## Project #10 – SYRIA – TURKEY

## Description

The Turkish and Syrian grids are currently linked with one 400 kV AC overhead interconnection line, connected to Haleppo SS at the Syrian side and to Birecik HPP Substation at the Turkish side (115 km, 400 kV, 2-Bundle Cardinal 2×954 MCM). Before TEIAS synchronously connected to ENTSO-E network, this interconnection had been used to connect 2 units of Birecik HPP in Turkey to feed the Syrian network (unit direction method). After joining the ENTSO-E, TEIAS had to switch off the line. A Back to Back (B2B) converter substation is planned to be constructed next to Birecik HPP Substation on Turkish side and was already in the investment plan of TEIAS before the war in Syria. TEIAS postponed this investment until the stabilization of the situation in Syria. After the completion of the converter station the two grids will be fully connected asynchronously to each other B2B.

Syria and Turkey are part of the 8 countries interconnection, including also Egypt, Lebanon, Jordan, Iraq, Palestine, and Libya.

The project consists of one additional interconnection between Syria and Turkey to be realized through AC overhead lines. Also the B2B converter station at the Turkish side, which is already in the investment plan of TEIAS, needs to be upgraded to 1200 MW capacity for the project. The realization of the project is aiming to further increase the interconnection capacity between Turkey and the Syria of about 600MW.


| *Project Description Table* | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Description*** | ***Substation (from)*** | ***Substation (to)*** | ***GTC contribution (MW)*** | ***Total Route length (km)*** | ***Present status*** | ***Expected commissioning date*** | ***Evolution*** |
| *New interconnection between Syria and Turkey (AC)* | Syria (SY) | Turkey (TR) Birecik HPP | 600 | 115 | Long-term project | Project under consideration | |

## Project #10 – SYRIA – TURKEY

## Project Merits

The major merits of the project relevant to the Mediterranean electricity system are listed below:

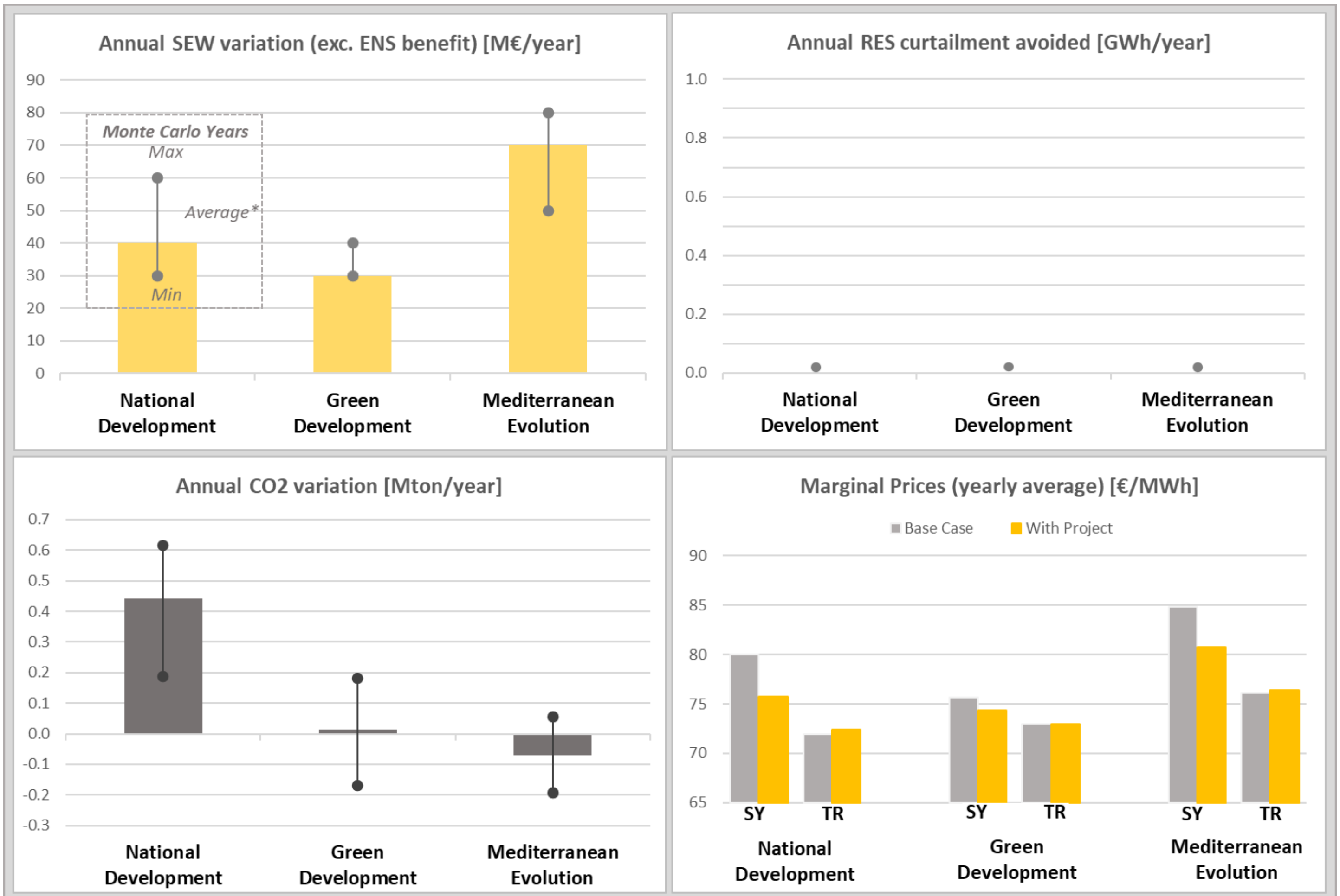
| | PROJECT MERITS | ASSOCIATED SYSTEM NEEDS | PROJECT 10 |
|---|---|---|---|
| **Market** | Reduce high price differentials between different market nodes and/or countries | Power studies with a 2030 time horizon can highlight significant differences in average marginal prices between countries, groups of countries or bidding zones. These differences are generally the consequence of structural differences in the composition of production fleets. The increase in the exchange capacity between these zones allows an economic optimization of the use of the generation plants and will be accompanied by electricity flow massively oriented in one direction, from the lower price country to the higher prices country, thus reducing the price differential. | X |
| **Dispatch, Adequacy and Security of Supply** | Positively contribute to the integration of renewables | Infrastructure to mitigate RES curtailment and to improve accommodation of flows resulting from RES geographic spreading. | |
| | Contribute to solving issues related to adequacy and security of supply | Infrastructure that presents a benefit for the security of supply or system adequacy, in general by allowing additional importation at peak hours, in countries and areas presenting current of future risk of deficiencies | X |
| **Operation** | Fully or partially contribute to resolving the isolation of countries in terms of power system connectivity or to meeting specific interconnection targets | Infrastructure to connect island systems, or to improve exchange capacity of countries showing low level of connectivity, or to contribute to meeting specific interconnection capacity targets | |
| | Introduce additional System Restoration mechanisms | Infrastructure that could provide capability for Black Start & Islanding Operation thus decreasing the need for generation units with such capabilities | |
| | Improve system flexibility and stability | Infrastructure to improve system flexibility and stability, by increasing sharing possibilities, namely in countries were expected changes in the generation fleet may raise concerns in those specific issues.<br>Decreasing levels of dispatchable generation can be compensated by infrastructure and/or market design to provide balancing flexibility at cross-border level (international pooling/sharing of reserves, coordinated development of reserve capacity).<br>The large increase in the penetration of asynchronous renewable generation is leading to Higher Rate of Change of Frequency (RoCoF) on the system, creating transient stability issues and causing voltage dips. This can be compensated through infrastructure designed to contain frequency during system events. | |
| | Increase system voltage stability | Reactive power controllability of converters can be used to increase system voltage stability | |
| | Enable cross-border flows to overcome internal grid congestions | Infrastructure to facilitate future scenarios and enable cross border flows, accommodating new power flow patterns, overcoming internal grid congestions | X |
| | Mitigate loop flows in bordering systems | Infrastructure to mitigate the loop flows occurrence in the borders between Mediterranean countries, contributing to the improvement of exchange capacity. | |
| | Contribute to the flexibility of the power systems through the control of power flows | Contribution to flexibility of power system operation by controlling power flows and optimizing usage of existing infrastructure | |
| **Physical infrastructure** | Refurbishment of obsolete infrastructure | Infrastructure to contribute to the refurbishment of obsolete part of grid initially designed in different context | |

## Project #10 – SYRIA – TURKEY

## Project assessment analysis

### CBA Indicators

Project 10 yields a positive impact in the expected values of the SEW across the 3 simulated scenarios. The impact of the project on $CO_2$ emissions and RES curtailment it is rather negligible and scenario dependent, with the greater expected benefit being noticed for $CO_2$ emissions in the Mediterranean evolution scenario.




* *Average of the outputs calculated for all the Monte Carlo Years*

## Project #10 – SYRIA – TURKEY

## Project assessment analysis

### Market Studies

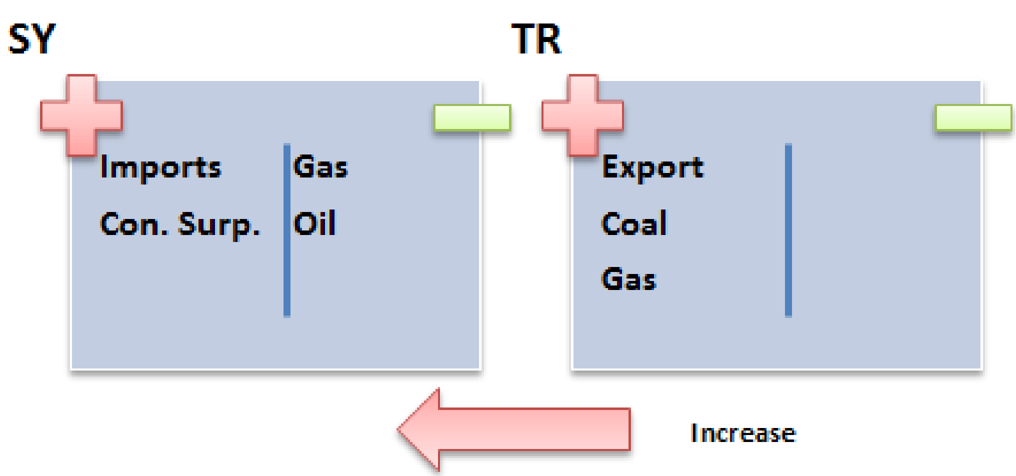
Project 10 drives an overall reduction in gas and oil-based generation, which are replaced by coal-based generation. Furthermore, the project leads to significant exports from Turkey to Syria, with coal and gas-based generation in Turkey substituting mainly gas-based generation in Syria (and oil-based generation to a lesser extent). More specifically:

- **Generation mix:**
  - **SY:** reduction in local gas-based generation and oil-based generation in a smaller degree, in all scenarios
  - **TR:** increase in local coal and gas-based generation in all scenarios
  - **LB:** reduction in oil-based generation in all scenarios, reduction in gas-based generation in the National Development scenario and increase in gas-based generation in Green Development and Mediterranean Evolution scenarios

- **Country balance and cross-country power flows:** due to the increase in the NTCs with the new interconnection, there is a significant increase in the flows between Turkey and Syria, mainly in the Turkey to Syria direction, although there is a decrease in the number of hours of saturation of the flow in this direction. A slight decrease in exchanges of Syria with Jordan and an increase with Lebanon is also observed.

<u>Note</u>

1. Since no data were directly provided to Med-TSO by the Syrian TSO, the Syrian system was modelled starting from available data to obtain an average scenario.
2. The combined effect of the implementation of Project 9 – JOSY and Project 10 – SYTR was also assessed with an additional simulation. The analysis concludes that the combined implementation results in slightly lower expected values of the SEW across the 3 simulated scenarios, compared to the separate implementation of the two projects. The results of this additional simulation may be found in the detailed project assessment (see paragraph Additional Information).



## Project #10 – SYRIA – TURKEY

## Project assessment analysis

The project consists in a new interconnection between Syria and Turkey, to be realized through 400kV AC overhead line and HVDC Back-to-Back station in Turkey. With this link the interconnection capacity between these countries will be additionally increased by 600 MW.


The system of Turkey is represented with its full network model. For the system of Syria the model was not available, thus the Syrian system was represented as an external bus.

The security analysis for the Turkish system was applied to the transmission levels. Therefore, for the N and N-1 static analysys 400 kV branches are considered. The security analysis performed for 3 different scenarios and 8 Points in Time in total, identified that for the Turkish system there is no need of additional lines, just an upgrade of some existing lines is necessary, as detailed below. For the third countries that are included in the project no internal reinforcements were suggested.

| Scenario 1, 2, 3 |
| --- |
| **Description (Turkey)** |
| Upgrade the existing 400kV line between Atatürk and BirecikHES |
| Upgrade the existing 400kV line between Birecik and BirecikHES |
|  |

## Project #10 – SYRIA – TURKEY

## Project assessment analysis

The overall investment cost ranges between 204M€ and 234M€, 5%-4.4% of which represents investment for internal reinforcements in Turkey. The more detailed breakdown of the cost is presented below.

| ***Investment cost-Interconnection*** | | |
|---|---|---|
| ***Line*** | ***Cost [M€]**** | |
| | ***LCC*** | ***VSC*** |
| AC line Syria | 20 | 20 |
| AC line Turkey | 10 | 10 |
| Line bay Syria | 2 | 2 |
| Line bay Turkey | 0.5 | 0.5 |
| BtB Turkey | 160 | 190 |
| line reactor Syria | 1 | 1 |
| **TOTAL** | 193.5 | 223.5 |

| ***Investment cost –internal reinforcements*** | |
|---|---|
| ***Upgraded lines*** | ***Cost [M€]**** |
| 400 kV OHL Atatürk - BirecikHES | 10 |
| 400 kV OHL Birecik - BirecikHES | 0.5 |
| **TOTAL** | **10.5** |

*Rounded values

## Project #10 – SYRIA – TURKEY

## Project cost benefit analysis results

| Assessment results for the Project #10: Syria - Turkey | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GTC increase direction 1 (MW) | | | 600 | | | | | | | | |
| GTC increase direction 2 (MW) | | | 600 | | | | | | | | |
| Scenario Specific | | | MedTSO Scenario | | | | | | | | |
| | | | 1 - National Development (ND) | | | 2 - Green Development (GD) | | | 3 - Mediterranean Evolution (ME) | | |
| | | | Reference Scenario | With new project | Delta | Reference Scenario | With new project | Delta | Reference Scenario | With new project | Delta |
| GTC/NTC - Import | | SY | 1900 | 2500 | 600 | 1900 | 2500 | 600 | 1900 | 2500 | 600 |
| | | TR | 3560 | 4160 | 600 | 3560 | 4160 | 600 | 3560 | 4160 | 600 |
| GTC/NTC - Export | | SY | 1900 | 2500 | 600 | 1900 | 2500 | 600 | 1900 | 2500 | 600 |
| | | TR | 3080 | 3680 | 600 | 3080 | 3680 | 600 | 3080 | 3680 | 600 |
| Interconnection Rate - Import/Export (%) [1] | | SY | 17.6% / 17.6% | 23.1% / 23.1% | 5.6% | 13.9% / 13.9% | 18.2% / 18.2% | 4.4% | 12.1% / 12.1% | 15.9% / 15.9% | 3.8% |
| | | TR | 2.9% / 2.5% | 3.4% / 3.0% | 0.5% | 2.8% / 2.4% | 3.3% / 2.9% | 0.5% | 2.5% / 2.2% | 2.9% / 2.6% | 0.4% |
| Scenario Specific | | | MedTSO Scenario | | | | | | | | |
| | | | 1 - National Development (ND) | | | 2 - Green Development (GD) | | | 3 - Mediterranean Evolution (ME) | | |
| Based on Monte Carlo Years | | | Average | Min | Max | Average | Min | Max | Average | Min | Max |
| Benefit Indicators | B1 - SEW[2] | (M€/y) | 40 | 30 | 60 | 30 | 30 | 40 | 70 | 50 | 80 |
| | B2 - RES Integration[3] | (GWh/y) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | B3 - $CO_2$ | (Mton/y) | 0.4 | 0.2 | 0.6 | 0.0 | -0.2 | 0.2 | -0.1 | -0.2 | 0.1 |
| | B4 - Losses[2] | (M€/y) | 20 | | | 20 | | | 20 | | |
| | | (GWh/y) | 290 | | | 230 | | | 250 | | |
| | B5a - SoS Adequacy[4] | (GWh/y) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 2.8 | 0.0 |
| | | (M€/y) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 8.5 | 0.0 |
| | B5b - SoS System Stability | | | | | | | | | | |
| Residual Impact Indicators | S1 - Environmental Impact | | | | | | | | | | |
| | S2 - Social Impact | | | | | | | | | | |
| | S3 - Other Impact | | | | | | | | | | |
| Costs | C1 - Estimated Cost[5] | (M€) | 220 | | | | | | | | |

[1] considering the GTC/NTC for 2030 and the Installed generation for 2030

[2] considering adequate rounding of values (to the tens)

[3] ignoring low values and negative values of RES integration (average values below 50GWh lead to setting average, min and max equal to zero) and considering adequate rounding of values (to the tens)

[4] ignoring low values (average values below 0.1 GWh/y lead to setting average, min and max equal to zero)

[5] based on the average value of the different technology options considered in the analysis (if applicable)

**Rules for sign of Benefit Indicators**

| | |
|---|---|
| B1- Sew [M€/year] = | Positive when a project reduces the annual generation cost of the whole Power System |
| B2-RES integration [GWh/Year] = | Positive when a project reduces the amount of RES curtailment |
| B3-$CO_2$ [Mton/Year] = | Negative when a project reduces the whole quantity of $CO_2$ emitted in one year |
| B4-Losses - [M€/Year] and [GWh/Year] = | Negative when a project reduces the annual energy lost in the Transmission Network |
| B5a-SoS [GWh/Year] and [M€/y]= | Positive when a project reduces the risk of lack of supply |

| Assessment | Color code |
|---|---|
| negative impact | red |
| neutral impact | light pink |
| positive impact | light green |
| Not Available/Not Applicable | grey |
| monetized | yellow |