MedReg
Mediterranean Energy Regulators

Performance indicators and penalties applicable to generators in case of failure

Electricity Working Group

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1. Introduction

Security of supply is a high priority topic for National Regulatory Authorities for energy (NRAs); more specifically, the issue of generation availability is a well discussed topic in many countries of the south shore of the Mediterranean region.

In those countries, with the objective to deliver sustainable and secure energy, it is clear that security of supply is mainly based on the generation performances and efficient use of existing generation.

In this respect, the first part of the present report analyses current practices and methods used by regulatory authorities/TSO's to evaluate generation performances based on answers received from MedReg members and covering the following topics: role and responsibilities of the NRA, performance indicators, indicators calculation.

The second part of the report aims to compare different practices regarding penalties applicable to generators in case of failure.

Failures include mainly the following cases:

- The power plant (the producer) does not meet the production committed with the market
- Failure involving responsibility of the producer (technical origin, wrong setting, malfunction of protections,…) causing a major incident (blackout, regional breakdown, ...)
- Long unavailability of a power plant with negative consequences on security of supply.

An internal questionnaire was circulated to MedReg members in order to establish an in-depth stock of the current practices. Responses to the 16 questions were provided by 11 NRAs: Albania, Algeria, Cyprus, Egypt, France, Israel, Italy, Palestine, Portugal, Spain and Turkey.

This document intends to analyse these responses and formulate a set of findings in relation to the generation performances.

This is obviously of higher interest to the southern Mediterranean countries where cross-border energy trade is low and where investment costs in production are difficult to sustain.

The report aims also to define and specify the role of the regulator with respect to performance evaluation of producers as well as sharing best practices in the field of production failures.

At national level, the study aims at providing the most appropriate indicators and corresponding standards to MedReg's member to evaluate production performance.

At regional level, the aim is to enhance data quality by comparing and sharing reliable data for benchmarking.

2. Analysis of responses

2.1. Part I: Generation performances assessment

Assessment of generation performances aims to establish requirements and indicators for the technical performances of the generating power plants with the following objectives:

a) promoting data exchange and best practices to achieve the most effective use of generation assets and energy resources,
b) providing realistic expectations for power plants in the near term to ensure that they can be achieved,
c) ensuring that the generation plants will submit to regulator a relevant information required to monitor compliance with the issued generation license,
d) to be able to evaluate and compare technical performances of power plants.

2.1.1. Roles and responsibilities with respect to generation regulation

This chapter describes the relationship between regulators and generators, in particular by specifying the regulated aspects in the generation activity and the particularities of generators located in small electrical systems (isolated grids, islands).

Table 1. Relationship between regulators and generators

Country	Relationship between regulators and generators
Albania	The Public Generation Company (KESH – Gen) offers electricity and its services based in a yearly agreement to buy the electricity with regulated generation prices based in the cost of the generation of electricity. Wholesale Public Supplier will be obligated to buy this electricity within the limit approved by the regulator (ERE). Every year KESH – Gen will sell the ancillary services for the TSO (OST) based in a yearly agreement, by the existing hydro power plants technically qualified to provide this services with a regulated price approved by ERE.
Algeria	Sales are made through bilateral contracts between distributors and producers. These contracts set the negotiated tariffs.
Cyprus	The regulator issues licenses for the producers and all market players, imposes fines and penalties and regulates tariffs.
Egypt	Generation is licensed and benchmarked
France	Investment decisions and power plant operation have to be market based. Market regulation includes some commitments from producers through the balancing requirements
Israel	- No energy market or capacity market - PUA is setting the rates for both producers (public and IPP's) - Failing to produce energy or provide availability is embedded in the price signal producers receive, and they are subject to penalties.
Italy	According to the liberalization law power generation is not regulated. However power plants which are considered essential for the security of the electric system need to comply with specific rules set out by the regulatory authority
Palestine	- Generation is ruled by General Electricity Law - Generation is under the monitoring of the regulator
Spain	Only some aspects of the generation are regulated: - Availability of power plants that receive capacity payment is subject to a regulated payment. - Cogeneration power plants that receive support. - Renewable power plants that receive support. - Generators located in small electrical systems outside of the peninsula.
Turkey	- Liberalized energy market - Generators are not subject to KPI's - Licenses from NRA - Compliance with related technical regulations
Portugal	- Generator Promotors apply to the Government for investment decisions, driven by the Market and also by the generation planning exercise by the Government, described in the "Security of Supply Monitoring Report"

2.1.2. Information transmitted to the NRA/TSO

The responsibility of ensuring generation performances assessment varies between countries.

In liberalized markets, this responsibility is attributed to the TSO.

In countries where markets are not fully liberalised, responsibility for ensuring generation performances assessment seems to be shared between the NRA and the TSO.

However, generators in the all examined countries have an obligation in terms of reporting information to the NRA and/or to the TSO.

For example, in France, producers have to inform the TSO of their generation program and maintenance to inform about the availability of the power plants. This is an aspect of the balancing regime: the difference between the expected production and the maximum generation capacity of a plant has to be made available to the TSO. The TSO and producers also share the information about maintenances within bilateral agreements.

In Israel, all the energy information is monitored and registered by the System Operator and submitted on a regular basis to the NRA by the System operator. The information submitted is of a type related to tariffs paid by the System operator to the producers such as fuel consumption, energy, capacity and down time.

Situation in the Mediterranean countries is summarized below:

Table 2. Information transmitted to the NRA or TSO

Country	Information transmitted to the NRA or the TSO
Albania	Obligations imposed on the producer in terms of reporting information to the NRA (ERE): - Keep accounting records and prepare financial statements. - Prepare and submit to the ERE by March 31 of each year, an annual report relating to its operations in the previous calendar year and containing the following: - Anticipates an emergency as defined by legislation in force, licensee shall notify immediately the ERE and such notice shall describe what steps the licensee will take to avert or ameliorate the impacts of the anticipated emergency. Obligations imposed on the producer in terms of reporting information to the TSO : - The Independent Generator should prepare and submit a 5-year plan of power system / development objectives as specified by the Planning Code and report it to the TSO. - Generators report every hour technical data to the dispatching Center/TSO.
Algeria	The regulator may request any information it deems necessary for the performance of his work.
Cyprus	During the application for a license the producer has to submit to the regulator several studies and information (eg feasibility study, EIA etc). When the producer is licenced by the Regulator, then he has to report to the Regulator information about his accounts, the quality of services he provides, the development plan and tariff calculation. The main information that the Producer has to report to the TSO is the generation schedule/plan.
France	Producers have to inform the TSO of their generation program and maintenance to inform about the availability of the power plants. The TSO and producers share the information about maintenances within bilateral agreements.
Egypt	Generators transmit technical, financial and legal information to the regulator-Financial
Israel	All the energy information is submitted to the NRA by the System operator. The information submitted is of a type related to tariff paid by System operator to the producers such as fuel consumption, energy, capacity, down time etc.
Italy	Apart from anagraphic data, producers have no direct information obligations towards

	the Authority. Market monitoring tasks are carried out by the Authority through the TSO (Terna) and the Power Exchange (GME).
Palestine	The law states that the regulatory authority can request any needed information from the producers
Portugal	Generators have to report to the TSO: - The annual programed availability plan, - The forced outages, - Hourly telemetered data of the generation output (active and reactive meter information for each unit)
Spain	- Availability of the plants (for market purposes and for capacity payments), including related information such as scheduled and non- scheduled outages and trippings - Cogeneration power plants submit their audited equivalent electrical performance - Generators located in small electrical systems report their availability and submit electrical performance indicators Besides, the TSO and the power market provide additional relevant information to monitor the situation and functioning of power plants.
Turkey	Generators transmit a daily generation plan, and an annual maintenance plan to the TSO for the purposes of monitoring. TSO may demand changes in the annual maintenance plans in order to prevent supply shortages and avoid excessive price volatility.

2.1.3. Key Performance Indicators (KPI)

Generation performance standards can be categorized into three types:

a- Technical parameters and other national standards: voltage, frequency, harmonics or rather environmental compliance;

b- Plant availability and energy generation capability standards,

c- Efficiency standards: combustion efficiency and heat rate.

In this report, the focus is on group b and c performance indicators. Also it is taken into account the fact that currently energy markets in some countries are not fully liberalized. Therefore it becomes more important and relevant to include some indicators that would not be considered so important in liberalized markets.

During the preparation of the questionnaire, members of the WG ELE selected the following indicators considered relevant for the assessment of power plants and generators performances:

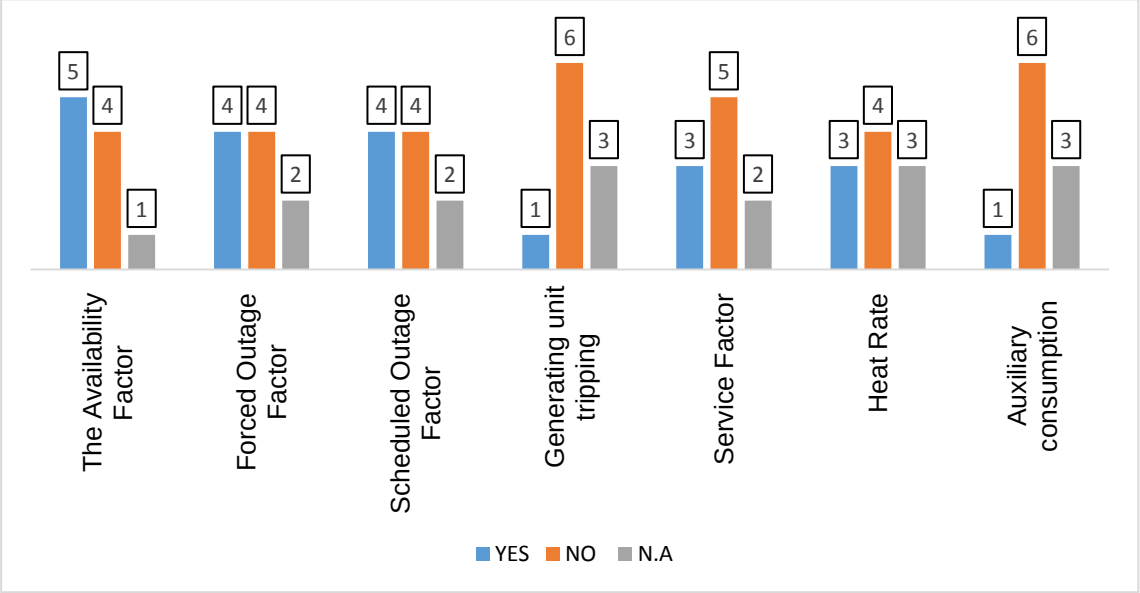
- Availability Factor: The Availability Factor is a measure of the extent to which the generation unit is actually available for electricity production. It is defined for any considered period of time as the ratio between the period of time that a unit is able to provide service and the considered period.
- Forced Outage Factor : A forced outage is an unplanned component failure
- Scheduled Outage Factor: The Scheduled Outage Factor is an indication of the frequency of outages that were planned or related to maintenance activities. Scheduled outages is defined as the sum of planned and maintenance outages and their extensions.
- Generating unit tripping: Number of times the unit triggered.
- Service Factor: The Service Factor is defined as the ratio between the total number of hours a unit was electrically connected to the transmission system divided by the number of hours in the period. The factor is important for the dispatch of a unit (base load versus peak load). A high service factor of a unit indicates that unit is used as base load unit and a low service factor indicates that the unit is used as peaking unit

- Heat Rate: Heat Rate is supporting information that is defined as the ratio of thermal energy of the fuel consumed and the gross electricity generated by the same period.
- Auxiliary Consumption: Means the quantum of energy consumed by auxiliary equipment of the generating plant and transformer losses within the generating station, and shall be expressed as a percentage of the sum of gross energy generated at the generator terminals of all the units of the generating station.

2.1.4. Used Performance Indicators

Responses to the questionnaire show that the most used KPI are: availability factor, forced outage factor and scheduled outage factor.

Figure 1. Used Key Performance Indicators



* N.A: Not Available.

In addition to the proposed indicators in the questionnaire, some countries apply additional factors:

- In case of Egypt: Starting reliability, gross capacity factor, load factor, gross generation factor, utilization factor, average run time and CO_2 emission (CO_2/kWh).
- In case of Spain: Number of functioning hours in a year and equivalent electrical performance.

2.1.5. Homogeneity of indicators calculation

The questionnaire includes standard formulas used for the calculation of each indicator.

From responses received, 4 countries don't have any differences with the proposed formulas: Albania, Algeria, Israel and Egypt.

Factors related to scheduled outages, generating unit trippings and auxiliary consumption are calculated with the same formulas in all countries.

Italy, Portugal and Spain use adapted formulas to evaluate the availably factor, forced outage factor, service factor and heat rate factor. Differences are shown in the tables below:

1. Availability Factor

Table 3. Availability factor

Country	Proposed Formula	Applied Formula
Italy	$AF = \frac{\text{Available Hours}}{\text{Period Hours}} * 100\ \%$	$AF(i) = 1 - \frac{\sum_{h=1}^{H} P_{available}(i,h)}{\sum_{h=1}^{H} P_{installed}(i,h)}$ Where H is the set of hours of the year, defined as a subset of the 100 hours of higher load in the year in which: $P_{available}(i,h) \geq 0{,}75 * P_{installed}(i,h)$ The Power Plant is not affected by a planned outage The factor AF (i) is considered reliable if the set H is composed by more than 49 hours, otherwise AF for the Power Plant "i" is assumed equal to the average value of AF over the Power Plants of the same technology belonging to the same bidding zone.
Portugal		This factor may also be calculated using the ratio between the delivered energy and the scheduled energy. For the hydro plants these energy takes into account the actual head (efficiency)

2. Forced Outage Factor

Table 4. Forced outage factor

Country	Proposed Formula	Applied Formula
Italy	$FOF = \frac{\text{Forced Outage Hours}}{\text{Period Hours}} * 100\ \%$	The set of hours of the year (H1) in which the Power Plant was not in planned outage (H1). Then, the final FOF value for the Power Plant i is calculated as: $FOF(i) = \frac{FOF'(i) \cdot H1 + FOF^{avg}(i) \cdot (Hyear - H1)}{Hyear}$ Where: - FOF'(i) is the FOF computed for the Power Plant i in the hours which belong to the set H1. - FOFavg(i) is the average value of FOF'(i) on the Power Plants of the same technology.

3. Service Factor

Table 5. Service factor

Country	Proposed Formula	Applied Formula
Spain	$SF = \frac{\text{Service Hours}}{\text{Period Hours}} * 100\ \%$	Number of functioning hours in a year: Total number of hours a unit was feeding electricity to the grid throughout a natural year.

4. Heat Rate

Table 6. Heat rate

Country	Proposed Formula	Applied Formula
Spain	Ratio of thermal energy of the fuel consumed and the gross electricity generated by the same period	Equivalent electrical performance (EEP) for cogeneration: $EEP = \frac{E}{F - \frac{H}{RefH}}$ - E: Electrical energy fed into the grid - F: Fuel consumption - H: Useful heat produced - Ref H: Performance reference value for production of (only) heat

2.1.6. Performance comparison

The table below summarizes the available data for each KPI for four technologies: coal, nuclear, combined cycle (size more than 400 MW), gas turbines (size more than 100 MW) and steam turbines (size more than 600 MW).

- **Availability Factor (%)**

For all 5 countries, the availability of combined cycles is more important than the availability of the other technologies.

Table 7. Availability factor

Year	2012						2013						2014					
Country	**Algeria**	**Egypt**	**Italy**	**Israel***	**Spain**	**Portugal**	**Algeria**	**Egypt**	**Italy**	**Israel***	**Spain**	**Portugal**	**Algeria**	**Egypt**	**Italy**	**Israel***	**Spain**	**Portugal**
Nuclear	-	-	-	-	90,5	-	-	-	-	-	84,0	-	-	-	-	-	84,5	-
Coal	-	-	97	88,3	91,3	95	-	-	96	88,3	91,7	92	-	-	93	88,3	89,7	96
Combined cycle	81	N/A	96	89,3	92,2	95	96	92	93	89,3	94,9	98	82	88	91	89,3	91,7	94
Gas Turbine	96	89	97	92,5	-	-	55	95	96	92,5	-	-	75	90	98	92,5	-	-
Steam	-	N/A	-	-	-	-	-	88	-	-	-	-	-	87	-	-	-	-

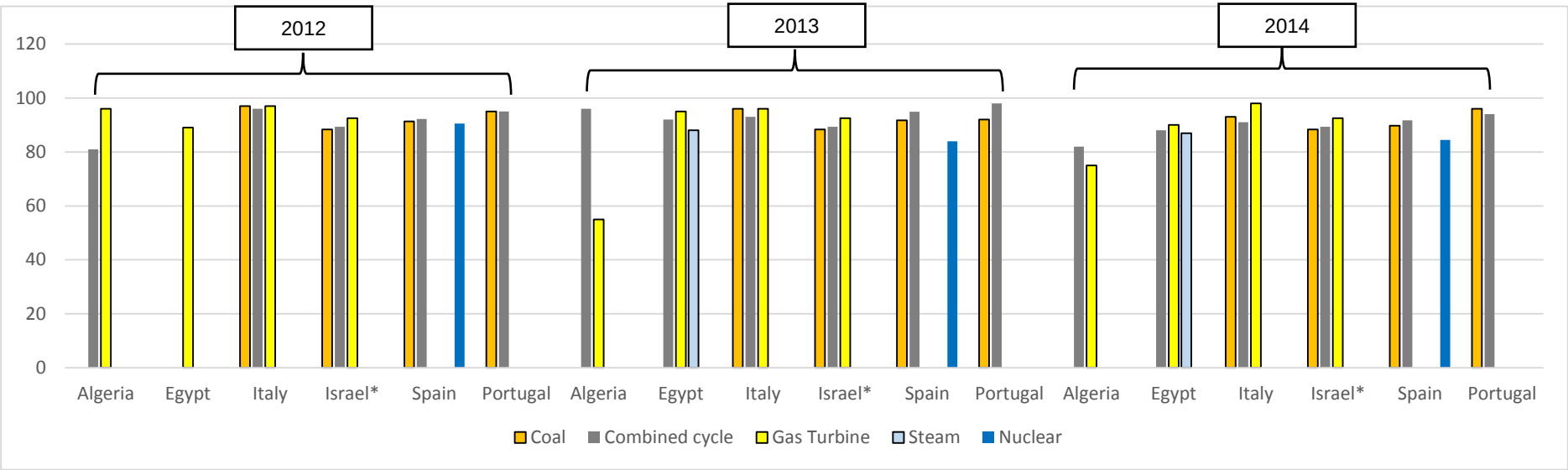


Figure 2. Yearly comparison of the Availability Factor (%), *Case of Israel: values are normative

- **Scheduled Outage Factor (%)**

The Scheduled Outage Factor is quite the same for all the 5 countries for each technology.

Table 8. Scheduled Outage factor

Year	2012					2013					2014				
Country	**Algeria**	**Egypt**	**Italy**	**Israel***	**Spain**	**Algeria**	**Egypt**	**Italy**	**Israel***	**Spain**	**Algeria**	**Egypt**	**Italy**	**Israel***	**Spain**
Nuclear	-	-	-	-	8,4	-	-	-	-	12,6	-	-	-	-	13,8
Coal	-	-	6,5	8	4,0	-	-	5,1	8	5,8	-	-	4,8	8	4,1
Combined cycle	11	N/A	9,2	5,7	5,1	2	6	10,3	5,7	3,4	6	10	10,0	5,7	6,0
Gas Turbine	4	9	10,1	2,5	-	1	4	9,7	2,5	-	1	8	8,6	2,5	-
Steam	-	N/A	-	-	-	-	3	-	-	-	-	10	-	-	-

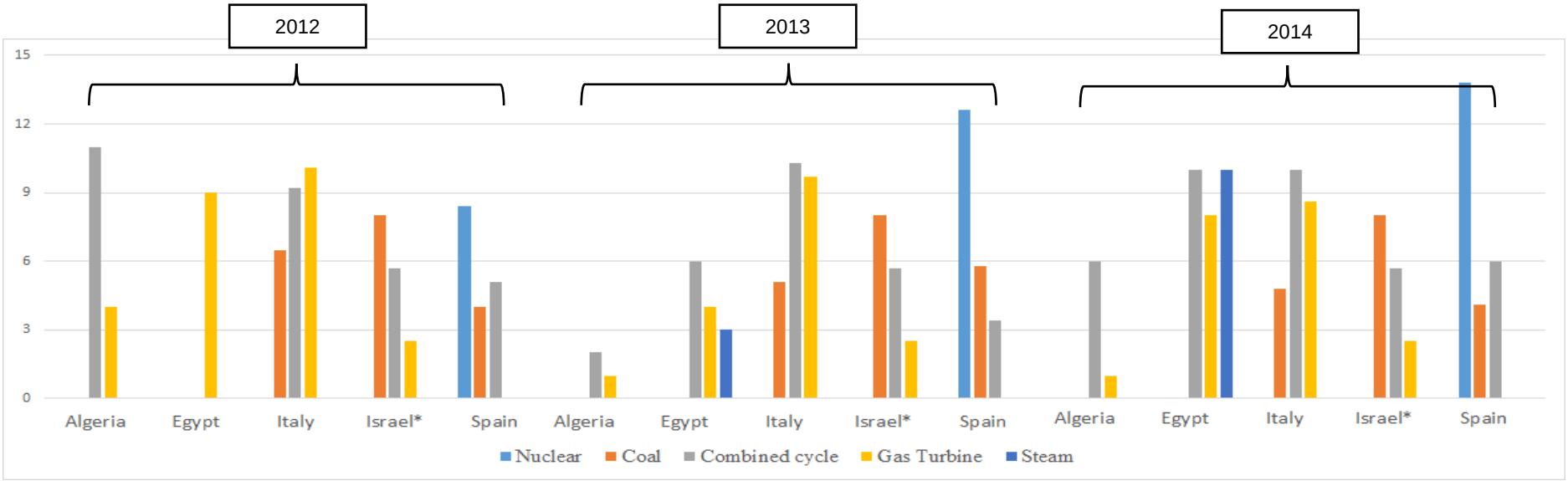


Figure 3. Yearly comparison of the scheduled outage Factor (%), *Case of Israel: values are normative

- **Forced Outage Factor (%)**

Table 9. Forced Outage factor

Year	2012					2013					2014				
Country	**Algeria**	**Egypt**	**Italy**	**Israel***	**Spain**	**Algeria**	**Egypt**	**Italy**	**Israel***	**Spain**	**Algeria**	**Egypt**	**Italy**	**Israel***	**Spain**
Nuclear	-	-	-	-	1,1	-	-	-	-	3,4	-	-	-	-	1,7
Coal	-	-	20,0	3,7	4,7	-	-	21,2	3.7	2,5	-	-	15,8	3,7	6,3
Combined cycle	8	N/A	9,3	5	2,7	2	2	8,8	5	1,6	12	3	9,4	5	2,3
Gas Turbine	-	6	21,7	5	-	44	11	33,3	5	-	24	13	20,2	5	-
Steam	-	N/A	-	-	-	-	9	-	-	-	-	4	-	-	-

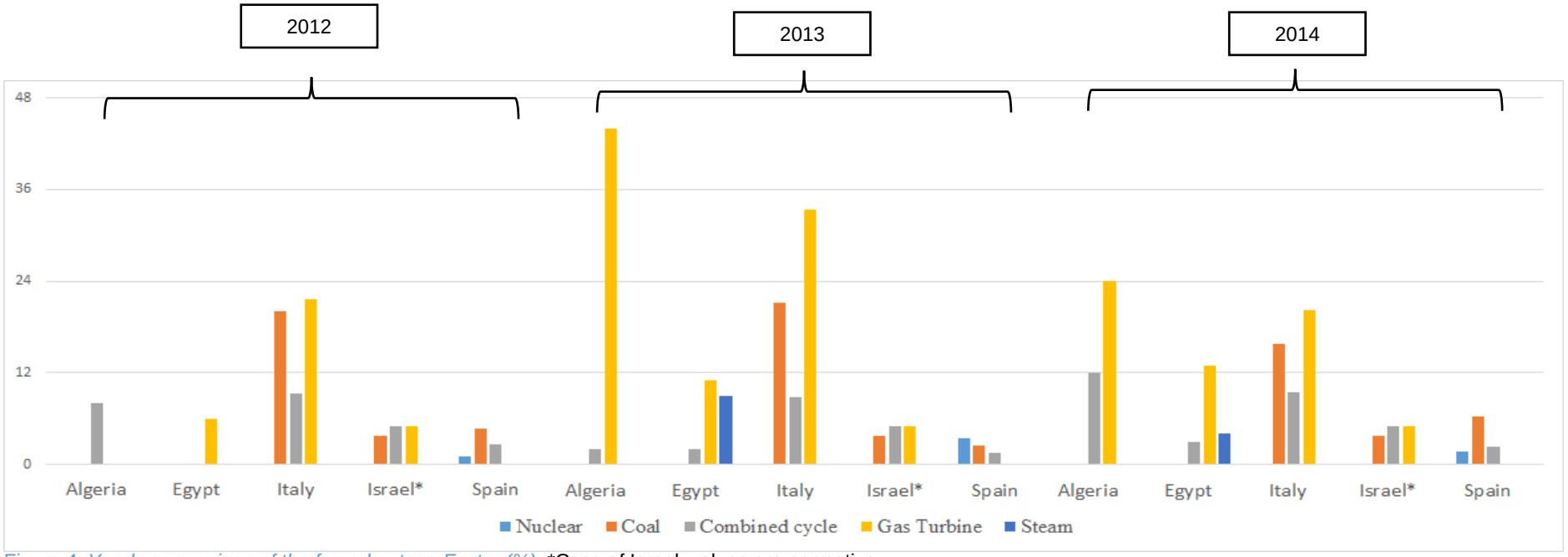


Figure 4. Yearly comparison of the forced outage Factor (%), *Case of Israel: values are normative

- **Service Factor (%)**

The indicator Service Factor reflects the primary resources and the energetic mix of each country.

Table 10. Service factor

Year	2012				2013				2014			
Country	**Algeria**	**Egypt**	**Italy**	**Spain**	**Algeria**	**Egypt**	**Italy**	**Spain**	**Algeria**	**Egypt**	**Italy**	**Spain**
Nuclear	-	-	-	91	-	-	-	84	-	-	-	84
Coal	-	-	-	65	-	-	-	50	-	-	-	56
Combined cycle	80	N/A	-	28	97	91	-	20	82	87	-	19
Gas Turbine	65	74	-	-	27	54	-	-	53	56	-	-
Steam	-	N/A	-	-	-	88	-	-	-	86	-	-

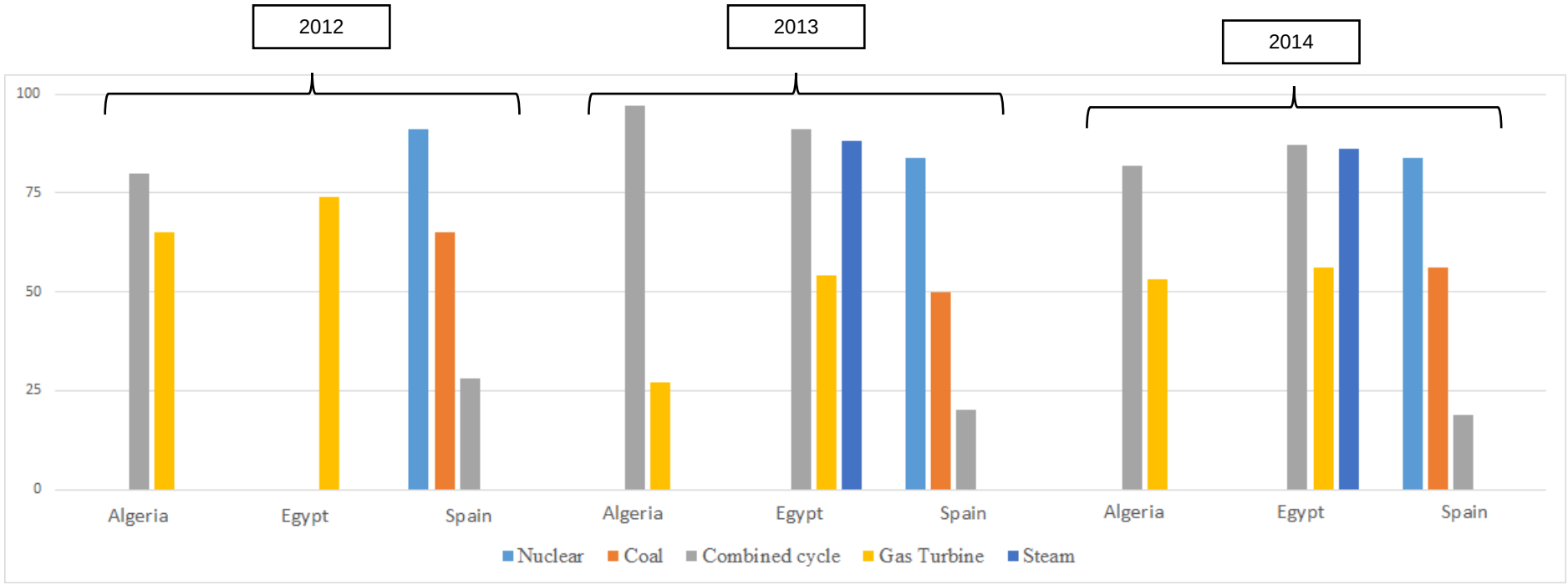


Figure 5. Yearly comparison of the Service Factor (%), *Case of Israel: values are normative

- **Heat rate (th/kWh)**

Table 11. Heat Rate

Year	2012				2013				2014			
Country	**Algeria**	**Egypt[1]**	**Italy**	**Israel***	**Algeria**	**Egypt**	**Italy**	**Israel***	**Algeria**	**Egypt**	**Italy**	**Israel***
Nuclear	-	-	-	-	-	-	-	-	-	-	-	-
Coal	-	-	-	2,170	-	-	-	2,170	-	-	-	2,170
Combined cycle	1,587	N/A	-	1,533	1,586	167		1,533	1,532	166	-	1,533
Gas Turbine	2,545	272	-	2,592	2,579	272	-	2,592	2,538	274	-	2,592
Steam	-	N/A	-	-	-	214	-	-	-	214	-	-

*Case of Israel: values are normative

Instead of the heat rate indicator, in Spain, the “equivalent electrical performance” is used for the cogeneration units.

Units must have a value equal or greater than the threshold required by the national regulation.

Table 12. Heat rate for Spain used for the cogeneration units

Spain	
Fuel type	**Equivalent electrical performance (%)**
Liquid fuel in power plants with boilers	49
Liquid fuel in engines	56
Solid fuels	49
Natural gas and liquefied gas from oil in engines	55
Natural gas and liquefied gas from oil in gas turbines	59
Other fuels and/or technologies	59

[1]Case of Egypt : the heat rate is expressed on (g/kWh)

- **Auxiliary consumption (%)**

The auxiliary consumption factor is available ***for Egypt and Italy***.

Table 13. Auxiliary consumption for Egypt and Italy

Year	2012		2013		2014	
Country	**Egypt**	**Italy**	**Egypt**	**Italy**	**Egypt**	**Italy**
Nuclear	-	-	-	-	-	-
Coal	-	9,0	-	9,5	-	9,3
Combined cycle	N/A	2,6	2	2,5	2	2,6
Gas Turbine	1	2,5	1	2,7	1	2,6

2.2. Part II: Penalties applicable to generators in case of failure

The second part of the report aims to compare different practices regarding penalties applicable to generators in case of failure.

Failures include mainly the following cases:

- The power plant (the producer) does not meet the production committed with the market
- Failure involving responsibility of the producer (technical origin, wrong setting, malfunction of protections,…) causing a major incident (blackout, regional breakdown, ...)
- Long unavailability of a power plant with negative consequences on security of supply.

The questionnaire includes 6 items on the following subjects:

- Penalties applied to producers in case of power plant failure in each member country.
- Implementation tools (contracts, regulations...).
- Responsible party for determining and controlling the application of penalties.
- Payment of penalties.
- Challenges and impacts.
- Role of regulatory authorities.

Received responses show that only countries with a liberalized market apply penalties in case of failure of a power plant. Penalties are applied through several mechanisms.

On the one hand, a functioning market mechanism can be considered as an effective penalty tool in case of failures in production.

On the other hand, regulatory provisions provide for penalties, especially when the tariff received by production units is partially based on the level of their availability. In this case, availability standards are determined.

Main practices by country are as follow:

- **France:** Penalties are implemented within the balancing mechanism. Power producers are responsible for the balance between their injection of energy and the consumption of their clients. In case they are imbalanced, they have to pay for a penalty proportional to the market price. However, if power suppliers source the missing energy on the market (on an intra-day basis) there is no penalty: the market offers complementary tools to power generation.
- **Israel:** The lower the indicator the lower is the tariff paid to the producer by the System Operator.

- **Portugal:** For the majority of hydro and thermal power plants, contracts were signed defining monthly remuneration. This remuneration is composed by a fixed term (related to the investment) and a variable term (related to OPEX). The first term is penalized if units are unavailable or do not respond as expected during each particular month.

For other generators there is a capacity mechanism payment, which is function of availability factors.

Portuguese generators participate in the wholesale market MIBEL, if the scheduled hourly energy values are not met, deviation penalties (deviation energy X € / MWh) must be paid.

The TSO manages a balancing market. Units have penalties to pay if their generation values are not adequate with defined rules (e.g. TSO set point).

- **Spain:** The more general penalty faced by a power plant is the imbalance charge when the power plant does not meet the production committed with the market. The imbalance charge is the difference between the energy committed and the energy delivered, multiplied by the imbalance cost per unit of energy (€/MWh) computed by the TSO based on the results of the balancing markets.

If power plants receiving capacity payments do not meet the availability standards required by the regulation, they lose the incentive granted for availability (i.e. part of the capacity payment).

The “equivalent electrical performance” of cogeneration units in a year must be equal or greater than the threshold required by the national regulation; otherwise, the support is reduced in a proportional way. If this KPI does not comply with the requirement of the regulation again in another year, the cogeneration unit stops receiving any support (it exits the support scheme).

The renewable power plants that receive support have to exceed a certain number of functioning hours. If this number is below a certain threshold, they will not receive any support to investment. If this number is between this threshold and a reasonable number of functioning hours, they receive the proportional part of the established incentive to investment. Beyond that, the full established incentive to investment will be granted.

The generators located in small electrical systems that do not meet the availability standards required by the regulation lose the associated fix remuneration.

From the responses obtained, the aforementioned situation could be summarized as follows:

- **Turkey:** Turkish Grid Code specifies that any generation plant has to be designed and operated in such a way that the plant remains operational in certain system frequency ranges for a certain period of time. Generation plants also need to comply with certain technical parameters such as frequency control (primary, secondary), and limits on flicker, voltage dip and harmonics. Violation of these requirements is subject to one-time warning and monetary penalties as per the provisions of the use of system agreements.

  Market participants (MP) (can have more than one generator unit within their accounts) are responsible for balancing their portfolio injection and off-take of energy. At the end of each month the accounts are settled by the market operator. If the MP is at an energy deficit, the MP is billed at the maximum relevant hourly energy price plus %3 mark-up. If the MP is at an energy surplus, MP receives minimum relevant hourly energy price minus %3 penalty. If the MP account imbalance has a consistent and long term character, the NRA may choose to impose an administrative penalty fee (after a one time warning).

  Generators are responsible for communicating their day ahead generation plans daily to the TSO. A generator who consistently fails to conform to the generation plan is first warned, and then punished by an administrative fee.

From the responses obtained, the aforementioned situation could be summarized as follows:

Country	Instrument used for penalty	Responsibility and control	To whom are they owed (payable)?	What are the key challenges to applying them?	What impact are those penalties likely to exert on the costs of energy?	Role of the NRA
France	Regulation	TSO and CRE	To the TSO and deducted afterwards from the transmission tariffs	/	/	NRA monitors the functioning of the balancing regime
Israel	Tariff formula	PUA and TSO	To the TSO	/	/	Setting tariff and market rules
Portugal	-Contracts -Government legislation -ERSE Regulation -Market rules	ERSE and TSO	-Reduce the electrical tariffs as the corresponding costs are lower -Paid to the generators that replace the faulty units	Availability of data	/	ERSE verifies the capacity mechanism payments' adequacy and includes them in the electrical tariffs
Spain	Regulations, including market rules	Established by regulation	-Imbalance charges: to the TSO -Capacity payments and reductions in payments to RES and cogeneration: to the electrical system (to the access tariff)	-Imbalance charges -Need to certify auditors that assess the performance. -Need to follow up the number of functioning hours of each unit. -Monitor the availability of power plants (for capacity payment)	Low	To establish the rules, to enforce them, to impose sanctions if necessary and to settle the payments of the penalties in the overall settlement process of regulated costs and incomes
Turkey	Regulation, use of system agreements, market rules	TSO DSO (for distributed generators), MO	To the TSO ((DSO for distributed generators)	TSO's lack of monitoring infrastructure	Directly: none Indirectly: It is theoretically possible that the monetary penalties become a serious financial burden to small generators	Preparing regulations, mains of use of system agreements, and market rules,

Table 14. Penalties applicable to generators by country

3. Conclusion

The topic of security of supply is of key importance to all countries and energy regulatory authorities.

In order to ensure a constant equilibrium between electricity supply and demand – be it on a daily basis or when establishing forecasts - the integration of intermittent energy sources needs to be increasingly taken into account.

This is especially the case for southern Mediterranean countries where the possibility for import-export is limited and therefore the means for conventional electricity production need to be strong enough to guarantee security of supply.

In this context, the ELE WG wanted to analyze and evaluate the various approaches applied by member countries in relation to generation performance.

In order to analyze and evaluate the different methods applied by regulators and TSOs in relation to generation performance, WG ELE launched an inquiry by means of a questionnaire.

A list of key performance indicators discussed and approved in the Electricity Working Group was given. It consists of 7 indicators: Availability Factor, Forced Outage Factor, Scheduled Outage Factor, Generating unit tripping, Service Factor, Heat Rate and Auxiliary consumption.

The study also covers an analysis of the approaches applied by Mediterranean countries in case of power plant failure. One of the aims was to find out if generators receive penalties in case they cause disruptions to the electricity network, especially in the following cases:

- The power plant (the producer) does not meet the production committed to the market.
- -The producer fails to fulfill its technical responsibilities (wrong setting, malfunction of protections…) causing a major incident (blackout, regional breakdown...).
- Long unavailability of a power plant with negative consequences on security of supply.

11 responses to the questionnaire were received. These came from Albania, Algeria, Cyprus, Egypt, France, Israel, Italy, Palestine, Portugal, Spain and Turkey.

Analysis of responses shows that regulators and TSOs share the responsibility of monitoring and evaluating producers and production facilities – but results showed that in most countries the main responsibility for these tasks clearly lies with the TSO

In many cases, the regulator receives the information on the producers' performance from the TSO.

Regarding the key performance indicators, the ones which are most used are those related to availability such as the availability factor, forced outage factor and scheduled outage factor.

Answers to the questionnaire showed also that despite differences in the definitions and calculation models of the indicators, they are still very similar in all countries. This allows comparing them easily.

Concerning the application of penalties in case of power plant failures a major difference exists between liberalized and non-liberalized markets.

In markets where generation is regulated, producers do not receive penalties for failures in production.

In liberalized markets, penalties are applied through several mechanisms.

On the one hand, a functioning market mechanism can be considered as an effective penalty tool in case of failures in production.

On the other hand, regulatory provisions provide for penalties, especially when the tariff received by production units is partially based on the level of their availability. In this case, availability standards are determined.

Regulators play an important role in this context given that they develop or participate in the

development of rules and regulations to be enforced. At the same time, regulators face a number of challenges in this regard, notably the availability of data and adequate information.

Overall, the impact of penalties remains limited. Only small producers may feel a stronger impact.