Israel Electric

Israel Electric Corporation

Environmental Report for 2021

Photo by Tomer Elad | IEC employee

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Introduction

Introduction

The Israel Electric Corporation (IEC) operates as an integrated and coordinated system that engages in all stages of the electricity supply chain, starting from the production of electricity, through its transmission and transformation, and ending with its sale and distribution to its customers. As a result, the IEC considers itself committed to the supply of available and high-quality electricity from a variety of production sources available to the national electricity market, both by the IEC production system and by the production of private electricity producers that operate under the Electricity Market Law that entered into force in 1996.

The company has five primary fields of activity, which are known as segments in the Financial Statements:

A. Generation of Electricity in power stations activity – the operations of the company in this field includes all of the operations that are involved in the production of electricity at the sites of the company.
B. Generation activity in the transmission and transformation of electricity segment – the operations of the company in this field include the transmission of electricity from the company's and the private electricity producers' ("PEPs") production sites, using high voltage lines to the company's switching stations, where the process of transformation to extra-high voltage is carried out and from there the continuation of the transmission of electricity is carried out via extra-high voltage lines to the substations. An additional second transformation from extra-high voltage to high voltage is carried out in the substations, and the energy is transferred to a high voltage grid through output transformers. In addition, they include supervision, management and control of the transmission and transformation system through the transmission control unit and operating, maintenance and malfunction handling.
C. Generation activity in the electricity distribution segment – the operations of the company in this field includes the transfer of electricity from substations to consumers via high voltage lines and low voltage lines, including metering the consumed energy at the customers' installations (the electricity meters). This segment includes transformation from high voltage to low voltage through tens of thousands of transformers.
D. Electricity supply - the operations of the company in this field includes the collection and service system of the company, which is responsible for the preparation and production of invoices, collection activities and consumer services, including customer call service centers, customer reception and customer file coordinators.
E. Other activities - include the operations of the company as part of business entrepreneurship and the company's operation in the IBC communications enterprise.

We hereby respectfully present to you the annual environmental report for the year 2021. This report has been published voluntarily since the year 2000.

The Electricity Production Segment

The IEC electricity production is based on steam power plants and on aeroderative and industrial turbines – mostly combined cycle turbines (CCGT).
IEC produces, transmits, distributes and supplies most of the electricity consumed by the Israeli economy, and holds an essential service provider license

The total nominal production capacity at the end of 2021 reached 11,615 MW. In 2021, IEC owned and operated 52 production units in 15 power plant sites, according to the following breakdown:

- 16 steam generation units
- 36 gas turbines, including:
- 20 industrial gas turbines, of which 11 are part of a CCGT
- 16 aeroderivative gas turbines

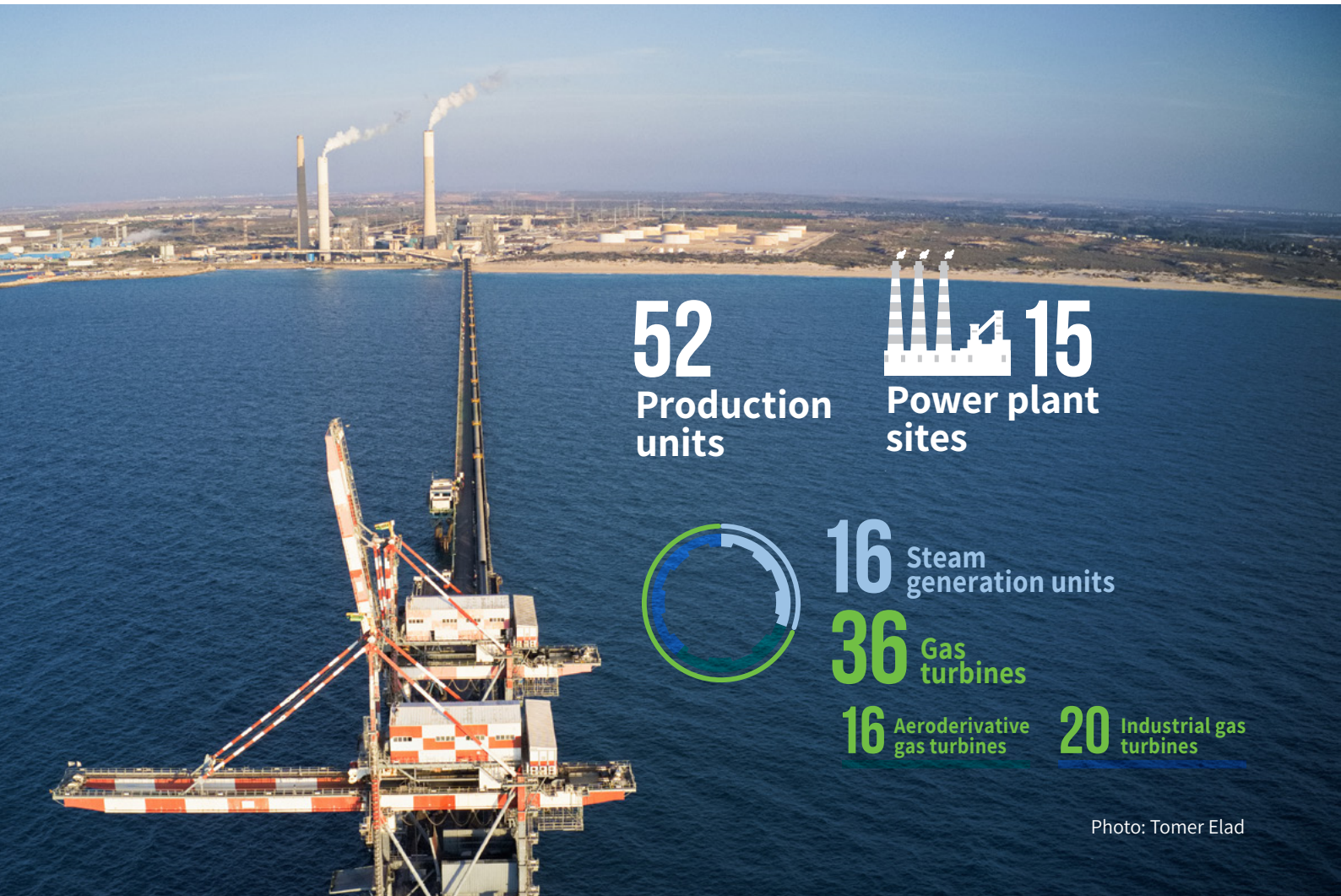

Photo: Tomer Elad

Steam generation units:

The IEC steam generation units produce electricity using steam turbines (at Orot Rabin, Rutenberg, Reading, Eshkol power plants). All generation units are "dualfuel", except for the Reading power plant which is operated with natural gas only. Some of the power plants are operated with coal as primary fuel and heavy fuel oil or diesel oil as secondary fuel, and the other ones are operated with natural gas as primary fuel and heavy fuel oil or diesel oil as backup fuel.
In 2021, IEC operated 16 steam generation units.

Gas turbines:

These units produce electricity by the rotation of turbines with emission gas (gas turbines). Most of these gas turbines are "dualfuel" turbines and can be operated with natural gas as primary fuel and diesel oil as backup fuel.
The gas turbines split into two types: aeroderivative gas turbines and industrial gas turbines:

Aeroderivative gas turbines:
Gas turbines with a low nominal capacity. In the IEC, the maximal nominal capacity of each aeroderivative gas turbines is 50 MW.
Since it is possible to start and stop these production units relatively quickly, they provide a quick and specific response to peak electricity demands. All production units are operated with diesel oil only, and defined as backup units.

Industrial gas turbines:
Gas turbines are based on the operation principle of the aeroderivative gas turbines, but with a different structure that that enables the production of electricity in a larger scale.
The industrial gas turbines split into two types:

- Open cycle gas turbines: most units of this type are operated with natural gas as primary fuel and diesel oil as backup fuel.
- CCGT gas turbines: a combination of an industrial gas turbine and a steam turbine. In CCGT the industrial gas turbine produces electricity as usual, and the residual heat of the emission gas is used to generate steam that propels the steam turbine to produce additional electric energy, without additional fuel use. With this operation mode, the energetic efficiency is increased.

Table 1: - List of the IEC production units with their production capacity (Megawatt on December 31, 2021)

Unit Type	Site	Number of units	Installed capacity (megawatt)
Steam driven power plants production units			
Coal powered units			
Coal – primary fuel, Heavy fuel oil – secondary fuel (for Units 5 and 6 only)	Orot Rabin (Maor David A, B)	6	2,590
Coal – primary fuel, Heavy fuel oil – secondary fuel	Rutenberg	4	2,250
Total Coal units		**10**	**4,840**
Units converted to natural gas			
Natural gas – primary fuel, Heavy fuel oil – secondary fuel	Eshkol	4	912
Natural gas – primary fuel	Reading	2	428
Total steam- units converted to natural gas		**6**	**1,340**
Total steam driven power plants generation units		**16**	**6,180**

* In the next few years, the installed capacity of the power plants owned by IEC is expected to decrease according to the rate of sale of the production units according to the reform performed in the electricity market.

Gas turbines	**25**	**1,418**
See next page		

Combined cycle gas turbines	**11**	**4,017**
See next page		

Total production units in the company	**52**	**11,615**

Table 1: List of the IEC production units with their production capacity (Megawatt on December 31, 2021) *

	Site	Number of units	Installed capacity (megawatt)
Gas turbines		**25**	**1,418**
Industrial gas turbines		9	914
	Zafit	2	220
	Eilat	1	34
	Atarot	2	68
	Gezer	4	592
Aeroderivative gas turbines		16	504
	Hartuv	1	40
	Eitan	1	40
	Raanana	1	11
	Caesarea	3	130
	Haifa	2	80
	Kinarot	2	80
	Orot Rabin	1	15
	Rutenberg	2	40
	Eshkol	1	10
	Eilat	2	58
Combined cycle gas turbines		11	4,017
	Hagit	4	1,394
	Eshkol	2	771
	Gezer	2	744
	Zafit	1	360
	Haifa	2	748
Total production units in the company		**52**	**11,615**

* In the next few years, the installed capacity of the power plants owned by IEC is expected to decrease according to the rate of sale of the production units according to the reform performed in the electricity market.

IEC environmental protection policy

The Israel Electric Company environmental vision

The Israel Electric Company (IEC) will operate out of social and environmental responsibility, following a long-term sustainable vision and forward looking information. The company will minimize its environmental impacts, arising from its activities and will lead in environmental nuisances' scope and environmental footprint mitigation.

Environmental protection policy principles

IEC operates according to environmental protection policy principles that were first approved in 1997, and were updated from time to time. These principles include:

A. Integrating environmental considerations in all areas of activity, including in decision-making processes:

- A-1) Including environmental considerations in the preparation of the development plans of the company.
- A-2) Preparing environmental protection guidelines documents for main projects and activities.
- A-3) Including mandatory environmental protection criteria in the procurement tenders published by the company.

B. Designing and operating the facilities while ensuring continuous reduction of the environmental impacts, taking into consideration sustainable development principles, while adopting the best proven and economical technologies:

- B-1) Adopting the best available techniques (BAT).
- B-2) Promoting the use of high-quality fuels – mainly natural gas.
- B-3) Promoting the installation and operation of facilities preventing environmental impact, such as the installation of air pollution control facilities at the coal-fired power plants, for the reduction of sulfur dioxide emissions (FGD) and the reduction of nitrogen oxide emissions (SCR).
- B-4) Adopting the "prudent avoidance" principle to reduce electric and magnetic fields in the electricity transmission and distribution grids.
- B-5) Expanding the use environmental friendly materials.
- B-6) Performing regular monitoring and control on the environmental impacts of IEC facilities on the soil, air, water bodies and sea.
- B-7) Performing transmission of real-time monitoring data and free public access to information.
- B-8) Implementing environmental protection standardISO 14001and environmental management and control system.

C. Adopting advanced and proven environmental protection criteria:

- C-1) Operating work teams for the follow up of pluriannual work plans and implementing them according to the environmental protection policy of the company.
- C-2) Following Israeli and international legislation and regulation and evaluating their future trends.
- C-3) Promoting active involvement in environmental legislation and regulation processes.
- C-4) Promoting the organization of the company management in the environmental protection field, using hierarchical supervision and establishing, inter alia, appropriate manpower and budget allocations, and writing of the relevant internal rules.

D. Integrated natural resource management: soil, air, water and fuels:

- D-1) Protecting air quality by reducing pollutant emissions.
- D-2) Reducing the use of soil area when designing and building new facilities, optimizing its use in existing sites and promoting integration with other infrastructures.
- D-3) Performing routine activity for the purpose of saving fuels.
- D-4) Saving and integrating water resources.

E. Reduction and recycling of waste and by-products:

- E-1) Managing waste at the company level and site levels (reduction of waste production, increase of recycling, and reduction of waste disposal).
- E-2) Promoting beneficial uses of by-products: coal ash and FGD gypsum.
- E-3) Promoting the uses of treated waste water and brine produced in-site, and the use of poor-quality water from external sources.

F. Incorporating landscaping, spatial and environmental considerations design of new facilities and in the maintenance of existing facilities:

- F-1) Promoting activities for improving aesthetic aspects of existing facilities.
- F-2) Building new production, transmission and transformation facilities, while taking in consideration the landscape and the environment.
- F-3) Including the participation of a landscape architect in the design of new projects already at the beginning of the process, for ensuring proper consideration for nature and landscape conservation.
- F-4) Including the rehabilitation of the natural landscape and environment as part of the completion of the project.

G. Establishing an open and transparent dialogue with the public for plans with environmental impacts:
- G-1) Applying the free access of the information to the public for activities with environmental impacts.
- G-2) Cooperating and establishing a dialogue with the public in planning processes related to the location and the licensing of projects.
- G-3) Working in cooperation and coordination with the environmental authorities at national, regional and local levels, in order to reach agreements in a continuous work process.
- G-4) Tightening and improving the existing relations with nature protection organizations.
- G-5) Maintaining relations with public and private environmental associations.
- G-6) Publishing a periodic environmental report.

H. Reducing the emission of greenhouse gas, in agreement with principles of the international conventions signed by the State of Israel, by increasing the efficiency of power plants, expanding the use of environmental friendly fuels and energy sources, and encouraging the saving of electricity:
- H-1) Incorporating the use of natural gas, considered as a clean fuel, as primary fuel in existing power plants, in order to reduce the emission of pollutants, including greenhouse gas.
- H-2) Installing production units with high efficiency generation facilities such as CCGT, burning natural gas as primary fuel. These power units are characterized by particularly low emissions of air pollutants, including greenhouse gas.
- H-3) Promoting activities for improving energy efficiency, both at the IEC sites and by advising the customers of the company in the fields of energy saving and smart use of electricity. These activities contribute to the reduction in the electricity demand, thereby reducing the consumption of fuels, and consequently reducing the emission of pollutants, including greenhouse gas.

I. Joint activities in the field of environmental protection with academic institutions at national and international levels, including participation in researches and development of advances technologies:
- I-1) Assisting the State of Israel to fulfill commitments as part of international environmental protection conventions.
- I-2) Promoting and performing renewable energy projects, subject to the regulatory restrictions imposed on IEC.
- I-3) Developing cooperation with electric companies around the world.
- I-4) Allocating research and development budgets for environmental protection issues.
- I-5) Following development and application of new technologies.
- I-6) Promoting environmental innovation by providing support and supervision to environmental research.
- I-7) Cooperation with research and academic institutions.

J. Integrating environmental values in the organizational culture, increasing environmental awareness and commitment of the company employees and integrating environmental issues in its activities in the community:

- J-1) Integrating environmental policy principles as part of the IEC organizational culture.
- J-2) Encouraging awareness and commitment among the company employees to environmental issues, especially to the company activities and goals in this field.
- J-3) Integrating environmental protection subject in courses that are part of the company training program.
- J-4) Organizing conferences, workshops, study tours at power plants, activities in the company website.

IEC has a management committee dealing with the environment, headed by the VP of engineering projects, with the role of updating the company environmental policy from time to time.
The company performs a dynamic process of setting goals and objectives in the environmental field. These objectives are set in order to operate in accordance with the requirements of environmental laws and regulations, and with consideration to environmental global trends, all that in view of its technological capability and the local conditions at the company installations.

Environmental protection constitutes an integral part of the operation, maintenance, design and development of IEC facilities. The company activities are subject to extensive regulation in this field. The company checks the implications of environmental laws, acts to prevent or mitigate the environmental risks connected with its activities, makes preparations to deal with the financial, legal and operational impacts of these environmental laws, and allocates budgets to fulfill the requests of environmental laws, existing or expected in the future.

Incorporation of quality standards and environmental management and control system

The management of environmental protection in the company is based on a control system that operates through supervision and role definition, and includes, among others, staffing the required and relevant personnel, allocating required budgets and writing appropriate procedures.

In addition, the company has divisions certified for integrated management systems, as detailed below:

The Generation and Energy Division holds the quality management system standard (ISO 9001) and the environmental management system standard (ISO 14001) for its division headquarters and various production sites.

The Logistics and Assets Division holds the quality management system standard (ISO 9001), the occupational health and safety management system standard (ISO 45001), the environmental management system standard (ISO 14001) and the traffic safety and quality management system standard (ISO 9301).

The Transmission Projects Division holds the quality management system standard (ISO 9001), the occupational health and safety management system standard (ISO 45001), and the environmental management system standard (ISO 14001).

The Generation Projects Division is currently in an advanced process for getting the following standards: quality management system standard (ISO 9001), occupational health and safety management system standard (ISO 45001), and environmental management system standard (ISO 14001).

The Transformation Projects Division is currently in an advanced process for getting the following standards: quality management system standard (ISO 9001), occupational health and safety management system standard (ISO 45001), and environmental management system standard (ISO 14001).

Promoting environmental awareness among employees

The IEC acts to raise awareness of environmental protection and sustainability issues, and conducts activities for its employees on various levels, including:

Development and implementation of training programs on environmental protection for company employees and managers for the purpose of raising awareness of the environmental subjects and providing knowledge on them.

The company organizes the "Green-Blue-Orange – CEO environmental protection prize" competition, that is intended to mention employees who excelled in environmental protection. This competition encourages the adoption and integration of environmental protection values among the employees of the company, , through the promotion of personal responsibility and of initiative and leadership to achieve significant and measurable improvement in fields of environmental protection and resources' smart use, at work and at all.

Free access for the public to information regarding environmental issues

In accordance with the Free Access to Information Regulations (Providing Environmental Information for Public Review, 2009), IEC publishes on its website environmental information. Recent announcements can be consulted on the company website https://www.iec.co.il/home.

More information can be consulted on the company website, among others in the following publications:

Annual environmental reports since year 2000

Reporting within the framework of voluntary mechanism on recording and reporting of greenhouse gas emissions, mainly as a result of fuel combustion for electricity production.

Air pollution monitoring reports

Real-time air monitoring data from the Ministry of Environmental Protection website

Reports in accordance with emission permits

A carbon dioxide calculator, that allows electricity consumers to calculate the amount of carbon dioxide (CO2) emitted to the atmosphere as a result of their electricity consumption for a given year and to compare between different years. This calaculator is based on the emission coefficients of fuel combustion for electricity production and refers to IEC power plants only.

The Corporation Business Description report for 2021

Relations with stakeholders

IEC maintains a long-standing relationship and a fruitful dialogue with the environmental organizations in the country, and gives great importance to maintain this relationship. The cooperation between the environmental organizations and IEC takes place in a number of ways, and among others, occurs in the framework of "round table" discussions as well as meetings dedicated to various issues.

Round table discussions

The company initiated round table discussions with environmental organizations several years ago, and in this context, a number of discussions were held on environmental issues related to the activities of IEC.
The company gives great importance to these meetings, and they are conducted at the most senior level in the company. Usually, the CEO leads these meetings, with the company high management members, and meetings devoted to specific issues are led by various company high professional managers. These meetings are a key tool in the cooperation with environmental organizations, as they strengthen the relationship and the dialogue with them as well as the agreement points and improve the interface between the parties.
Within the process of constructing the CCGT production units at Orot Rabin site, debates were held with stakeholders, including the Ministry of Environmental Protection, heads of all local authorities in the area, planning commissions and stakeholders from the localities around the site, including a public discussion evening.
In 2021, only professional meetings were held with environmental organizations, on specific issues raised by them, thanks to the relationship established during the former years. Examples of these issues are transporting sand near IEC power plants, the "green investment" rating index. The meeting scheduled to discuss the smart electricity metering was postponed following Covid-19 quarantines, and will most likely take place in 2022.

Dialogue with the environments

The “dialogue with the environment” activity initiated by IEC is a strategic tool in creating “shared value” - social and/or environmental value for stakeholders as well as business value, while reflecting the company core values and its commitments to act with corporation responsibility. The dialogue and the collaborations resulting from this activity are characterized by constant attention to the needs of the community, and they are carried out with empathy, while maintaining a regular dialogue based on social responsibility policy, in order to advance toward the company objectives while gaining public confidence and reducing opposition.

How does it work in practice?

The dialogue focuses on presenting the IEC activity, especially environmental aspects, and giving particular attention to the areas around Rutenberg power plant in Ashkelon and Orot Rabin power plant in Hadera. The dialogue, led and administered by the Service, Marketing, and Regulation Division (SMR), is conducted with the public and stakeholders near these power plants, and it includes collaborations with various stakeholders, such as the local authorities, environmental organizations, education institutions, etc. Among others, IEC delegates collaborate with the academy on various issues concerning the company core fields of activity, through lectures raising discussions on questions like: how is electricity produced? Which amount of electricity does the power plant produce? What is the cause of the white plume? IEC also organizes tours in sites and plans and promotes collaborations in the framework of graduation projects, in which students address challenges and needs touching the company's areas of activity, such as cyber security, system management, energy storage, environmental protection etc.

The "green energy" experience training, a specific development to enhance dialogue

Within the "dialogue with the environment" activity, the SMR division developed a specifically designed educational training program on "green energy". This is an experiential learning program composed of clips and riddles for grades 4 to 6. This activity is conducted by "community leaders" (volunteer company employees) that received special training for this purpose, and in the future, it is planned to be conducted by all company employees who are interested. Currently, there are 28 "community leaders" from power plants, service centers and "performance centers" near the power plants, who conduct this activity in schools, including primary and secondary schools in the Ashkelon and Hadera regions, to present and explain how the company operates and how IEC cares to protect the environment during the electricity production process. In the future, the "green energy" experience training will be proposed to all company employees who wish to present it at their children's schools. It should be mentioned that lectures were even held during the Covid-19 pandemic via Zoom .

Academic lectures

In collaboration with the academy, company managers presented 8 enrichment lectures to students on various issues in core fields of the IEC activity during the 2021 academic year.

Stakeholder tours and visits

Within this activity, 3 tours of the power plants were held for stakeholders from areas close to the power plants, for example workers in the local authorities concerned by the power plants, academy groups (students and staff), local authorities employees, and members of the public living around the power plants. The tours include a general presentation of the electricity market and the company interfaces with external institutions, a presentation of the power plant and a tour of the turbine hall, the coal jetty, the coal storage site, an observation from the boiler balcony etc.

Meetings and "round tables" with authority heads and senior representatives

As part of the dialogue activity, 4 meetings were held with authority heads and senior representatives from the power plants' areas, to share information about the company activity in a spirit of transparency and mutual trust, while raising suggestions and ideas to reinforce the cooperation between the IEC and the local authorities, and to promote good neighbourship.

Compliance with environmental regulation

The company activities are legally exposed as a result of the various environmental effects due to these activities, like pollutants emission to air due to fuel combustion, storage and use of hazardous substances and fuels, soil and water sources pollution, discharge of industrial waste water, asbestos dispersal, improper treatment of coal ash, noise, non-ionizing radiation, etc.
Therefore, the company activities are subject to extensive environmental protection regulation. In recent years, the environmental regulation requirements became more stringent (part of these regulations are currently in various steps before adoption), as well as supervision and enforcement of these environmental requirements. The company estimates that this trend is expected to continue, and even to worsen in the upcoming years, in in view of the growing awareness, and international requirements following current practice in western countries.

The environmental protection laws affecting IEC activity include, among others, the Prevention of Sea Pollution from Land-Based Sources Law; the Hazardous Substances Law; the Protection of the Coastal Environment Law; the Clean Air Law; the Prevention of Hazards from Asbestos and Harmful Dust Law; the Freedom of Information Law; the Non-Ionizing Radiation Law; the Energy Sources Law; the Environmental Protection Law (Releases and Transfers to the Environment - Reporting and Registration Obligations); the regulations promulgated under these laws as well as various bylaws.

IEC checks the impact of environmental laws and operates its facilities in order to prevent or minimize environmental risks that might occur following their operation. In addition IEC makes necessary preparations in view of economic, legal and operational effects of these environmental laws and allocates budgets in order to respect the parts of these environmental applicable to the company. The company operates according to its environmental protection blueprint, taking responsibility for the environment, in a long-term and sustainable approach.

Non-compliance with environmental protection laws and with conditions included in permits issued to IEC might expose the company and its managers to criminal and administrative proceedings, including the imposition of fines, as well as the payment of environmental clean-up and rehabilitation costs.
IEC estimates that at the date of this report it generally observes the instructions of environmental protection laws. IEC holds the environmental permits required for its operations, and if a few are missing, it is active to obtain them as soon as possible.

Environmental Costs and Investments of the Company in environmental protection

The following table presents information on investments made by IEC in the environmental protection field for the years 2015 – 2021 :

Table 2: Data on environmental protection costs and investments made by IEC in the environmental protection field [NIS million, current prices after remeasurement deducted)] – for the twelve months ended on December 31

	2015	2016	2017	2018	2019	2020	**2021**
Total investments in environmental protection facilities	Approx. 956	Approx. 765	Approx. 831	Approx. 610	Approx. 465	Approx. 470	**Approx. 426**
Current costs (without depreciation)	Approx. 89	Approx. 105	Approx. 88	Approx. 82	Approx. 142	Approx. 156	**Approx. 160**

A. Investments and expenses in 2021

In 2021, IEC invested NIS 406 million in environmental protection measures in the production sector (with also about NIS 20 million invested in the transmission and distribution segments and in special projects), especially in the installation of air pollution control facilities at the Rutenberg power plant (such as "primary methods", FGD scrubbers, and catalytic SCR systems) and in conversion to gas at the Rutenberg power plant Unit 1.
In addition to these investments, in 2021 IEC expended, as part of the operating costs of power plants and additional expenses for fuels, an amount of NIS 157 million in order to comply with environmental protection regulations (not including NIS 3 million not connected with the production system). IEC estimates that the environmental expenses in 2021 were mostly intended to environmental effects prevention and to environmental damage minimization, and the rest was intended to environmental clean-up and rehabilitation.

B. Budget for 2022

IEC allocates money in its budgets to comply with environmental regulations and licenses conditions. In 2022, the IEC allocated, as part of its current operation and development budgets, an amount of about NIS 780 million ("deducted from measurements and depreciation") in order to comply with environmental protection requirements, including: fauna and flora protection, prevention of air, soil, groundwater and surface water pollution, asbestos cleaning, waste water treatment, noise reduction, radiation protection and waste management.

C. Budget for the conversion of coal-fired units to natural gas

As part of the five-year budget approved by the Board of Directors in December 2021, IEC allocated for the project of conversion to gas about NIS 1.1 billion, based on an initial estimate. For 2022, about NIS 141.2 million were allocated to the conversion to gas project. The initial distribution of the budget between the years was based on the multi-year plan for long-term planning as the overall investment plan has not yet been prepared.

The estimations of IEC management regarding the planned scope of investments in environmental protection are "forward-looking information", as defined in the Securities Law, and are based on the company budget and work plans. These estimations might not be materialized, or be materialized partially or in a different manner, as a result of factors not controlled by IEC. These factors include changes in the regulatory requirements applicable to the IEC, changes in the scope of generation activities of IEC and in fuels purchased by IEC for generation operations, and other events; including those resulting from the realization of "legal risks" affecting IEC.

Environmental incidents in 2021

In 2021, there were a number of environmental incidents at IEC, they were reported to the Ministry of Environmental Protection as required in the permits issued to IEC. A few legal proceedings are in progress on this subject.

In January 2021, a notice before legal action was received for allegations of violation of the permit on groundwater discharge to the sea at the Orot Rabin power plant. This notice includes claims on exceedances from the criteria set in the permit. IEC claims that this this incident was caused by sand penetration into the pump line. IEC submitted its response to the Ministry of Environmental Protection. As of the date of preparation of this report, the Ministry of Environmental Protection response to IEC claims has not yet been received.

In August 2021, IEC received a notice before legal action on alleged coastal pollution at the exit of Unit 3 cooling water channel at Rutenberg power plant, causing a violation of the “discharge to the sea permit” conditions. In this notice, resulting from a stain observed in the sand near the cooling water channel, IEC was requested to provide information and to take various measures. IEC submitted its response on September 5, 2021, claiming, among others, that the discharges were performed according to all the permit conditions.

In November 2021, IEC received a notice before legal action from the Ministry of Environmental Protection, on alleged “strong or unreasonable air pollution” by nitrogen oxides causing an exceedance from the emission value for flue gas from Unit 6 stack at Hagit power plant. IEC submitted clarifications to the Ministry of Environmental Protection, stating that the exceedances from the emission value were obtained during a calibration process, therefore there was no actual exceedance from the permit value.

AIR

Annual Environmental Report 2021 | Chapter 1

Use of materials, energy consumption, and energetic efficiency

The main raw materials that are used by the company for the purpose of producing electricity are different types of fuels: coal, natural gas, liquefied natural gas, heavy fuel oil, and diesel oil. In addition, the company owns a fleet of vehicles that use gasoline and diesel oil.
In the context of the use of raw materials (fuels), it should be noted that for the production process, no alternative fuels are used. Projects investigating this possibility are not relevant today, in view of the steps taken to stop the use of coal and to switch to the use of natural gas as the primary fuel at coal-fired power plants.

Table No. 3 presents information on IEC fuel consumption for the production of energy and raw material consumption data. Fuel consumption data are expressed as amounts, in thousands of tons/ thousands of liters and as thermal energy, in terajoules. Most of the fuels consumed by IEC are used to produce electricity.

According to the information presented in this table, in the past few years there has been a considerable decrease in use of coal and a considerable increase in the use of natural gas. This trend contributed to a significant reduction in emission of air pollutants, including greenhouse gas, as described in the section “main air pollutant emissions” in this report.

Regarding the efforts made in order to reduce the consumption of gasoline and diesel oil for transportation (for the company vehicle fleet), see details in the section “transportation and IEC vehicles” in this report.

Table 3: Consumption of fuel by IEC for the generation of electricity and for the fleet of Vehicles, and consumption of raw materials, 2015-2021

	2015	2016	2017	2018	2019	2020	**2021**
Coal (based on financial reports publications data)							
Thousand metric tons	10,700	9,100	8,200	7,800	8,300	7,200	**6,400**
TJ	266,804	226,216	205,001	194,994	207,504	180,003	**160,003**
Natural gas, including LNG (based on financial reports publications data)							
Thousand metric tons	2,989	3,390	3,700	3,900	3,600	3,800	**3,200**
TJ	148,803	168,770	185,002	194,975	179,981	189,980	**159,983**
Diesel fuel (based on financial reports publications data)							
Thousand metric tons	91	46	115	55	107	30	**16**
TJ	3,881	1,939	4,906	2,370	4,625	1,297	**692**
Heavy fuel oil (based on financial reports publications data)							
Thousand metric tons	18	19	26	22	20	13	**9**
TJ	704	781	1025	864	760	494	**342**
Limestone for use in FGD scrubbers							
Thousand metric tons	41	33	44	66	78	73	**59**
Gasoline for transportation (vehicle fleet of the Company only)							
Thousand metric tons	3,366	3,835	3,340	3,562	3,431	2,206	**2,214**
TJ	116	132	115	123	118	76	**76**
Diesel fuel for transportation (vehicle fleet of the Company only)							
Thousand metric tons	9,831	9,106	7,882	9,528	10,034	9,780	**10,080**
TJ	357	331	287	347	365	356	**367**

Consumption of fuel for the generation of electricity
Consumption of raw materials
Consumption of fuel for the vehicle fleet

Tables No. 4 below and No. 5 on following page, present data on the summarized energy consumption by IEC and data on energetic efficiency, expressed as heat rate of electricity production.

The improvement in the energy consumption and energetic efficiency at the company level is due to two reasons: a decrease in the total electricity production, and therefore also in the consumption of fuels for the production of electricity, as a result of the contribution of private electricity producers; an improvement in the heat rate, i.e. a decrease in the amount of energy required for producing one MW/hr, as a result of shift from production of electricity by coal-fired units to production by CCGT units primarily operated with natural gas, with a consistently higher percentage of efficiency.

Table 4: Total energy consumption by IEC, 2015 - 2021

	2015	2016	2017	2018	2019	2020	**2021**
Coal [TJ]	266,804	226,216	205,001	194,994	207,504	180,003	**160,003**
Natural gas including LNG [TJ]	148,803	168,770	185,002	194,975	179,981	189,980	**159,983**
Diesel fuel [TJ]	3,881	1,939	4,906	2,370	4,625	1,297	**692**
Heavy fuel oil [TJ]	704	781	1,025	864	760	494	**342**
Gasoline for transportation (vehicle fleet of the Company only) [TJ]	116	132	115	123	118	76	**76**
Diesel fuel for transportation (vehicle fleet of the Company only) [TJ]	357	331	287	347	365	356	**367**
Power plants self-consumption of electricity [TJ]	6,909	6,802	6,666	6,501	6,614	6,294	**5,776**
Estimation of self-consumption of electricity in administrative and other sites [TJ]	360	231	216	216	216	216	**216**
Total (TJ)	427,934	405,202	403,218	400,390	400,183	378,716	**327,455**

Table 5: Energy Efficiency in the Electricity generation segment: Energy Intensity – Heat rate for electricity generation – 2015-2021

	2015	2016	2017	2018	2019	2020	**2021**
Electricity generation	50,641	48,718	48,788	47,905	47,810	44,363	**38,248**
Energy intensity	8.30	8.16	8.12	8.21	8.22	8.38	**8.39**
Energy Consumption	420,192	397,706	395,934	393,203	392,870	371,774	**321,020**

Total electricity generation [MWh*1000]
Energy intensity – Heat rate for electricity generation [GJ/MWh]
Total thermal energy consumption for electricity generation [TJ]

Table 6 : Electricity Self – consumption of power plants 2015 - 2021

	2015	2016	2017	2018	2019	2020	**2021**
Actual generation	50,641	48,718	48,788	47,905	47,810	44,363	**38,248**
Self –consumption of electricity	1,919	1,890	1,852	1,806	1,837	1,748	**1,604**
Self –consumption as total generation (%)	3.79%	3.88%	3.80%	3.77%	3.84%	3.94%	**4.19%**

Actual generation [MWh*1000]
Self –consumption of electricity in power plants [MWh*1000]
Self –consumption as total generation percentage [%]

Energetic efficiency projects promoted in recent years at IEC

IEC observes the provisions of the Energy Sources Law, 1989, and the regulations promulgated thereunder, concerning energetic efficiency, as well as the Government Decisions that are published from time to time regarding energetic efficiency and reduction of greenhouse gas emission. The company is committed to comply with this regulation and studies its impact, together with the impact of new regulatory initiatives in this field.
In recent years, various energy efficiency projects have been carried out, including:

- Activities in order to increase energetic efficiency in existing production units.
- Replacement of air conditioners in various sites by newer air conditioners with a high energy rating.
- Replacement of lighting fixtures with new models that save energy.
- Promoting the construction of "green roofs".
- Activities in order to increase awareness of energetic efficiency among employees.
- Activities in order to increase awareness of energetic efficiency among the general public.

Environmental emissions

The IEC considers as highly important to perform the design and operation of its facilities, while taking care of a continuous reduction in environmental impacts, and taking in consideration the sustainable development principles, through adopting the best available technologies from environmental and economic points of view.

The next section will provide a survey of pollutants emissions to air from electricity production sites, which is a main issue that the company deals with, in the context of environmental emissions. Further information can be found in the reports submitted to the Ministry of Environmental Protection according to the Environmental Protection Law (Releases and Transfers to the Environment - Reporting and Registration Obligations), 2012. According to this law, a report was submitted in 2021 on the data from 2020, for 14 sites that require reporting, using a computerized form. The reports submitted in 2022, on the data from 2021, will be published in the second half of 2022.

further reading about emissions

PRTR reports on the IEC website

In addition, these reports are published on the website of the Ministry of Environmental Protection

These reports include, among others, the quantities of pollutants emitted to the air, water resources and soil (above the threshold values defined in technical manuals), including the quantities of pollutants transferred in waste waters to the environment routinely and during malfunctions, as well as the quantities of the different types of waste transferred off-site.

Main air pollutants emissions

During the electricity generation process different types of gases are emitted to the atmosphere as a result of fuel combustion. The main gases emitted are: sulfur dioxide (SO_2), nitrogen oxides (NO_X), particulate matter (PM) and carbon dioxide (CO_2).

There is a trend of continuous reduction of air emissions due to the main following factors:

- Expanding the use of natural gas, the sulfur content of which is negligible
- Successful completion of the air pollution control project at the Orot Rabin site
- Successful completion of the air pollution control project at the Rutenberg site
- Operation of the CCGT units with particularly high efficiency
- Reduction in the use of coal according to the instructions of the Minister of Energy and to emission permits instructions
- Use of low-sulfur liquid fuel only for backup

Table 7: Data on electricity generation by fuel in the years 2012-2021

Year	Generation percentage using natural gas	Generation percentage using liquefied natural gas (LNG)	Generation percentage using coal	Generation percentage using diesel fuel	Generation percentage using heavy fuel oil
2021	**53.1**	**2.4**	**44.3**	**0.1**	**0.1**
2020	50.9	6.0	42.7	0.3	0.1
2019	45.1	8.0	45.8	1.0	0.1
2018	49.1	7.4	43.0	0.4	0.1
2017	48.5	5.0	45.2	1.1	0.2
2016	46.3	3.6	49.6	0.4	0.1
2015	40.3	1.3	57.6	0.7	0.1
2014	41.1	0.6	58.2	0.1	0.0
2013	36.5	4.1	56.2	2.6	0.6
2012	14.3	0.0	63.4	15.2	7.1

The shift of electricity production from coal and liquid fuels to natural gas can be seen in Table 7. It contributed to a significant reduction in emissions of air pollutants and greenhouse gas.

Table 8: Comparison of actual air emissions reduction rates with the targets for 2030

Pollutant emitted to the air as a result of burning fuel for electricity generation	Emission reduction target [gr/KWh]: 2030 compared to 2015	Actual emission reduction [gr/KWh]: 2021 compared to 2015
Nitrogen oxides (NOx)	-65%	-51%
Sulfur Dioxide (SO_2)	-85%	-69%
Particulate Matter (PM)	-40%	-37%
Carbon Dioxide (CO_2)	-30%	-7%
Carbon footprint (CO_2eq)	-30%	-7%

Table 9: Emissions of pollutants to the air as a result of fuel combustion for electricity generation by IEC in the years 2010-2021 [gram/KWh generated]

Year	NOx emissions [gram/ kWh generated]	SO_2 emissions [gram/ kWh generated]	PM (Particulate Matter) emissions [gram/ kWh generated]	CO_2 emissions [gram/ kWh generated]	CO_2eq emissions [gram/ kWh generated]	Electricity generation [thousands of MWh]
2021	**0.65**	**0.42**	**0.029**	**622**	**624**	**38,248**
2020	0.75	0.41	0.030	615	617	44,363
2019	0.75	0.45	0.028	618	620	47,810
2018	0.88	0.63	0.032	605	608	47,905
2017	0.92	0.77	0.038	614	617	48,788
2016	1.07	1.08	0.042	635	637	48,718
2015	1.32	1.34	0.046	667	669	50,641
2014	1.42	1.36	0.035	659	661	51,726
2013	1.59	1.47	0.047	674	677	57,119
2012	1.80	1.68	0.056	754	757	61,074
2011	1.70	1.60	0.053	707	709	57,146
2010	1.60	1.50	0.051	699	702	56,102
2021 vs. 2020	-13%	+2%	-3%	+1%	+1%	-14%
2021 vs. 2015	-51%	-69%	-37%	-7%	-7%	-24%

Table 10: Emissions of pollutants to the air as a result of fuel combustion for electricity generation by IEC in the years 2010-2021 [metric ton/year]

Year	NOx emissions [metric ton/ year]	SO_2 emissions [metric ton/ year]	PM (Particulate Matter) emissions [metric ton/ year]	CO_2 emissions [metric ton/ year]	CO_2eq emissions [metric ton/ year]	Electricity generation [thousands of MWh]
2021	**24,839**	**16,154**	**1,096**	**23,793,248**	**23,870,304**	**38,248**
2020	33,116	18,198	1,317	27,300,821	27,387,896	44,363
2019	35,876	21,425	1,327	29,525,691	29,634,047	47,810
2018	41,957	29,951	1,516	29,006,456	29,109,700	47,905
2017	44,800	37,592	1,856	29,978,814	30,087,822	48,788
2016	51,888	52,663	2,041	30,938,165	31,055,231	48,718
2015	66,925	67,636	2,336	33,757,748	33,893,752	50,641
2014	73,577	70,423	1,835	34,069,079	34,207,232	51,726
2013	90,680	84,167	2,661	38,500,369	38,655,755	57,119
2012	109,920	102,648	3,403	46,035,963	46,240,061	61,074
2011	95,419	93,051	3,028	40,373,568	40,543,180	57,146
2010	92,324	82,860	2,873	39,214,127	39,375,206	56,102
2021 vs. 2020	-25%	-11%	-17%	-13%	-13%	-14%
2021 vs. 2015	-63%	-76%	-53%	-30%	-30%	-24%

Table 11: Total air pollutants emissions in relation to sales turnover 2012-2021

Year	Intensity of nitrogen oxides emissions [Tons/USD million sales]	Intensity of sulfur dioxide emissions [Tons/USD million sales]	Intensity of particulate matter emissions [Tons/USD million sales]	Total nitrogen oxide emissions from IEC power plant sites [ton/year]	Total sulfur dioxide emissions from IEC power plant sites [ton/year]	Total particulate matter emissions from IEC power plant sites [ton/year]
2021	**3.49**	**2.27**	**0.15**	**24,839**	**16,154**	**1,096**
2020	4.48	2.46	0.18	33,116	18,198	1,317
2019	5.03	3.01	0.19	35,876	21,425	1,327
2018	6.67	4.76	0.24	41,957	29,951	1,516
2017	6.65	5.58	0.28	44,800	37,592	1,856
2016	8.79	8.92	0.35	51,888	52,663	2,041
2015	11.33	11.45	0.40	66,925	67,636	2,336
2014	11.35	10.86	0.28	73,577	70,423	1,835
2013	11.40	10.58	0.33	90,680	84,167	2,661
2012	14.52	13.56	0.45	109,920	102,648	3,403

The air pollution control project at coal-fired production units of "Orot Rabin" and "Rutenberg" sites

In recent years, IEC has built air pollution control facilities at "Orot Rabin" Site in Hadera, and is in the final stages of completing also the installation of air pollution control facilities at "Rutenberg Site" in Ashkelon. This is a complex project, the construction of which has taken many years with a final cost of about NIS 7 billion (not including interest during the construction period).

At of the date of this report (2021), and according to the emissions permits that were issued for the coal-fired units, units 5-6 at "Orot Rabin" site operate successfully with air pollution control facilities, and units 1-2 and 4 at "Rutenberg" site operate successfully with the same facilities, this in compliance with the emissions values set in the emissions permits. At "Rutenberg" site (2021), the installation of the facility to reduce nitrogen oxides emission in unit 3 is nearly completed and operational, after the addition of the SCR facility.

The projects at "Orot Rabin" and "Rutenberg" sites include the upgrade of existing systems in the units (primary methods), the installation of scrubbers to reduce sulfur dioxide emissions (Flue Gas Desulfurization - FGD) and the installation of catalytic systems (Selective Catalytic Reduction - SCR) to improve the reduction of nitrogen oxide emissions. The FGD scrubber operation is based on the reaction of the sulfur dioxide in the flue gas with a limestone suspension in water. As a result of the "wet" reaction process, the treated gases are saturated with water vapor and therefore a white plume can be observed from the stack exit, it results from the humidity of the emitted gases.

The FGD facilities could not be fitted and connected to the existing stacks at the sites, so new stacks were built at both sites. The new stacks are used for generation units 5 and 6 at "Orot Rabin" site and for generation units 1 and 2 at "Rutenberg" site (a FGD facility already existed for "Rutenberg" units 3-4 since the date of their operation).

The by-product of the sulfur oxide removal process is gypsum, with a quality suitable for the cement industry and the gypsum wall manufacturing industry.

The completion of this project is a milestone in the investments made by IEC in the environmental protection field. In parallel, following the development of natural gas reservoirs and the extension of the gas transmission system in Israel, IEC is performing an additional project aimed to reduce pollutants emissions even more: the project of converting the major coal-fired units to operating using natural gas as primary fuel, while keeping the ability to operate using coal only in case of emergency period and natural gas shortage.

Upon completion of this project, the State of Israel will enjoy a further reduction in pollutants emissions, and will stand better to its commitment according to the Paris Agreements, while continuing to provide reliable and available electricity to Israeli residents, that in a “cleaner” and more environmental friendly way.

As a result of the “wet” reaction process, the treated gases are saturated with water vapor and therefore a white plume can be observed from the stack exit, it results from the humidity of the emitted gases.

IEC air monitoring system

IEC has established and operates an air quality monitoring system including in 2021 25 air quality and meteorological monitoring stations in various parts of the country. This monitoring system is part of a national air quality monitoring system, operating according to the Clean Air Law. The members of this monitoring system are Environmental Cities Associations (Haifa, Hadera, Ashdod and Ashkelon), the Ministry of Environmental Protection, industry representatives and the IEC.

The IEC monitoring stations operate in the following areas:

In the Haifa area - 3 stations;
in the Hadera area - 3 stations;
in the Tel Aviv area - 7 stations;
in the Ashdod area - 3 stations;
in the Ashkelon area - 3 stations;
in the Gezer area - 4 stations;
and in the Eilat area - 2 stations.

The air pollutants (all or part of them) measured by the IEC monitoring stations in 2021 were:
Sulfur dioxide (SO_2), nitrogen oxides (NO_X), nitrogen dioxide (NO_2), ozone (O_3), and fine particulate matter (PM 10 and PM 2.5).

In addition, measurements of wind direction, wind speed and other meteorological parameters are performed at several sites.

Findings from the air quality measurements obtained from the IEC monitoring stations in 2021 show that concentrations of SO_2 (a typical pollutant for coal, heavy fuel oil or diesel oil combustion) are in a downward trend and are significantly lower than environmental standards fixed according to the "Clean Air Regulations (Air Quality Standards) (Temporary Provisions), 2011". This is in line with the reduction in emissions by IEC electricity generation units, as described above.

With regard to other air pollutants, in 2021 IEC monitoring stations recorded occasionally concentrations of nitrogen oxides, nitrogen dioxide, ozone and respirable and fine particulate matter, which were relatively high and sometimes even higher than the appropriate air quality standards. These cases appear to have been unrelated, or at least not directly related to emissions from power plants.
High concentrations of nitrogen oxides and nitrogen dioxide are associated with the transportation sector, high ozone concentrations are attributed to photochemical processes in the atmosphere, and high concentrations of respirable and fine particulate matter were measured during dust storms and haze events coming from remote desert locations.

During 2021, the IEC continued the upgrading of monitoring devices, as well as the buildings and infrastructures at all existing monitoring stations. This activity ensures improvement of the data reliability and availability.

The IEC air monitoring laboratory is certified according to the ISO 17025 standard for the performance of monitoring, and calibration of instruments and environmental air quality systems.

Table 12: List of IEC air quality monitoring stations and meteorology stations - 2021

Station name and address		Altitude above sea level [meter]	Measured parameters
Haifa area			
Carmel Central	Hugim High School, 4 Yair Katz St., Haifa	274(+20)	SO_2 NO_2 NO_X O_3 w/s w/d
Carmel Park	Carmel Park office, Haifa	507	SO_2 NO_2 NO_X O_3 PM2.5 w/s w/d
Einstein	135 Einstein St., Haifa	363	SO_2 NO_2 NO_X O_3
Hadera area			
Katzir	Katzir Community Settlement	390	SO_2 NO_2 NO_X O_3 PM10 w/s w/d
Orot Rabin	Orot Rabin power plant site	13(+13)	PM10 w/s w/d
Caesarea	Caesarea gas turbine site in front of Or Akiva	19(+7)	PM10 w/s w/d
Tel Aviv area			
Yad LaBanim	Beit Yad LaBanim, 15 Maale HaBanim St., Ramat Gan	77(+14)	PM10 PM2.5
Fire department	Fire station – 13 Ben Eliezer Street	50(+10)	SO_2 NO_2 NO_X O_3
Bitzaron	Technical Center, 7 Kremenetsky St., Tel Aviv	17(+16)	w/s w/d
Petach Tikva Road	Old Central bus Station, 13 Petach Tikva Road, Tel Aviv	28(+20)	SO_2 NO_2 NO_X O_3 PM10 PM2.5 w/s w/d
Antokolsky	People's University, 4 Antokolsky, Tel Aviv	34(+20)	SO_2 NO_2 NOX O_3 PM2.5
Hamashtela	Meteorological Tower, National Supervision, Ramat HaSharon	65(+10+65)	NO_2 NO_X O_3. SO_2 Temp in two altitudes + w/s w/d
Shikun Lamed	Aran School, 25 Burla St., Tel Aviv	17(+15)	PM10

Notes :

Sulfur dioxide – SO_2,
Nitrogen oxides – NO_X,
Nitrogen dioxide – NO_2;
Ozone – O_3;
Suspended fine particulate matter – PM10 and PM2.5;
wind direction - w/d;
wind speed - w/s.

Station name and address		Altitude above sea level [meter]	Measured parameters
Ashdod area			
Nir Galim	Moshav Nir Galim	20	SO_2 O_3 PM10 NO_2 NO_X w/s w/d
Gan Darom	Moshav Gan Darom	45	SO_2 NO_2 NO_X O_3
Yavneh (City)	Kupat Holim Clalit, HaDekel Street, Yavneh	38(+15)	SO_2 NO_2 NO_X O_3 PM10 w/s w/d
Ashkelon area			
Bat Hadar	Hof Ashkelon Regional Council	59(+4)	SO_2 NO_2 NO_X O_3 PM10
Kfar Menahem	Zafit High School, Kfar Menahem	119 (+11)	SO_2 NO_2 NO_X O_3 w/s w/d
Luzit	Moshav Luzit	189	SO_2 NO_2 NO_X O_3 w/s w/d
Gezer area			
Beit Hashmonay	Herzog High School, Beit Hashmonay	103	SO_2 NO_2 NO_X O_3 w/s w/d PM10
Karmei Yosef	Commercial Center, Karmei Yosef	260	SO_2 NO_2 NO_X O_3 w/s w/d
Modiin	Mekorot Facility, Modiin	267	SO_2 NO_2 NO_X O_3 PM10 w/s w/d
Achisemech	Moshav Achisemech	80	SO_2 NO_2 NO_X O_3 w/s w/d
Eilat			
Eilat Office	Regional IEC office, Eilat	68(+10)	w/s w/d
Eilat Goldwater	Goldwater High School, Eilat	49 (+15)	SO_2 NO_2 NO_X O_3 w/s w/d

Notes :

Sulfur dioxide – SO_2,
Nitrogen oxides – NO_X,
Nitrogen dioxide – NO_2;
Ozone – O_3;
Suspended fine particulate matter – PM10 and PM2.5;
wind direction - w/d;
wind speed - w/s.

IEC monitoring system of pollutants emitted from stacks

According to the emission permits instructions, the IEC operates devices for continuous monitoring of pollutant emitted from the stacks of the production units. The data are transmitted online and in real time to the Ministry of Environmental Protection. In addition various operational data are also transmitted.

The company also operates a manual sampling system according to an internal "stack sampling manual" and a work plan approved by the Ministry of Environmental Protection. Manual sampling is also used to calibrate the devices for continuous monitoring systems installed in the stacks.

The sampling work is performed by the IEC pollutant sampling laboratory, part of the environmental monitoring and hygiene department, that, as mentioned above, has undergone certification to the ISO 17025 standard.

Climate change mitigation and reduction of greenhouse gases emissions

Greenhouse gases emissions – national policy and IEC activities

In 2016, the State of Israel signed the Paris Agreement, according to which the governmental policy for reducing greenhouse gases emissions was established. For the purpose of implementing this policy, some national targets have been set, including among others, electricity production from renewable sources at 17% of total production in the country by 2030.

In June 2020, this target was updated by the minister of energy, who presented the Ministry of Energy plan to increase electricity production from renewable sources to 30% by 2030.

National targets were also set for reducing greenhouse gases emissions per capita, to 8.8 tons per capita in 2025 and 7.7 tons per capita in 2030 This would moderate the increase in total greenhouse gases emissions from 72 million tons in the base year 2005 to 81 million tons in the target year 2030.

IEC joins the national effort to achieve these goals and focuses its effort in the following areas:

Expanding the use of natural gas – IEC expanded the use of natural gas from about 14% of electricity production in 2012, to about 55% of electricity production in 2021. The combustion of natural gas is characterized by significantly lower emissions of carbon dioxide as compared with the combustion of coal and liquid fuels.

Reducing the use of coal – Since 2016, restrictions were imposed on electricity production from coal combustion, according to the instructions of emission permits issued under the Clean Air Law, and according to the Ministry of Energy instructions. In 2021, electricity production from coal production was reduced by about 42% as compared to 2015.

Building CCGT plants – CCGT units generate additional electricity from a steam turbine, through the use of residual heat of emission gases from a gas turbine, without additional fuel consumption. That is, units using this technology are characterized by markedly high efficiency rate that results in low emissions of air pollutants and greenhouse gases. In addition to the CCGT plants that already operate, two CCGT units, equipped with the "H technology" (advanced technology allowing a still higher efficiency), are currently in construction at the "Orot Rabin" site near Hadera. These units will be operated with natural gas as primary fuel and diesel oil as backup fuel. They are planned to emit air pollutants and greenhouse gases in drastically lower amounts these emitted by the four old coal-fired units at this site, which will be shut down when the new CCGT units will start operation. From this date, these units will be transferred to "backup" status and accordingly will be operated only in emergency situations (as defined in the emission permit) and for maintenance and ensuring operational capacity, and the new CCGT units will replace them.

Conversion of coal-fired units to natural gas use – In the coming years, the other more recent coal-fired units will be converted to natural gas combustion as primary fuel, while maintaining their operational capacity with coal in case of emergency and natural gas supply shortage. Upon completion of this project, the State of Israel will reach a further reduction in emissions of air pollutants and greenhouse gases according to State of Israel commitments in the framework of the Paris Agreement. These developments will be possible together with a continuous supply of reliable electricity to Israeli residents. The governmental target is to stop using coal for electricity production by 2030.
The Minister of Energy anticipates that progress toward achieving that target will take effect in 2025.

Integration of renewable energies in the power grid

IEC is preparing for the power grid upgrade needed for the transmission of 30% production from renewable energy by 2030. Although IEC is prevented from producing electricity with renewable energies following regulatory restrictions, it contributes to the implementation of the above-mentioned governmental targets by connecting renewable energy production facilities of private producers to the power grid. These private producers of renewable energy sell the excess electricity that they produce to IEC, and through its grid of electricity distribution, this "green" electricity can reach all electricity consumers.
IEC conducts detailed analyzes regarding the implications of the integration of the facilities producing electricity from renewable sources in the electricity system, that for all its activity segments, including the implications of the development plan required as preparation for fulfilling the governmental targets. In addition, , according to the guidelines of the Electricity Authority IEC has published a large number of feasibility studies regarding various initiatives in this field, and even updated the Master Plans accordingly.

Data update for 2021

In 2021, IEC connected private production facilities using renewable energy, with an installed production capacity of 845 megawatts peak (MWp) for the distribution system, and of 60 MWp for the transmission system.
The total installed capacity of electricity production facilities based on renewable energy amounted in 2021 to 3,665 MWp (including facilities in the Palestinian Authority), a capacity equivalent to approximately 9.4% of the annual average consumption in the country.
The energy actually produced using renewable energy in 2021 amounted to 5,516 thousands MWh, approximately 8.1% of the total energy produced in the electricity sector (IEC and private producers).
Since the transition from centralized production to decentralized production, in addition to the increased production capacity in the country require the development and the upgrade of the transmission and distribution systems, IEC invests significant resources for accelerating the development of these systems.

- **Development in the transmission and transformation segment**

  IEC promotes plans to upgrade and to establish new 400 kW and 161 kW lines as well as to upgrade the transformation capacity, in order to adapt the transmission and transformation systems to the electricity sector needs. This adaptation is necessary in view of the governmental targets in the field of renewable energy, as upgrading and developing these systems will enable extended connection to the grid of private electricity producers, including producers in the field of renewable energy,

helping to their integration in ultra-high voltage lines. In addition, IEC acquired a computerized Transmission Management System (TMS) as a result of the transfer of the "system operator" to an independent company. The TMS is planned to start operation in 2023, and will improve the operational and control capacity concerning the transmission systems for which the company is responsible.

- **Development in the distribution segment**

  IEC promotes also a development plan for the distribution grid that is involved by the connection of private producers with the high and low voltage systems.

  In 2021, IEC promoted extensive activity necessary for production decentralization, with the objective to meet the target set by the Ministry of Energy, i.e. 30% production from renewable energy in 2030, and moving toward a target of 10% production from renewable energy by the end of 2021, including:

  • Holding weekly meetings at the project administration department in order to promote connections and remove barriers impeding advancement. These meetings includes representatives from the company and from other entities (Ministry of Energy, Israel Electricity Authority, System Operator Company, entrepreneurs, and others).

  • Increasing the rate of connecting new production facilities to the grid.

  • Appointing project managers for each regional division of the grid, in order to connect all facilities that the company was committed to connect by the end of 2021, and even to promote the early connection of facilities planned to be connected during the first trimester of 2022.

  • Appointing dedicated service representatives for producers (producer-oriented service) with many PV connections, for improving IEC service to producers.

  • Coordinating with producers to remove barriers and promote orders.

  • Carrying out telephone surveys to determine the producers readiness to be connected by the end of the year (a complete survey was carried out with producers in the case of "competition regulation", and a sample survey was carried with producers in the case of "tariff regulation").

  • Organizing a "producers conference" in order to present the progress reached with connections, innovations in this field, and to learn about barriers needing to be removed.

  • Promoting computerization and information systems solutions in order to improve the efficiency in the connection process, like: providing a dashboard to display the system potential to connect facilities (distributed geographically), setting up a customer experience portal for producers, proposing a daily production plan management system, etc.

  • Organizing a kaizen event in cooperation with producers and setting up the "green track" for connections with low-voltage facilities (up to 10 kVA), including a review option after one year, to increase it to 15 kVA (the Israel Electricity Authority has issued a principle approval).

IEC activities to get adapted to climate change and deal with its consequences

The climate change process has many effects on the electricity sector and IEC. It is expected that extreme weather events will cause an increase in electricity demand and damages to the electricity system, including substations, transmission and distribution lines and even in extreme cases to power plants. In addition, climate change might cause a rise in sea level due to global warming, as well as an increase in the occurence of floods and strong winds in inland areas following extreme rainfall events. These events might cause temporary or permanent damages to IEC power plants in coastal areas as well as to power plants, lines, substations and switching stations located inland. Climate change might result also in an increase in the frequency of significant fire events including “fire storms”, due to an increase in the frequency of drought and heat wave events, and these events might also severely damage IEC infrastructures.

The electricity sector development plans take in account extreme scenarios of rising electricity demand due to extreme heat waves (as part of the electricity sector reform, the electricity sector development plans are currently dealt with by the new governmental System Operator Company). The possible effects of rise in sea level on the electricity system infrastructures located near the coast are also being examined.

In addition, the company is prepared for dealing with extreme weather events and their effects on the electricity system infrastructures. The CEO has established a steering committee to coordinate preparation for dealing with extreme weather events, led by the CEO and including all the VPs as members. In addition, he designated readiness for dealing with extreme weather as a major topic in the work plans for 2022. So the company is exercised to cope with such events, prepares work plans to increase this readiness, purchasing appropriate equipment, and working with the Ministry of Energy, the Electricity Authority and other relevant institutions to coordinate activities and improve the capacity for operational continuity in the electricity sector, should these extreme scenarios take place.

Greenhouse gases emissions – IEC reporting as part of the "voluntary mechanism reporting project"

Starting in 2010 the IEC takes an active part in the "voluntary mechanism reporting project", the aim of which is recording and reporting greenhouse gases emissions. This project, established by the Ministry of Environmental Protection, allows involved companies to participate to the preparation of the project, as well as to get experience in gathering the necessary information and processing it for this reporting framework.

Details of the different calculation methodologies determined within the framework of the project can be found on the Samuel Neaman Institute website

But even before this project, since the year 2000, IEC has reported continuously greenhouse gases emissions resulting from fuel combustion for electricity generation, as part of its environmental reports. These emissions account for about 99.5% of all direct greenhouse gases emissions resulting from IEC operations.

An updated report for 2020, issued in the framework of the "voluntary mechanism reporting project" can be found on the IEC website

Note: The report for 2021, prepared as required by the Ministry of Environmental Protection, will be published later this year.

Table 13 shows the distribution of greenhouse gases emissions reported in the "voluntary mechanism reporting project" for the years 2019- 2021. It confirms that the vast majority of IEC direct greenhouse gases emissions are due to fuel combustion for electricity generation.

Table 13: Distribution of direct greenhouse gases emissions by sources, reported to the framework of the Voluntary mechanism reporting project of the Israel Ministry of Environmental Protection: 2019- 2021

Year	Source of greenhouse gas emissions – direct emissions (Scope 1)		
	Total direct emissions as a result of fuel combustion for electricity generation	Total direct emissions not resulting from fuel combustion for electricity generation*	Measurement units
2021	23,870,304	119,327	Metric ton CO_2eq
	99.5%	0.5%	% of total direct emissions
2020	27,387,896	125,372	Metric ton CO_2eq
	99.54%	0.46%	% of total direct emissions
2019	29,634,047	127,457	Metric ton CO_2eq
	99.57%	0.43%	% of total direct emissions

* Mainly emissions from the vehicle fleet, sulfur hexafluoride emissions, emissions from the chemical process in the FGD scrubbers.

Table 14: IEC's greenhouse gases emissions reported to the framework of the voluntary mechanism reporting project of the Israel Ministry of Environmental Protection for the years 2010-2021

Year	CO_2eq emissions [metric tons]		
	Scope 1	Scope 2	Scope 1+2
2021	**23,989,635**	**1,228,350**	**25,217,985**
2020	27,513,268	1,318,812	28,832,080
2019	29,761,504	1,391,330	31,152,834
2018	29,227,942	1,349,698	30,577,640
2017	30,188,779	1,386,878	31,575,657
2016	31,152,001	1,429,760	32,581,761
2015	33,997,496	1,476,177	35,473,673
2014	34,312,517	1,811,959	36,124,476
2013	38,762,789	1,547,592	40,310,381
2012	46,366,484	1,838,728	48,205,212
2011	40,661,709	1,558,797	42,220,506
2010	39,467,669	1,568,718	41,036,387

Table 15: IEC's greenhouse gases emissions reported to the framework of the voluntary mechanism reporting project of the Israel Ministry of Environmental Protection for the years 2010-2014: breakdown of the direct emissions according to the types of greenhouse gases

Year	CO_2eq emissions [metric tons]				
	CO_2	N_2O	CH_4	SF_6	Total metric ton CO_2eq
2014	34,123,738	128,097	10,684	49,998	34,312,517
2013	38,554,817	145,145	10,904	51,922	38,762,789
2012	46,108,389	188,309	16,770	50,519	46,363,988
2011	40,440,866	158,381	12,178	50,283	40,661,709
2010	39,272,597	150,993	10,930	33,149	39,467,669

Table 16: IEC's greenhouse gases emissions reported to the framework of the voluntary mechanism reporting project of the Israel Ministry of Environmental Protection for the years 2015-2021: breakdown of the direct emissions according to the types of greenhouse gases

Year	CO_2eq emissions [metric tons]				
	CO_2	N_2O	CH_4	SF_6	Total metric ton CO_2eq
2021	**23,852,085**	**68,626**	**8,962**	**59,962**	**23,989,635**
2020	27,366,625	77,263	10,385	58,994	27,513,268
2019	29,596,988	99,030	9,984	55,501	29,761,504
2018	29,070,696	94,042	9,846	53,359	29,227,942
2017	30,027,557	99,394	10,169	51,659	30,188,779
2016	30,983,438	107,533	10,107	50,923	31,152,001
2015	33,810,454	125,834	10,773	50,435	33,997,496

CO_2: carbon dioxide
N_2O: nitrous oxide
CH_4: methane
SF_6: sulfur hexafluoride

Table 17: Global Warming Potential of the various greenhouse gases, as set out in the calculation methodology of the voluntary mechanism

	Global warming potential (GWP)		
	Until 2013	2014- 2019	Starting from 2020
CO_2 (carbon dioxide)	**1**	**1**	**1**
N_2O (nitrous oxide)	310	298	265
CH_4 (methane)	21	25	28
SF_6 (sulfur hexafluoride)	23,900	22,800	23,500

Table 18: Total IEC direct greenhouse gases emissions and specific emissions (GHG Intensity) with relation to the sales turnover and with relation to the electricity production, for the years 2010- 2021

Year	CO_2eq emissions Scope 1 [metric tons]	GHG Intensity	
		Metric tons CO_2eq / USD million sales	Metric tons CO_2eq / gross MWh*1000
2021	**23,989,635**	**3368.29**	**627**
2020	27,513,268	3720.04	620
2019	29,761,504	4175.78	623
2018	29,227,942	4644.96	610
2017	30,188,779	4478.58	619
2016	31,152,001	5278.93	639
2015	33,997,496	5755.46	671
2014	34,312,517	5292.77	663
2013	38,762,789	4874.66	679
2012	46,366,484	6124.14	759
2011	40,661,709	6120.25	712
2010	39,467,669	6945.84	703

Table 19: specific emission factors for the various greenhouse gases in gram/ net-kwh (transmitted to the electricity transmission and distribution grid from the power plants, i.e., after deduction of the electricity self- consumption of the electricity generation equipment) for the years 2010 to 2021

Year	Gram CO_2eq/net-kwh	Gram CO_2/net-kwh	Gram N_2O/net-kwh	Gram CH_4/net-kwh
2021	**651**	**649**	**0.00702**	**0.00869**
2020	643	641	0.00679	0.00867
2019	645	642	0.00718	0.00865
2018	631	629	0.00680	0.00850
2017	641	639	0.00707	0.00864
2016	663	661	0.00767	0.00860
2015	696	693	0.00863	0.00881
2014	688	685	0.00860	0.00856
2013	703	700	0.00848	0.00936
2012	787	783	0.01030	0.01329
2011	737	733	0.00925	0.01021
2010	729	726	0.00899	0.00940

Table 20: Specific emission factors for the different greenhouse gases in gram/gross kWh (gram/kWh produced) for the years 2010 to 2021:

Year	Gram CO_2eq/gross-kwh	Gram CO_2/gross-kwh	Gram N_2O/gross-kwh	Gram CH_4/gross-kwh
2021	**624**	**622**	**0.00672**	**0.00832**
2020	617	615	0.00653	0.00833
2019	620	618	0.00691	0.00831
2018	608	605	0.00655	0.00818
2017	617	614	0.00680	0.00831
2016	637	635	0.00737	0.00827
2015	669	667	0.00830	0.00848
2014	661	659	0.00827	0.00823
2013	677	674	0.00817	0.00901
2012	757	754	0.00991	0.01278
2011	709	707	0.00891	0.00984
2010	702	699	0.00865	0.00905

Table 21: Greenhouse gases indirect emissions (SCOPE 2) resulting from the self-consumption of electricity in power plants and in administrative/other sites for the years 2010-2021

Year	CO_2eq- indirect SCOPE 2 emissions from self consumption of electricity in power plants [metric tons]	CO_2eq- indirect SCOPE 2 emissions from self-consumption of electricity in administrative/other sites [metric tons]	TOTAL: CO_2eq- indirect SCOPE 2 emissions [metric tons]
2021	**1,185,003**	**43,346**	**1,228,350**
2020	1,272,963	45,849	**1,318,812**
2019	1,341,086	50,244	**1,391,330**
2018	1,299,959	49,739	**1,349,698**
2017	1,352,746	34,132	**1,386,878**
2016	1,391,053	38,707	**1,429,760**
2015	1,406,606	69,571	**1,476,177**
2014	1,680,614	131,345	**1,811,959**
2013	1,448,455	99,137	**1,547,592**
2012	1,751,380	87,348	**1,838,728**
2011	1,488,828	69,969	**1,558,797**
2010	1,489,936	78,782	**1,568,718**

Table 22: Emissions of carbon dioxide, electricity generation, and specific emission of carbon dioxide for whole IEC

	2016	2017	2018	2019	2020	**2021**
	30,938,165	29,978,814	29,006,456	29,525,691	27,300,821	**23,793,248**
	48,718	48,788	47,905	47,810	44,363	**38,248**
	635	614	605	618	615	**622**

Table 23: Emissions of carbon dioxide, electricity generation, and specific emission of carbon dioxide for coal-fired power plants

	2016	2017	2018	2019	2020	**2021**
	21,519,375	19,574,308	18,447,933	19,486,999	17,020,507	**15,198,929**
	24,164	22,052	20,599	21,885	18,943	**16,944**
	891	888	896	890	899	**897**

Table 24: Emissions of carbon dioxide, electricity generation, and specific emission of carbon dioxide for natural gas-fired power plants

	2016	2017	2018	2019	2020	**2021**
	9,298,913	10,036,806	10,411,997	9,721,492	10,202,474	**8,564,442**
	24,310	26,102	27,066	25,373	25,243	**21,228**
	383	385	385	383	404	**403**

	Annual CO_2 emissions [Metric Tons]
	Annual gross electricity production (MWh*1000)
	Carbon intensity (Gram /kwh)

Greenhouse gases emissions – Electricity transmission segment

In recent years, the Israeli electricity market has undergone a structural change. Among others, this includes a change in the distribution of energy sources used for electricity generation.

The amount of electricity generated by private producers that use fossil energy sources (mostly natural gas) and private producers that use renewable energy sources (mostly solar energy) has increased over the years. At the same time, the rate of electricity generation by IEC as part of the total energy generated has declined: in 2020, the IEC supplied 61% of the total electricity, and the private producers supplied the remaining part, using fossil and renewable energy sources.

The greenhouse gases emission coefficients in the IEC electricity generation segment are only affected by the IEC electricity generation technology, and their values are presented above in Tables 19 and 20.

The electricity transmission segment is a segment that transmits the electricity generated by different companies, not only the electricity generated by IEC itself. Consequently, as opposed to the greenhouse gases emission coefficients for IEC electricity generation segment, the greenhouse gases emission coefficients for the electricity transmission segment are calculated as the weighted average of emission coefficients for IEC and emission coefficients for the private producers. It should be noted that the electricity flowing through the electricity transmission system is supplied to IEC customers as well as to consumers who are not IEC customers.

For the first time, IEC finds it appropriate to present greenhouse gases emission coefficients for the Israeli national power grid in this present environmental report.

The greenhouse gases emission coefficients in the transmission segment are calculated according to the method presented above and published by the Ministry of Environmental Protection.

Table 25: Weighted average of Annual Emission factors for the National Electricity transmission Grid – The Israel Electric Corporation and Independent Power Producers (IPPs) for the years 2010 to 2021, As Published by the Israel Ministry of Environmental Protection

Year	Gram CO_2/net-kwh	Gram N_2O/net-kwh	Gram CH_4/net-kwh	Gram CO_2eq/net-kwh
2021	**469**	**0.00362**	**0.00624**	**470**
2020	496	0.00414	0.00663	497
2019	543	0.00595	0.00703	545
2018	537.5	0.006	0.0071	539.5
2017	567	0.00522	0.00782	568.8
2016	600	0.00767	0.0152	602.7
2015	693	0.00863	0.00881	695.8
2014	685	0.0086	0.00856	687.8
2013	700	0.00848	0.00936	702.8
2012	783	0.0103	0.01329	786.5
2011	733	0.00925	0.01021	736.0
2010	726	0.00899	0.0094	729.0

Source: The Voluntary Mechanism's Operation Rules File, Part 3, page 8

Gases emissions from air-conditioning systems, including gases harmful to the stratospheric ozone layer

IEC uses air-conditioning and cooling systems both in office buildings and in order to cool the operational equipment in the company facilities.

IEC operates in this field according to the Hazardous Substances Regulations (Implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer), 2004. No refrigerants that harm the ozone layer are used in the large and medium air-conditioning systems introduced since 2000, and in the small air-conditioning units since 2005.

In the recent years, IEC conducted surveys to characterize the inventory of air-conditioning systems and the types and amounts of refrigerants used. The annual release percentage and the global warming potential were calculated according to the methodology set out in the "voluntary mechanism reporting project". The damage potential to the ozone layer for the gas R22 was set out according to the Montreal Protocol Regulations.

Table 26: Data regarding the emissions of air conditioner refrigerants: amounts emitted, ozone depletion potential and global warming potential for power plants, as reported in PRTR report for 2021

				Total amount of refrigerant / gas released in 2021			
Name of refrigerant/ refrigerant mix	CAS NUMBER	Chemical formula	GWP	ODP [metric tons]	Metric tons	As CFC-11eq [metric tons] *	Metric tons of CO2eq
Name of refrigerant							
R22=HCFC-22	75-45-6	CHF2Cl	1760	0.055	0.049	0.002	86
R-134A	811-97-2	C2H2F4	1300	0	0.018	0	23
Name of Refrigerant mix:							
R-407C	75-10-5	CH2F2	1624	0	0.105	0	171
	354-33-6	C2HF5					
	811-97-2	C2H2F4					
R-410A	75-10-5	CH2F2	1924	0	0.510	0	982
	354-33-6	C2HF5					
Total					**0.682**	**0.002**	**1,262**

GWP : Global Warming Potential

ODP : Ozone Depletion Potential

CFC-11 : Chlorofluorocarbon

* ODP of CFC-11 = 1

Transportation and distance traveled

The Company strives to continuously improve transportation and the employees' commute. Among other things, this is done to minimize air pollutant and greenhouse gas emissions; mitigate road congestion; encourage employees to use resources reasonably, sparingly, and environmentally; and foster a supportive and empathetic work environment for environmental, economic, and energetic efficiency.

Within this, various measures are taken, such as:

- Providing ways to arrive at work without using a private car and encouraging public transportation use, emphasizing Israel Railways, to minimize individual use of private cars.
- Increasing use of teleconferencing systems for meetings, leading to a shorter distance traveled.
- An official publicity campaign on proper tire air pressure, to minimize fuel consumption.
- Providing training on efficient and ecological driving.
- Providing comparative information for Company car owners, on fuel consumption and mileage, to increase awareness of wise car usage issues among Company car drivers.
- Transitioning to a hybrid work model because of the Covid-19 pandemic constraints, which contributed to shorter distances traveled and reduced road congestion.

Data on vehicles consuming Gasoline:

Table 27: Gasoline consumption by administrative vehicles, 2017 to 2021

	Total Number of administrative vehicles (gasoline vehicles)	Out of this: Number of hybrid vehicles	Total gasoline consumption [liter]	Annual traveled distance [km]	km per liter gasoline
2021	**1076**	**596**	**2,155,714.00**	**43,324,119**	**20.1**
2020	1044	565	1,811,493.00	39,779,252	22.0
2019	931	417	2,114,051.61	36,904,373	17.5
2018	943	323	2,110,956.79	29,643,234	14.0
2017	914	244	1,775,264.44	21,556,310	12.1

*Including leased vehicles

Table 28: Information on commercial vehicles, light Commercial Vehicles, and motorcycles consuming gasoline in 2017 to 2021

	Number of vehicles (commercial + light commercial + motorcycles that consume gasoline)	Total gasoline consumption [liter]	Annual traveled distance [km]	km per liter gasoline
2021	**55**	**58,041.00**	**794,135**	**13.68**
2020	88	394,236.00	4,422,143	11.22
2019	286	1,316,586.70	15,037,839	11.42
2018	487	1,450,795.56	14,972,577	10.32
2017	513	1,564,536.00	16,321,212	10.43

*Including car leases

Table 29: Information on the number of diesel fuel vehicles and their fuel consumption, in 2017 to 2021. Data on vehicles consuming diesel fuel:

	Number of diesel fuel vehicles	Total diesel fuel consumption [liters]	Annual traveled distance [km]	km per liter diesel fuel
2021	**2,292**	**8,034,016.00**	**73,572,518**	**9.16**
2020	2,092	7,802,460.00	65,969,409	8.45
2019	1,885	6,900,132.87	52,599,419	7.62
2018	1,778	6,969,740.68	50,518,503	7.25
2017	1,711	6,771,445.00	51,762,346	7.64

*including car leases

Table 30: Information on diesel fuel consumption and annual traveled distance of the heavy and mechanical engineering equipment in 2017 to 2021

	Total diesel fuel consumption of heavy and mechanical engineering equipment [liters]	Annual traveled distance [km]
2021	**2,046,199**	**1,123,516**
2020	1,977,870	927,535
2019	3,133,982	1,737,091
2018	2,558,309	1,876,692
2017	1,110,285	1,290,937

water use and conservation

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Water use and conservation

IEC promotes careful water consumption in all its sites. In 2021, the careful use of water continued in the power plants as well as in the administrative sites. Water conservation is achieved, among others, by the control of water use processes and by increasing the reuse of waste water effluents.

IEC makes extensive use of low-quality water resources, from both internal and external origins, as detailed in the following tables. The drinking water supplied to power plants by the national water supply system includes aquifer water (wells), Sea of Galilee water (through the national carrier), desalinated seawater, desalinated brackish water and surface water from various sources.

The use of industrial waste water effluents and boron-enriched water in FGD facilities

As part of the air pollution control project, most of the coal-fired units were equipped in the past few years with scrubbers reducing sulfur dioxide emissions in flue gases (below: "FGD system").

The core of the system is an absorber column that serves as sulfur dioxide filter. The principle of the FGD system is the reaction of the sulfur dioxide in the flue gases with a limestone suspension and air injection into the bottom of the absorber column to complete the oxidation process. The by-product obtained from this process is FGD gypsum, the quality of which is suitable for the production of gypsum walls or for the cement industry. Part of the water remaining after the removal of formed gypsum is emitted through the stack, forming a white plume mainly constituted of water vapor.

As a result of this wet desulfurization process, the FGD system operation consumes huge amounts of water. As part of the national effort to save water resources, IEC has checked the possibility to use for the process low-quality water instead of drinking water. As part of the effort to reduce the amount of purified industrial waste water discharged to the sea, and to reduce drinking water consumption, part of industrial waste water is used for the FGD system operation. In addition, a water effluent originating from the desalination facility adjacent to Orot Rabin power plant in Hadera is used.
This kind of boron-enriched water originates from the final stages of the desalination process and is in fact considered as high quality water, that is intended to be discharged to the sea only as a result of boron content that may be harmful to agricultural crops. But there is no fear to use this kind of water for an industrial use such as the FGD system at the power plant.

In 2021, the consumption of low-quality water for use in FGD installations, from internal source (purified industrial waste water from the power plants) and from external source (boron-enriched water from the desalination plant) amounted to over 1 million m^3.

The use of treated sanitary waste water from an external source for the cooling towers at CCGT power plants

At the Gezer power plant, CCGT units are operated, and they are cooled by wet cooling using cooling towers. This is a cooling method based on water as opposed to the prevalent dry cooling method that is based on air. The source of water for these cooling towers is treated sanitary waste water from a regional waste water treatment plant. In 2021, the use of treated waste water for this purpose saved over 3 million m^3 of drinking water.

Another site in which wet cooling is performed using treated waste water in cooling towers is the Alon Tavor power plant site, but this plant was sold at the end of 2019. Consequently, the consumption of treated waste water by IEC was reduced since then.

Use of treated sanitary waste water and brine for irrigatation of gardening areas

Part of the power plants treat sanitary waste water using their own treatment plant. These treated waste water effluents are used for irrigation of gardening areas inside these sites as a substitute to drinking water use, according to permits issued by the Ministry of Health. In addition, at power plant sites, brine (also called "concentrate water") originating from reverse osmosis facilities intended for the production of deionized water is reused inside the site for irrigation of gardening areas. In 2021 the use of treated sanitary waste water and brine for irrigation saved the consumption of hundreds of thousands of cubic meters of drinking water.

Water consumption reduction targets in relation to base year 2013 (prior to the emissions mitigation projects)

	2030 Targets in relation to base year 2013	2024 Targets in relation to base year 2013
Total water consumption from all sources (fresh and poor quality water)	-30%	-10%
Effluent water usage targets in relation to base year 2013 (prior to the emissions mitigation projects)		
	2030 Targets	2024 Targets
increased of effluent water usage (self pruduced and external sources)	+2%	-

Table 31: Summary of fresh water Consumption by the IEC for the years 2013-2021

Does not include water consumption by substations, switching stations, logistic and administrative sites

	Total fresh water consumption by IEC's power plants sites [m3]
2021	**5,503,905 ***
2020	4,910,415
2019	5,341,845
2018	4,851,136
2017	4,797,440
2016	4,565,698
2015	4,866,935
2014	4,285,882
2013	5,096,584

* In 2021, there was an increase in the fresh water consumption, following:

The "new" operation of production units to which were added FGD scrubbers to reduce SO_2 emissions in flue gases at Rutenberg site, and the reduced reuse of industrial effluents as FGD feed water due to seawater infiltration.

The increased use of fresh water by the cooling towers at the Gezer site production units in April - May 2021, instead of part of the treated waste water normally used as cooling water, following a too low water quality – high turbidity and suspended solids content.

Table 32:Summary of poor-quality water consumption by the IEC for the years 2013-2021 [m^3]

	Total consumption of external origin treated sanitary effluents used for cooling towers [m^3]	Total consumption of self-treated sanitary effluents for gardening areas irrigation [m^3]	Total reuse of self-treated industrial effluents and self-treated concentrate water [m^3]	Total boron-enriched water consumption (from external origin) [m^3]	**Total poor quality water consumption by the IEC [m^3]**
2021	**3,065,293**	**71,566**	**699,694**	**565,276**	**4,401,829**
2020	2,159,270	102,881	542,993	587,051	**3,392,194**
2019	4,144,109	87,241	663,795	768,715	**5,663,860**
2018	5,172,668	103,140	686,161	637,867	**6,599,836**
2017	4,443,348	101,774	554,362	410,946	**5,510,430**
2016	4,067,951	102,502	649,884	0	**4,820,337**
2015	3,867,815	97,039	643,934	0	**4,608,788**
2014	4,212,482	101,850	536,563	0	**4,850,895**
2013	4,349,836	94,643	652,162	0	**5,096,641**

Notes:

* An additional site where wet cooling with sanitary effluents was used for cooling towers is the Alon Tavor power plant site. This plant was sold as part of the electricity sector reform at the end of 2019. In view of this fact, the use of sanitary effluents from external sources for cooling towers was reduced, and the total amount of poor-quality water used by IEC was reduced accordingly.

** In 2021, as compared with 2020, there was an increase in the poor-quality water consumption following the increased operation of cooling towers using sanitary effluents from external source at the Gezer site.

Table 33: Summary of the cunsumption of water from all sources by the IEC for the years 2013-2021 [m^3]

Does not include seawater consumption for main cooling of coastal power plants

	Total consumption of water from all sources by the IEC [m^3]
2021	**9,905,733**
2020	8,302,609
2019	11,005,705
2018	11,450,972
2017	10,307,870
2016	9,386,035
2015	9,475,723
2014	9,136,777
2013	10,193,225

*In 2021, there was an increase in the fresh water consumption, following:
The "new" operation of production units to which were added FGD scrubbers to reduce SO_2 emissions in flue gases at Rutenberg site, and the reduced reuse of industrial effluents as FGD feed water due to seawater infiltration.
The increased use of fresh water by the cooling towers at the Gezer site production units in April - May 2021, instead of part of the treated waste water normally used as cooling water, following a too low water quality – high turbidity and suspended solids content.

Notes:

* An additional site where wet cooling with sanitary effluents was used for cooling towers is the Alon Tavor power plant site. This plant was sold as part of the electricity sector reform at the end of 2019. In view of this fact, the use of sanitary effluents from external sources for cooling towers was reduced, and the total amount of poor-quality water used by IEC was reduced accordingly.

** In 2021, as compared with 2020, there was an increase in the poor-quality water consumption following the increased operation of cooling towers using sanitary effluents from external source at the Gezer site.

Table 34: Percentage of poor-quality water out of all water sources consumed by the IEC for the years 2013 to 2021

	Percentage of poor-quality water out of all water sources consumed by the IEC [%]
2021*	**44%**
2020**	41%
2019	51%
2018	58%
2017	53%
2016	51%
2015	49%
2014	53%
2013	50%

Notes:

* An additional site where wet cooling with sanitary effluents was used for cooling towers is the Alon Tavor power plant site. This plant was sold as part of the electricity sector reform at the end of 2019. In view of this fact, the use of sanitary effluents from external sources for cooling towers was reduced, and the total amount of poor-quality water used by IEC was reduced accordingly.

** In 2021, as compared with 2020, there was an increase in the poor-quality water consumption following the increased operation of cooling towers using sanitary effluents from external source at the Gezer site.

Table 35: Summary of seawater consumption for main cooling of coastal power plants ,by the IEC for the years 2013-2021 [m3]

	Total consumption of seawater for main cooling of coastal power plants, by the IEC [m3]
2021	**5,850,274,128**
2020	5,865,870,606
2019	5,835,648,997
2018	5,896,219,446
2017	5,522,770,404
2016	5,464,694,022
2015	5,588,037,522
2014	5,867,958,700
2013	6,471,656,527

Table 36: Summary of treated industrial waste water effluents discharged to the sea from IEC's sites, according to authorities' permits, for the years 2013-2021 [m3]

	Amount of treated industrial waste water effluents discharged to the sea [m3]
2021	**341,275**
2020	413,015
2019	375,419
2018	357,940
2017	389,054
2016	370,722
2015	400,092
2014	411,035
2013	485,595

Table 37: Summary of the amounts of treated wastewater effluents used or discharged, while separating effluents from industrial sources from effluents from sanitary sources, during the period 2015 to 2021:

Part A– wastewater and sanitary effluents

2015 (m^3)	2016 (m^3)	2017 (m^3)	2018 (m^3)	2019 (m^3)	2020 (m^3)	**2021 (m^3)**
Total self-sanitary wastewater						
371,130	357,240	357,060	344,280	342,540	344,490	**333,090**
Total external-origin sanitary effluents used in cooling towers						
3,867,815	4,067,951	4,443,348	5,172,668	4,144,109	2,159,270	**3,065,293**
Total self-sanitary effluents reused for gardening areas irrigation						
97,039	102,502	101,774	103,140	87,241	102,881	**71,566**
Total self-sanitary wastewater transferred to authorized sewage treatment plants						
274,091	254,738	255,286	241,140	255,299	241,609	**261,524**

Table 38: Summary of the amounts of treated wastewater effluents used or discharged, while separating effluents from industrial sources from effluents from sanitary sources, during the period 2015 to 2021:

Part B– Treated Industrial effluents, boron- enriched Water, concentrate water from demineralized water production facilities

2015 (m^3)	2016 (m^3)	2017 (m^3)	2018 (m^3)	2019 (m^3)	2020 (m^3)	**2021 (m^3)**
Total amount of self-treated industrial effluents and self-concentrate water						
1,044,026	1,020,606	943,416	1,044,101	1,039,214	956,008	**1,040,969**
Total amount of reused treated industrial effluents and self-concentrate water						
643,934	649,884	554,362	686,161	663,795	542,993	**699,694**
Total treated industrial effluents discharged to the sea according to authorities' permits						
400,092	370,722	389,054	357,940	375,419	413,015	**341,275**
Boron enriched water from external sources						
0	0	410,946	637,867	768,715	587,051	**565,276**

Table 39: Total withdrawal Intensity of all water types in relation to sales turnover 2013-2021

	Total consumption of water by IEC's power plants sites [m³]			Water withdrawal intensity (m³/ USD million sales)		
	Freshwater	Poor-quality water	**Fresh+ poor-quality**	Freshwater	Poor-quality water	**Fresh+ poor-quality**
2021	**5,503,905**	**4,401,829**	9,905,733	**772.8**	**618.0**	**1390.8**
2020	4,910,415	3,392,194	**8,302,609**	663.9	458.7	**1122.6**
2019	5,341,845	5,663,860	**11,005,705**	749.5	794.7	**1544.2**
2018	4,851,136	6,599,836	**11,450,972**	771.0	1048.9	**1819.8**
2017	4,797,440	5,510,430	**10,307,870**	711.7	817.5	**1529.2**
2016	4,565,698	4,820,337	**9,386,035**	773.7	816.8	**1590.5**
2015	4,866,935	4,608,788	**9,475,723**	823.9	780.2	**1604.2**
2014	4,285,882	4,850,895	**9,136,777**	661.1	748.3	**1409.4**
2013	5,096,584	5,096,641	**10,193,225**	640.9	640.9	**1281.9**

In 2021, there was an increase in the fresh water consumption, following:

a. The "new" operation of production units to which were added FGD scrubbers to reduce SO2 emissions in flue gases at Rutenberg site, and the reduced reuse of industrial effluents as FGD feed water due to seawater infiltration.

b. The increased use of fresh water by the cooling towers at the Gezer site production units in April - May 2021, instead of part of the treated waste water normally used as cooling water, following a too low water quality – high turbidity and suspended solids content.
following the increased operation of cooling towers using sanitary effluents from external source at the Gezer site.

* An additional site where wet cooling with sanitary effluents was used for cooling towers is the Alon Tavor power plant site. This plant was sold as part of the electricity sector reform at the end of 2019. In view of this fact, the use of sanitary effluents from external sources for cooling towers was reduced, and the total amount of poor-quality water used by IEC was reduced accordingly.

** In 2021, as compared with 2020, there was an increase in the poor-quality water consumption following the increased operation of cooling towers using sanitary effluents from external source at the Gezer site.

Table 40: Total withdrawal Intensity of all water types in relation to the Electricity Generation 2013 to 2021

	Total consumption of water by IEC's power plants sites [m³]			Water withdrawal intensity (m³/ Gross MWh*1000)		
	Freshwater	Poor-quality water	Fresh+ poor-quality	Freshwater	Poor-quality water	Fresh+ poor-quality
2021	**5,503,905**	**4,401,829**	**9,905,733**	**143.9**	**115.1**	**258.9**
2020	4,910,415	3,392,194	8,302,609	110.7	76.5	187.2
2019	5,341,845	5,663,860	11,005,705	111.8	118.5	230.3
2018	4,851,136	6,599,836	11,450,972	101.3	137.8	239.0
2017	4,797,440	5,510,430	10,307,870	98.3	112.9	211.3
2016	4,565,698	4,820,337	9,386,035	93.7	98.9	192.7
2015	4,866,935	4,608,788	9,475,723	96.1	91.0	187.1
2014	4,285,882	4,850,895	9,136,777	82.9	93.8	176.6
2013	5,096,584	5,096,641	10,193,225	89.2	89.2	178.4

In 2021, there was an increase in the fresh water consumption, following:

a. The "new" operation of production units to which were added FGD scrubbers to reduce SO2 emissions in flue gases at Rutenberg site, and the reduced reuse of industrial effluents as FGD feed water due to seawater infiltration.

b. The increased use of fresh water by the cooling towers at the Gezer site production units in April - May 2021, instead of part of the treated waste water normally used as cooling water, following a too low water quality – high turbidity and suspended solids content.
following the increased operation of cooling towers using sanitary effluents from external source at the Gezer site.

* An additional site where wet cooling with sanitary effluents was used for cooling towers is the Alon Tavor power plant site. This plant was sold as part of the electricity sector reform at the end of 2019. In view of this fact, the use of sanitary effluents from external sources for cooling towers was reduced, and the total amount of poor-quality water used by IEC was reduced accordingly.

** In 2021, as compared with 2020, there was an increase in the poor-quality water consumption following the increased operation of cooling towers using sanitary effluents from external source at the Gezer site.

Waste and By-Products

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Coal combustion by-products

Electricity production at coal-fired power plants leads to the formation of two by-products: coal ash and FGD gypsum.
Coal ash is formed from the mineral fraction in the coal that remains after burning it.
FGD gypsum is produced in the flue gas desulfurization (FGD) facilities as a result of the reaction of sulfur dioxide in the flue gases with limestone.

Production and uses of coal ash from the Orot Rabin and Rutenberg power plants sites

Coal ash is a by-product from coal combustion at Orot Rabin and Rutenberg power plants.
In 2021, IEC produced 583,700 tons of coal dust. The annual coal ash amount produced decreased in recent years as a result of the increase in the use of natural gas for electricity production and the decrease in the coal-fired units operating hours.

About 88% of the ash produced is fly ash, collected by the particles emission reduction facilities installed at the coal-fired units (electrostatic precipitators), and the remaining 12% is bottom ash, collected at the bottom of the boiler.

Since 1999, the whole amount of ash produced by IEC has been supplied for industrial, infrastructure and agricultural uses. The main ways of using coal ash are cement and concrete production, which are also the most common and preferred uses in the developed countries in the world. In 2021, 41.6% of the coal ash produced were used for concrete production; 54.6% were used for cement production; and 3.8% were used for the production of other construction products. Since 2018, there was no use of coal ash in infrastructures, and since 2021, use of coal ash ceased in applications not related to the construction industry.

Fly ash is a beneficial additive to construction products as result of its bonding properties (fly ash is a "pozzolanic material"). Fly ash promotes the improvement of the concrete properties: enhanced strength, lower specific weight, improved workability and better corrosion resistance. From an environmental point of view, the use of ash as a raw material for the production of cement and concrete avoids the damages to the environment and the landscape, which would result from the quarrying of raw materials replaced by the ash, such as limestone, clay and sand (that is becoming increasingly scarce in Israel). Another environmental advantage of using fly ash for producing cement (inter-grinding) and concrete is the indirect reduction in CO2 emissions by the cement production at the Israeli cement production plants. According to IEC estimation, in 2021 the annual CO2 emission prevented following the use of fly ash for concrete and cement production amounts to 189,400 tons.

Coal ash uses are made on the basis of permits issued by the authorities, including the Ministry of Environmental Protection. IEC monitors the environmental quality of coal ash (mainly the concentration of trace elements and radioactive elements) on a semiannual basis. The results comply continuously with the criteria for using fly ash safely from an environmental point of view.
The groundwater has been monitored near the coal ash storage sites at Orot Rabin and Rutenberg power plants for a long time, and according to the monitoring results, open coal ash storage had no effect on water quality. The same conclusion was drawn from the monitoring plan near the first road enbankment built using coal ash in Israel - below Jasser-a-Zarqa access road.

Coal, like other geological materials, contains low concentrations of natural radioactive elements. The use of coal ash is supervised concerning radioactivity, since construction products containing coal ash must comply with Israeli Standard SI 5098, that limits the content of radioactive elements in all construction marketed in the State of Israel. In addition, it should be noted that, according to the international standard published by the International Atomic Energy Agency in 2014 (International Basis Safety Standards, GSR Part 3), coal ash with radioactive elements' concentrations within the range known in Israel should be "cleared" from the need of administrative control.

Table 41: Production and use of coal ash for the years 2011-2021 [thousands metric tons]

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	**2021**
Total production of coal ash											
	1,186	1,370	1,200	1,083	1,055	848	804	719	758	657	**605**
Total use of coal ash											
	1,191	1,340	1,258	1,056	1,054	848	805	719	741	634	**584**
Categories of coal ash use											
	659	703	645	548	603	519	480	382	344	268	**243**
	498	577	497	452	385	280	273	331	389	361	**341**
	0	0	57	0	30	14	17	0	0	0	**0**
	34	60	59	56	36	35	35	6	8	5	**0**

	Use for cement production
	Used for concrete and other concrete products production
	Use for infrastructures
	Agricultural and other uses

Production and use of gypsum from the flue gas desulfurization (FGD) facilities at Orot Rabin and Rutenberg power plants

Flue gases emitted by generation units 1-4 at Rutenberg site, and generation units 5 and 6 at Orot Rabin site pass through FGD facilities. In the FGD system they are treated by a limestone suspension: sulfur dioxide (SO_2) reacts with calcium carbonate ($CaCO_3$) and gypsum ($CaSO_4, 2 H_2O$) is the final product of this process. The quality of the gypsum produced is not lower than that of natural gypsum. In 2021, the IEC produced 103,570 tons of FGD gypsum. From this amount, 70,950 tons were produced at Rutenberg site and 32,620 tons were produced at Orot Rabin site. The whole amount of gypsum produced by IEC was supplied for use in the cement industry (Nesher and Shafir plants), as a concrete setting time retarder.

Table 42: The consumption of limestone and the production of gypsum by FGD scrubbers at coal-fired power plants during the years 2011-2021 [metric tons]

	FGD gypsum production	Limestone consumption
2021	**103,570**	**58,834**
2020	134,330	72,689
2019	142,160	77,805
2018	118,660	65,585
2017	73,690	44,345
2016	61,771	33,290
2015	72,557	40,600
2014	72,100	39,400
2013	74,200	37,800
2012	86,500	46,800
2011	93,700	52,400

Hazardous materials and hazardous waste

IEC owns, uses and stores hazardous materials in some of its sites.

IEC is constantly active **to reduce the potential risk** resulting from the use of hazardous materials and production of hazardous waste that accompany the different segments of the electricity generation transmission and distribution chain. The IEC activity in this field includes the reduction of hazardous materials' consumption in the production processes (source reduction), the replacement of hazardous materials by lower-risk materials, the search of environmental-friendly substitutes, workers' training , the search of alternative solutions to the disposal of hazardous waste to landfills, expanding the types of hazardous waste that receive dedicated treatment etc.

As part of its statutory obligations, IEC sends hazardous waste only to authorized sites.

Green purchasing

Green purchasing is another kind of activity with environmental benefits. It is reducing the environmental impact of the company. The preference given to green products is expected to reduce the environmental footprint of the company, as well as to reduce the risk of health impacts. In addition, examining the purchasing of goods from its environmental aspects also enables a better knowledge of products and materials purchased by the company and integration of sustainability in the purchasing processes.

In recent years, IEC has been active to extend green purchasing through a variety of operations, such as:

- Transition to digital tenders
- Using recycled paper as the main source of paper for the needs of the company
- Investigating the possibility to purchase environmentally acceptable oils and greases as substitute for those previously used
- Use of green detergents
- Use of water-based silicon
- Use of environmental-friendly paints
- Purchase of energy-saving air conditioners and lamps
- Use of green materials to absorb oil
- Promoting the use of multi-use packages in warehouses

IEC examines from time to time proposals for various new environmental-friendly products and services from green purchasing suppliers, with the objective of their integration in the green purchasing processes.

Solid waste

IEC treats waste generated as a result of its operations in the framework of the "total waste management" approach

In this approach, a variety of activities are conducted at different stages of the waste production and treatment chain (prevention, reduction, collection and treatment) in order to reduce as far as possible waste environmental effects. Among others, activities are conducted to reduce materials' consumption and prevent waste production (source reduction), and to reduce the amounts of waste disposed into landfills. For this objective, it is attempted to separate as far as possible the different types of waste and to increase the amounts of waste transferred to reuse and recycling. All this activity depends on the development of the recycling market in the State of Israel.

IEC activity in this field includes the following examples of office and wood waste reduction:

- Transitioning to the use of “printing centers”. The innovative printing centers combine three separate functions in one device (MFP – Multi Function Printer): printer, photocopier and scanner. These centers allow to save money and office space, as well as to protect the environment by saving resources, such as paper, electricity and consumables. The default printing-mode is two-sided.
- Purchasing recycled A4 paper for all the company offices. The use of recycled paper is part of the smart use of natural resources, contributes to paper saving and raises the company employees’ awareness for the importance of resource conservation.
- Reuse of wooden drums for the benefit of the community.

Waste management targets in relation to base year 2020

	2030 Target
Reduction of solid waste transferred to landfills	-10%
Reduction of hazardous material waste	-15%
Increase of solid waste transferred to recycling	+10%
Increased of reused solid waste	+5%

Table 43: Total Hazardous Waste and Non-Hazardous Waste Transfers from the Israel Electric Corporation Power Plant Sites for 2021

	Total transfer of hazardous waste for 2021 [metric tons]	Total transfer of non-hazardous waste for 2021 [metric tons]	**Total Waste for 2021 [metric tons]**
Orot Rabin	658	378,168	**378,826**
Rutenberg	150	321,911	**322,061**
Haifa	497	2,450	**2,947**
Reading	115	182	**297**
Eshkol	1,421	692	**2,113**
Hagit	640	7,519	**8,159**
Gezer	382	5,578	**5,960**
Zafit	729	2,689	**3,418**
Eilat	0	101	**101**
Atarot	0	0	**0**
Kinarot	15.7	7.8	**23**
Caesarea	73	85.2	**158**
Hartuv	4	0	**4**
Eitan	2	0	**2**
Total IEC	**4,687**	**719,382**	**724,070**

Data reported as part of the Pollutant Release and Transfer Register (PRTR) report

Table 44: Distribution of the amounts of Hazardous Waste (excluding Industrial wastewater) according to treatment methods, for the period 2015-2021 [metric ton]

Total hazardous waste	2015	2016	2017	2018	2019	2020	**2021**
Transferred to landfills	12	49	883	57	151	1,191	**690**
Transferred to recycling	13,458	2,871	454	5,462	1,500	690	**3,913**
Transferred to reuse	0	0	0	0	0	0	**0**
Transferred to disposal	2,792	1,595	3,908	3,047	2,922	4,224	**197**
Total hazardous waste - excluding Industrial wastewater	16,262	4,515	5,245	8,566	4,573	6,105	**4,800**

Table 45: Distribution of the amounts of non- hazardous waste according to treatment methods, for the period 2015-2021 [metric ton]

Total solid waste	2015	2016	2017	2018	2019	2020	**2021**
Transferred to landfills	13,175	12,655	16,916	9,470	7,217	8,512	**8,086**
Transferred to waste to energy facilities	----	10,344	5,232	3,944	3,605	2,704	**4,360**
Transferred to recycling	10,419	6,780	7,259	8,027	9,904	8,777	**12,848**
Total solid waste - excluding byproducts, as detailed below	23,594	29,779	29,407	21,441	20,726	19,993	**25,294**
Total byproduct							
Gypsum (1)	72,557	61,771	73,690	118,660	142,160	134,330	**103,570**
Coal ash (2)	1,054,700	847,600	803,905	719,000	745,716	646,670	**587,300**

(1) Gypsum transferred to reuse

(2) Coal ash (dry basis) transferred for reuse (*including coal ash from field excavation operations intended for the construction of combined cycles)

Table 46: Total waste transfer intensity in relation to sales turnover, 2016 - 2021

	2016	2017	2018	2019	2020	**2021**
Total transfers [metric ton]						
Non-hazardous waste	1,006,504	989,368	937,429	906,895	801,110	**719,382**
Hazardous waste	54,447	55,090	69,038	63,412	33,255	**4,687**
Hazardous and non-hazardous waste	1,060,951	1,044,457	1,006,466	970,307	834,365	**724,070**
Waste Intensity (metric ton/ USD million sales)						
Non-hazardous waste	171	147	149	127	108	**101**
Hazardous Waste	9	8	11	9	4	**1**
Hazardous and non-hazardous waste	180	155	160	136	113	**102**

Environmental aspects of electric and magnetic fields

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Noise reduction

The electricity generation and supply processes can be a source of noise to the environment. Noise is mainly generated from equipment used to generate electricity at power plants, and to a lesser extent, from transformers at substations or from insulators on transmission lines. This equipment is installed, for the most part, far away from inhabited areas.
Other parts of the transmission, transformation, and distribution systems, that are adjacent to inhabited places (like power lines, distribution transformers, distribution boards and switches), are usually not significant sources of noise. Nevertheless, these sources are also inspected, and if necessary, they are subject to acoustic treatment at the source or to other protective measures.

IEC is active to meet everywhere the permitted noise levels as specified in the governmental Prevention of Noise Regulations, and also works to fulfill requirements mentioned in the documents issued during the licensing processes for the building and operation of its facilities. Noise control is performed during the entire life of the equipment: from the design and purchase stages, through the initial operation stage, and finally during the routine operation, with the aim of allowing continuous operation without causing noise nuisances.

During the design stage of new electricity facilities, the expected noise levels are predicted for inhabited places near the installation site. The noise level prediction findings are submitted to the environmental authorities as part of the environmental impact assessments or other environmental licensing documents. On their basis, they issue environmental monitoring requirements and additional measures if necessary.
Acoustic requirements are implemented during **the purchase stage**. These requirements will ensure compliance with the permitted noise levels near the facilities. **In the initial operation** of new facilities, noise measurements will be performed around the site and in nearby inhabited places, in order to ensure compliance with the permit conditions, and to ensure that the regulatory thresholds are not exceeded.
During the routine operation stage, regular measurements are performed, and if local exceedances are detected, or if complaints are received regarding noise nuisances, acoustic treatments are carried out to reduce noise from the involved facilities.

Environmental aspects of electric and magnetic fields

Electric and magnetic fields – What is it?

The transmission of electric energy through electric facilities creates electric magnetic fields. The electric and magnetic field levels are determined mainly by the voltage and current level (respectively) for the facility as well as the distance from it. These fields vary in their direction with a frequency of 50 cycles per second [50 Hz], a frequency which is considered as extremely low [extremely low frequency – ELF]. The energy associated with this frequency is very low and in fact negligible.

Electric and magnetic field effects

Over the past four decades, many researches have been conducted around the world to examine the connection between long-lasting exposure to magnetic fields resulting from electricity grid facilities or home electric appliances and the prevalence of some illnesses. In November 2010, the guidelines published by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) included a maximal exposure value from the electricity grid, of 2,000 milligauss for short-term effects on the general population, on the basis of the known health effects induced by electric fields on the human body. In the same document, the committee noticed that no sufficient information was accumulated to establish a lower threshold value, also with respect to epidemiological findings concerning health effects that might occur for continuous exposure to magnetic fields at lower levels than the threshold value.

With regard to the long-term health effects from prolonged exposure to magnetic fields, the World Health Organization (WHO) and other institutions around the world support the application of the precautionary principle, according to which even in the absence of certainty regarding the mere existence of a risk and its limited scope - if any- it is still justified to take certain measures, that are not far-reaching, to reduce exposure to magnetic fields.

Findings of researches on this subject are presented in the following publications:

The WHO report originally published in June 2007 entitled: ELF Fields - Environmental Health Criteria Monograph No. 238

The report published by the ICNIRP in November 2010 entitled: Guidelines for limiting exposures to time-varying electric and magnetic fields (1Hz TO 100 kHz)

The International Agency for Research on Cancer (IARC), that is part of the WHO, classified magnetic fields in the class 3 “not classified as to carcinogenicity to humans”, which is considered to be the lowest classification level. This category also includes emissions from gasoline engines and hot beverages.

Further information can be found in the IARC summary report

Legislation and policy in Israel

The precautionary principle with respect to magnetic fields is integrative part of the Non-Ionizing Radiation Law in Israel, and also applies to the company for the building and operation of radiation sources. In March 2005 the report of the experts committee on magnetic fields from the electricity grid (below: the "Experts Committee") was published. The Experts Committee accepted the threshold value for magnetic fields produced from the power grid as set by ICNIRP at this time, i.e. 1,000 milligauss, while in the same time it recommended to apply the precautionary principle when designing new facilities and operating existing facilities. For that purpose, IEC is applying the precautionary principle in existing facilities, according to the Experts Committee recommendations. In addition, following the measurements performed, IEC estimates that its electric facilities comply with ICNIRP guidelines.

In accordance with the Non-Ionizing Radiation Law, the maximal permitted levels of exposure to radiation for humans should have been set in regulations that were scheduled to be promulgated until January 1, 2007. The law states that as long as such regulations are not yet promulgated for the electricity sector, the decisions of the head of the Ministry of Environmental Protection radiation department (below: the supervisor) concerning construction and operation permits regarding the electricity sector, among others, will be made according to the recommendations given in the Experts Committee report.

The Experts Committee report

In addition, the law states that the decisions of the supervisor connected with subjects that affect the costs of electricity (for which a written notice was issued to the supervisor by the Minister of Environmental Protection or the Minister of Energy), require the approval of the Minister of Environmental Protection, the Minister of Finance, and the Minister of Energy. In December 2011, the Minister of Energy informed the Minister of Environmental Protection that regulations that would set the threshold values for exposure to non-ionizing radiation originating from electric facilities might have a direct and significant effect on the costs of electricity. A similar notice was issued by the Minister of Finance to the Minister of Environmental Protection in February 2012.

Draft regulations pursuant to the Non-Ionizing Radiation Law are presently in the approval process and were published for public comments in January 2019.

IEC activity

For the purpose of building and operating radiation sources, with their meaning in the Non-Ionizing Radiation Law, IEC is required to hold proper permits issued by the Ministry of Environmental Protection according to this law.
IEC holds the permits required for the operation of the non-ionizing radiation sources in course of building and these which already operate, and if they are missing, IEC is active to obtain them.

IEC builds new electric facilities in agreement with the conditions included in the building and operation permits regarding the implementation of measures to limit exposure levels, such as access restriction, warning signs placing, reporting obligations etc.

Biodiversity

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Managing influence on biodiversity

IEC thousands of kilometers of power lines, at different voltage levels, that are deployed throughout the entire country, and a large number of other types of facilities. The facilities situated in or close to natural areas may have an impact on terrestrial biodiversity, and other ones may have an impact on marine biodiversity (coastal power plants). Some of the power lines are close to declarated nature reserves, and some of them even cross such areas.

As part of the environmental impact statements and other environmental documents prepared for IEC projects, the impact of IEC facilities on the natural life and landscape values has been examined for many years. More recently, in parallel with the global development of all aspects of the preservation of biodiversity, the scope of issues that are considered in this context was expanded. Deepeening and extending the ecological review allow to improve the management of the effects of existing and planned IEC facilities on biodiversity.

Activities for the management and improvement of the interface with biodiversity – terrestrial aspects

When considering the alternative for the locations for new electricity facilities and lines, the company takes in consideration the need to avoid location or passage in areas that are rich in biodiversity in order to mitigate impacts on these areas.

The following facilities are situated close to declared nature reserves according to National Outline Plan (NOP) 8 – the NOP for parks and nature reserves (up to 500 m from the facility):

Hagit Power Plant, near the "Nahal Tut" reserve
Yavneh switching station, near the "Shita Malbina" reserve
Hula substation, near the "Ein Teo" and "Nahal Kadesh" reserves
Nazareth substation, near the "Irus Natzarti" reserve
Safed substation, near the "Har Meron" reserve
Tefen substation, near the "Har Sneh" reserve
"Steel Plants" substation, near the "Holot Hamifratz" reserve.

The following facilities are situated close to declared national parks according to NOP 8 (up to 500 m):

Sha'ar Hagai substation, near the "Harei Yehuda" national park
"Ein Harod" substation, near "Maayan Harod" national park
Yokneam and Daliyat el-Karmel substations, near the "Ha Carmel" national park
Kinarot substation, near the "Kefar Nachum "national park.

For extra-high voltage lines (400 kW) and very-high voltage lines (161 + 110 kW) that are in the planning and building stages and cross ecologically sensitive areas or natural reserves, IEC performs environmental restoration in its work areas, including access roads. In addition, IEC performs activities to reduce the development of invasive species, in order to preserve valuable areas and specific habitats.

Conducting ecological surveys as part of environmental impact statements and integration of obligations in the outline plans

As part of the preparation of environmental protection statements and other environmental documents for new IEC projects planned in ecologically sensitive areas, the impact on biodiversity is examined. Reviewing the impact on biodiversity includes preparation of surveys to characterize the ecological value of these areas in terms of habitats and ecosystems, and to locate plant and animal species and characterize their risk levels. Based on these findings, the appropriate measures recommended to reduce and prevent the project impact at building and operation stages are presented. The proposed measures are incorporated in the outline plans submitted for the projects after coordination and approval by the relevant consultant of the planning authority. According to the type and location of the projects, relevant environmental guidelines are incorporated in the environmental impact statements and still later in the outline plans. For example, with regards to substations, guidelines for the preservation of habitats and high value species, for landscape restoration by local species, for handling/preventing invasive species, for the reduction of light, etc., are incorporated in these documents. With regards to power lines, guidelines are given to shield electric poles in order to prevent bird collisions in sensitive areas, for handling/preventing invasive species, etc.

Collaboration with environmental authorities and agencies regarding potential harm to birds

In addition to the activities performed for that purpose as part of the "porsim kanaf" ("Spreading Wings") project, since 2013 IEC is engaged in cooperation with the Israeli Society for the Protection of Nature, the National Parks Authority and the Ministry of Environmental Protection, concerning "calls for research proposals" aimed to include biodiversity considerations in company management. In this regard, two projects were performed in 2017-2019, in order to reduce the harm to biodiversity caused by the company activity, as detailed below:

1. In October 2018 was finished a two-year pilot project, first of its kind in Israel, for reducing the potential of bird collisions with power lines. It was performed on an existing 161 kV line passing through a highly sensitive area, between Afula and Muqeible, in the Yezreel valley that is very sensitive in this concern, especially during migratory seasons. The pilot project was conducted about two years, with the following objectives: quantifying the extent of bird collisions with the studied line, checking the effect of land use on the number of collisions, checking the efficiency of anti-collision elements, and improving the monitoring protocol for follow-up research of future monitoring. The study included comparative monitoring of collision occurrences before the installation of marking means (first year) and after their installation (second year).

The rate of reduction in the number of collisions for all bird species following the installation of marking means, comparing the two study periods, was about 26%. The findings indicated also that there was a high rate of bird collisions with the studied line, as compared with findings presented in the relevant international literature.

2. Following the findings of the above pilot project, a research project was conducted in order to map the potential risk of bird collisions with lines on a national level, and to issue recommendations and priorities in the treatment of this subject. The mapping is based on a GIS model which integrates environmental data (land uses and sensitive areas) with bird population data (sensitive species), and power line data. The model is supposed to serve as a tool for IEC for adopting and implementing an improved policy on this subject, for existing and new lines.

   An additional research activity, namely preparatory work in the field, was conducted in 2020 and 2021. Three types of accessories to mark lines, that are used and appreciated in the world, were selected for their efficiency in increasing the visibility of power lines. In parallel, very-high voltage and extra-high voltage lines were chosen to install these accessories. The installations will be carried out in Beit Shean Valley, on 10 portions of extra-high voltage lines, 10 portions of very-high voltage lines, and 10 control portions of lines on which no accessories will be installed. After the end of these installations, the various portions will be monitored using detection dogs to check the efficiency of the accessories in preventing collisions. The installations will be carried out using a drone, following a successful demonstration performed by a drone company in August 2020.

Increasing intra-organizational awareness

Since 2014 IEC is active to increase to the knowledge and awareness on biodiversity as affected by the IEC facilities among the company employees and managers. This activity is part of the integration of this issue in the company, and appropriate training is provided to relevant employees.

The “Spread Wings” project - Adopting vultures and other raptors

There have been records from the beginning of the eighties showing that vultures and other large birds are electrocuted while using electric poles as observation points, for night sleep or temporary resting place (for example for drying their wings after bathing). The greatest risk exists for birds with a wing span greater than 2 m and body length greater than 1 m. The reason for this is that their wings touch one electric wire and one pole, or two wires simultaneously, occurrences that cause the closure of an electric circuit and their electrocution.

Project goals:

- To confirm the number of vultures and other raptors in Israel and to return extinct species back to nature.
- To reduce significantly electrocution occurrences among vultures and other raptors in Israel.
- To create alternative and available food sources for vultures and other raptors in order to reduce the risk of poisoning.
- To create reproductive nuclei with the aim to return species to nature and increase their population.
- To identify the other factors that may endanger raptors and to mitigate this risk.
- To monitor the population of endangered species.
- To provide information and educational activities to increase public awareness to the issue.

Reducing electrocution of large birds

In order to reduce the electrocution of large birds, IEC has developed various types of shielding elements that are appropriate for the high-voltage and extra-high voltage poles, each according to its characteristics. The shielding equipment was developed by IEC engineers, in collaboration with the “Raychem” company and the professional team of the “Spread Wings” project. To our best knowledge, for the very-high voltage poles, it constitutes a unique development of its kind in the world. This shield includes special landing plates installed at the top of the poles and allowing safe landing for the birds, without any contact with the wires, as well as isolation sleeves from an insulated material designated for the electric wires themselves, special thorns and spikes to prevent landing on dangerous places, and more. The landing plates and isolation sleeves were developed and installed after a simulation using captive vultures. IEC has invested millions of NIS in this project since it began.

Conducting ecological surveys

In the framework of ecological surveys performed in order to examine the effects of planned projects on biodiversity (included in the environmental licensing documents), IEC conducts surveys of flora and fauna species present in the planned project area. In order to get detailed ecological information, IEC conducts botanical and zoological field surveys, as well as literature surveys, using as a reference the "Red Book of Vertebrate in Israel", which defines and classifies species in danger of extinction. If necessary, these surveys require action in order to prevent any danger for these endangered species.

The definitions in the "Red Book" comply with the definitions of the "Red List of Threatened Animals" published by the International Union for Conservation of Nature – IUCN.

Jungle Cat (also called Swamp Cat)
Vulnerable species

As an example, data are presented here from an ecological survey conducted in the framework of an alternatives analysis for a 400 kV extra-high voltage line planned to connect a planned generation area in the Beit Shean region to the national transmission grid. The best alternative from this viewpoint was recommended based on the basis of this ecological survey. The alternatives that were considered included two geographical areas:

1. Ramat Tzvaim - northern alternative.
2. Emek Harod - southern alternative.

Based on all the environmental considerations (and not just the ecological ones), an alternative that combines the northern and southern alternatives was selected.

The following tables present information regarding the observation of animals in the southern and northern alternative areas, including extinction risk levels according to the key provided in the “Red Book of Vertebrate in Israel” (Dolev and Perevolotsky 2002 – in hebrew):

Extinction risk levels according to the key provided in the “Red Book of Vertebrate in Israel”

DD	Data Deficient
LC	Least Concern
NT	Near Threatened
VU	Vulnerable
EN	Endangered
CR	Critically Endangered
RE	Regionally Extinct
EX	Extinct

Table 47: Mammals, Reptiles, and Birds Species Near the Southern Alternative route (Source: Biogis Website, 2018 Field Survey, Nature and Parks Authority Data)

LC NT VU EN CR RE EX

MAMMAL TYPES	
SPECIES AND STATUS	
Jackal	LC
European badger	LC
Jungle cat	VU
Otter	CR
Indian crested porcupine	LC
Nutria	LC
European hare	LC
Wild boar	LC
Gunther's vole	LC
Common red fox	LC
Mountain gazelle	VU

REPTILE TYPES	
SPECIES AND STATUS	
Black whipsnake	LC
Palatine Viper	LC
Pond turtle	LC
Bridled mabuya	LC
Sand lizard	LC
Turkish gecko	LC
Snake-eyed lacertid	LC
False coral snake	VU
Common chameleon	LC
Starred lizard	LC
Edible frog	LC
Green toad	EN
Lemon-yellow tree frog	VU

BIRD TYPES			
SPECIES AND STATUS		SPECIES AND STATUS	
Coot	NT	Bluethroat	
Eagle owl	NT	Spoonbill	
Oriental honey buzzard		Great egret	
Honey buzzard		Little egret	LC
Grey heron	RE	Brown ibis	LC
Bulbul	LC	White wagtail	NT
Lesser kestrel	EN	Sparrow hawk	LC
Eleonora's falcon		Levant sparrow hawk	
Kestrel	LC	Griffon vulture	VU
Peregrine falcon	RE	Moorhen	LC
Hobby	NT	Alpine swift	LC
Red-footed falcon		Swift	LC
Common redshank		Swallow	LC
Green sandpiper		Booted eagle	
Mallard	NT	Lesser spotted eagle	
Black kite		Tawny eagle	
Marsh-harrier	RE	Spotted eagle	RE
Montagu's harrier		Imperial eagle	
Pallid harrier	NT	Willow warbler	
Hen-harrier		Crested lark	NT
Skylark		Buzzard	NT

Extinction risk levels according to the key provided in the "Red Book of Vertebrate in Israel"

DD	Data Deficient
LC	Least Concern
NT	Near Threatened
VU	Vulnerable
EN	Endangered
CR	Critically Endangered
RE	Regionally Extinct
EX	Extinct

Table 48: Mammals, Reptiles, and Birds Species Near the Northern Alternative route (Source: Biogis Website, 2018 Field Survey, Nature and Parks Authority Data)

LC NT VU EN CR RE EX

MAMMAL TYPES	
SPECIES AND STATUS	
Jackal	LC
European badger	LC
Jungle cat	VU
Indian crested porcupine	LC
European hare	LC
Wild boar	LC
Gunther's vole	LC
Common red fox	LC
Mountain gazelle	VU
Striped hyena	VU

REPTILE TYPES	
SPECIES AND STATUS	
Black whipsnake	LC
Palatine Viper	LC
Pond turtle	LC
Bridled mabuya	LC
Sand lizard	LC
Turkish gecko	LC
Snake-eyed lacertid	LC
False coral snake	VU
Common chameleon	LC
Starred lizard	LC
Edible frog	LC
Green toad	EN

BIRD TYPES			
SPECIES AND STATUS		SPECIES AND STATUS	
Coot	NT	Armenian gull	
Eagle owl	NT	Teal	
Kestrel	LC	Black kite	
Mallard	NT	Palestine sunbird	LC
Rock partridge	NT	Isabelline wheatear	LC
Goldfinch	NT	White pelican	
Snake eagle	LC	Rose-ringed parakeet	
Stone curlew	NT	Collared turtle dove	LC
Great egret		Little grebe	NT
Shoveler	LC	Wood sandpiper	
Hooded crow	LC	Marsh sandpiper	
Jay	LC	Hoopoe	NT
Black partridge	VU	Long-legged buzzard	NT
Rock partridge	NT	Black partridge	VU
Snake eagle	LC	Graceful warbler	LC
Red-backed shrike	NT	Cormorant	
Lesser grey shrike		Egyptian vulture	VU
White stork	NT	Black-headed gull	
Black stork		White-throated kingfisher	NT
Snipe		Osprey	
Little grebe	VU	White pelican	
Domestic pigeon		European bee-eater	VU
Long-eared owl	LC	Barn owl	NT
Great tit	LC		

Extinction risk levels according to the key provided in the "Red Book of Vertebrate in Israel"

DD	Data Deficient
LC	Least Concern
NT	Near Threatened
VU	Vulnerable
EN	Endangered
CR	Critically Endangered
RE	Regionally Extinct
EX	Extinct

Biodiversity - Marine Aspects

The coastal power plants use seawater to cool the steam that drives the turbines in the power generation process. The pumping of seawater to the cooling systems, heating them and returning them to the sea, has an impact on the biodiversity in the pipes and in the condensers of the cooling systems, as well as around the hot water outlet from the power plants to the sea. Therefore, IEC makes sure to monitor and track the biodiversity in the area around the outlets.

Biodiversity in the Power Plant's Cooling Water Systems

The cooling water systems pump large quantities of seawater. The cooling water also contain tiny sea organisms that are not caught in the filters. These include meroplankton (the young stage of marine life) planktonic organisms that find a place to settle in the walls of the cooling system, as well as other planktonic organisms that constitute food for those that have settled on the walls and accelerate their growth. The fauna that grows on artificial bodies are known as "marine fouling". The water going through the power plants' cooling systems accelerate the growth of fouling animals adapted to the streaming water, such as oysters and barnacles. Marine fouling causes many operational issues, mostly concerning lower efficiency of power generation, and even blockage that might cause the shutting down of generation units.

In order to prevent such settlement and accumulation of marine fouling inside the cooling systems, it is necessary to add low concentrations of substances for settlement prevention to the seawater (the concentrations are dictated by the Ministry of Environmental Protection). Within the Israel Electric Corporation's endeavor to minimize use of these substances, examinations are carried out twice a month at the most, to check the concentrations of meroplankton and other planktonic organisms in the seawater, to get an indication of these organisms' potential for settling in the cooling systems. Figure 1 shows the concentrations of "mature" holoplanktonic organisms (planktonic organisms who go through their entire lifecycle in the body of water) and the meroplankton. According to these concentrations, the quantities of anti-settlement materials that need to be added to the cooling water can be adjusted. Figure 2 shows the average concentrations of plankton for every season of the year at the different power plants. It shows that there are differences in the plankton load between the stations in different seasons. At Orot Rabin, the load is heaviest in the winter, whereas at Rutenberg and Eshkol, it is heaviest in the summer.

One of the ways to keep the main cooling system clean without using chemical materials to prevent settlement is using silicon anti-fouling coats, whose composition prevents settlement without changing or compromising the sea-water quality in any way. These coats are used in most coastal power plant units. As shown in image 1A and 1B, the condenser is almost completely clean, after two years of work. Image 1C shows a condenser without silicone anti-fouling as a reference.

Image 1A

Image 1B

Image 1C

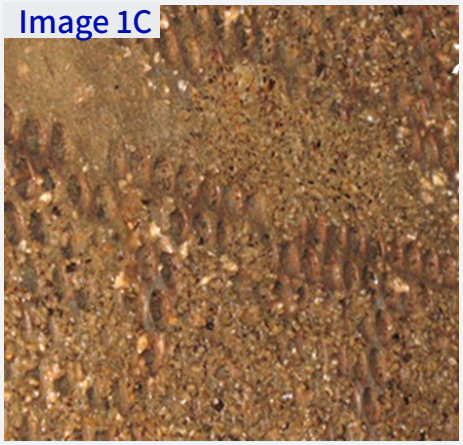


Image 1 A) the condenser walls in the main cooling system, coated with a silicone antifouling coat, after two years of work, Image 1B) The main condenser pipes' wall, coated with a silicone antifouling coat, opened for cleaning, after two years of work. Image 1C) The uncoated condenser pipes' wall, blocked with oysters and barnacles.

*The pictures were taken on February 26, 2019, when renovating Unit No. 4 at Orot Rabin, and it demonstrates the effectiveness of the antifouling coat in 2017 and 2018, since the last time it was cleaned on April 6, 2017.

Figure 1: Number of "mature" plankton (holoplankton) and meroplankton from the spring of 2020 to the spring of 2021 at the Rutenberg, Eshkol, and Orot Rabin power plants.

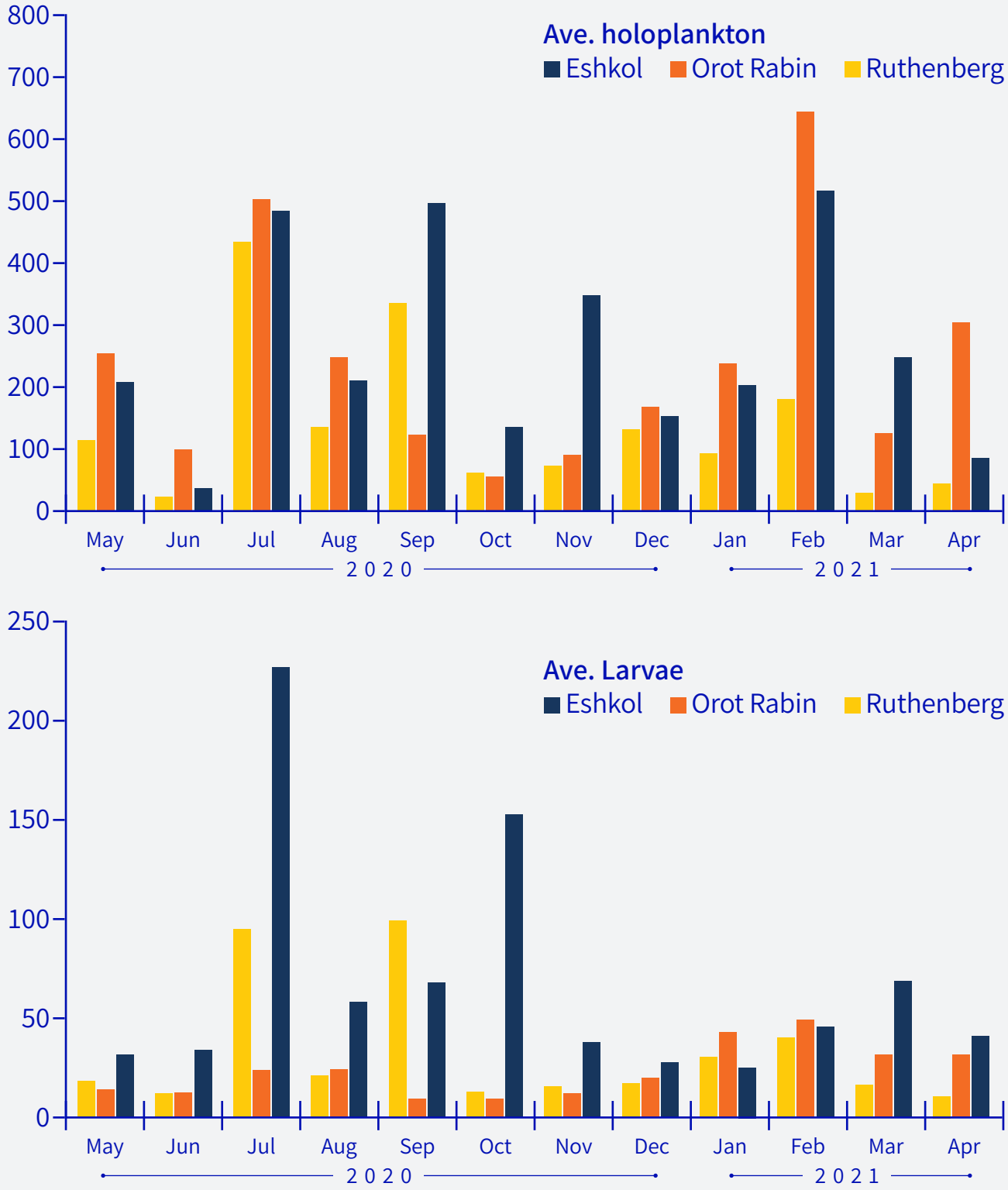
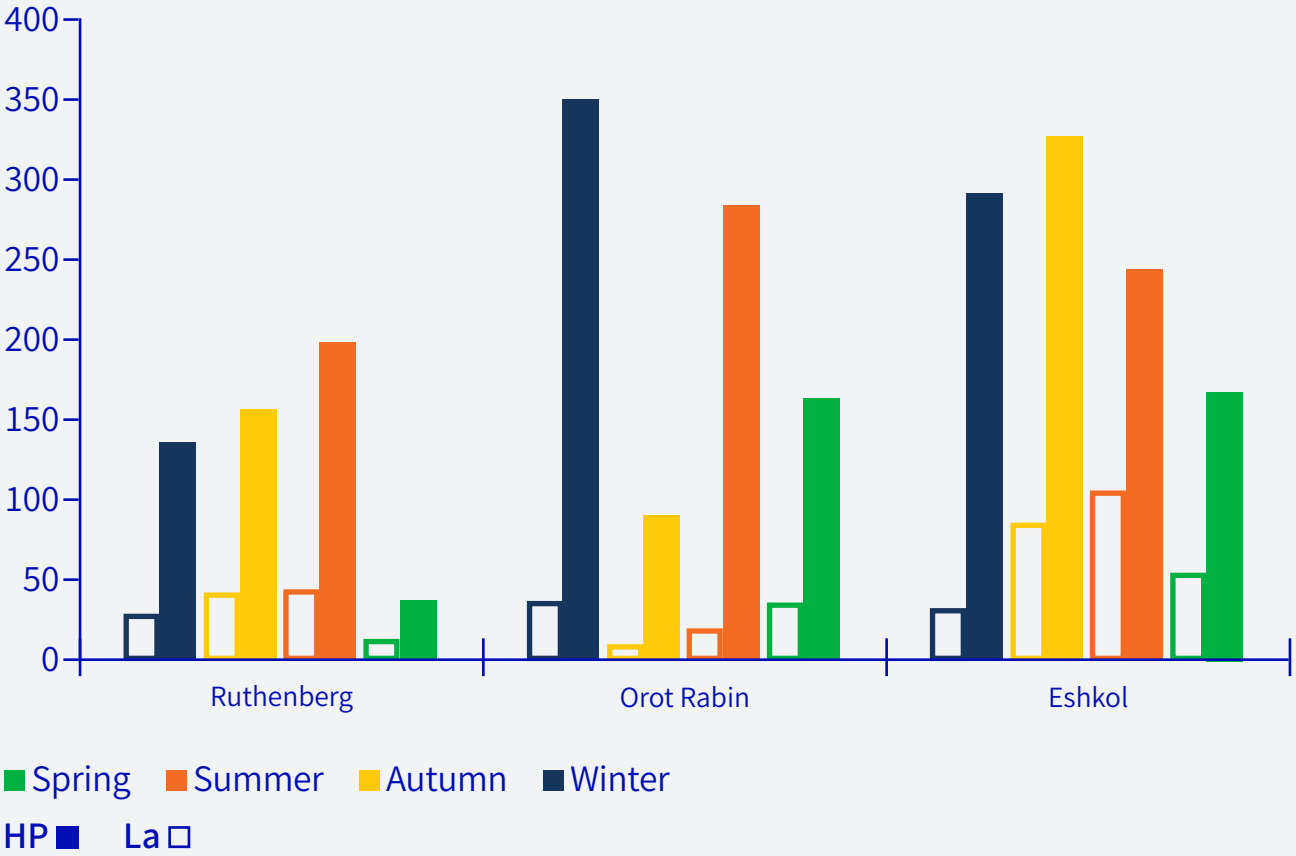


Figure 2: Average number of holoplankton and meroplankton specimens by season at the Rutenberg, Eshkol, and Orot Rabin power plants



Marine fauna biodiversity in the vicinity of the hot and salty sea water outlet at Orot Rabin power plant *

Monitoring the invertebrate population at the bottom of the sea (benthos).
According to the monitoring plan of the Ministry of Environment Protection, for the marine environment, monitoring of the benthos population is performed once every two years at the coastal power plants, Rutenberg and Orot Rabin and every five years at Reading power plant. The monitoring performed near the hot (from cooling the power plants' generation units) and salty (from brine of the desalination facilities) sea water outlets, compare points far away from the outlets to the north and to the south, (control points are located up to 2 km away), and nearby points, distributed around the outlet at different depths Figure 3. To check the extent of the hot and salty water streams' effect on the marine environment, the composition of the fauna population in the sand is compared between the sampling points. The benthic fauna population is affected by the environmental conditions in its habitat, and therefore can indicate long-term changes in its habitat.

The organisms are classified to the highest taxonomical classifications (polychaeta, crustacea, mollusca, and nematoda) Image 2, and to the lowest taxonomical level, i.e., species level when possible. As seen in Figures 4 and Figures 5, the effect of the hot and salty water streams is apparent at the spots OR2 and OR3, and to some extent, at OR4, that are the nearest points to the south of the water outlets (in the fall, some effect is observable at OR12, slightly further to the south). The reason for the long-term effect at these points is the direction of the water flow from the outlets to the south. The monitoring findings in 2021 show that the hot water and salt water outlets have a local impact on the marine fauna, no further than 600 meters south of the outlets, and 300 meters to the west.

The summary of the data presented here as a sample only applies to Orot Rabin; the monitoring plan also covers the Rutenberg, and Riding power plants.

A full report on all monitoring findings is available on the Ministry of Environmental Protection website – monitoring plans.

Figure 3: The sampling point distribution map. The spots at which fauna is sampled inside the medium or the OR points

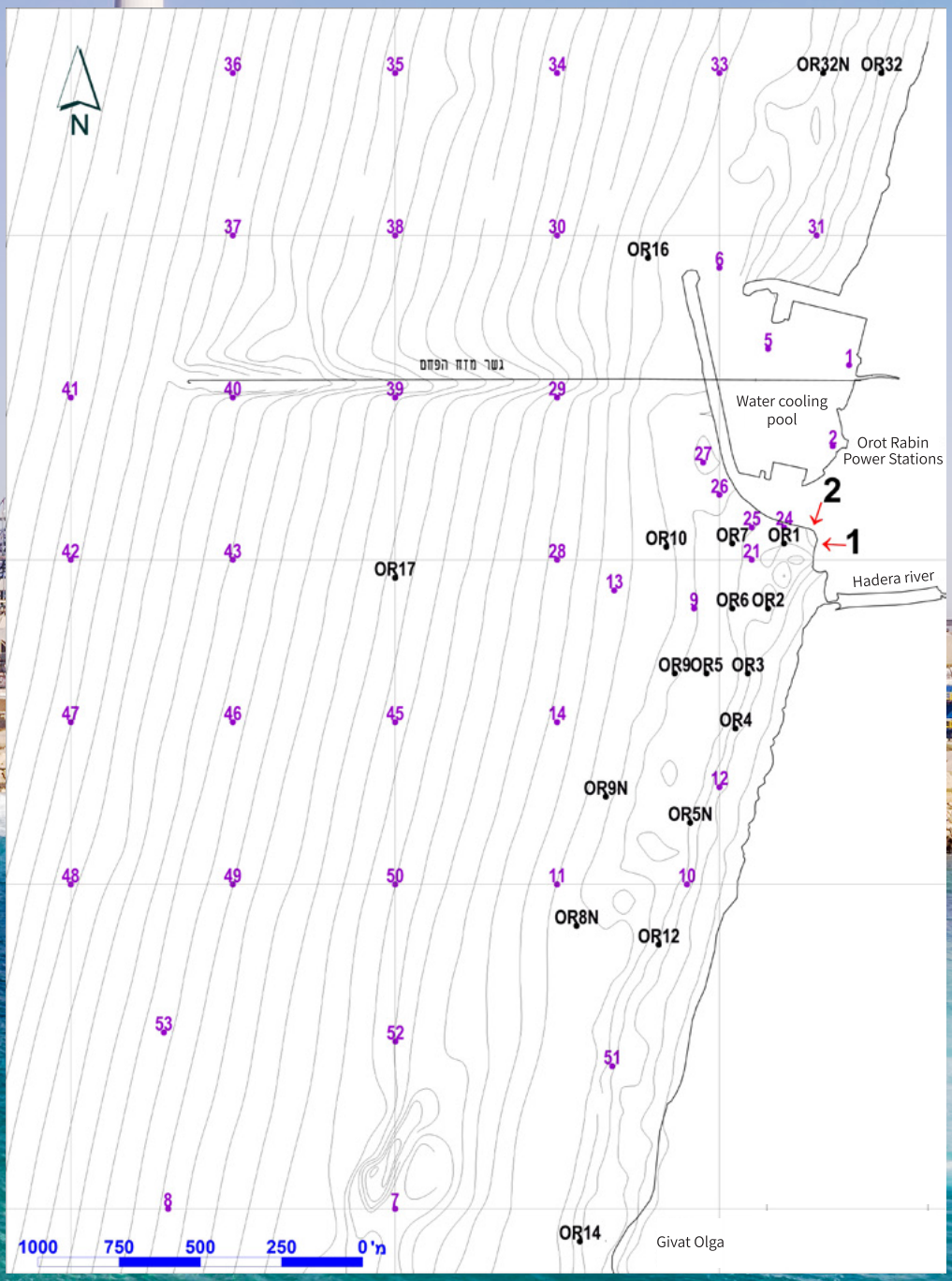


Figure 4: Prevalence (a three repetitions average) of specimen of the primary classes at the Orot Rabin outlet area, with depth at the sampling points, in the spring of 2021

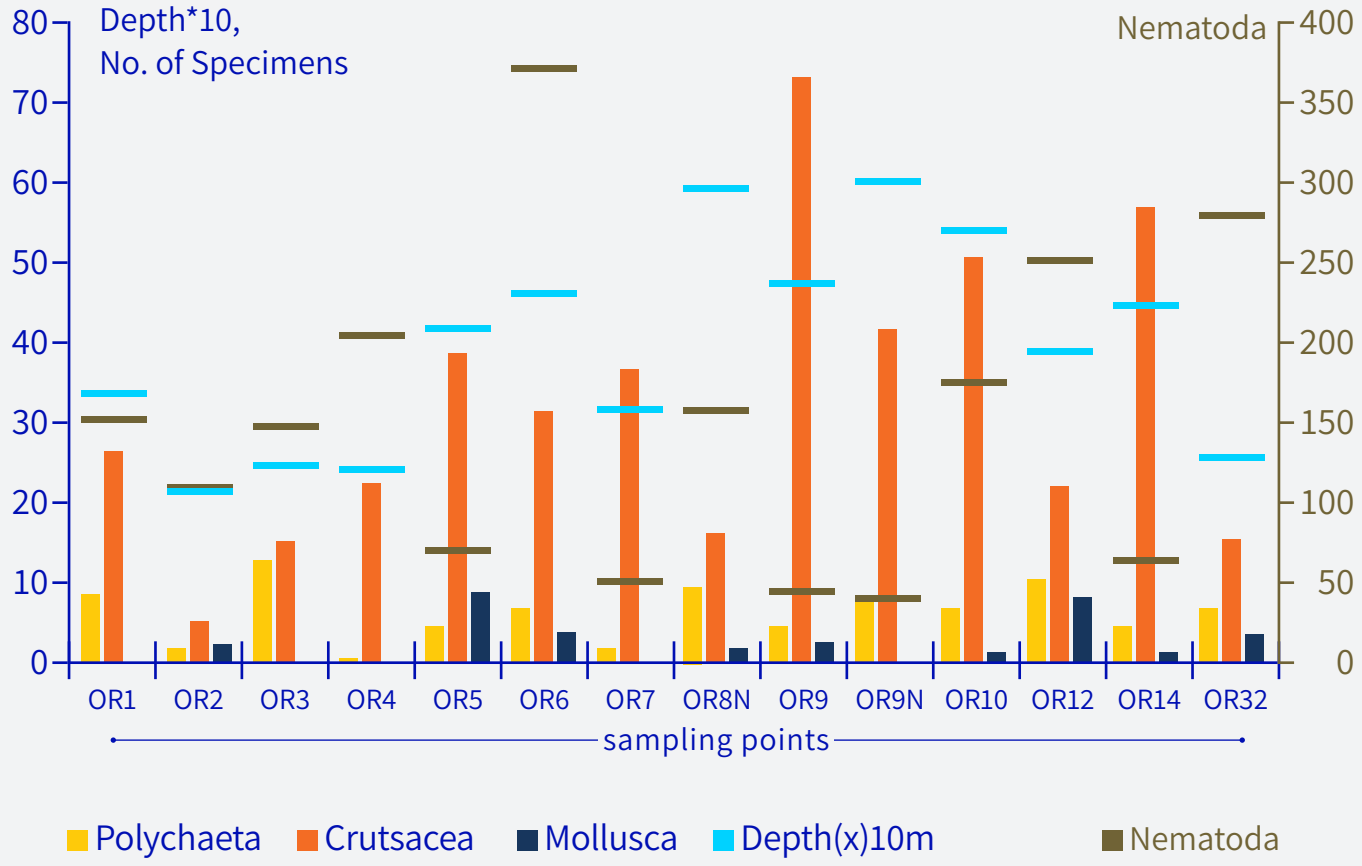
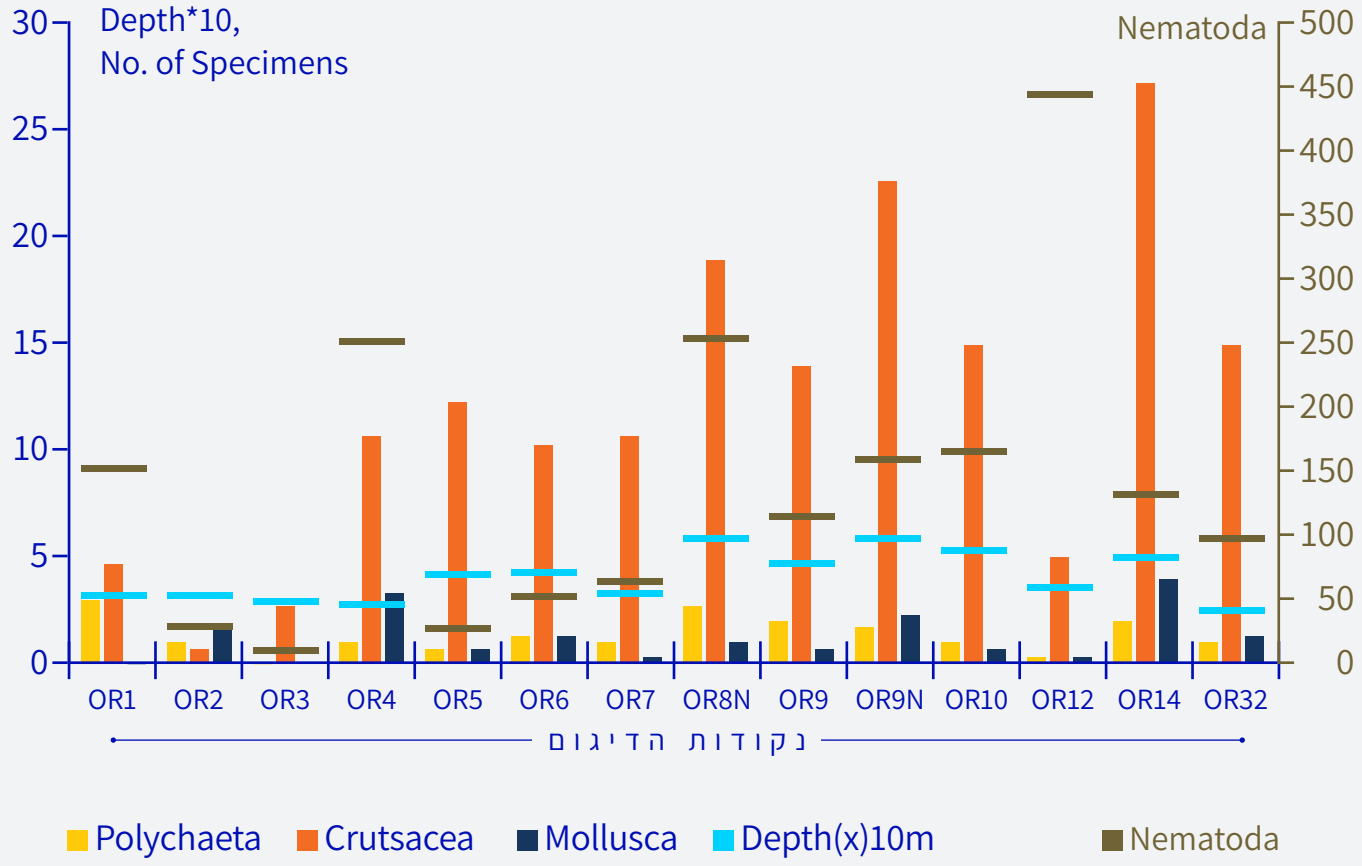
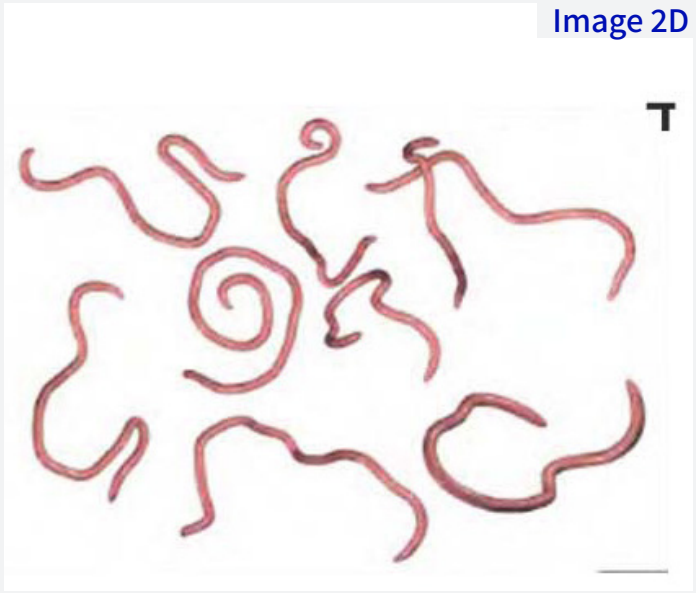


Figure 5: Prevalence (a three repetitions average) of specimen of the primary classes at the Orot Rabin outlet area, with depth at the sampling points, in the fall of 2021





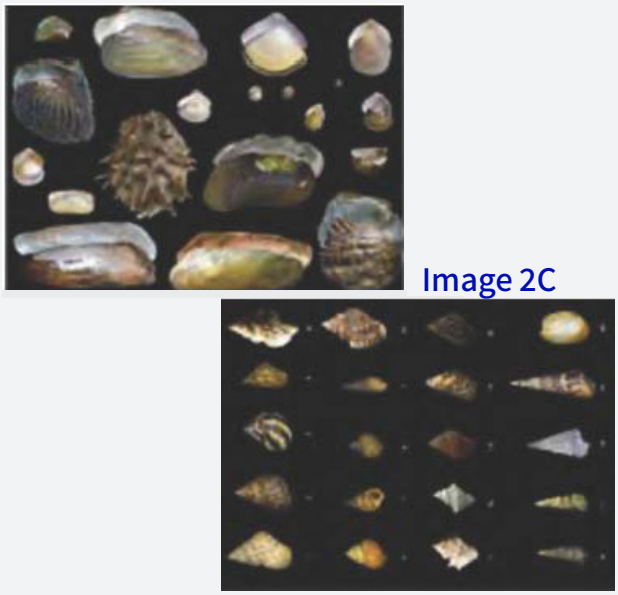


IMAGE 2A) Crustacea

IMAGE 2B Polychaeta

IMAGE 2C) Mollusca
(upper image: Bivalvia. lower image: Gastropoda)

IMAGE 2D) Nematoda

Marine micro-phytoplankton biodiversity in the hot and salty water outlet area at the Rutenberg power plant

Within the marine environmental monitoring plans carried out according to the Ministry of Environmental Protection requirements, the prevalence of algae (concentration of cells per liter) near the Rutenberg Power Plant water outlets is monitored annually in spring and autumn. These outlets include hot water from the Rutenberg and Dorad Power Plants, brine from the VAD desalination facility, and the desalination brine from the Mekorot drillings (enriched with nitrates).

Changes in temperature, salinity, and nitrate concentrations can affect the abundance of different classes of algae in the sea.
Because some algae can create toxins that might harm filtering animals such as oysters, fish, and birds in high concentrations, it is very important to monitor the concentrations of algae, to make sure they do not deviate from the norm.

Three sampling points are located perpendicularly to the shore:

- RUT3, 250 meters away from the cooling water outlets of Rutenberg Power Plant Unit No. 1 and Unit No. 4.
- RUT9, 800 meters away from the outlets.
- RUT17, 1,160 meters west of the outlets.

The algae were classified into five classes of size and taxonomical categories

1. Cells smaller than 2 µm, a class containing mostly the cyanobacteria;
2. Algae smaller than 5 µm meters, mostly the small eukaryote algae;
3. Algae larger than 5 µm, mostly dinoflagellates;
4. Diatoms larger than 5 µm;
5. Chlorophyceae; Image 3).

In 2021, in both seasons, the diversity of the cyanobacteria and chlorophyceae was smaller by an order of magnitude than that of the diatoms and the dinoflagellates. The diversity in the different categories was very similar between the three sampling spots, except for the diatoms category, in which the diversity was higher at RUT3, closer to the outlets (Figure 6). The total microalgae concentration was similar in the three sampling points. In the spring, the highest concentration was detected at RUT17, and the lowest concentration was detected at RUT9. In the fall, the algae concentration was almost identical in the three points (Figure 7).
The cyanobacteria were the most abundant at the three sampling points, comprising 94% of the total algae at RUT3 and RUT17, and 92% of all algae at RUT9. The most common cyanobacteria species was Synechococcus sp. This species is common in other areas of the Israeli shore.

In 2021, no unusual concentrations of algae species were detected, and algae species with a toxic potential, such as pseudonitzschia, were detected at very low concentrations, far from the threshold concentrations that might have adverse effects. The species Prorocentrum minimum, that creates a number of toxins, was found at concentrations lower than the potentially harmful threshold by three orders of magnitude. Some species of gymnodinium and chaetoceros, that can cause a skin irritation and the burning sensation in the eyes were detected at very low concentrations that cannot cause harm.

In summary, in terms of concentration of cells per liter, there are no substantial differences between the sampling points. In the spring, the diversity of diatoms species was higher in the outlet area, and the diversity of dinoflagellates was lower; this trend is less distinct in fall. The diversity of cyanobacteria was very low in the fall, in all three sampling points. The prevalence of species with the potential for toxicity was lower than the concentrations that might present an issue by at least three orders of magnitude. Hence, one can state that the hot and salty water streams from the Rutenberg Power Plant outlets do not have a negative effect on the regional population of algae.

Figure 6: Richness of different algae categories in the spring and fall of 2021

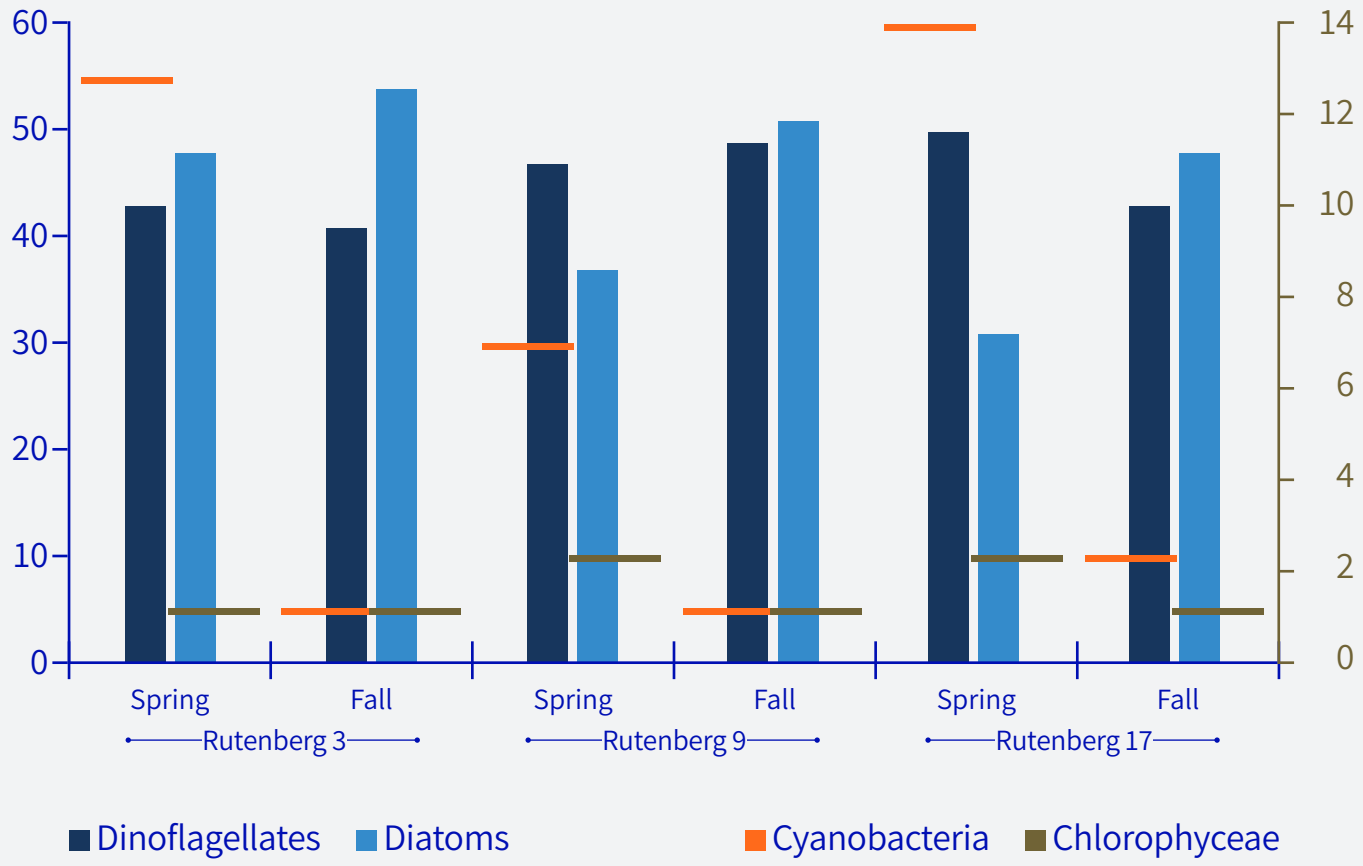


Figure 7: Concentration of cells per liter of different microalgae categories in the spring and fall of 2021.

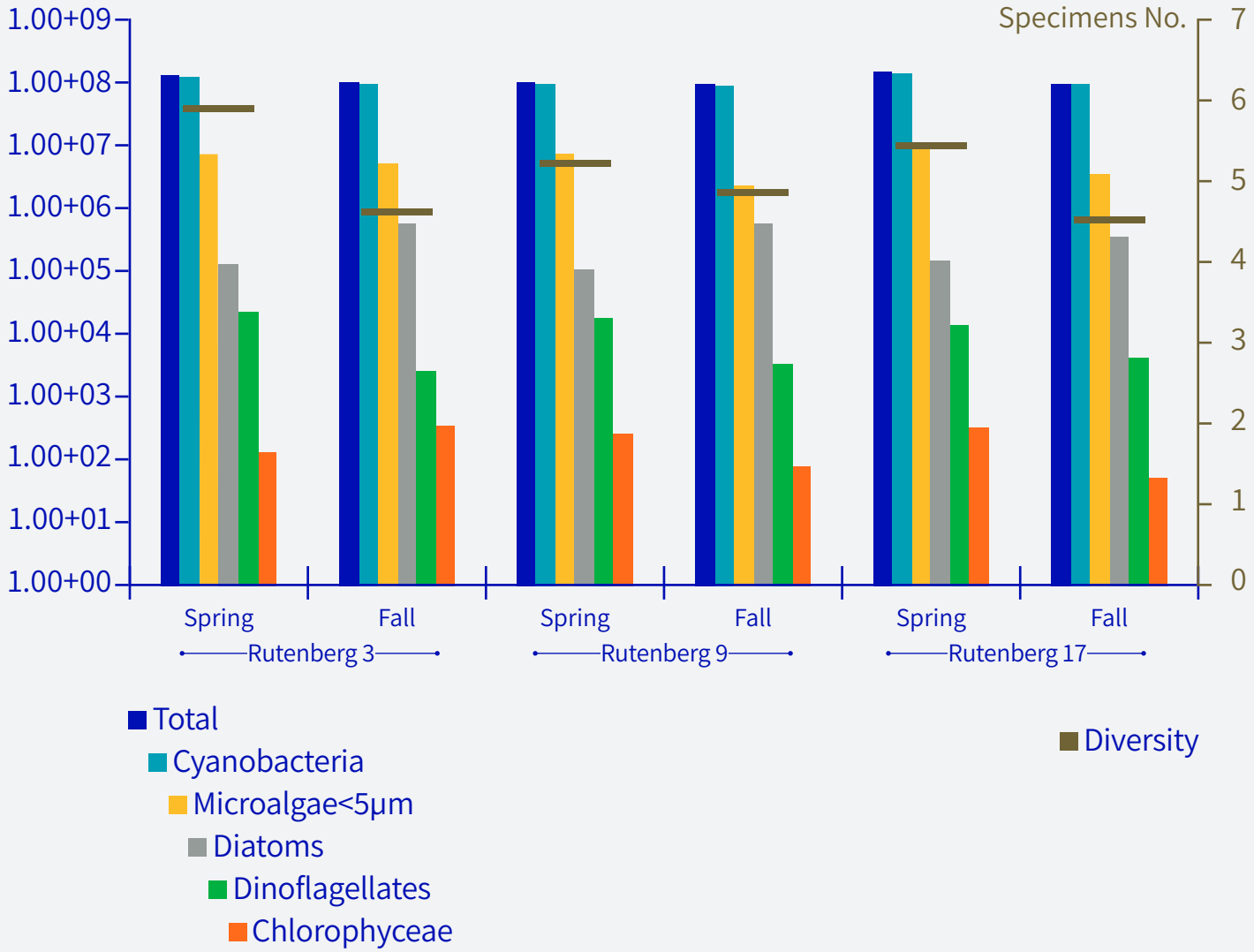


Image 3: Main groups of micro-algae

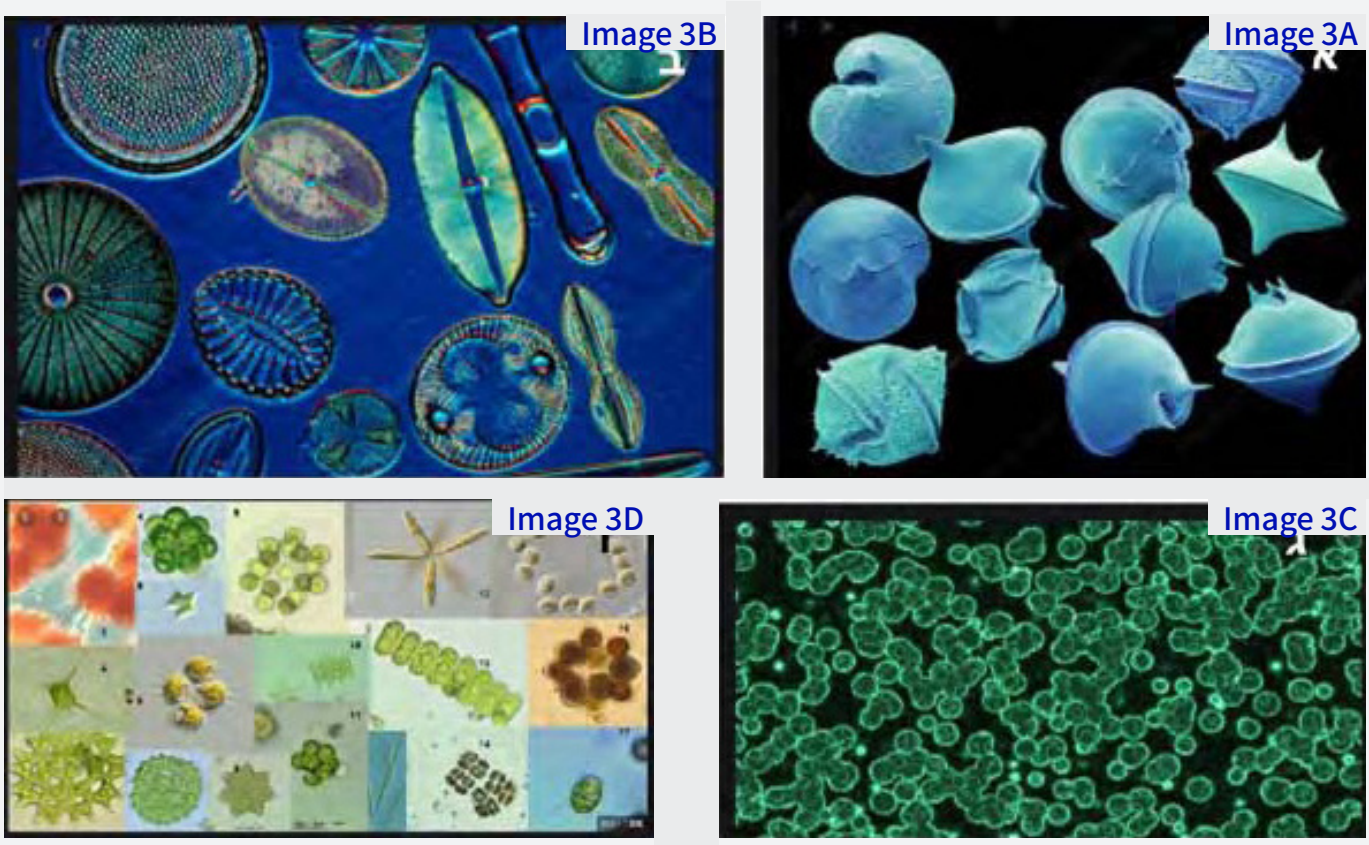


Image 3A. Dinoflagellates (over 5 µm)
Image 3B. Diatoms
Image 3C. Cyanobacteria (smaller than 2 µm)
Image 3D. Chlorophyceae.

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