4%	40%	40%	45%
RES 2030**	24.4	26.4	30.3	35.4
EE 2030***	21.0%	29.3%	30.1%	33.7%

Source: 2014 COM on 2030 Framework

- Commission analysis in 2012/13 showed that higher renewables and efficiency scenarios would result in higher investment costs, but lower energy purchases
- Overall system costs for a scenario with 30% RES were similar to one with 27% RES, assuming ambitious EE policies.
- A scenario with 45% GHG emission reductions and 35% RES was found to be only slightly more expensive (0.62%).

Background: Much has changed for renewable energies since the 2014 Commission Communication on the 2030 framework.

Comparison of investment and total system costs for the 2030 climate and energy framework - 2014 vs. 2016 Impact Assessments

	2014–2030 Framework IA			
	Ref2014		GHG40/EE	GHG40/EE/RES30
Avg. annual total system costs (2011-2030) in bn €'10	2067	N/A	2089	2089
Avg. annual investment expenditure for generation & boilers (2011–30) in bn €'10	50 bn €	N/A	53 bn €	55 bn €
Share of RES-E 2030	42.70%	N/A	46.10%	53.10%
	2016 – Winter Package IA			
	Ref2016	**EUCO27**	**EUCO30**	**EUCO3030***
Avg. annual total system costs (2010-2030) in bn €'10*	1880 (-9.1%)	1889	1896 (-9.2%)	1899 (-9.1%)
Avg. annual investment expenditure for power generation (2021–2030) in bn €'10	33.5 (-32.9%)	42.6	42.5 (-19.9%)	N/A
Share of RES-E 2030	42.5% (-0.2%)	47.30%	48.7% (+2.6%)	54.2% (+1.1%)

Source: 2030 Framework IA (2014), RES Re-cast IA (2016)

Changes in the modelling assumptions include:

- updated technology cost curves (especially lower costs for solar PV),
- a downward revision on overall electricity production/consumption;
- a downward revision on fossil fuel prices; and
- adjusted discount rates for cost accounting, including for energy efficiency investments (down from 17% to 10% - but still too high)