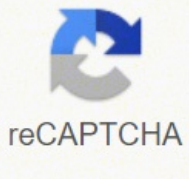




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# Optimal Planning of Integrated Energy Systems Based on Coupled CCHP

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**Abstract:** With the widespread attention on clean energy use and energy efficiency, the integrated energy system (IES) has received considerable research and development. This paper proposed an electricity-gas IES optimization planning model based on a coupled combined cooling heating and power system (CCHP). The planning and operation of power lines and gas pipelines are considered. Regarding CCHP as the coupled hub of an electricity-gas system, the proposed model minimizes total cost in IES, with multistage planning and multi-scene analyzing. Renewable energy generation is also considered, including wind power generation and photovoltaic power generation. The numerical results reveal the replacing and adding schemes of power lines and gas pipelines, the optimal location and capacity of CCHP. In comparison with conventional separation production (SP), the optimization model which regards CCHP as the coupled hub attains better economy. At the same time, the influence of electricity price and natural gas price on the quantities of purchasing electricity and purchasing gas in the CCHP system is analyzed. According to the simulation result, a benchmark gas price is proposed, which shows whether the CCHP system chooses power generation. The model results and discussion demonstrate the validity of the model.

**Keywords:** distribution power network; distribution gas network; IES; optimization; planning

## 1. Introduction

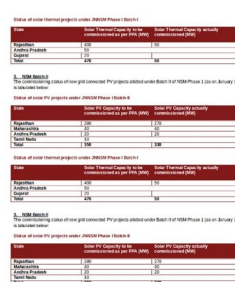
Owing to low capital costs, high thermal efficiency, and relatively low fuel cost, natural gas-fired generation is more attractive than traditional fossil units. According to the Energy Information Administration [1], natural gas consumed by the electric power sector has shown a sharp growth from 22.3% in 2000 to 34.1% in 2017. At the same time, the interactions between electrical and gas systems have become tighter [2,3]. Based on this background, it is necessary to regard the electrical and gas systems as an integrated energy system (IES) [4,5].

Specifically, IES refers to the energy integration system formed by the optimization of energy production, transmission, distribution, conversion, consumption, and storage in the process of planning, design, construction, and operation. IES can bring a great number of benefits, which mainly include complementary strengths of diverse energy systems for system operation and design, facilitating the integration of local renewable and sustainable energy resources, carbon emission reduction by increasing the whole system reliability and energy efficiency, improved system reliability and resilience [6].

Research of IES is presently increasing, and many scholars have explored in the aspect of energy flow, reliability and flexibility evaluation, system planning and operation schedule. Reference [7–11] analyzed energy flow in a coupled electricity and natural gas system. Reference [7] proposed a mixed-integer linear programming (MILP) method to calculate optimal power flow (OPF) and

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Al-Thobaiti, IMAN I. Manual load control using 8051 microcontroller 19. References - Implementation of the home-based Zigbee-GSM Safety Monitoring and Remote Control System (2011) SM Carelin Felix School of Electrical Engineering Noorul Islam Center for higher education Kumaracoil, India - 629180. Jacob Raglend (2011) is Bluetooth-based home automation system using mobile phone by r.piyaru, m. Tazil is Wireless home automation system using Zigbee by S. Project Timeline Literature Review Review Flowchart Simules Simulation Hardware Development GUI Development Temperature Sensor to Control Air Conditioning Photo Sensors to Control Light Intensity Artificial Intelligence 21. PC Application Control Android Based Control GSM Based Notifications 9. Al-Rousan Overcoming this obstacle includes the use of software programs that help optimize the processes of workflows and paperwork retention. 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Design andImplementation of a Wireless Home Automation SystemBased on ArduinoUno - The System is designed to control the appliances using MATLAB GUI. There are two modes of manual operations and self-control. Abosolaiman, Mahdi H. The main reason is that there are tangible gains through productivity, increased efficiency through the use of resources in the company, the reputation of business occurs through the loyalty of the company, turnover rates are reduced by increasing employee morale, the growth of the company is encouraged through challenging goals, It is possible to track deficits using monitoring systems.Managing Quality for Different BusinessesBecause every company has a different set of beliefs, goals, products and values, quality management systems are essential to reflect and embrace these differences. For example, if you know what to watch out for, you'll be more successful with your QMS strategy. The web page server provides global system control to authorize the user to use the World Wide Web. Contents afoIntroduction afoLiterature Magazine afoFlowchart afoSimulations afoAutomatic Cargo Control Using 8051 and Arduino Mega 2560 afoManual Cargo Control Using 8051 and Arduino Mega 2560 afoProject Timeline afo References 4. A. However, some companies have difficulty in due to complexity of these systems. 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