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Integrated combined cycle system with parabolic trough technology: A comprehensive review

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Abstract The enormous quantity of solar energy that is accessible on Earth has increased interest in centralizing solar power, and hybrid ideas in particular. One of the hybrid designs with the best potential for transforming solar power into electricity is the integrated solar combined cycle system integrated solar combined cycle system, which may soon overtake other options as the technology of choice. Since the 1990s, when such a notion was first introduced, research and development activities and previous works have been reviewed in this article. The paper discusses various combinations of solar energy with natural gas, coal, and other renewable energy sources, as well as the current situation. Additionally, it offers a thorough review of actual and anticipated R&D findings.

Keywords: combined solar thermal power plant, parabolic trough.

1 **Introduction**:

The two main causes that have increased energy consumption and costs are the economic boom in emerging nations, notably in China and India, and the ongoing rise in global population [1, 2]. World environmental effects including climate veers and world warming have gotten worse as a result [1-4]. With price increases, shortage risks, and depletion risks, this has also put pressure on the energy origins. According to recent estimates, there are still 2.670 trillion barrels of hydrocarbons, such as unrefined oil and natural gas, are still available, that can be recovered [1]. By 2050, this won't be sufficient to cover the world's energy demands, which would unavoidably lead to a scarcity and high energy costs for consumers. Research and development (R & D) efforts the creation of effective and (SES) have been blooming in order to maintain the limited origins and meet growing energy guarantee and environmental effects. In order to do this, three topics have received a lot of attention. [4–12]

Energy-efficiency developments, scaling-up of technology, (RE) technologies and low-carbon technologies. While technical advances reduce high energy prices, the surge in energy demand can be maintained by expanding the use of low-carbon technology and enhancing the (TE) of fossil-fueled (PP)s. (SE) in particular has the ability to solve global energy demands while resolving environmental and energy security issues. However, before (RE) becomes cost-competitive with traditional technologies, technological advancements in the generation of power from renewable sources are required. For instance, whereas solar-only power stations cannot produce energy with (TE) more than 30%, polygene ration (PP)s may Costs go rise as a result of this. Hybrid solutions that combine the benefits of the three aforementioned problems have been presented as a solution to this problem. (CSP) has the ability to contribute significantly to clean energy with better efficiency in all the renewable techniques accessible for hybrid due to its standard technology and ease of increasing [13 - 19].

The parabolic trough is currently the most reliable CSP technique for hybridization. There are several strategies to hybridize, such as using a fossil backup or auxiliary firing in thermodynamic cycles [20, 21]. Nine (SEGSs) were created in California desert in the 1980s. Each station has heated an Oil-HTF using a solar area and (PTT). A Rankine cycle is powered by steam produced from the chemical energy of the oil. Later, in the 1990s, Luz Solar International suggested integrating PTT into a contemporary combined cycle to enhance the efficiency of solar-to-electricity conversion. The (ISCCS)

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is the name for this cutting-edge idea. The ISCCS typically comprises of a Heat Solar Steam Generator, a solar area, and a Conventional (CC). The Global Environment Facility has given certain developing nations money over the past ten years to encourage R&D efforts and the installation of these sort of power facilities. Due to this, a number of feasibility studies, cost analyses, and thermal performance predictions have been conducted to look at ISCCSs that are active, under construction, or in the planning stages all over the world, with a focus on Iran, China, Mexico, the US, Algeria, Egypt, Morocco, Mexico, and Italy.

The current study provides a temporal overview of the ISCCS using parabolic trough technology, showing its present state globally, identifying its many configurations, and highlighting the most important published results of R&D operations.

2. Present conditions and initiatives throughout the planet

2.1. Running ISCCSs

Many ISCCPPs are running now on our planet. In African Arabic part , there are already 3 operational (PP)s: HassiR'Mel (150 MW, 20 MW solar), Egypt, and Morocco (AnBeniMathar, 470MW, with 20MW solar) (Kraymat, 140MW, with 20MW solar). The Yazad ISCCS was inaugurated in Iran in August 2010 . (Yazed, 467MW, with 17MW solar). The Archimedi solar (PP) near Priolo Gargallo, Italy, has been in operation since July 2010 but has a smaller solar field. Martine Next Generation (SE) Center, the biggest ISCC systems in the US, was officially opened in December 2010.

2.1.1. HassiR’Mel [22-25] .

Combined cycle at 130 MW and 25 MW (PTS) field that make up the HassiR'Mel ISCCS span a surface area of more than 180,000 m2. Tilghemt, HassiR'Mel, is where the factory is situated. The 216 sun concentrators in 54 loops that make up the solar area have an exit temp. of 393 °C and an intake fluid temp. of 290 °C. Solar (PP) One (SPP1) has pushed this project for Sonatrach over a 25-year term as part of a build-own-operate contract. Abener and New Energy Algeria NEAL are partners in SPP1. The project was created by NEAL, a partnership between Sonatrach, the SIM, and Sonelgaz. On January 5, 2007, the construction contract was signed. On July 14, 2011, the (PP) was officially opened after being put into service in June 2011. Natrach is purchasing all of the electrical power generated by the ISCCS to satisfy its demands for 4 cent kW/h.

2.1.2. Kraymat [26, 27].

2.5 kilometers separate the Kuraym (PP) from the eastern bank of the Nile and 90 kilometres south of Cairo. The Kuraymat ISCCS include a 61 MW solar area and a (CCPP) with 140MW. The field has a total reflecting area of around 131,000 m2, 1920 modules, and 160 concentrators. On the two sides where the wind is flowing in the direction that will do the least damage, wind breaks have been installed, The facility began operating in July 2011. It has been extremely beneficial since investigations have shown that the solar area can, on average, provide close to 8% energy more than predicted.

2.1.3. Aiin Beni Mathar[28].

The (HSP) facility at Aiin Beni Mathar is located in Morocco's eastern region. It includes the benefit of a 20MW (PTS) array with a 470MW (CCPP) covering 18x104 m2. Since the (CCPP) consists of two 150MW gas turbines, it is more adaptable, one 150MW steam turbine, and two 150MW gas turbines. The project was created for the Office National de l'Electricité, a state-owned power provider. Abener, Abengoa, Sun and Teyma have designed, in accordance with the conditions of a turnkey contract with ONE, built and commissioned the facility. Abener Energia, who along with ONE manages the facility, served as the EPC contractor. In May 2011, the factory began operating.

2.1.4. Yazd [29,30].

At KM33 of the Yazd-kazarabad Road, 900 halands away, Yazd ISCCS was built. It is the eighth biggest solar (PP) in the world and the first (ISCCS). Each of the two V94.2 gas turbines' 159MW capacities, a 143MW without reheat double stage pressure thermal unit, with a 17 MW-capacity solar steam turbine unit. make up the Yazd (PP). In 2003, Irani scientists began the feasibility assessment for the Yazd (PP) with the help of German consultant engineers and researchers.

2.1.5. posterior decent of the (SE) center at martin [31]

Located immediately north of Indian Town in Florida, is the Martin (SE) Center (ISCCS). The Martin County (PP), the largest (FFPP) in the USA, has a combined cycle with a capacity of 3705 MW. Construction began in Dec. 2008 and finished in Dec. 2010.

2.1.6. Thermo-solar towers [31,32].

The Termo-solar Borgis project is close to the biomass combustion units that generate around 70 t/year in the northeast of Spain. In its solar area, there are 336 concentrators with a interlay reflecting roof of 181,000 m^2. The factory, which cost roughly €153 million, was marketed by the Spinach businesses Comsa-Emte. With an operating time of around 6500 hours per year, this (RE) facility has been producing up to 98,000 MWh annually. It is facilitating the release of 24,500 t of CO_2 and providing power for 27,000 households.

2.1.7. Archimede [31–35]

In Sicily, Italy, close to Syracuse, sits Priolo Gargallo, where the Archimede integrated factory is situated. Enel has been the owner and operator. It was developed by Siemens Energy and Angelantoni Industrie in collaboration with ENEA and Archimede (SE) . Archimede is integrating the benefits of a 5MW solar area in a 750MW (CC). The solar area uses molten salt as HTF (60 percent $NaNO_3$ and 40 percent KNO_3), which has a reflecting surface of 30,000 m^2. Higher working temperatures of roughly 550°C are possible when salt-HTF is used. The heated tank in which the molten salt is maintained after that is used to make steam to drive a RC. With this setup, (FF) wastes is decreased and CO_2 smoke & ash are decreased by around 7300 t.

2.2. ISCCSs in process of building.

2.2.1. Agua Prieta II [37].

In Mexico's Sonora state, the Agua PrietaII is being built adjacent to the city of Agua Prieta. has assisted with ISCCS and promoted it on behalf of the Mexican Federal Electricity Commission (CFE). It is planned to produce an output of around 465 MW, with the solar area contributing 12 MW. A group led by the Spanish businesses Elecnor and Sener will build the project. It is anticipated to be put into operation in April 2013. The state-owned energy supplier in Mexico, Comisión Federal de Electricidad, is a consumer of the electricity produced by ISCCS.

2.2.2. Ningxia [28,31].

ISCCS was located on the Chinese province of Ningxia near the city of Yinchuan, with latitudes of 381 310 54.48 in the north, 1061 130 26.4 in the west, and a height of 923 m. The Hanas New Energy Group is the owner of the project. After starting in October 2011, it was predicted that the work would be finished on Oct. 2013.

2.3. Barred ISCCSs.

2.3.1. Palmdale [38,39].

In the far northern parts of the United States city of Palmdale in California, (SEAve.M).The facility will produce 617 MW of electricity on average. During sunny seasons, the solar area is designed to provide around 10 % of the all power output. Inland Energy, Inc. is intending to develop the project. The Palmdale ISCCS facility would have a 250acre (PTS) area, two 155 MW natural gas-fired gas turbines, two (HRSG), and a 260MW thermal turbine.

2.3.2. Victorville 2 [40].

The SCLA - previously, GeorgeAFB) will house the Victorville 2 (VV2). The plant's electrical output would be 563 MW. VV2's development will be overseen by the Palmdale project developer as well. A 250acre (PTS) area will be combined with a 268 MW steam turbine, pair 154MW gas turbines, and pair HRSG s, and two HRSGs as part of the VV2. The solar area might produce till 50MW, but it would need the plant to carry 13 MW in auxiliary loads.

2.3.3. Abdaleya [41,42].

The Abdaleya ISCCS, which would have 280MW, will be built in Kuwait. About 60 MW of (SE) would be produced. When compared to the solar share of contemporary ISCCS, which is about 22 percent, this ratio is significant. The station is designed to run in economic situation. Consequently, there will be a significant environmental benefit, including 48,000 t less CO2 emission than a mixed cycle using just pure (FF)s with a comparable capacity. The Abdaleya project is now in the planning stages which will be Kuwait's first (STPP).

3. PP technologies applied in the ISCCS.

In (STPP)s, concentrators are typically for produce vapor that powers a thermal station. (DSG) is possible in the hoarding tube. This is known as (DSG). Using a (HTF) to transfer sun energy from concentrators where steam is created to heat exchangers, is an alternative way. These two notions are introduced and briefly contrasted in this section.

3.1.(DSG) Techniques[44] .

The (DSG) directly generates vapor in the hoarding-tubes of the (PTC), This notion has been improved and examined in a number of R & D initiatives. DSG processes are classified into three types: injection, once-through, and recirculation. To accomplish the entire DSG process, which includes water preheating, evaporation, and steam super heating, each phase requires a solar area made of long lines of PTCs linked followed each other. During the first operation, all inning water is fed at the concentrator line inlets and transformed to super-heated vapor as it goes through the concentrator rows. During the adding procedure, small portions of feed water are added along the concentrator row. In the 3rd alternative, the re-circulation, at the end of the steaming part of the concentrator line, a water steam separator is inserted.

3.2. Heat Transfer Fluid techniques [44-47].

(HTFT) was first available at 1984. The reflecting region of the solar area absorbs the D-N-I in the hoarding tube, where it is transformed into thermal power in such a concept. Consequently, the HTF's temperature as it passes through the solar area increases. The connection between the solar area and the power conversion system is actually the HSSG. The thermodynamic cycle is powered by a (HE) that utilizes (SH) to produce vapor. High vapor pressure and the potential for freezing are issues with the DSG concept that are resolved by using HTF. HTFs like oil, however, can result in issues like fire when they leak out of absorber tubes or pipelines. Other downsides of HTF technology include drop in pressure and extra O and M expenditures for HTF equipment.

3.3. (D-S-G vs. H-T-F)[44]

The fact that DSG technology does not require an HSSG and has a significantly lower power requirement for the circulating pump makes it more promising than HTF technology. Several advantages would result from the use of DSG technology in ISCCSs, including an increase in the Rankine cycle's working temperature (to over 400 °C)and the decrease in costs. However, two-phase flow poses serious challenges to the DSG concept, leading to problems with solar area adjustment.4 Helpful Hints

4. A recent R and D works.

past works have already demonstrated that almost moiety of the cost decreasing potential for C S P systems can be deal with R and D activity [4,12] .Here we examined the most noteworthy discoveries from earlier R and D operations on the I-S-C-C-S. The suggested technique might be useful in determining forthcoming R and D precedence.

4.1. Natural gas-I-S-C-C-S

(N-gas) is the most environmentally friendly nonrenewable resource available. received originated from the sun In fact, electricity generation utilizing Natural gas has a respectable 21 percent market share and is still rising. The current part focuses on the notion of combining (SE) . as well as natural gas This concept allows for not just a significant decrease but also in environmental deterioration, however it might also be viewed as a Before every solar power generation, there is an intermediary stage.

4.1.1. HTF-ISCCS.

Alani et al.[48] investigated the practical and financial viability of imbedding HTF-ISCCS in Tunis in accordance with PAESI, which stands for "Projet d'Aménagement Energétique SolaireIntégré.". The proposed configuration intended to produce 58 MW at night and provide approximately 88 MW of electricity during the day while running in a (CC)mode. The (CC) consists of two G-turbines and a large S-turbine. The solar area is made up of (PTC) that supply broiling oil to a buffer tank as well as a (H-S-S-G), which is coupled to the (H-R-S-G). The researchers looked at both different action techniques in rapports of thermal concert, green-house gas emanations, and economics. The concentrated effectiveness approach & extreme authority approach are the two approaches. They found greatest effective plant correlates to a lesser solar area & highest power technique has a larger probable for CO_{II} reduction highest effectiveness strategy. Additionally, they claimed that the ISCCS is superior than solar electricity generation systems (SEGS To improve the H-R-S-G and H-S-S-G, Kani and Favret [49] combined a tweak technology method with thermo-dynamic displaying to enhance the quantity streams & heaviness stages of the vapor series. (STE) intake from the solar area has a significant impact on the energy losses in the network of heat exchangers. As a result, they have advocated using a higher-pressure steam cycle to increase energy efficiency. Kani and Favret [50] investigated the influence of heaviness stage & flow interface amid the H-R-S-G and H-S-S-G on the verve effectiveness of the H-T-F & I-S-C-C-S once again to enhance the hotness exchanger net. They evaluated three pressure level cases: humble heaviness stage for H-R-S-G and H-S-S-G, HRSG has two heaviness stages, HSSG has one pressure level, and both heat recoveries have two pressure levels. In each situation, various steam interaction designs amid the H-R-S-G and the H-S-S-G have inspected. Because of the improved thermal efficiency, The results show that the (PAESI) (PP)'s ideal design is an I-S-C-C-S with dual heaviness stages. The smallest pinch cannot be maintained when the steam turbine is operated under off-design conditions, and the quantity of thermal verve effort from the solar area has a significant impact on the energy losses, according to earlier study by Kane et al. [48–50]. To solve this problem, they combined a pinch technology technique with an optimization algorithm for mathematical programming to maximize energy effectiveness in vapor makers (H-R-S-G, H-S-S-G) in relation to the conditions of vapor turbin action [51]. The writers evaluated the act of the I-S-C-C-S for various vapor turbin types and working approaches. The outcomes show that a (PP) with a smaller solar area and double pressure-reheat operates more effectively. Furthermore, if a significant subsidy and CO_2 levies are implemented, it may be competitive with traditional CC (PP)s.

Six thermal (PP)s were compared technically and economically by Hosseini et al. [52] while taking different configurations and capacities into account, namely, I-S-C-C-S with 67MW solar area, & oil holdup, I-S-C-C-S with 33MW solar area, and oil back-up, S-E-G-S and a humble G-turbine. For Iran's first solar power facility, they discovered that I-S-C-C-S 67MW solar area is the optimal design. During its 30 years of operation, such a (PP) may save around $59x10^6$ dollars in gasoline usage and save approximately $2.4x10^6$ tons of CO_{II} emanations. Its Levelized Energy Cost (LEC), when environmental costs are taken into account, is 10% and 33% less than that of a CC and GT, respectively.

An verve & exergy research of I-S-C-C-S in [Yazid-Iran], was carried out by Baghernejad and Yaghoubi [53]. The enactment of the (PP), as well as the verve & exergy efficiency for essential apparatuses, was evaluated by analyzing the energy and exergy harms. The majority of energy harms are accounted for by the gas turbine combustor (29.63 percent), tailed by the solar area (IX %), with significant verve harms happening through condenser and stack. The enquiry also showed that the solar area, which has an energy efficiency of less than 27 percent, is the least effective part of the I-S-C-C-S. However, it was determined that the entire ISCCS energy and exergy efficiency were roughly 46.17 and 45.6 percent, respectively. These numbers outperform SEGS and even certain (FF) (PP)s.

Exergo economic theories and evolutionary algorithms were employed by Baghernejad and Yaghoubi [54] to optimize the Yazd ISCCS in terms of speculation prices, exergy obliteration costs, and current costs. To prepare this, the writers created a cipher utilizing MATLAB and legalized it using the outcomes of Silveira's standard scientific enhancement technique [55]. The imitation outcomes supported Baghernejad's exergy examination and shown that the ISCCS's exergy efficiency might be raised since 43.78 percent to 46.88 percent though reducing the exergy obliteration fee by 14.83 percent. Additionally, with a 13.3% increase in capital expenditure, the L-E-C of the S-turbine and G-turbine may stand reduced via roughly 7.11 and 1.18 percent, correspondingly. In other words, the L-E-C is lower the longer the solar area operates and the longer the (PP) operates.

Yazd I-S-C-C-S energy and efficiency study was the focus of Baghernejad and Yaghoubi's [56] research. To ascertain the reversibility and energy and exergy damages of each plant elements, they used three equilibrium equations, specifically the [mass-energy-exergy-balance-equations]. According to the exergy analysis, the combustor has the biggest exergy losses, followed by the solar area and G-turbine dissipate, that account for 29, 62, 9, and 7.78 percent of the plant's entire exergy feedback, respectively. The energy analysis, conversely, discovered that the condenser and heaps, which account for 35.94 and 10.15 percent of the entire energy feedback, respectively, suffer from the biggest energy losses. The overall energy and exergy effectiveness of the I-S-C-C-S in this situation were calculated to be 46.17 percent and 45.6 percent, respectively. The scientists have also pinpointed the cause of earlier losses, allowing future research to focus on improving ISCCS performance.

Khaldi [57] has completed the energy for Hassi R'Mel ISCCS and exergy study of Algeria's first HTF-ISCCS, using into account the intention idea circumstances. He has made use of the Cycle Tempo application created by Delft-University of Technology for evaluating the (PP)'s energy and exergy efficiency, and hence identifying inefficient components. He merged the exergy stream figure with the worth figure when designing heat exchangers so as to afford a extra detailed analysis. According to the imitation research, the G-turbine combustion and the solar area are the biggest causes of energy and exergy damages, but turbo-machinery such as compressors and turbines provide better performance. The author also offered a lot of information on the [Hassi R'Mel] I-S-C-C-S design data, and he discovered that the (SE) segment is roughly fourteen percent (that corresponds to 22MW), though the solar exergy segment is twelve percent (18.4MW). The (PP)'s energy and exergy effectiveness were 56 percent and 53 percent, separately, at the time of design.

Derbal-Mokraneetal. [58] simulated the yearly enactment of [Hassi R'Me] [lHTF-ISCCS] using the (TRNSYS) program. Both solar area and conservative (CC) applications have made use of the Solar Thermal Electric Component (STEC) model library. According to the data, the (PP) can produce 150-MW with a 52 percent efficiency. The solar component was discovered to be around 30-MW of the entire (PP) production.

Behar et al. [59,60] advanced a math-program in visual FORTRAN to analyze the functionality of the [Hass R'Mel] I-S-C-C-S. They planned an [HTF-ISCCS] with a straightforward pressure level. A massive steam turbine with a maximum output of 80 MW, 247 gas turbines, and a solar area with a reflecting zone of 183,120 m^2 make up the proposed power station. they observed that the (PP)'s production and effectiveness respond rationally to solar-thermal-energy-input, and that performance improves as (SE) input increases. At the project idea, the HTF-electricity ISCCS's creation and effectiveness outperformed those of the combined cycle (PP) (134-MW, $575x10^{-1}$ percent) by sevsnteen percent and $165x10^{-1}$ percent, respectively, corresponding to 157-MW and 67-percent.

Elhajetal [61] used Visual Basic 6.0 to develop a math-model to anticipate the advantages of converting an existing G-turbine in Misuratacity in [HTF-ISCCS] for Lybia. The Desal Solar 1.0 software data set was used to get the city's climate data, and the steam parameters were estimated using the CATT2). They looked into how the suggested integrated solar combined cycle system would perform in relation to solar concentration ratio and HSSG efficacy. In expressions of energy output and thermal effectiveness, it has been found that transforming a basic Brayton cycle into an ISCCS has a number of advantages.

Once more, Elhajetal [62] investigated how the solar area, G-turbine, and S-turbine impacted the enactment of an [HTF-ISCCS]. They attentive on the influence of efficiency, the contribution of (SE) , and the primary plan information of these crucial (PP) constituents. The imitation findings show that the steam mass flow to HTF ratio has the greatest impact on the plant's performance. According to the performance analysis, solar area, S-turbine, and G-turbine effectiveness may reach 62.0 percent, 32 percent, and 40 percent, respectively. As a result, the overall plant efficiency might be 29percent.

Elhaj et. al [63] has once more looked at the exergy investigation of an [HTF-ISCCS]. The [HTF-SF] was planned to be made up of many 3 m^2 (PTC), whereas the CC (PP) had a single G-turbine and a R-cycle with an isentropic effectiveness of 80%. The writers conducted easily affected analyses on the influence of solar emission, surrounding temp., and compressor heaviness quotient on the exergy effectiveness of each (PP) parts. They found that the exergetic effectiveness increased with the compression ratio. Nonetheless, It was discovered that the solar area and the G-turbine combustor, which account for 33percent of the DNI for the solar area and 39 percent of the former's (FF) consumption, are the main reasons of exergetic wastage.

Bakos and Parsa [64] analyzed the impact of solar area dimension on the prices of the Southern Greece (PP) for Europe, focusing on the commercial study of (H-T-F,I-S-C-C-S). A 35MW G-turbine, a 15MW S-turbine, and a (PTS) field make up the I-S-C-C-S employed for this study. The solar area is anticipated to be between 30,000 and 180,000 square meters, with six fields of various sizes being inspected. The hourly fuel feeding and solar influence were modeled and simulated using TRNSYS-STEC software in two operating modes: fuel conservation and boosting. The results suggest that the fuel conservation mode may produce lesser LEC than improving mode. Additionally, the size of the solar area raises the price of producing electricity. The scientists found that the I-S-C-C-S will turn out to be financially viable even with a higher solar area if the cost of exported energy in Greece growths from ($50.26x10^{-3}$ €/kWh to $60x10^{-3}$ €/kWh).

Franchini et al. [65] matched the (TE) of (H-T-F,I-S-C-C-S) with a (PTT) to that of a (CRS) technology in the Seville weather (Spain.). To reach this, they used (TRANSYS-STEC) and Thermo-flex program to look at how CSP technology affected the ISCCS's thermal performance. The hourly simulation results demonstrate that the parabolic trough technology ISCCS can outperform the tower technology ISCCS during the summer because of higher solar area photosensitive effectiveness, i.e., the (PTS) field gathers extra solar radioactivity than the heliostats field with (TE)up to (sixty percent) on hot days. However, the yearly presentation imitation demonstrates that I-S-C-C-S using (TPT) products more electricity with greater efficiency than I-S-C-C-S using a parabolic-trough. The (CRT) offers a far larger annual continuous energy gathering than the PT method. It should be underlined that reliable solar input conserves greater presentation and removes the extra prices brought on by solar emission instability.

In their brief review of the study on (STPP) for (India), Siva-Reddy et al. [66] included PT, CR, and dish type (PP)s. The I-S-C-C-S has been painted somewhat. A cost-benefit analysis of CSP plants in the tropical environment of India is provided by the evaluation. When a thirty-year lifetime and a ten persent interest amount on deal are taken into account, it has been shown that the dish sterling approach produces lesser L-E-C than the other two solar strategies for a (50MW) CSP plant.

The position and rudimentary design information of the Beni Mathar and Kuraymat (I-S-C-C-S)s for (Morocco-Egypt) were provided by Brakmann [67]. In addition, he has shown how the latter performs in three operating modes as a function of environment temperature and solar-radiation amount, including, (1) power boosting, necessitates an oversized steam turbine, which increases price and slice load damages, (2) G-turbine throttling method, which results in fewer dissipate heat reaching the H-R-S-G when solar radiation is higher, and (3) extra solar heat removal method, which involves de-focusing some concentrators and therefore consequences in higher price and greater part load damages.

The Kuraym design data and building status at I-S-C-C-S, excluding the solar area and (CCPP), were reported by Brakmann et al. [69]. They have outlined the building procedure for the solar field. They have painted the building growth of the G-turbine part, the H-R-S-G, the H-S-S-G, the S-turbine, the chilling system, and the electric power system for the (CC). The record contains critical technical data.

Antoanzas-Torresetal. [70] studied the effect of D-N-I, solar area dimension, and environment temperature on the operation of the (H-T-F,I-S-C-C-S) working in power advancing method in the United States. To achieve this, two locations have been chosen: (Las-Vegas) with a greater D-N-I and (Ciudad-Real) with a lower D-N-I.

The atmospheric situations of both positions were determined by (Meteonorm), that offers a year's worth of hourly observations of D-N-I, airstream speed, and air temp. A (270MWe) G-turbine and a (130MWe) S-turbine make up the combined cycle. The ISCCS functions better on warm days when solar radiation is stronger, according to the imitation using a novel typical added to the SAM program. Furthermore, compared to CC (PP)s, performance increases with increasing sun exposure. In other words, the I-S-C-C-S performs better in (Las-Vegas) than in Ciudad Real due to higher D-N-I, whereas the CC (PP) in (Las-Vegas) performs worse than the one in (Ciudad Real) because of greater temps.

Turchi et al. [71] evaluated the presentation of (H-T-F,I-S-C-C-S) first with (TES) and second without (TES) to that of (S-E-G-S), the G-turbine dissipate is utilized to heat the (H-T-F) in the (I-S-C-C-S) with no storage and the (salt-HTF) in the one with (T-E-S). The (I-S-C-C-S) was modeled using the IPSE-process program, the SEGS was simulated using SAM, and the gas turbine performance was modeled using a code embedded in Excel. The findings show that, in the US climate, ISCCS without storage has the lowest cost of producing power, followed by ISCCS with storage. Furthermore, it has been demonstrated that the solar component of the special integration method may perform up to 64% better than any previous ISCCS design. On the other hand, it has been demonstrated that the suggested design's (TE) is only about 48%, significantly lower than the preceding design, which could reach up to 68%.

Dersch et al. [72] conducted a comparison analysis of the (I-S-C-C-S, S-E-G-S, and CC (PP)s) in several conformations. The effectiveness of 50 MW triple pressure-reheat (PP)s was examined in relation to the (DNI), solar area, (TES), and operating mode. The investigation was carried out using commercial tools, Gate Cycle and (IPSEpro). The result show that the (I-S-C-C-S) has the maximum (TE) when matched to the other. Extra specifically, (I-S-C-C-S) efficiency is substantially better than (S-E-G-S) efficiency (68.6 percent for I-S-C-C-S vs. 34.7 percent for S-E-G-S), yet S-E-G-S emits less G-H-G, particularly in advancing style.

Siva Reddy et al. [73] have matched the presentation of a (CCPP) to that of an (H-T-F,I-S-C-C-S) with a linear (Fresnel-solar-field). To do this, the scientists created a computer program with EES Software. The chosen (CC) is considered to consist of two G-turbines, one multi pressure heat retrieval vapor producer, and one over-sized S-turbine. They also provided a precise mathematical-explanation of the CC as well as the solar field. According to the CC's energy study, the condenser experiences the largest energy losses, followed by the HRSG, and the combustion chamber experiences the largest energy losses.

To discover the ideal (integrated-plant) structure with 3 distinct pressure ranks, Kely et al. [74] used the Gate Cycle program. They looked examined how the power cycle is affected by the use of (SE) , as well as how unlike solar area dimensions and heat retrieval G-generator types respond to ambient temperature on the presentation of (PP)s. The results of the simulations demonstrate that the (I-S-C-C-S) design is powerfully influenced by the strength of the solar area. For instance, a solar contribution of 1% to 2% per year can produce 40–42% solar electricity efficiency. However, the solar contribution increases with increasing solar area and, thus, solar influence. Growing the solar input to nine percent can cause the net exchange effectiveness to fall to between 32 and 35%.

Guna Sekaran et al. [75] examined 4 distinct formations of (H-T-F,I-S-C-C-S) with Carbon-Capture.The writers used the Rankine cycle's steam (ASPEN-CUSTOM) to replicate the solar system, while JACOBIAN and ASPEN PLUS control the (PP) mode. The findings demonstrate that the arrangement that utilizes (SE) for intermediate-pressure water/steam heating or evaporation generates more electricity than the selected methods.

Cau and colleagues [76] developed an progressive (H-T-F,I-S-C-C-S) conception. that makes use of carbon dioxide as a heat transfer fluid. The suggested authority plant is made up of (250MW) triple pressure turbines. They have utilized the Gate Cycle program for thermal presentation and price analysis. Because this program lacks a (C-S-P) systems archive, the writers created a novel typical for the solar field. 2 technologies are studied and compared for turning solar thermal energy into electricity. In example (1), (SE) was utilized to preheat, evaporate, and superheat (water/vapor), but in case (2), (SE) was used to generate steam. According to the thermal performance analysis, the efficiency of (SE) conversion is about (23-25) percent for a CO2 maximum temp. of (550 ^{o}C) and approximately (1.5-2.0) percent at a temp. of 450 ^{o}C.

AlSulaiman [77] was intrigued by the exergy study of the new HTF-ISCCS, a (PTS) field connected to the organic and steam R-Cycle makes up the HTF-ISCCS plant. A code has been incorporated into (EES) to quantify exergetic presentation, excluding (effectiveness- exergy devastation amount- fuel depletion ratio- irreversibility ratio- improvement potential). Seven working fluids (R134a- R152a- R290- R407c- R600- R600a- ammonia) have been examined and their performance for the (organic cycle) compared.

4.1.2. Coal fired-ISCCS.

To incorporate (D-S-G) strategy into the R-cycle. Montes et al. [78] examined the performance of a (220MW) (DSG-ISCCS) (PP) in contrast to a pure (CCPP) in two distinct weather styles, namely (Almeria-Spain) with a (Mediterranean) environment and (LasVegas-US) with a hot-dry weather. The simulation using the well-known program TRANSYS showed that while the (D-S-G,I-S-C-C-S) has better presentation in Las-Vegas than in (Almeria) due to solar hy-bridization, the (CCPP) has worse presentation in Las Vegas due to higher temp. Additionally, at 52.18% and 51.90%, respectively, the (D-S-G,I-S-C-C-S) in Las Vegas has a better global efficiency than Almeria.

DSG-ISCCS implementation has been proposed by El-Sayed [80]in Kuraymat, Egypt, The projected (PP) had a (30MW) G-turbine, a (65MW) S-turbine, and a $190x10^3$ m^2 solar area, that equated to (90MW) of STE at the design point of (720 W/m^2) solar radioactivity. Both the (power-boosting and fuel-saving) methods were used for the analysis. According to the operation mode, the author's research on the ISCCS cost benefit ratio revealed values between 1.25 and 1.35. He also concluded that fuel saver mode is more expensive than power boosting. Additionally, the sensitivity analysis showed that DSG-ISCCS might be financially viable if solar area costs decrease and natural gas expenses increase.

Elsaket [81] created a arithmetic method for modeling DSG-ISCCS performance under Libyan environmental circumstances. The research focuses on employing direct steam production technologies to convert the existing 451 MW B-cycles into an (ISCC). The author has published the complete mathematical formulations of every element in addition to the flow diagrams of the generated program. In Libyan conditions, the solar area had an effectiveness of about 0.78.

Li and Yang [82] presented & studied a 2-stage solar feedback (D-S-G,I-S-C-C-S) under Yulincity in China. A single G-turbine, a double pressure-single re-heat (H-R-S-G), and an enormous S-turbine make up the plant. They enhanced and evaluated the hourly, monthly, and annual presentation of the suggested conformation using the (ASPEN-PLUS) process imitation program. The mass and energy equilibrium are used to imitate the components, while the (RK-SOAVE) and (STEAM-TA) prototypes are used to approximate the thermal and thermodynamic properties. The meteorological year data base is used to produce the atmospheric metrics, containing DNI, airstream velocity, and other climate situations. The optimization determined that 16 bar and 560 °C, respectively, are the ideal design pressure and temperature for the re-heat and low-pressure vapor at the project opinion.

Craigetal. [83] suggested a fresh (I-S-C-C-S) idea that merges a (PTSF) with a (CCPP) at the Brayton cycle grade. The authors claim that they have shown the viability of the suggested technique, that has a great degree of trustworthiness and little commercial danger. It has been discovered that integrating a (100MW) solar thermal energy into a (40MW) aero-derivative G-turbine improves presentation and results in a solar fraction of roughly (57-59) percent.

Livshits and Kribus [84] proposed a new approach for improving the thermodynamic performance of a steam injection gas turbine by using solar radiation collected by a medium-temperature (PTS) field. The suggested plan involves the installation of a condenser to collect and recycle the inserted water, reducing water use. They modeled the insignificant performance of 4 commercial G-turbines using Honeywell Unisim process software, namely the Solar Centaur 40-T 4700 (3.51 MWe), the GELM 2000 (17.56 MWe), the GELM 6000PC (43.57MWe), and the Mitsubishi 701 G (334MWe).

4.1.3. (HTF-ISCCS) vs. (DSG-ISCCS)

Nezammahalleh et al. [85] conducted a comparison analysis of three (PP) strategies, namely (D-S-G,I-S-C-C-S), (HTF-ISCCS), and (HTF-SEGS), with alike project information to those used by Hoseini et al. [7]. They discovered that the (DSG-ISCCS) outperforms the other two (PP)s. Its (LEC) has been 2.93 percent lesser than (HTF- ISCCS) because to reduced exploitation expenses, greater (TE), and lower (O & M) expenses. Furthermore, as compared to ISCCS-HTF, the DSG-ISCCS may save around 46000000 dollars in (FF)s for the duration of a 30-year lifespan.

Baghrnejad and Yaghobi [86] used multi objective evolutionary procedures to find the best answers that meet both exergetic and commercial goals for 400 MWISCCS in (Yazd- Iran). In the solar area, the situations of employing air-water- -oil, as a heat transfer fluid have been examined and contrasted. The findings show that the suggested optimization method can increase energy effectiveness by 3.2percent while reducing price rate by 3.82percent.

Rovira et al. [87] investigated and contrasted (DSG-ISCCS) and (HTF-ISCCS), taking into account several techniques for incorporating (SE) into the combined cycle. The solar area is 50 MWth, and the (CCPP) is 110MWe with a single 73MWe G-turbine and double pressure grade (HRSG) devoid of re-heat. The authors investigated four ISCCS technology combinations. (SE) is used for vaporizing vapor, pre-heating and evaporation of water/vapor. For all configurations, they also performed 3 other rapprochement: constant solar area with a 50MWth output, identical solar area, and hy-brid solar area.

To determine which technology would be implemented in Egypt, Horn et al. [88] examined the Trough(HTF-ISCCS) and the Air-Tower(ISCCS) on both a technical and financial level. They came to the conclusion that the previous is extra cost-effective cause the (LEC) for the solar component is (9.5US cents per kWh), as opposed to 10.2 US cents per kWh for the Air-Tower-ISCCS. Additionally, according to the environmental analysis, the (HTF-ISCCS (PP) emits around 200t/year less carbon-dioxide than the Air-Tower idea.

Two innovative configurations have been put out by Popov [89] for compared to the (HTF-ISCCS) in the (San-Bernardino) County, California, US environment. In the suggested configuration, the gas turbine's intake cooling system is powered by (SE) . The G-turbine cove is outfitted with a mechanics cooler driven by photo-voltaic sheets in the first proposed configuration, while the cove freezing organism is talented with an sucking cooler delivered with a (DSG) Linear Fresnel solar area in the second. Thermo-flex program was utilized by the author, who concentrated on the total (TE)and exploitation price of the chosen facilities.

4.2. Coal fired-ISCCS

4.2.1. HTF-ISCCS.

Yang et al. [90] investigated 8 alternatives for incorporating thermal energy gathered by a (PT) solar area into a 200MW (SAPG) plant in all power boost up and fuel reserve process styles. The drain-off vapor is partially or completely changed by (STE) transported by the (Oil-HTF) in each combination pattern to a normal coal-fired power station. The authors discovered that at 260 1C and 215 1C, the solar to power effectiveness is 36.58% , 25.48%, respectively.

Peng et al. [91] examined the design performance of a 330MW solar-coal power station. According to reports, the latter is situated in China, and the atmospheric data is from the System Advisor Model (SAM) library. Numerous factors, including as the period of year, the (HTF) mass flux, and the replaced ratio of removed vapor, have all been exhaustively investigated for their effects on plant performance. In this investigation, three operating steam turbine loads were investigated to observe the effect of freight on net solar-to-electricity effectiveness, namely 100percent, 75percent, and 50percent of turbine minimal load.

Peng et al. [92] matched a 330MW solar-coal power station to (SEGS) and offered a brief commercial investigation. This was accomplished using the well-known simulation tool ASPENPLUS. They used the energy use chart technique to analyze the off-design performance of the two plants and establish that the hy-brid solar-coal (PP) has higher exergy and solar-to-electricity efficiency compared to SEGS and lesser exergy devastation in the solar provender water heater and S-turbine. It has also been discovered that the hybrid coal-fired (PP)'s solar exergy efficiency and solar-to-electric efficiency are around 1.3% and 1.4% greater than those of the sole solar plant, respectively.

4.2.2. (DSG-ISCCS)

Gupta and Kaushik [93] evaluated the presentation of a 220MW coal-solar thermal (PP) to that of a 50kW(STPP). They found that the latter performs healthier than the former, especially in terms of effectiveness.

4.2.3. (HTF-ISCCS) and (DSG-ISCCS)

Suresh et al. [94] conducted an energy, exergy, commercial, and environmentally friendly study of solar-thermal assisted coal-fired sub-critical and super-critical steam (PP). They chose to research two solar technologies, (HTF) strategy and (DSG) strategy, and they certain a 500MWe sub-critical plant and a 660MWe super-critical (PP). Cycle Tempo, a flow-sheet computer application, was utilized for thermodynamic forming and investigation. The presentation imitation results suggest that replacing turbine-bleed-streams with Solar-assisted feed water heating in both sub-critical and super-critical steam (PP) increases fuel feeding by (5-6percent) and saves (14-19percent) of coal. Solar thermal energy has been proven to be more efficient for feed water heating. In terms of the environment, the 500 MWe Sub C and 660 MW e Sup C coal-fired (PP)s may save around 62,000 and 65,000 t of CO2 per year, separately.

Yang et al. [95] studied the presentation of several assimilation strategies using (DSG-SF) and (HTF-SF) in conjunction with a 300MW solar-coal-fired power generation facility. They examined all assimilation technique and discovered that integrating (SE) at greater temperatures improves conversion efficiency. The results also reveal that SACPG can save around (4302.8t/year) of charcoal.

5. Examining and contrasting.

5.1. Growth in (R & D) undertakings

Research and development in hy-brid (STPP) is significantly linked to (FF) pricing and energy procedure [30,74]. Since the invention of such a theory by Alani et al. in 1997, (R & D) activities for I-S-C-C-S, which suggestions the supreme cost-effective means of exchanging (SE) into electricity, have increased fast. the progress of published publications on the I-S-C-C-S, containing practicality assessments and (energy-exergy-economics-environment) analyses. More specifically, we have identified four-stages in the progression of (R & D) activity.

The 1st stage, [1997 – 2003], shows an increase in (R & D). They effort in their primary stages, and as a result, little research were available. This is owing to decreased (FF) costs, the great price of solar-systems, and a absence of management support in the formula of provender in rates and tax exemptions. The incorporation of (SE) into the (CC) has been the topic of available revisions with the goal of determining the best I-S-C-C-S design. The optimal arrangement has been discovered to use (SE) to generate vapor to power a R-cycle.

The 2nd stage, [2003 – 2007], saw a tremendous and exponential increase in interest in the ISCCS. In only 4 years, the proportion of printed articles has increased to forty present. This development has been aided by management subsidies and the implementation of national & international (RE) initiatives in several wealthy and increasing nations. Furthermore, massive undertakings, including Desertec, have paved the way for such sophisticated technologies to make the concept more competitive. The growth in the cost of (FF)s has also had a role in this period. The writers concentrated on the 3E (energy, economics, and environment) evaluation. In terms of energy, the results show that the ISCCS may provide significant benefits over other (PP) technics such as (S-E-G-S) and simple G-turbine, while the CC stays the top huge scales power production technology.

The 3rd stage, [2008-2010], saw a surge in interest. Exergy and exergeo economic investigation have been offered as advanced assessment approaches. During this time, In various plans were under creation or progress. The area of the (MENA), notably in [Egypt-Algeria-Morocco]. These I-S-C-C-Ss have a lower population. The last-stage arises in 2011 and corresponds with the establishment of several I-S-C-C-Ss such as [Beni-Mathar], [HassiR'Mel], and others. In 2011, 20% of entire articles were printed. In [2014], we noticed that several nations, such as [China], have lately indicated interest in hy-brid(STPP)and have considerably sponsored R&D operations. The quantity of published research is a reliable measure of this.

5.2. Published papers summary.

The majority of researchers have chosen to conduct their studies in the Sahara desert (Algeriaa-Egypt-Libya-Morocco-Tunisia). The others have included Iran-US-Spain-Mexico-China. This is owing to the vast latent of these places in terms of SR and fossil-origins , which facilitate the installation of hy-brid (PP)s. This is backed up by active, below creation & proposed I-S-C-C-S in the aforementioned nations. We examined the articles that were studied and we discovered some really intriguing outcomes. Because of the parabolic trough Because technology cannot support greater operating temperatures, (SE) was utilized to produce saturated steam, which was used to power theTo increase the performance of the R-cycle or the B-cycle, greater than ninety five percent of the writers were including the (PTT). (PTT) has been included into contemporary S-turbines. R-cycles of various lengths have been scanned, including basic heaviness levels, dual heaviness levels, three heaviness levels, as well as sub-critical and super-critical rotations, all of which show great promise for improving efficiency and reliability. As a result, ISCCS technology will become more economical.

Nonetheless, the incorporation of (SE) into the B-cycle has recently been offered as a means of improving the achievement of a solar hy-brid (SIGT). The achievement investigation has proved the concept's latent, particularly when paired with small-price solar concentrators.

Several writers ensure concentrated on predicting the performance of ISCCS power stations. Technical reviews have been undertaken since the commencement of various projects, such as Yazd and HassiR'mel. Comparative research has also been intriguing. This contains a contrast of the I-S-C-C-S to other (PP) systems including G-T, C-C, S-E-G-S, and the interior receiver. The consequences have validated the ISCCS's attractiveness with (PTT).

The majority of I-S-C-C-Ss were observed to use natural fuel for hy-bridization. Natural gas has been mentioned in around 75% of all published studies (N-G). This is for the reason that to its cheaper prices when matched to other (FF). Furthermore, natural fuel is one of the dirt free (FF)s, allowing for superior performance than coal. When matched to environmentally kindly re-newable foundations such as bio-mass and geo-thermal, natural fuel provides the greatest cost-effective and proficient solutions, hence supporting the improvement and attractiveness of I-S-C-C-S strategy. Energy sources described earlier, namely natural-gas, coal, and re-newable, are employed or suggested for hy-bridizing the I-S-C-C-S. There is less importance in incorporating (SE) into a coal fired (CCPP). This is undoubtedly connected to the green consequences of coal-ISCCS and the greater exploitation prices of coal I-S-C-C-S matched to N-G I-S-C-C-S. There is apparently fewer attention in combining I-S-C-C-S with re-newables. From the total number of published publications, no more than 9% were discovered. This is owing to their greater prices; the expense of the hy-brid basis growths as the LEC growths, which reduces the economics of the I-S-C-C-S.

5.3. Key R&D finding and comparison

(R&D) event is a primary driver for CSP plant technological advancement and cost reduction [12].. Approximately bisection of the papers available deal for energy investigation since it is an significant instrument to forecasting ISCCS effectiveness and matching it to that of G-T,C-C,S-E-G-S, and (CRS). The performance of I-S-C-C-Ss in Sun Belt nations with Hot-Dry climates was a key conclusion of the energy study. It has been discovered that the I-S-C-C-S idea is capable of outperforming the (CCPP). Furthermore, I-S-C-C-S performs better than that of the C-C, G-T, and S-E-G-S when solar radiation concentration is higher and hence environmental temperature is higher. The L-E-C of I-S-C-C-S is weaker economically compared to that of S-E-G-S, and the poorest is the one of the (C-C-P-P). Furthermore, advances in (R & D) and the ongoing increase in (FF) expenses would position the I-S-C-C-S as the prefer option in the nearby future. It was highlighted that the combined cycle, which is the most affordable and efficient power technology now present, has been utilized as a standard by the minority of authors (PP) in their town evaluations. It was determined that the (PTT) still gives lower L-E-C than the C-R-S. In terms of the environment, the only solar (PP), like S-E-G-S, has demonstrated the capacity to minimize environment variation and GHG releases. Furthermore, the I-S-C-C-S is extra favorable than the (CC) for lowering environment dangers, especially if influential efforts are implemented.

5.4. Methods applied for modifying the ISCCS

Beforehand executing any (R & D) assignment, investigators frequently employ imitation tools. For estimating the performance, imitation technologies have been used for calculating the performance of energy systems, resulting in lower investment hazards. An in-depth examination of the examined publications reveals that the majority of the authors have created their own tools for Using a parabolic trough to forecast the performance of ISCCSs technology. This is due to the fact that such a technology was just recently introduced. As a result, there is a scarcity of effective and controlling tools for simulating the whole I-S-C-C-S. However, comparable attempts may be made help with the creation of complex programs and software.

Because there are few instruments for forecasting the whole station performance, some writers have explored the primary ingredient of the I-S-C-C-Ss. Some writers have utilized Gate Cycle and Cycle-Tempo to simulate the (PCS), that comprises the G-turbine and the S-turbine. Based on (MEB), these programs model the achievements of the P-C-S. Off-design performance is also included. A graphical user interface, similar to TRNSYS, may be employ to build P-C-Ss and arrive-data. This latter has been used to represent various transitory ISCCS behaviors with integrated ingredients. Besides the programes mentioned above, the (SAM), which integrates hourly imitation representations with exhibition, price, and economics prototypes to predict production, prices, and cash-currents, was used to investigate the ISCCS. Recently, two sophisticated software programs, ASPENPLUS and Thermoflex, were developed to simulate the whole ISCCS configuration. As a result, the most recent published studies have made use of these software packages. Many mathematical tools and methodologies have been seen to be used for optimization purposes. Kane et al. used tweak strategy with a thermodynamic-molding approach to improve the Rankine cycle's pressure levels and temperatures. Furthermore, a pinch technology technique was used in conjunction with a programing and algorithms to minimize the tweak point caused by integrating a (PTS) field into a contemporary combined cycle (PP). Baghernejad. and Yaghoubi. concentrated on the ISCCS's exergy and cost study and discovered good findings.

6. Conclusion

The I-S-C-C-S using (PTT) has been analyzed in this research. The state of existing, under creation, and strategic (PP)s has been underscored, as have the significant findings of R & D operations and available revisions, which have been described and analyzed in depth. It have been seen an exponent surge in R & D efforts as well as ISCCS implementation. Several patterns have been planned and tested for achievement. Involve (SE) hybridization with natural-gas and coal as well as renewables such as biomass and geothermal. The majority of the Several research have looked into the incorporation of (SE) at the level of the R-cycle. Other sophisticated ideas that A (PTS) area has been incorporated into a B-cycle. Lately, the solar-steam-injected-gas has been introduced. Turbine with a high implicit for (SE) improvement electricity proportion. The improvement of hybrid natural gas sun combination cycle NG-ISCCS has attracted a lot of attention and especially in the D.S.G-I.S.C.C.S strategy. The writers discovered that the D.S.G.-I.S.C.C.S outperforms the condition of the art H.T.F-I.S.C.C.S. Designing and imitation employing strong apparatuses and methodologies revealed that implementing the D-S-G idea would result in a 3percent decrease in L-E-C owing to cheaper exploitation and operation and manufacturing expense, as well as greater thermal efficiency. Furthermore, as compared to the HTF-ISCCS, the DSG-ISCCS may save a 100 million dollars in (FF) s through its lifespan. In terms of the environment, the DSG idea provides for a $25x10^{-1}$% decrease in G-H-G releases. However the S-E-G-S is still the greatest environmentally friendly (PTS) thermal (PP) technology available today.

According to the findings of current analysis research:

1. As the performance of the solar area become more efficient, the operating temperature increase and the efficiency.
2. When the solar area is small the exergy efficiency will increase.
3. The performance of the steam cycle increases with increasing steam pressure level and number of feed water heaters.
4. The cost of the electricity generated decreases with plant size.
5. ISCCS effectiveness increases as fossil fuel costs rise.

Quick development in I-SCCS R-&-D projects has made it possible to build extremely effective and affordable configurations. I-SCCS is gaining popularity as fuel resource reserves and prices rise in light of this as well as the continued drop in the price of fossil fuels than conventional combined-cycle power plants in terms of cost-effectiveness In the near future, it may potentially emerge as the standard technology.

References

[1] World Energy Outlook. Executive summary. ⟨http://www.worldenergyout look.org/⟩; 2013.

[2] Energy Policy. ⟨http://www.iea.org/publications/freepublications/publication/Energy_Policy_Highlights_2013.pdf⟩; 2014.

[3] World Energy (origines . http://www.worldenergy.org/wp-content/uploads/ 2013/09/Complete_WER_2013_Survey.pdf; 2013.

[4] Behar Omar, Kellaf Abdallah, Mohammedi Kamal. A review of central receiver solar thermal (PP)s. Renew Sustain Energy Rev 2013;23: 12–39.

[5] Sharma Naveen, Varun, Siddhartha. Stochastic techniques used for optimization in solar systems: a review. Renew Sustain Energy Rev 2012;16:1399–411

[6] Pierre Garcia, Alain Ferriere, Jean-Jacques Bezian. Codes for solar flux calculation dedicated to central receiver system applications: a comparative review. Sol Energy 2008;82:189–97

[7] Antonio L Ávila-Marín. Volumetric receivers in(STPP)with central receiver system technology: a review. Sol Energy 2011;85: 891–910.

[8] Tian Y, Zhao CY. A review of solar concentrators and thermal energy storage in solar thermal applications. Appl Energy 2013;104:538–53.

[9] Mekhilef S, Saidurb R, Safari A. A review on (SE) use in industries. Renew Sustain Energy Rev 2011;15:1777–90.

[10] Thirugnanasambandam Mirunalini, Iniyan S, Goic Ranko. A review of solar thermal technologies. Renew Sustain Energy Rev 2010;14:312–22.

[11] Barlev David, Vidu Ruxandra, Stroeve Pieter. Innovation in concentrated solar power. Sol Energy Mater Sol Cells 2011;95:2703–25.

[12] Pitz-Paal R, Dersch J, Milow B. European concentrated solar thermal roadmapping (ECOSTAR): roadmap document. SES6-CT-2003-502578.

[13] Technology Roadmap Concentrating Solar Power. IEA. ⟨http://www.iea.org/ papers/2010/csp_roadmap.pdfS⟩; 2010.

[14] Li Jun. Scaling up concentrating solar thermal technology in China. Renew Sustain Energy Rev 2009;13:2051–60.

[15] Behar Omar, Kellaf Abdallah, Mohammedi Kamal. Scaling up hybrid solar gas turbine: simulation and results. SEN2012. Alger (Algeria); 2012.

[16] Behar Omar, Kellaf Abdellah, Mohammedi Kamal. 50 MW hybrid solar gas turbine: simulation and performance, ICRE2012. Bejaia; 2012.

[17] Evaluating Policies in Support of the Deployment of Renewable Power. IRENA. 2012.

[18] Triebn Franz, Schillings Christoph, Pregger Thomas, O'Sullivan Marlene. Solar electricity imports from the Middle East and North Africa to Europe. Energy Policy 2012;42:341–53.

[19] (RE) Technologies. Cost analysis series. Concentrating solar power, vol. 1. Power sector issue 2/5. IRENA; June 2012.

[20] Trieb Franz, Muller-Steinhagen Hans, Kern Jurgen. Financing concentrating solar power in the Middle East and North Africa – subsidy or investment? 2011;39:307–17Energy Policy 2011;39:307–17. [21] Larraın Teresita, Escobar Rodrigo, Vergara Julio. Performance model to assist solar thermal (PP) sitting in northern Chile based on backup fuel consumption. Renew Energy 2010;35:1632–43.

[22] ⟨http://en.wikipedia.org/wiki/Hassi_R'Mel_integrated_solar_combined_cycle_ power_station⟩.

[23] ⟨http://portail.cder.dz/spip.php?article1456⟩. [24] ⟨http://www.solarpaces.org/News/Projects/Algeria.htm⟩.

[25] ⟨http://www.abengoasolar.com/web/en/nuestras_plantas/plantas_en_opera cion/argelia/index.html⟩.

[26] ⟨http://www.solarnovus.com/index.php?option=com_content&view=article&id=3919:on-site-integrated-solar-combined-cycle-power-plant-of-kuray mat&catid=38:application-tech-features&Itemid=246⟩.

[27] ⟨http://www.nem-group.com/EN/projects/solar_power/6/al_kuraymat/8/⟩.

[28] http://www.afdb.org/fileadmin/…/Ain%20Beni%20Mathar%20français.pdf.

[29] ⟨http://news.tavanir.org.ir/press/press_detail.php?id=14714⟩.

[30] ⟨http://payvand.com/news/07/apr/1132.html⟩.

[31] ⟨http://www.CSP-World.com⟩. [32] SolarPACES. ⟨http://www.solarspaces.org⟩; 2012.

[33] ⟨http://en.wikipedia.org/⟩. [34] ⟨http://www.archimedesolarenergy.it/⟩.

[35] Giostri A, Binotti M, Astolfi M, Silva P, Macchi E, Manzolini G. Comparison of different solar plants based on parabolic trough technology. Sol Energy 2012;86(5):1208–21.

[36] ⟨www.Nerl.com⟩.

[37]⟨http://www.ptb.gov.kw/en/Al-Abdaliyah-Integrated-Solar-Combined-Cycle- (ISCC)⟩.

[38]⟨http://www.cityofpalmdale.org/departments/publicworks/power_plant/⟩.

[39] ⟨http://palmdale1.com/⟩.

[40] ⟨http://www.inlandenergy.com/projectv2.html⟩.

[41]⟨http://ksa.solarenergyseries.com/solar-energy-projects-in-kuwait/⟩.

[42]⟨http://www.researchandmarkets.com/reports/2309512/mew_al_abdaliya_ integrated_solar_combined_cycle⟩.

[43]⟨http://www.meedprojects.com/Regions/kuwait/power/mew-al-abdaliya-in tegrated-solar-combined-cyle-iscc-power-plant-7628.aspx⟩.

[44] Romero-Alvarez Manuel, Zarza Eduardo. Concentrating solar thermal power. Spain: Taylor & Francis Group, LLC; 2007.

[45] Lotker M. Barriers to commercialization of large-scale solar electricity: lessons learned from LUZ experience: informe Te´cnico SAND91-7014. Albuquerque (NM): Sandia National Laboratories; 1991.

[46] Price H, Luepfert E, Kearney D, Zarza E, Cohen G, Gee R, et al. Advances in (PTS) power technology. Int J Sol Energy Eng 2002;124:109–25.

[47] Feldhoff Jan Fabian. (DSG)(DSG) – technology overview. SFERA summer school. Almerá (Spain); 28 June 2012.

[48] Allani Y. CO2 mitigation through the use of hybrid solar-combined cycles. Energy Convers Manag 1997;38:661–7.

[49] Kane Malick, Favrat Daniel. Approche de conception et d'optimisation de centrale solaire intégré à cycle combine inspiré de la méthode du pincement (partie i: paliers de récupération). Int J Therm Sci 1999;38:501–11.

[50] Kane Malick, Favrat Daniel. Approche de conception et d'optirnisation de centrale solaire intégré cycle combine inspire de la méthode du pincement (partie i1: r seau d' changeurs de chaleur). Int J Therm Sci 1999;38:512–24.

[51] Kane Malick, Favrat Daniel, Ziegler K, Allani Y.

Thermoeconomic analysis of advanced solar–fossil combined (PP)s. Int J Appl Thermodyn 2000;4 (3):191–8.
[52] Hosseinia R, Soltanib M, Valizadeh G. Technical and economic assessment of the integrated solar combined cycle (PP)s in Iran. Renew Energy 2005;30:1541–55.
[53] Baghernejad A, Yaghoubi M. Exergy analysis of an integrated solar combined cycle system. Renew Energy 2010;35:2157–64.
[54] Baghernejad A, Yaghoubi M. Exergoeconomic analysis and optimization of an integrated solar combined cycle system (ISCCS) using genetic algorithm. Energy Convers Manag 2011;52:2193–203.
[55] Silveira JL, Tuna CE. Thermoeconomic analysis method for optimization of combined heat and power systems. Part I. Prog Energy Combust Sci 2003;29:479–85.
[56] Khaldi Fouad. Energy and exergy analysis of the first hybrid solar–gas (PP) in Algeria. In: Proceedings of the 25th international conference on efficiency, cost, optimization, simulation and environmental impact of energy systems. Ecos 2012. Perugia (Italy); 26–29 June 2012.
[57] Baghernejad A, Yaghoubi M. Energy, exergy and second law performance of parabolic trough concentrator integration into combined cycle system (ISCCS). In: Proceedings of the fourth international conference on thermal engineering: theory and applications. Abu Dhabi (UAE); 12–14 January 2009.
[58] Derbal-Mokranea Halima, Bouaichaoui Sofiane, El Gharbi Najla, Belhamel Mayouf, Benzaoui Ahmed. Modeling and numerical simulation of an integrated solar combined cycle system in Algeria. Procedia Eng 2012;33:199–208.
[59] Behar Omar, Kellaf Abdallah, Mohamedia Kamal, Belhamel Maiouf. Instantaneous performance of the first integrated solar combined cycle system in Algeria. Energy Procedia 2011;6:185–93.
[60] Behar Omar, Khellaf A, Mohammedi K. Hassi R'Mel hybrid solar thermal (PP): annual performance and advantages in Sahara desert. JST9. Oran; 2013.
[61] Elhaj Mohammed A, Matrawy Kassim K, Yassin Jamal S. Theoretical analysis of a solar combined cycle (PP). In: Proceedings of the 3rd BSME– ASME international conference on thermal engineering. Dhaka (Bangladesh); 20–22 December 2006.
[62] Elhaj Mohammed A, Matrawy Kassim K, Yassin Jamal S. Modeling and performance prediction of a solar powered RankineCycle/gas turbine cycle. In: Proceedings of the international conference on power engineering-2007. Hangzhou (China); 23–27 October 2007. p. 103–7.
[63] Elhaj Mohammed A, Matrawy Kassim K, Yassin Jamal S. Exergy analyses of solar integrated combined cycle (PP). Al -Satil :67–79.
[64] Bakos GC, Parsa D. Technoeconomic assessment of an integrated solar combined cycle (PP) in Greece using line-focus (PTC). Renew Energy 2013;60:598–603.
[65] Franchini G, Perdichizzi A, Ravelli S, Barigozzi. G. A comparative study between parabolic trough and solar tower technologies in Solar Rankine Cycle and Integrated Solar Combined Cycle plants. Sol Energy 2013;98:302–14.
[66] SivaReddy V, Kaushik SC, Ranjan KR, Tyagi SK. State-of-the-art of(STPP)– a review. Renew Sustain Energy Rev 2013;27: 258–73.
[67] Brakmann Georg. Integrated solar combined cycle (PP)s in Egypt and Morocco. In: Paper presented at clean energy power 2007. Berlin; 24 January 2007.
[68] Brakmann Georg, Berrehili Mohammed, Filali Khalid. ISCC ain beni mathar integrated solar combined cycle (PP) in morocco. In: Paper fa4-s6 presented at the 13th international symposium on concentrating solar power and chemical energy technologies. SOLARPACES. Seville (Spain); 20–23 June 2006.
[69] Brakmann Georg, Ameen Mohammad Fathy, Dolejsi Miroslav, Wiemann Mathias. Construction of the ISCC Kuraymat. In: Presented at the international symposium on concentrating solar power and chemical energy technologies. Solarpaces; 2009.
[70] Antoñanzas-Torres Fernando, Sodupe-Ortega Enrique, Sanz-García Andrés, Fernández-Martínez Roberto, Javier Martínez-de-Pisón-Ascacíbar Francisco. Technical feasibility assessment of integrated solar combined cycle (PP)s in Ciudad Real (Spain) and Las Vegas (USA). In: Proceedings of the XVI congreso internacional de ingeniería de proyectos. Valencia; 11–13 de Julio de 2012. p. 1282–891.
[71] Turchi Craig S, Ma Zhiwen. Co-located gas turbine/solar thermal hybrid designs for power production. Renew Energy 2014;64:172–9.
[72] Kelly Bruce, Herrmann Ulf, Jane Hale Mary. Optimization studies for integrated solar combined cycle systems. In: Proceedings of the solar forum 200. (SE) : the power to choose. Washington (DC); 21–25 April 2001.
[73] Siva Reddy V, Kaushik SC, Tyagi SK. Exergetic analysis of solar concentrator aided natural gas fired combined cycle (PP). Renew Energy 2012;39:114–25.
[74] Dersch Jü rgen, Geyer Michael, Herrmann Ulf, Jones Scott A, Kelly Bruce, Kistner Rainer, et al. Trough integration into (PP)s – a study on the performance and economy of integrated solar combined cycle system. Energy 2004;29:947–59.
[75] Gunasekaran S, Mancini ND, El-Khaja R, Sheu EJ, Mitsos A. Solar – thermal hybridization of advanced zero emissions power cycle. Energy 2014;65: 152–65.
[76] Cau Giorgio, Cocco Daniele, Tola Vittorio. Performance and cost assessment of integrated solar combined cycle systems (ISCCSs) using CO2 as heat transfer fluid. Sol Energy 2012;86:2975–85.
[77] Fahad A, Al-Sulaiman. Exergy analysis of (PTS) concentrators integrated with combined steam and organic Rankine cycles. Energy Convers Manag 2014;77:441–9. O. Behar et al. / Renewable and Sustainable Energy Reviews 39 (2014) 223–250 249
[78] Montes MJ, Rovira A, Muñoz M, Martínez-val JM. Performance analysis of an integrated solar combined cycle using (DSG)in (PTC). Applied Energy 2011;88:3228–38. http://dx.doi.org/ 10.1016/j.apenergy.2011.03.038.
[79] Montes MJ, Rovira A, Muñoz M, Martínez-Val JM. Proposal of an integrated solar combined cycle system using (DSG)technology. In: Proceedings of the 15th international solarPACES symposium on solar thermal concentrating technology. Berlin (Germany); 2009.
[80] Mohamed AH El-sayed. Solar supported steam production for power generation in Egypt. Energy Policy 2005;33:1251–9.
[81] Elsaket Gamal. Simulating the integrated solar combined cycle for (PP)s application in Libya [Master thesis]. School of Engineering, Cranfield University; 2007.
[82] Li Yuanyuan, Yang Yongping. Thermodynamic analysis of a novel integrated solar combined cycle. Appl Energy 2014;122:133–42.
[83] Turchi Craig S, Ma Z, Erbes M. Gas turbine/solar parabolic trough hybrid designs. In: Proceedings of the NREL/CP-5500-50586. 2011.
[84] Livshits Maya, Kribus Abraham. Solar hybrid steam injection gas turbine (STIG) cycle. Sol Energy 2012;86:190–9.
[85] Nezammahalleh H, Farhadi F, Tanhaemami M. Conceptual design and techno-economic assessment of integrated solar

combined cycle system with DSG technology. Sol Energy 2010;84:1696–705.
[86] Baghernejad A, Yaghoubi M. Exergoeconomic analysis and optimization of an Integrated Solar Combined Cycle System (ISCCS) using genetic algorithm. Energy Conversion and Management 2011;52:2193–203. http://dx.doi.org/10.1002/er.1715.
[87] Rovira Antonio, José Montes María, Varela Fernando, Gil Mónica. Comparison of heat transfer fluid and (DSG)technologies for integrated solar combined cycles. Appl Therm Eng 2013;52:264–74.
[88] Horn Mechthild, Fü hring Heiner, Rheinlä nder Jü rgen. Economic analysis of integrated solar combined cycle (PP)s a sample case: the economic feasibility of an ISCCS (PP) in Egypt. Energy 2004;29:935–45.
[89] Popov Dimityr. Innovative solar augmentation of gas turbine combined cycle plants. Appl Therm Eng 2014;64:40–50.
[90] Yang Yongping, Yan Qin, Zhai Rongrong, Kouzani Abbas, Hu Eric. An efficient way to use medium-or-low temperature solar heat for power generation e integration into conventional (PP). Appl Therm Eng 2011;31:157–62.
[91] Shuo Peng, Hui Hong, Yanjuan Wang, Zhaoguo Wang, Hongguang Jin, et al. Off-design thermodynamic performances on typical days of a 330 MW solar aided coal-fired (PP) in China. Appl Energy 2014. http://dx.doi.org/10.1016/j.apenergy.2014.01.096, in press.
[92] Shuo Peng, Zhaoguo Wang, Hui Hong, Da Xu, Hongguang Jin, et al. Exergy evaluation of a typical 330 MW solar-hybrid coal-fired (PP) in China. Energy Convers Manag 2014. http://dx.doi.org/10.1016/j.enconman.2013.12.073, in press.
[93] Gupta MK, Kaushik SC. Exergetic utilization of (SE) for feed water preheating in a conventional thermal (PP). Int J Energy Res 2009;33 (6):593–604.
[94] Suresh MVJ, Reddy KS, Kolar Ajit Kumar. 4-E (energy, exergy, environment, and economic) analysis of solar thermal aided coal-fired (PP)s. Energy Sustain Dev 2010;14:267–79.
[95] Yang Yongping, Cui Yinghong, Hou Hongjuan, Guo Xiyan, Yang Zhiping, Wang Ninling. Research on solar aided coal-fired power generation system and performance analysis. Sci China Ser E: Technol Sci 2008;5(8):1211–21.

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